of the FET, the flowing charges can be either electrons or holes.

The researchers placed the FETs above and below the tetracene crystal. The bottom FET was designed to flood its channel with electrons, while the top FET sent holes. The team then applied a voltage between the two FETs, which drew the flood of positive and negative charges into the tetracene, where they produced a burst of photons that triggered the lasing process. The scheme worked to perfection, generating a yellowish-green laser pulse. This novel use of FETs "is an important concept, because it allows them to control the charge injection, which is the key to getting this to work as a laser," Yang says.

Despite the organic laser's success, it may be a while before organics take over that $500 million market. Growing high-purity organic crystals requires manufacturing processes nearly as exacting as those used to grow conventional ceramic chips. And researchers must also learn how to mass-produce lasers with transistors positioned above and below. Still, Batlogg notes that researchers should easily be able to change the tetracene to other organics to produce a whole range of different colors of laser light. That should give lasermakers something to beam about.

–ROBERT F. SERVICE

NEUROSCIENCE

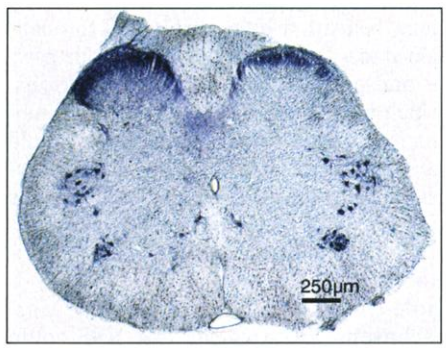
Early Insult Rewires Pain Circuits

For many years, physicians rarely anesthetized infants or gave them pain-killing medication. They worried that such treatments could interfere with breathing—and they downplayed babies' ability to perceive pain. That's changed in the past 15 years, partly thanks to studies showing that infants respond physiologically and hormonally to pain. A new animal study should amplify the call to manage pain more aggressively in newborn humans: Pain experienced by the youngest infants, the study suggests, could have the longest lasting effects.

On page 628, neuroscientist M. A. Ruda of the National Institute of Dental and Craniofacial Research (NIDCR) at the National Institutes of Health (NIH) and her colleagues report that painful stimuli delivered to rats shortly after birth permanently rewire the spinal cord circuits that respond to pain. Not only do the circuits contain more axons, but the axons extend to more areas of the spinal cord than they normally would.

Researchers knew that pain circuits are somewhat malleable in adult animals, but the Ruda team's study shows that "injury to the neonate or fetus can produce changes that are in some way different than [those] in adults," says neuroscientist Clifford Woolf of Massachusetts General Hospital and Harvard Medical School in Boston. What's more, the NIDCR workers have preliminary evidence that these wiring changes make the animals more sensitive to pain later in life.

Pain pathways start with sensory neurons in the skin, link to the dorsal horn of the spinal cord, and from there climb to the thalamus and cortex in the brain. To see how painful stimuli affect the spinal portion of these pathways, Ruda and her colleagues injected one hind paw of newborn rat pups with an inflammatory agent that causes the paw to swell and turn red for several days—"kind of like gout" in humans, Ruda explains.



Hardwired. Early pain fosters the development of pain-sensitive axons, as indicated by the darker stain at the top left of this spinal cord.

Some 8 to 12 weeks later, the researchers sacrificed the adult rats and stained their spinal cords with a dye that seeks out pain-sensitive axons. They found about 25% more stained axons in the side of the spinal cord corresponding to the paw that had been inflamed weeks earlier. In addition, the sciatic nerve, which delivers input from the hind limb, projected to six segments of the spinal cord on the treated side, compared to just four on the other side. "You can really see spreading and invasion of these fibers into new areas of the cord," says molecular neurobiologist David Julius of the University of California, San Francisco.

Pain changed neuroanatomy only when induced during a distinct developmental window. If the pups were given the noxious injection just after birth or on day 1 or day 3, more neurons became devoted to processing pain. If the researchers waited until day 14, however, they found no neuroanatomical changes. In terms of neurological milestones, day 0 in a rat pup corresponds to about 24 weeks of gestation in a human infant, says Ruda. This suggests that at a very early age, particularly in premature infants, "what's happening could impact the ultimate wiring of the brain."

