Barres and then-postdoc Frank Pfrieger reported in *Science* that the synapses of neurons grown with astrocytes in the cell culture were 10 times as active as those of neurons grown alone. They suspected that the glia somehow either turned up the volume on the neuron transmitting the signal or increased the sensitivity of the neuron receiving it. No one expected to find that glia controlled the number of synapses, says Barres—although, as neurobiologist Charles Stevens of the Salk Institute for Biological Studies in La Jolla, California, points out, the result makes a lot of sense. "Once you know it's true," Stevens says, "you believe it instantly."

Postdoc Erik Ullian and others in Barres's lab set out to pin down astrocytes' power over synapses by performing dozens of experiments on retinal ganglion cells. Unlike other types of neurons, these cells can be raised on a diet of growth factors and other nutrients and don't require glia for survival. In study after study, these neurons grown with glia nearby—even if the glia didn't touch the neurons—were seven times more responsive to various kinds of stimulation than were those unexposed to glia.

The reason for this improved communication became apparent when the researchers stained various proteins that neurons use to build synapses. Although both types of neurons contained plenty of these proteins, the glia-exposed neurons clustered the proteins into seven times as many synapses as did the isolated neurons. The team confirmed this count by tallying synapses under the microscope. Synapses looked just the same on both types of neurons—their sizes, shapes, and numbers of neurotransmitter-containing vacuoles didn't differ—but the synapses were seven times as numerous in the presence of glia.

"Every time we used a new technique, we saw the same sevenfold increase," says Barres. "Eventually, we had to believe it." And the glia aren't just telling neurons to build synapses, the researchers report. They're also helping neurons maintain the synapses they've established. If glia are removed, the study shows, neurons start to shed synapses within a few days.

These cell culture findings fit nicely into the picture of how neurons develop in vivo, says Ullian. Neurons send out dendrites and axons to the appropriate parts of the brain very early in development, but they don't form most of their synapses with other neurons until many days later—at the same time that astrocytes mature.

The team hasn't identified the signal astrocytes send that triggers synapse formation. Once they do, says Stevens, that signal might help decode how neurons register memory. Researchers are convinced that learning forges stronger connections between neurons. Two main theories of how this happens are now being debated, Stevens says: When neurons form a new memory, they might build more synapses with their companions, or they might strengthen existing synapses. Possibly, Stevens says, whatever glial message is at work in this study might also signal neurons to solidify memories.

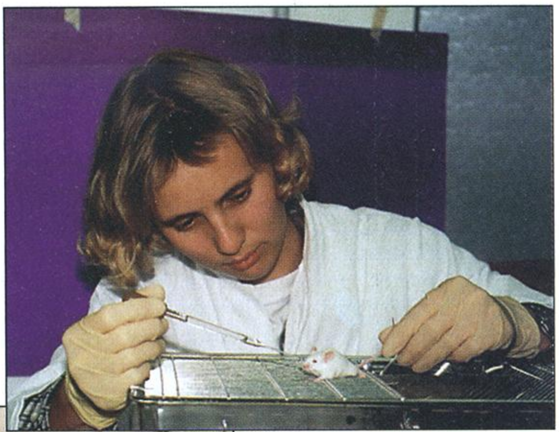
–LAURA HELMUTH

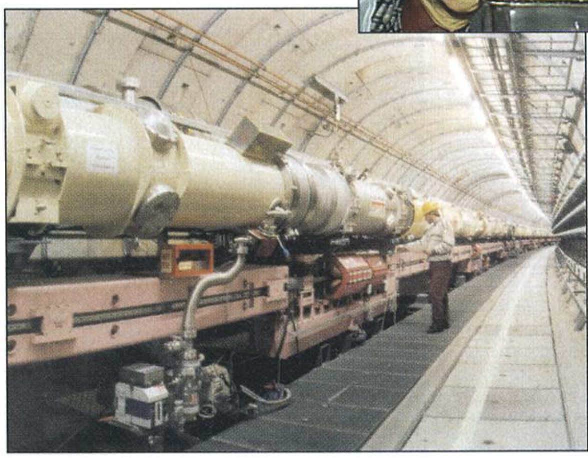
GERMANY

National Centers Urged To Team Up, Compete

FRANKFURT—Germany's 16 national research centers—a sprawling, $2-billion-a-year array of labs ranging from the DESY synchrotron in Hamburg to the Max Delbrück Center for Molecular Medicine in Berlin—are too insular, according to a new report from the nation's top scientific evaluative body. It urges the government to foster cooperation—as well as healthy competition—among the centers and between them and outside labs by following a U.S.-style funding model that emphasizes research programs that cut across many institutions rather than block grants to individual facilities.

