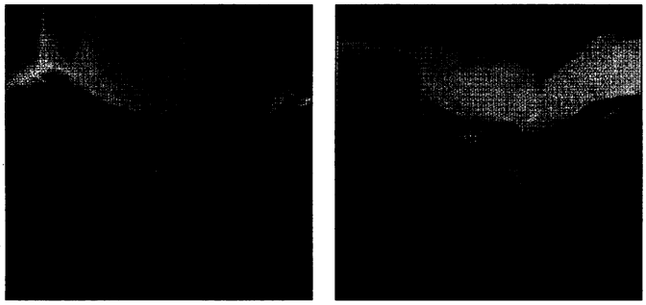
NEUROSCIENCE

Learning Visualized, On the Double

Researchers have long believed that when the brain learns, the synapses, the connections between neurons, get stronger. For years, neuroscientists focused on chemical changes that boost synapse strength, but more recent work suggests that synapses change structurally, too. Now, in this week's issue of *Nature*, a team led by neuroscientist Dominique Muller of the University of Geneva in Switzerland reveals one dramatic change: Some strengthened synapses actually double, with a second synapse quickly forming right next to the one that was active.



Doubling up. These synapse reconstructions, which are based on electron microscope images, show just one spine (white) contacting a presynaptic neuron (red) before LTP occurs (left). Afterward (right), there are two spines.

The Geneva team first stimulated rat brain slices to produce a form of synapse strengthening called long-term potentiation (LTP), which may mimic some events in learning. Then, with an electron microscope (EM), they looked at synapses where LTP had occurred. Researchers had tried to see physical changes at the strengthened synapses before, but those synapses were hard to find because they are only a small percentage of the total. To get around that problem, the Geneva group took advantage of a synaptic change known to happen during LTP.

When the presynaptic neuron fires, it releases neurotransmitter molecules, which cross the synaptic gap and are picked up by a structure sticking out from the receiving neuron, called a spine. If the receiving neuron has already been activated in a way that primes it for LTP, the arrival of the neurotransmitter triggers LTP by causing calcium ions to flood into the spine. Muller's team treated the brain slices with a chemical that precipitates calcium, forming deposits that can be seen in the EM and serve as tags for spines that had undergone LTP.

Team member Nicolas Toni found that when he looked at electron micrographs made an hour after inducing LTP, 20% of the tagged synapses had double spines, both contacting the same presynaptic neuron, a configuration that he very rarely saw in synapses that hadn't undergone LTP. The authors conclude that LTP triggers "a duplication of the active synapse," presumably strengthening it, says Muller.

Neuroscientist Tobias Bonhoeffer of the Max Planck Institute for Neurobiology in Munich, Germany, calls the work a "nice addition" to the growing story of how synapses reshape when they strengthen. It complements findings earlier this year by his team and one led by Roberto Malinow and Karel Svoboda at Cold Spring Harbor Laboratory on Long Island. Using a technique called two-photon microscopy, those teams watched synapses in living tissue. Within an hour after inducing LTP, the researchers saw what looked like new spines popping out of neurons near the strengthened synapses.

"The question that was totally unresolved" in that work, says Bonhoeffer, was whether the new spines form synapses with the presynaptic neurons. If the double spines captured by Muller's group in EM images represent those new spines, Bonhoeffer says, the answer to that question would be yes.

–MARCIA BARINAGA

NUCLEAR PHYSICS

DOE Gives Up on Brookhaven Reactor

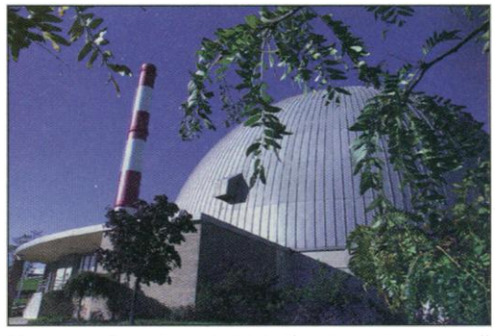
Researchers lost a major tool for probing the structure of matter last week when Energy Secretary Bill Richardson announced that he will permanently close the mothballed High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory in Upton, New York. The surprise move stunned both opponents and supporters of the facility, who were preparing for a battle over the safety of restarting the controversial reactor.

The HFBR, opened in 1965, is a 60-megawatt nuclear reactor that provides scientists with neutron beams. Researchers use the particle streams to probe the atomic structures of everything from metals to tissues and to produce radioactive isotopes for use in medicine and in biomedical studies. The reactor has been on indefinite standby since January 1997, when workers discovered that radioactive tritium gas had leaked from the reactor into nearby groundwater (*Science*, 5 September 1997, p. 1431). The revelation ignited local opposition to restarting the reactor and prompted the Department of Energy (DOE) to replace the lab's management. The agency also announced that it would undertake a full-scale review of the reactor's potential threat to public health and the environment.

A first draft of that review was due to be released next month. But Richardson short-circuited the process by announcing that a lack of support in Congress for restarting the reactor and his view that the funds could be better spent elsewhere led to the decision. "While I don't believe the Brookhaven reactor is a threat to the public or the environment, we need to focus our limited resources on productive research," Richardson said in a 16 November statement. DOE officials estimate that the agency has spent $23 million per year keeping the HFBR on standby, but declined to estimate how much it will cost to decommission and dismantle the reactor. Brookhaven officials earlier had estimated closing costs at nearly $200 million.

While environmentalists praised the decision, researchers mourned their loss. "The cost to national science effectiveness is likely to be far greater" than the cost of restarting the reactor, said Brookhaven director John Marburger in a statement decrying the HFBR's "untimely demise." Richardson "pulled the rug out from under us—we weren't given a fighting chance," added Brookhaven physicist Steve Shapiro, who noted that close to 300 scientists used the reactor the year before it was shut down. Now, he says, they will have to fight for time at two other facilities—one at Oak Ridge National Laboratory in Tennessee, the other in Grenoble, France—that produce neutron beams of similar energies. Both "run 24 hours a day, 7 days a week, and they still are oversubscribed," he says.

DOE officials hope to relieve the overcrowding with upgrades to several other neutron sources and the completion of Oak Ridge's new Spallation Neutron Source in 2005. Those sources, they note, may benefit from equipment scavenged from Brookhaven's abandoned reactor.



No entry. Brookhaven's High Flux Beam Reactor will be closed permanently in a cost-saving move.

–DAVID MALAKOFF

CREDITS (TOP TO BOTTOM): TONI *ET AL.*, *NATURE* **402** (25 NOV 1999); BROOKHAVEN NATIONAL LABORATORY