Severed nerve regrows to bridge a gap

Biodegradable chemicals have succeeded in encouraging severed nerves in rats to regenerate and span a ⅔-inch gap in tissue. Preliminary results of this work, reported last week in Chicago at the American Chemical Society's national meeting, suggest that these chemicals might become the basis for a device to treat trauma patients with significant damage to nerves in the extremities.

Moreover, the fact that the same polymeric material "can induce regeneration of two very distinct tissues [the sciatic (leg) nerve and skin]," says Ioannis Yannas of the Massachusetts Institute of Technology (MIT), "suggests very strongly that there is potential for regeneration in other organs that has been significantly underrated." Yannas collaborated on the nerve regeneration device with colleagues at MIT, Case Western Reserve University in Cleveland and two Boston hospitals.

Yannas was a developer of the "artificial skin" used to grow new epidermis on human burn victims (SN: 1/30/82, p. 73). He says the nerve regeneration device employs the same chemistry: a plastic silicone outer layer (here a tube) filled with cowhide-derived collagen (connective tissue) that has been chemically bonded to a carbohydrate polymer — glycosaminoglycan, or GAG — derived from shark cartilage.

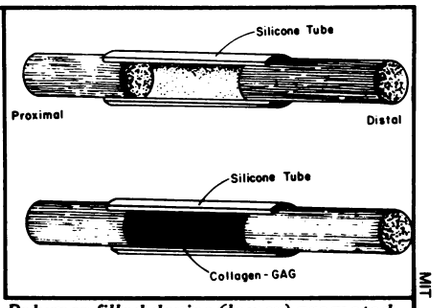
The collagen-GAG polymer acts as an initial "scaffold" to support the nerve endings' new growths. By the time the polymer had degraded — six weeks after surgery — "we saw continuous nerve fibers bridging the 15-millimeter gap," Yannas says. (In any final device, the plastic tubing would also have to be replaced with a biodegradable material.)

Yannas notes that work led by Swedish researcher Goran Lundborg showed that severed nerves guided by an empty silicone conduit could regenerate across a 6- to 12-mm gap — but not across 15 mm. "So we worked at 15 mm," Yannas says, "to find out if our material was offering a significant advantage over what was thought to be the best previous work."

Last year Luis de Medinaceli and his colleagues at St. Elizabeth's Hospital in Washington, D.C., reported that they had restored nerve function in rats whose sciatic nerves had been severed, splinted back together and allowed to reattach (SN: 1/28/84, p. 52). Referring to Yannas's work, de Medinaceli says, "He is addressing an issue which I have not — how to bridge a gap." Spanning gaps is "fundamentally important" to reconstructive surgeons, he says, but only if nerve function returns. And establishing that will be essential to proving the value of Yannas's device, he believes.

De Medinaceli likens nerve tissue to a trunk line of optical fibers transmitting telephone messages across the Atlantic. He notes that while merely reattaching two stump ends of the fiber bundle may be enough to restore most American callers to a party in Europe, if the original ends of each fiber are not matched precisely the American caller will reach a stranger, not the party dialed. In the body, he says, similar confusion may arise if nerve tissues don't know whom they're addressing. De Medinaceli says tests of how well the rats walk again show that his patched nerve ends match reasonably well the original connections.

Yannas concedes that similar tests need to be conducted on rats whose nerves grew back across a 15-mm gap. However, he says it's not unreasonable to suspect that enough valid reconnections can span a gap to restore function. Citing unpublished data on tests that his group conducted two years ago, he says rats regained the ability to walk after severed sciatic nerves regenerated across a 5-mm polymer-filled gap. — *J. Raloff*



MIT

Polymer-filled device (lower) promoted reattachment of proximal and distal nerve stumps.

Pinning down the pole's position

Columbus and other mariners found their way around the globe by noting their latitude as measured by the height of the North Star above the horizon. Centuries later, scientists discovered that there are subtle variations in this height caused by the circular excursions of the earth's spin axis relative to its solid crust — a motion called the Chandler wobble (SN: 10/24/81, p. 269). Measuring this wobble is important not only for surveying and navigation but also for understanding the planet's inner workings that cause it. Until recently, however, these measurements were too inexact to shed much light on the dynamics of the pole's peculiar dance.

