light, which breaks apart the PMMA and forges links between neighboring polystyrene molecules holding them in place. The result was a polystyrene matrix honeycombed with tiny tubes, which the team filled with cobalt. By changing the size of the copolymer components, "we can control the size of the cylinders [and nanowires] from 13 to 130 nanometers," Russell says.

Although the researchers have yet to test the magnetic properties of individual cobalt posts, they say the array as a whole shows promising characteristics. One is unusually high coercivity, or magnetic resistance, a trait that suggests cobalt nanowire arrays may be better than standard magnetic media at holding their magnetization when subjected to heat or other random fluctuations.

Russell notes that the team is pushing ahead with other applications as well. Silicon-filled holes may be useful as tiny electron storage devices for other types of computer memory. Cylinders lined with particular compounds may form membranes that let certain chemicals pass through while blocking others. The researchers also are teaming up with other groups to use the holes to trap large membrane proteins, the better to decipher their three-dimensional structure. If even one of these uses pans out, plastic templates with nanosized pores could have a big future. **–ROBERT F. SERVICE**

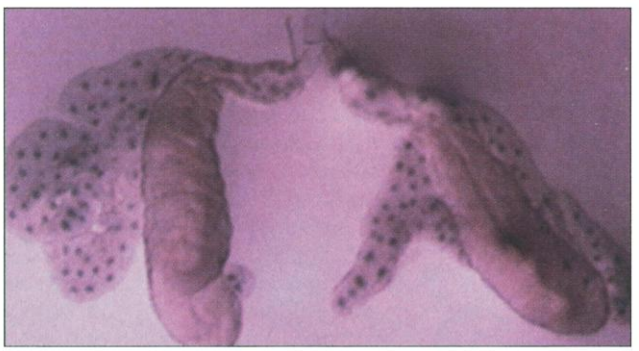
AGING RESEARCH

Old Flies May Hold Secrets of Aging

Sensible people know better than to believe in pills that promise perpetual youth or weight loss without dieting. But then Stephen Helfand isn't known for always being sensible. Seventeen years ago, he left a lucrative career as a neurologist at a prominent Boston hospital to search for aging genes in fruit flies, a task many considered hopeless at the time. Yet, as he and his colleagues at the University of Connecticut Health Center in Farmington demonstrate on page 2137, there's lots to be learned by departing from the norm.

Helfand's team has discovered a gene that, when altered, can double the average life-span of fruit flies and may one day lead to that long-awaited miracle pill. "This [gene] provides optimism that it may, indeed, be possible to manipulate active life-span beyond the constraints that ordinarily apply in natural evolution," says Seymour Benzer, the geneticist at the California Institute of Technology in Pasadena who in 1998 discovered a different fruit fly aging gene, dubbed *methuselah* (*Science*, 30 October 1998, p. 856).

Preliminary data suggest that the protein encoded by this gene, called *Indy* for "*I'm not dead yet*," transports and recycles metabolic byproducts. Helfand thinks that defects in the gene, two copies of which exist in each fruit fly, can lead to production of a protein that renders metabolism less efficient; as a result the body functions as if the fruit fly were dieting, even though its eating habits are unchanged. As such, the discovery provides a "clear genetic link between metabolism and the rate of aging," comments Tomas Prolla, a geneticist at the University of Wisconsin, Madison. The work may lead to a better understanding of how metabolism plays into aging. It may also illuminate why worms, fruit flies, and rodents, at least, live longer on a spartan diet.



Antiaging protein. Dark staining indicates that *Indy* genes are active in the fat bodies of fruit flies, the right place to alter metabolism.

Helfand came upon *Indy* by accident. In mutant strains of fruit flies produced for a different experiment, he and Connecticut's Blanka Rogina noticed that some lived longer than usual. Working with Connecticut's Robert Reenan, they first did some experiments to make sure that a mutation in *Indy* and not some other factor was indeed conferring longevity on these flies. It was. They determined that fruit flies carrying one good copy and one defective copy of *Indy* lived the longest, averaging 70 days versus the usual 37—"quite impressive extension of life-span," notes Judith Campisi, a cell and molecular biologist at Lawrence Berkeley National Laboratory in California. With two altered copies of the gene, flies live only about 20% longer than the norm.

The Connecticut team tracked down other mutant strains with defects in the *Indy* gene, culling some from their own stocks and those of colleagues. They eventually came up with five different mutant versions of *Indy*, one copy of which always made the fruit fly live much longer. They chose the name based on a quip in the movie *Monty Python and the Holy Grail*.

In each mutant, *Indy* seems to extend life-span without exacting any other costs from the fruit fly. In tests, individuals belonging to the *Indy* strains flew just as well, ate just as much, and courted each other with as much vigor as did their shorter lived counterparts. They started reproducing at the same age, laid as many eggs, and even continued to reproduce long after other flies had stopped—suggesting they retained their youthful vitality.

Indy codes for a protein that resembles a sodium dicarboxylate cotransporter, a membrane protein found in many organisms, from bacteria to mammals, including humans. In mammals, dicarboxylate cotransporters show up in cells in the digestive tract, placenta, liver, kidney, and brain, where they transport metabolic intermediates across the cell membrane. In the fruit fly, the gene "is right at the places you'd like it to be" to serve a similar function, Helfand notes: It is active in fat bodies—which function as the liver in insects—the midgut, and in cells called oenocytes, which appear to store glycogen and be involved in metabolism. "Perhaps it's altering the nutrients, either their utilization or absorption, or making intermediate metabolism slightly less efficient," he suggests. "Either way, it may be the genetic equivalent of caloric restriction."

Given these data, the *Indy* mutants could prove a gold mine to aging researchers, says Prolla, as they may help clarify antiaging mechanisms. He'd like to see what happens to the life-span of flies that have both a mutation in *Indy* and one in genes that alter the fly's ability to deal with oxidative stress, another putative cause of aging. If those flies lived even longer, "it would suggest that there are in fact many routes for intervention in the aging process," Prolla adds.

Despite their enthusiasm, aging researchers stress that much work remains. "The genetic evidence is strong, but there is some biochemistry that needs to be done to show that this really works the way they say it does," says Campisi. Researchers have not studied cotransporters extensively in humans, except those in the kidney. So exactly how they work in, say, the gut of humans or flies remains unclear. Researchers must also find out how the protein works in different mutant strains.

But Helfand is hopeful. The *Indy* protein's location and nature suggest that eventually, "it may be possible to design a drug that can extend life," he suggests. "The drug may very well work with weight control, too." And that sounds like a chance even sensible people might be willing to take. **–ELIZABETH PENNISI**

CREDIT: B. ROGINA *ET AL.*