cell can do better than a hexagon if appropriately penalized for having more than six sides or outward curves," says John Sullivan of the University of Illinois, Urbana-Champaign. Although other mathematicians, including Weaire, had discovered a penalty for the number of sides, Hales is the first to find the right penalty for the curvature of the sides and to combine both penalty terms.

Other geometers seem quite pleased with the proof. Unlike Hales's proof of the Kepler conjecture, which involved thousands of elaborate computer calculations, the proof of the honeycomb conjecture does not require a computer at all. "The overall idea just seems right," Sullivan says. "There should be an easy reason for a pattern this simple, and I think Hales has found it." **–DANA MACKENZIE**

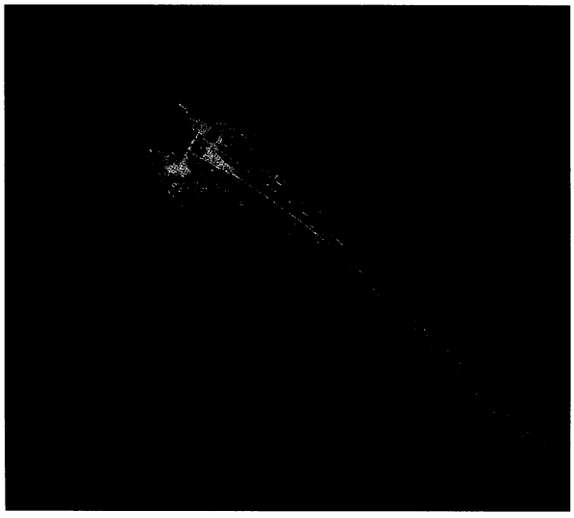
Dana Mackenzie is a writer in Santa Cruz, California.

DEVELOPMENTAL BIOLOGY

Selenium's Role in Infertility Explained

Many proteins lead multiple lives, depending on environmental conditions or on the presence of particular partners. It's rare, however, for a protein to change its stripes completely, acting as a soluble enzyme under some circumstances and an insoluble structural component under others. But that's what new research suggests for a particular selenium-containing protein of sperm—a discovery that may help explain the long-standing mystery of why selenium deficiency in lab and domestic animals leads to male sterility.

On page 1393, biochemists Leopold Flohé of the Technical University of Braunschweig in Germany, Fulvio Ursini of the University of Padova in Italy, and their colleagues report that the protein, previously identified as an enzyme that helps rid developing sperm of dangerous reactive oxygen molecules, moonlights as part of the glue that holds together mature sperm. "This is a new function for a selenoprotein—to form a structure, not just to carry out a reaction," says Raymond Burk, a selenium expert at Vanderbilt University in Nashville, Tennessee.



CREDIT: (LEFT TO RIGHT) TONY BRAIN/PHOTO RESEARCHERS; CHUN *ET AL.*, *NATURE NEUROSCIENCE* 2, 844 (1999)

Sperm aid. A selenoprotein known as PHGPx may help keep normal sperm, such as this one, from breaking apart.

Although selenium deficiency is rarely a problem for humans, who get the element from common foods such as seafood, liver, lean red meat, and grains grown in soil that is rich in selenium, scientists showed decades ago that animals fed selenium-deficient diets produce sperm that break in the middle and can therefore no longer fertilize eggs. Beyond demonstrating that selenium is concentrated in the midpiece, the region between the head and tail, of normal sperm, scientists made little headway in explaining this effect. Several years ago, they thought they had an answer: The selenium deficiency might be interfering with another protein they had identified in the mitochondrial capsule, a structure that holds the energy-producing mitochondria in the sperm midpiece.

But that idea dropped out when sequence analysis of the corresponding gene revealed that in some perfectly normal animals it doesn't encode the amino acid that carries selenium—evidence that the element isn't required for the protein's function. "There's been a question of whether there is such a thing as a real structural selenoprotein in sperm," says Thressa Stadtman, a selenium biochemist at the National Heart, Lung, and Blood Institute in Bethesda, Maryland.

