University of Rochester in New York. Mukamel notes that the work marries two long-studied areas in optics: multilayer mirrors and a property known as birefringence, whereby light moves at different speeds as it travels through a material in different directions. The offspring of the marriage is an inexpensive plastic film capable of reflecting more than 99% of the light that hits it. (A typical silver-on-glass telescope mirror reflects only 95%.)

The 3M researchers didn't set out to reinvent the mirror. They were developing a new set of mirrors to reflect polarized light out of multiple layers of plastics. Such multilayer mirrors and filters had been around for decades. They take advantage of the fact that light waves bounce off boundaries between two materials that pass light at different speeds, such as air and water. Multilayer reflectors amplify this effect by repeatedly alternating a "slow" material (one with a high refractive index) with another that has a low refractive index. Each boundary between layers reflects a fraction of the incoming light. As light waves reflect off different boundaries, their oscillating peaks and troughs can either line up and reinforce one another or cancel one another out. By controlling the thickness of each layer, researchers can determine how these light waves will interfere and thus which colors of light will be reflected.

The most common multilayer mirrors are made up of alternating layers of two inorganic materials, such as glass and titanium dioxide. Though effective, such mirrors suffer a common drawback: Their refractive index is always the same no matter at which angle the light moves through the film. One result is that certain kinds of polarized light can pass through at sharp angles, because they don't see a change in refractive index as they move through the layers. Polymers, on the other hand, are birefringent: The refractive index can change depending on which way the long, chainlike molecules are oriented in a film.

The 3M researchers wanted to see if they could use that property of birefringent plastics to reflect all kinds of polarized light. They came up with a new proprietary way to extrude sheets of hundreds of alternating layers of two or more common plastics, such as polymethylmethacrylate and polyester. They then followed the common practice of heating and stretching their polymer sheets into thin films. And when they did, they got a surprise: The resulting films not only were nearly perfect plastic mirrors, but remained almost perfect reflectors even at sharp angles.

"When we saw it, we thought something weird was going on," says report co-author Michael Weber. By controlling each layer's thickness and the orientation of the polymer molecules, they found that they could tailor their films to determine exactly which colors and polarizations of light were reflected in any direction. When they searched the literature, they were surprised to find that they were the first ones to control multilayer films in this manner. "It floored us that no one had ever noticed it before," says Weber.

People will be noticing soon. The 3M researchers have already started turning the new films into products both serious and fun. Already on its way to market, Weber says, is a way of using the films to improve the performance of displays for laptop computer and handheld organizers. Set at the back of the display, the 3M film can reflect light from an internal bulb out of the screen, thereby saving energy and battery power. Other soon-to-be-seen products include optical filters, iridescent and reflective packaging, bows and ribbons, and—who knows—off-the-rack rainbows, one size fits all.

–ROBERT F. SERVICE

CREDIT: P. BAGLA

NATIONAL IGNITION FACILITY

Richardson Puts Laser Project on Short Leash

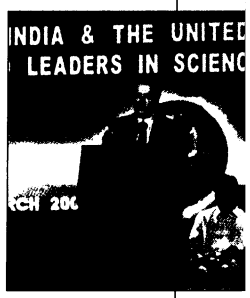
The Department of Energy (DOE) is tightening its oversight of the world's largest laser project, which is years behind schedule and at least $300 million over budget. Energy Secretary Bill Richardson last week announced a series of steps designed to put the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California back on track.

The moves aren't the final word on the troubled project, observers predict. Next month federal lawmakers are expected to receive a highly critical audit report from the General Accounting Office, its investigative arm, followed by new cost estimates from DOE that could balloon NIF's price tag. "NIF is headed for choppy seas," predicts one House aide.

The $1.2 billion NIF is designed to focus 192 laser beams on a lozenge-sized target in a bid to test the feasibility of fusion energy and simulate nuclear weapons behavior without actual testing. A host of technical glitches and management missteps have forced Livermore officials to consider scaling back the project and stretching the timeline beyond its scheduled completion in 2003 (*Science*, 17 September 1999, p. 1831). On 24 March Richardson took a series of interim steps, including the appointment of Livermore weapons scientist George Miller to a new

ScienceScope

Giving Back A group of Indian-born business leaders who have made it rich in Silicon Valley has pledged $300 million toward a $1 billion network of private research universities in their native country. Their plan to create a half-dozen Global Institutes of Science and Technology received a pat on the back last week from President Bill Clinton (right), who mentioned it during a speech to high-tech business leaders in Hyderabad.