The latest evaluation, released Monday by the Science Council, adds the final piece of a comprehensive review of the entire German research system. Done by a 14-member panel of German and international experts, the new study finds that the research centers and their governing organization—the Helmholtz Association—suffer from inadequate networking and "too few incentives for competition." It also recommends that the centers broaden their research agendas and bolster ties with university researchers.





Centers of attention. A new report says greater collaboration, from particle physics to biotechnology, is key to better research at Germany's 16 Helmholtz centers.

Helmholtz's 9300 scientists constitute Germany's biggest scientific workforce outside the university system. The nation's federal and state research ministries spend about $1.5 billion a year on the centers, with grants from other German and European research agencies and industry adding another $500 million. Helmholtz's president—Detlev Ganten, who heads the Max Delbrück Center—says the association has already been moving in the direction of more center-spanning research and is conducting "intensive negotiations" with federal and state research ministries over how to manage a revised funding system. He says that the centers already pool 5% of their budgets for competitive grants in six strategic areas.

Ganten warns that the suggested changes would require more predictable budgeting. (The centers have received relatively small increases in recent years and are still awaiting their budget for this year.) "For long-term research programs, we need longer term budgeting and more flexibility," he says. "We don't want politically 'guided' research. We want absolute academic freedom within the categories of research that are agreed upon."

One significant reform already under way involves the GBF biotechnology center in Braunschweig. Its new director, mouse-mutant researcher Rudi Balling, is shifting the center's focus from 1980s-era biotech projects such as bacterial fermentation to studies on the genetic basis of infectious diseases. GBF is also planning to work more closely with other biomedical research centers, including Max Delbrück, Heidelberg's DKFZ cancer research center, and Munich's GSF environmental health research center. "National research institutes can't be islands or ivory towers," says Balling. "They have to become more competitive and more useful for other German researchers."

CREDITS: (TOP TO BOTTOM) GBF; DESY-HAMBURG

National research centers in the physical sciences—such as the GSI heavy-ion research group in Darmstadt and the DESY particle physics center in Hamburg—say their equipment is already being used extensively by scientists at universities and other German research institutions. GSI's scientific director, physicist Walter F. Henning, says that about 900 of the 1000 users of the heavy-ion accelerator come from outside the center, mainly from European universities.

Although Henning thinks that program-oriented financing is a good idea, he worries that Germany may not have enough experts on the federal payroll to make the system work. "Program-oriented research is the way to go," Henning says, "but administering it effectively requires a structure that doesn't yet exist in Germany." —ROBERT KOENIG

PLANT BIOLOGY

Xylem May Direct Water Where It's Needed

If plants are nature's architecture, the xylem is a lowly piece of plumbing. For decades, researchers have seen the xylem as a column of dead tissue, like a worn pipe, that sits inside plant stems passively supplying water to thirsty leaves. But a surprising new study suggests that the xylem is far more active than scientists have suspected.

In a paper published online today by *Science* (www.sciencexpress.org), Harvard University plant biologist N. Michele Holbrook, with postdocs Maciej Zwieniecki and Peter Melcher, reports that gels in key xylem membranes constantly shrink and swell. With this motion, the xylem actually adjusts the flow of mineral-rich water coursing toward leaves. "Researchers assume the xylem is a bunch of inert tubes, but it's not," remarks Holbrook. "It's actually a very sophisticated system for solving a plant's water-flow problems."

"This is the first good evidence I know of that the xylem regulates water transport in plants," says John Boyer, a plant biologist at the University of Delaware, Lewes. Bioengineer William Pickard of Washington University in St. Louis adds: "This idea just came out of nowhere, and it's an excellent paper."