Flohé and his colleagues have now shown that there likely is, by studying a known selenoprotein called phospholipid hydroperoxide glutathione peroxidase (PHGPx). The enzyme, which likely protects the developing sperm cell against damage by converting toxic peroxides to harmless alcohols, climbs to extremely high levels in testes. Because the levels are much higher than would be expected for protection against the amounts of peroxides probably present in that tissue, Flohé describes the situation as "kind of strange." About 2 years ago, however, his team's work began pointing to a structural role for the protein. Their analysis of the mitochondrial capsule showed that PHGPx is its most abundant component, accounting for about 50% of the capsule material.

But even though it constitutes such a large proportion of the capsule, tests revealed that the protein from mature sperm had lost its enzymatic activity, apparently because the protein molecules had become linked together in an inactive form. Based on these findings, the researchers propose that PHGPx acts as a soluble enzyme early in sperm development and later polymerizes into a protein mesh that contributes to the structural integrity of the midpiece. If so, says Burk, "this [work] may explain the head-to-tail separation seen in sperm of selenium-deficient animals."

In addition, the result opens the door to a better understanding of the mechanisms underlying normal sperm development, presumably in humans as well as in animals, say experts. Currently, Stadtman notes, the triggers for the switch from active enzyme to inactive structural protein are not known. "The next step is to work out the signals that tell the sperm to undergo this developmental change," she says. Indeed, as anyone who has juggled identities knows, timing is one key to success. **–EVELYN STRAUSS**

NEUROBIOLOGY

New Role Found for The Hippocampus

When you remember a friend, your first day of work, or your address, you're fully aware of what you're remembering. But memory has another guise: nonconscious skills like riding a bicycle or knowing how to tie your shoes. Subjectively, the two kinds of memory seem very different, and the brain structures responsible for them are different as well. Results reported in this month's issue of *Nature Neuroscience* suggest, however, that the hippocampus, a twist of tissue deep in the brain long believed to help form only conscious memories, also serves certain memories that don't rise to the level of awareness.

T is for target. Without a healthy hippocampus, subjects couldn't learn from seeing the same complex pattern twice.

The report comes from psychologists Marvin Chun of Vanderbilt University in Nashville, Tennessee, and Elizabeth Phelps of New York University. Chun and Phelps compared how normal people and those with anterograde amnesia, a memory defect caused by damage to the hippocampus, respond to certain complex patterns. They found that the normal subjects, but not the amnesiacs, could learn to remember repeated patterns they weren't consciously aware of. "What they've con-

tributed," says neuroscientist Larry Squire of the University of California, San Diego, "is probably the first demonstration that the hippocampal system can be dissociated from conscious awareness."

The finding bolsters an emerging theory that the role of the hippocampus in memory is to relate different elements of experience —a role that is suggested by the fact that it receives information from many other brain regions. "Anatomically, the hippocampus is a big convergence zone," says Squire. The hippocampus and interconnected neural structures register and temporarily hold new information, he says, binding the various elements—place, odors, sounds, people —that constitute a remembered episode. By showing that the hippocampus binds the spatial relations of a dozen objects, but without awareness, this study suggests, says Squire, "that relational work may be more fundamental to the work of the hippocampus than awareness."

Indeed, the growing evidence that the hippocampus is involved in tying together the various aspects of memory was one of the inspirations for Chun and Phelps's study, which they began while they were both still at Yale University. Like much other research on human memory, their work relies on studying patients with severe anterograde amnesia. Because of hippocampal damage, say from stroke or a brain infection such as encephalitis, such people can remember their distant pasts but cannot create new memories. However, they can learn new skills and habits. With repeated practice, for example, an amnesic patient could learn to trace a complex pattern while looking at his or her hand in a mirror, but never remember seeing the pattern before. Such findings had persuaded researchers that the hippocampus is needed for forming conscious memories but not for learning unconscious skills, so what Chun and Phelps found came as something of a surprise.