Ruda doesn't know precisely how the stimuli strengthen pain circuits. The extra neural activity could save neurons that

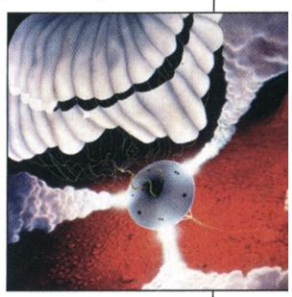
CREDITS: (LEFT TO RIGHT) M. A. RUDA *ET AL.*; NASA

ScienceScope

Martian Gamble NASA and the White House are locked in a quiet but intense struggle over the future scale of Mars exploration. NASA space science chief Ed Weiler this week intended to announce plans to send a single lander to Mars in 2003, rather than a single orbiter, in the wake of two mission failures in the past year (*Science*, 10 March, p. 1722). But NASA abruptly canceled the 24 July press conference after senior officials insisted on considering sending two landers, according to Administration officials. Agency managers and Mars researchers argue that sending two spacecraft will reduce risk. "There were two Viking landers and orbiters," says one scientist. "When it really matters, double up."

But doubling up means a heftier price tag, and the White House is loath to ask Congress for more Mars money in 2001 and future years. "It's big bucks," says one Administration manager. The White House may still approve two landers—but on the condition that NASA cut current programs to pay for an expanded Mars effort. That would be bitter medicine for an overall space science effort already strapped for cash.

NASA chiefs must move quickly. The larger program would require more planning, and NASA had already set a 1 August decision deadline to ensure that it could meet the 2003 launch date. Yet NASA won't know its 2001 budget—which is still stalled in Congress—until fall, while the 2002 budget request won't be released until next year. So if the agency wants two landers, it may have to gamble that there will be money to do it. Says one Administration manager: "We're playing a high-stakes game."



Into the Finals California Governor Gray Davis last week named the six academic teams that are still in the running for $300 million in state funds to set up new research institutes, along with a five-member panel that will pick the three winners this fall (*Science*, 26 May, p. 1311). The judges, led by Scripps Research Institute president Richard Lerner, will choose among multi-institution teams proposing new centers focusing on systems biology, agricultural genomics, information technology, nanosystems, biomedicine, and the social impacts of information systems. Eleven teams had entered the competition.

would otherwise die, or it could encourage new connections between neurons. But in either case, rats that endured traumatic early days are somewhat more sensitive to pain as adults. Some animals that had experienced the painful injection as pups were injected again as adults. Compared to rats that were injected for the first time as adults, the previously treated ones pulled their paw away from a hot floor faster. Their spinal cord neurons also fired more rapidly in response to a tail pinch in the treated adult rats.

As for how this study relates to human newborns, Charles Berde, a professor of pediatrics and anesthesiology at Harvard Medical School, says the rat pup is a "useful model," even though a few days in a rat's life correspond to months of development in a newborn human. Animal research that shows early pain causes hardwired changes might help convince skeptics of the importance of managing pain in newborns, says Berde.

Kanwaljeet Anand of the Arkansas Children's Hospital in Little Rock, a pediatrician and neuroscientist whose surveys show that babies in intensive care aren't always getting the analgesics they need, agrees. "What we need now," says Anand, "is an NIH[-sponsored] consensus panel to provide evidence-based guidelines and help standardize the way premature and full-term babies receive analgesic management." This sort of research, he says, should help dictate those standards.

–LAURA HELMUTH

OCEAN SCIENCE

Academy Panel Backs Sea-Floor Observatories

The National Academy of Sciences wants marine scientists to go deep. An expert panel last week strongly endorsed a network of remotely operated sea-floor observatories to monitor everything from water chemistry to bacteria. The backing may help ocean researchers win a boost in next year's budget proposal now being crafted by the outgoing Clinton Administration.

The new report* is in response to a request last year by the National Science Foundation (NSF), which asked whether submerged stations packed with sensors—an approach promoted by some marine scientists—are technically feasible and scientifically desirable. The eight-member panel, led by seabed mapper William Ryan of Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, answered "yes" on both counts. "Sea-floor observatories present a promising, and in some cases essential, new approach for advancing basic research in the oceans," it concluded.