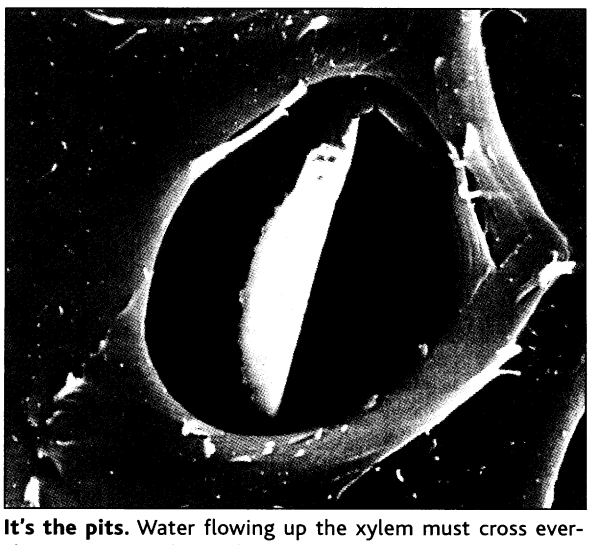
The xylem evolved millions of years ago, helping some primitive plants develop into higher vascular varieties—including angiosperms and conifers—that can survive on dry land. For much of the 20th century, researchers assumed the xylem had just two modes: on and off, or working and broken. More recently, they realized that the xylem frequently repairs breaks in its water column.

Last year, while researching xylem repair, the Holbrook team stumbled across the inspiration for their new study: a 1978 paper by Harvard biologist Martin Zimmerman. In that paper, Zimmerman's team noted that when they pumped tap water—full of everyday salts—into the xylem, it flowed much faster than deionized water. But why? The paper left the question open.

Maybe, Holbrook's group reasoned, the added salts somehow alter the xylem. To test that idea, the team cut segments of stems from laurel (*Laurus nobilis*). They tied a stem's downstream end to a tube that emptied into a cylindrical balance, measured over time. Then they fixed the upstream end to a small, pressurized tank. Using this setup, the researchers pumped water through the stem, steadily increasing the amount of potassium chloride (KCl). Sure enough, by the time the KCl concentration had increased from 0 to 50 mM, the water was flowing up to 2.5 times more quickly. Repeating the experiment with the salts NaCl, KNO_3, and $CaCl_2$, they found similar jumps in water flow.

What's more, the fast flow rates held when the researchers tested these solutions on 18 other angiosperms, five conifers, and three ferns. By contrast, when the team tried deionized water, the xylem's flow rate dropped considerably. Finally, they documented the same phenomenon in vivo, monitoring xylem uptake of salty versus deionized water in the split stem of a tobacco plant. "These changes were clearly due to some mechanical property of the xylem and the way it conducts water," Zwieniecki says.

Here they had a hint from industry: Engineers have shown that hydrogels, jellylike substances that can shrink and expand, influ-



It's the pits. Water flowing up the xylem must cross ever-changing pit membranes like this one to reach thirsty leaves.

CREDIT: M. ZWIENIECKI *ET AL.*

ScienceScope

Off the Hook ... Last week's transfer of U.S. presidential power brought good news for MIT chemistry professor John Deutch, former director of the CIA. Deutch was in the middle of negotiating a plea agreement with the Justice Department over his mishandling of classified data while at the CIA when Bill Clinton awarded him a last-minute presidential pardon. Deutch was stripped of his security clearances last August and was expected to plead guilty to a misdemeanor charge of keeping classified files on his home computer.

... And Staying On Meanwhile, NASA Administrator Daniel Goldin received another kind of reprieve: The new Bush White House accepted his offer to stay on as agency chief for a few more months until a permanent replacement is named. The list of possible successors to Goldin, who was appointed by Bush père, includes former astronaut and Senator Harrison Schmitt and Air Force General Pete Worden. And Charles Groat, director of the U.S. Geological Survey, has been spared the ax. "I very much wanted to continue and made that desire known," he said in a 22 January staff memo announcing his continued employment.

Animal Defense The United Kingdom wants to protect an ailing drug firm from animal-rights protesters. Last week the government pledged to help Huntingdon Life Sciences (HLS), Europe's largest center for animal experiments, with legislation banning protests outside employees' homes. The government may also outlaw mail threats.

For several years, employees of the Cambridgeshire firm have endured violent attacks and other abuse from protesters. Adding to the HLS's woes, activists recently claimed credit for triggering a financial crisis after pressuring a major financial backer to withdraw loans. To help out, U.K. Home Secretary Jack Straw plans to amend the Police and Criminal Justice Bill to clamp down on violent protest and spend $1.45 million to beef up security for HLS staff. U.S. financiers also stepped in to provide new financing.

Many scientists are glad that the government is acting but would like to see it do more. "These half-measures will do little or nothing to prevent the harassment," predicts Mark Matfield of the Research Defense Society, which represents scientists who experiment on animals. Protesters have vowed to continue their campaign.

Contributors: Gretchen Vogel, Wayne Kondro, Andrew Lawler, John Pickrell