"I have no doubt they will succeed," said Clinton about plans to set up six nonprofit institutes that would offer undergraduate and advanced degrees in biotechnology, materials science, information technology, and other hot fields to 2000 students on each campus. Officials at the University of California, Berkeley, have agreed to help design the curriculum, lend faculty, and offer distance-learning courses, although details have yet to be worked out. "The students would be exposed to the best facilities and faculties available anywhere," says Purnendu Chatterjee, managing director of the $1.2 billion software management Chatterjee Group of New York, a prime mover in the venture. He said the institutes would also serve as incubators for new high-tech companies. Site selection is expected to be completed over the next 8 to 12 months.

Rescued Legislation aimed at ending 30 years of controversy over "rescue archaeology" in France is close to becoming law. The National Assembly last month voted to approve a proposal by Culture Minister Catherine Trautman that supporters say will improve protection of artifacts threatened by development (*Science*, 14 May 1999, p. 1099). The French Senate was expected to take up the bill as *Science* went to press.

The new law—which would replace an existing agency for rescue archaeology with a new organization under the culture and research ministries and open rescue digs to researchers from universities and the basic research agency CNRS—is being greeted enthusiastically by Françoise Audouze of the Center for Archaeological Research in Nanterre. But Audouze is wary that the law does not adequately define how archaeologists will work with the new organization. Turf battles, she warns, could still hamper efforts to study and save threatened artifacts.

position leading the project, the hiring of an outside contractor to track the project, and the assignment of more DOE staff to oversight tasks. He also ordered demotions and reassignments for an unspecified number of unidentified Livermore and DOE staff. At the same time, in an apparent reaction to NIF's troubles, the University of California has denied a routine pay raise to Livermore director Bruce Tarter, singling him out from among 26 senior managers at the three DOE labs it manages.

Richardson's announcement generated a terse reply from Tarter, who said he would "work cooperatively with DOE to ensure NIF's success and funding." Richardson told the House Appropriations Committee earlier this month that his goal is to wake NIF from its "management nightmare." And although critics say NIF faces formidable technical challenges, from growing ultrapure crystals to pouring extremely fine glass, Richardson says he's "convinced that the underlying science ... remains sound." **–DAVID MALAKOFF**

GENETICS

Chipping Away at the Causes of Aging

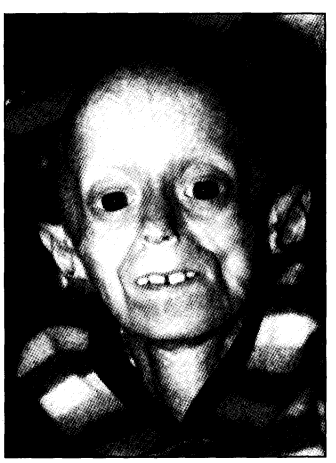
Aging is not kind. Our skin wrinkles, our hair may fall out, our bones and muscles weaken, and we become increasingly susceptible to a raft of fatal diseases. But despite ever-increasing interest as the baby boomers age—not to mention extensive research—relatively little is known about what causes this physical degeneration. Now, researchers are getting some clues from a hot new technology: DNA microarrays or chips, which enable them to perform wholesale analysis of gene expression patterns.

In one of a flurry of new studies, a team led by Richard Lerner and Peter Schultz of The Scripps Research Institute in La Jolla, California, has used microarrays to provide a snapshot of the gene changes that occur in aging fibroblasts, the cells that help form skin and connective tissue. As the researchers report on page 2486, some of the changes they found could produce such signs of old age as skin wrinkling. And they also found evidence for what may be a more global explanation of aging: an impairment of the machinery needed for normal separation of the chromosomes during cell division that could lead to genetic instability and a variety of disturbances in gene function.