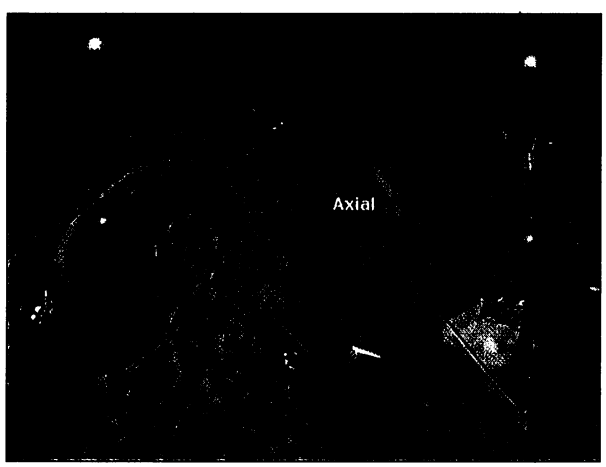
The panel urged NSF to get on with plans for long-term monitoring stations hung beneath a buoy or hitched to abandoned sea-floor cables that can provide power and communications. Such stations, which might be assisted by automated submarines that scan surrounding seas, would augment traditional short-duration, ship-based expeditions and help researchers get a clearer picture of long-term changes in marine environments, says panel vice chair Robert Detrick, a geophysicist at the Woods Hole Oceanographic Institution in Massachusetts. He suggests that NSF could phase in the new program by field testing new sensors and power supplies at a few sites, such as the University of Washington's planned NEPTUNE system that would wire sensors to 3000 kilometers of fiber-optic cable in the northeastern Pacific (see below).

Expanding such test-beds into a "comprehensive" network of deep and shallow water bases would be expensive, however. The panel estimated that it would cost several hundred million dollars to build and tens of millions a year to operate. NSF's budget couldn't accommodate that "extremely ambitious vision" immediately, says NSF's Mike Purdy, head of ocean sciences. But advocates are hoping that NSF will propose spending up to $30 million in start-up funds as part of its 2002 budget request, to be submitted this fall.

Some recent high-profile interest in marine research may help their cause. On 28 June President Bill Clinton suggested that Congress consider "shifting another few hundred million dollars to explore the deepest depths." The speech came a few weeks after Marcia McNutt of the Monterey Bay Aquarium Research Institute in Moss Landing, California, bent his ear on the topic during a White House "millennium" event. And last week, the leaders of a new Congressional Oceans Caucus, including Representatives Tom Allen (D–ME) and James Greenwood (R–PA), told a sea science conference that they will work to strengthen the field next year.

Another endorsement could come this fall, when the Commerce Department's National Oceans Service is due to deliver a White House–ordered wish list for federal oceans research. Some scientists are pulling for sea-floor research to float to the top of the list.

–DAVID MALAKOFF



CREDIT: NEPTUNE/UNIVERSITY OF WASHINGTON

NEPTUNE's realm. Ocean studies would benefit from automated sea-floor observatories like this proposed Pacific Ocean system.

* *Illuminating the Hidden Planet*: The Future of Seafloor Observatory Science, National Research Council.

DEVELOPMENTAL BIOLOGY

Embryonic Lens Prompts Eye Development

A blind cave fish is providing new insight into how eyes come to be. In work reported on page 631, developmental biologists Yoshiyuki Yamamoto and William Jeffery of the University of Maryland, College Park, show that the lens plays a leading role in eye development in this fish. If it doesn't form properly, the researchers found, the embryo will not go on to make the cornea and other eye structures.

During the 1960s, work in Russia and Spain had suggested such a role for the lens, but this new study "nails it," says Peter Mathers, a developmental biologist at West Virginia University School of Medicine in Morgantown. What's more, he adds, because the eye develops similarly in all vertebrates, including humans, "the implications are much broader than [for] just the cave fish."

The Maryland team has been studying the fish, which is called *Astyanax mexicanus*, for the past 6 years. Several dozen isolated populations of the species exist in northeastern Mexico, with some living in surface ponds and streams and others in caves and underground waterways. Over the past million years or so, the eyes of the underground fish have degenerated to varying degrees, while the surface fish have retained their large eyes.

To begin to understand this difference, Jeffery and Yamamoto first monitored eye development in the blind fish. They observed a precursor lens and the rudiments of the optic cup forming during the embryo's first 24 hours. But soon afterward, they found, the cells in the embryonic lens underwent programmed cell death. Other eye structures, such as the cornea and the iris, never appeared, and the retina never developed distinct, organized layers, as it does