For their study, they chose a mental skill. The task was to pick a sideways letter T out of a field of 11 Ls and push a button to indicate which way the T was tilting. Over the course of 240 trials, the 15 control subjects and four amnesic patients got faster at finding the target T.

Half of the patterns were generated randomly and were unique. But unbeknownst to the subjects, the other half were repeated over and over again throughout the course of the experiment. None of the subjects noticed the repetition, and no one could pick out the repeated patterns at the end of the experiment. Even so, as the experiment proceeded, the control subjects responded faster to these repeated patterns than they did to newly created ones. The amnesia patients, however, responded to the old forms only as fast as they responded to new.

The work shows that even though people with damage to the hippocampus can learn simple patterns and skills, this brain structure is crucial to unconscious recognition of more complex patterns. Some theorists think the hippocampus's role in relating different elements of an experience may explain its role in conscious memory as well. Neuroscientist Howard Eichenbaum of Boston University says that awareness might emerge as the hippocampus ties together the interconnected properties of an experience. Alternatively, he says, conscious awareness might be just one element of an experience, stored with all the other information we register about an event. **–LAURA HELMUTH**

CHINA

Academy Seeks to Tap University Elites

BEIJING—Scrambling to retain its dominant position in the country's research establishment, the Chinese Academy of Sciences (CAS) is offering its first-ever university scholarships to both undergraduate and graduate students at 20 leading universities. The just-announced scholarships, for the upcoming school year, are seen as a recruitment tool for the academy's shrinking network of research institutes as well as a way to forge closer ties to the increasingly important university system. The academy intends to offer positions to every scholarship winner who wishes to join a CAS institute after graduation.

CAS's 122 institutes, traditionally set off from the rest of the scientific community, once ruled the roost, attracting the best young talent by offering better working conditions, newer facilities, and greater prestige than most universities and other research institutions. But times have changed. Academy officials are in the midst of closing at least a third of those institutes and cutting even deeper into the workforce, even as they strive to raise overall research quality by consolidating programs and improving conditions for an elite core of researchers (*Science*, 8 January, p. 150).

At the same time, China is beefing up its top universities, several of which offer scholarships funded by private companies, in an attempt to foster world-class science as well as entrepreneurship. The new academy scholarships are an effort to link those two trends. "It will further close the gap between the two institutions that existed under the old system by integrating the innovation, processing, dissemination, and application of knowledge," says Min Weifang, executive vice president of Beijing University, one of the 20 schools (see table) participating in the new program.

The academy will provide up to 20 scholarships at each school, with 10 slots for undergraduates and five each for master's- and doctoral-level students. Graduate scholarship winners will also be able to participate in the research and educational programs run by individual CAS institutes, which currently enroll more than 11,000 students. The universities were chosen based on their excellent reputations both domestically and abroad, says Li Hongwei, an official with CAS's graduate education section. "We are badly in need of talented students to replace an ever-increasing brain drain," says Li. The schools themselves will choose which students will get the awards. The university agreements, which represent an annual commitment of $85,000, run through 2001 and are seen as a "trial run," says Sun Dianyi, a CAS press officer. "If we see that the efforts are really paying off, the investment is sure to increase, with more money for more universities."

–LIN GU

Lin Gu writes for *China Features* in Beijing.

AN ELITE PARTNERSHIP

CAS plans to award scholarships to science and engineering students at the following universities:

Beijing University
Beijing University of Science and Engineering
Central China Univ. of Science and Engineering
China Geological University
China University of Science and Technology
Dalian Engineering University
Fudan University
Harbin Polytechnical University
Jilin University
Lanzhou University
Nankai University
Nanjing University
Northeast China University
Sichuan University
Shandong University
Shanghai Jiaotong University
Tsinghua University
Wuhan University
Xian Jiaotong University
Zhejiang University