"This is an extremely interesting piece of work," says aging researcher Leonard Guarente of the Massachusetts Institute of Technology. Still, he and others caution that it will be necessary to verify that the changes the Scripps group detected occur in living people and not just in the cultured cells they are working with.

The Scripps group compared gene expression in cells from healthy people of various ages and also from children with Hutchinson-Gilford progeria, a rare hereditary disorder that resembles an accelerated form of aging. In essence, microarray analysis involves putting snippets of DNA from known genes on a fingernail-sized chip and seeing which ones light up when the chip is exposed to fluorescently labeled DNA copies of the messenger RNAs from the cells under study. These are the active genes. The researchers found that the expression of just 61 genes—out of a total of some 6300 checked—changed with age. Many of these same changes also occurred in the fibroblasts from the progeria patients, a finding that indicates that these individuals, who often die in their early teens from such conditions as heart disease, are indeed experiencing an accelerated form of aging.

Although the changes the Scripps group found were intriguing, some were not surprising. For instance, several of the fibroblast genes whose expression patterns were altered are involved in forming and remodeling collagen and other proteins of the extracellular matrix, which provides support for the skin and other tissues. The researchers also observed up-regulation of genes involved in inflammation, which has been linked to a variety of the ills of old age, including heart disease and Alzheimer's. But perhaps the most intriguing change was the down-regulation of a set of some 15 genes that help control mitosis, the part of the cycle in which cells actually divide.



Aging too fast. This 10-year-old girl shows the typical features of progeria.

CREDIT: W. TED BROWN/INSTITUTE FOR BASIC RESEARCH, STATEN ISLAND

A common consequence of defects in the genes involved in mitosis is chromosome instability, a known contributor to cancer development, as it can lead to loss of genes that suppress tumor formation or activation of genes that promote it. Chromosome instability may also be a more general contributor to aging, by triggering the malfunction of genes other than those involved in cancer. From this, Lerner concludes, "aging is predominantly a disease of mismanagement of cell division checkpoints." Although other studies had pointed in that direction, the Scripps work "provides much more solid evidence for that idea, because the [microarray] screen picked up a lot of genes involved [in mitosis]," says aging researcher Judith Campisi of Lawrence Berkeley National Laboratory in California.

Still, Campisi and others would like to see the results confirmed. She notes that the Scripps team tested just 11 cell lines. Another concern is that the cells, which were obtained from commercial sources, might not be comparable in such features as the ability to divide, although Lerner says his team controlled for that possibility.

But if they're correct, the new findings would also suggest that different gene changes underlie aging in different tissues. In previous work, a team led by Richard Weindruch and Tomas Prolla of the University of Wisconsin, Madison, used microarrays to probe aging in mouse skeletal muscle (*Science*, 27 August 1999, p. 1390). Like the Scripps team, the Wisconsin team found that aging did not cause widespread alterations in gene expression.

Just 55 genes, or slightly less than 1% of those assayed, showed decreased activity in aged animals' muscles, while the activity of a comparable number went up. Many of the genes whose activities declined produce proteins needed for energy production and the synthesis of proteins, lipids, and other cell constituents—changes that could account for the muscle weakening that occurs with age. In contrast, many of the genes whose activities increased produce so-called stress proteins, which are needed to repair or eliminate damaged DNA or proteins. What's more, the Wisconsin team found that many of the changes they saw in aged animals fed a normal diet did not occur in mice on a calorie-restricted diet—a finding that provides a long-awaited explanation for how calorie restriction extends rodent life-spans.

But except for some stress-response genes, there was little overlap between the alterations the two groups saw. That suggests, Prolla says, that the fibroblasts, which are dividing cells, and the skeletal muscle cells, which have lost that ability, "probably undergo aging through two different mechanisms—a very important observation."

Whether the type of microarray studies being done by the two teams will help people live longer, or at least healthier, lives, is anyone's guess. Says Lerner: "Is the Fountain of Youth here, because of this paper? I don't think so." Still, the research is providing ideas to explore about the causes of aging—in other words, a fountain of knowledge, if not youth. **–JEAN MARX**