Now the accuracies of two measurement techniques have reached new heights. In the Sept. 20 SCIENCE geophysicists report that estimates of the earth's pole position made by satellite laser ranging (SLR) and very long baseline interferometry (VLBI) differ by about 2 milliseconds (msec) of arc, or about 6 centimeters, indicating that this is the maximum total root-mean-square error for both techniques together. For comparison, the total displacement of the pole during the corresponding 14-month Chandler period was about 500 msec of arc, or about 15 meters.

"A lot of people were very startled by this accuracy," says Douglas Robertson at the National Geodetic Survey (NGS) in Rockville, Md., who co-authored the paper with William Carter at NGS and three researchers at the University of Texas at Austin. The errors of other methods currently in use range from about 3 to 10 times greater than those of SLR and VLBI.

The high degree of accuracy of SLR, which involves bouncing a laser beam from earth off a satellite, and of VLBI, which measures at different observatories the differences among arrival times of radio waves from very distant quasars, has been available for only a few years. When Robertson and Carter last compared the time series data from these two techniques, in 1983, they obtained a root-mean-square error of about 6 msec of arc. Both this and the more recent study are part of an internationally sponsored project called MERIT (Monitor Earth's Rotation and Intercompare Techniques of Observation and Analysis).

By improving the accuracy of these measurements scientists hope to resolve the debate over which forces drive the Chandler wobble. Most researchers agree that the earth's spin axis is affected by any change in the distribution of mass in the earth, oceans and atmosphere. Some believe that the disproportionately heavy snowfall in Siberia is primarily responsible, while others have argued that the wobble is due mainly to changes in the atmosphere and winds blowing on mountains. Still others think that large earthquakes are the real culprits.

"The answer is likely to be all of the above and then some," says Robertson. "The bottom line is that we want to get accurate measurements [for a while] and then let the theoreticians squabble over what the numbers mean."

In their recent paper, Robertson's group took a quick look at the possibility that earthquakes affected the motion of the pole during the study period. They found no discernible effect near the times of earthquakes with a magnitude 7 or larger. Robertson notes, however, that some models have predicted that earthquake-induced effects might be delayed by as much as 20 years and then spread out over

News of the week continued on p. 186

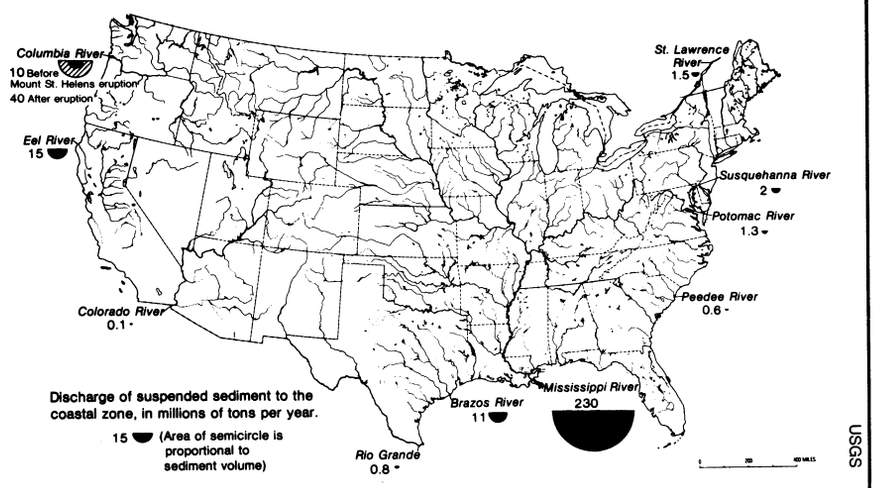
News of the week continued from p. 183

a few years. Now that this millisecond accuracy is available, he would also like to test for effects of much larger earthquakes such as those that rattled Alaska and Chile in the 1960s.

Meanwhile, a group of researchers led by Thomas Herring at Harvard University has used VLBI data to measure a different kind of motion of the spin axis, one that changes relative to the rest of space and is driven by the sun's and moon's gravitational fields acting on the earth's equatorial bulge. Based on the VLBI data, Herring's group has concluded in a paper recently submitted to the JOURNAL OF GEOPHYSICAL RESEARCH that the coupling between the earth's core and mantle is much stronger than predicted by current geophysical models of the earth. These results imply that the liquid core is flatter by about half a kilometer in the pole direction than is presently thought. The amazing thing about all this, says Robertson, is that with VLBI the internal structure of the earth is being determined by observing the far edge of the universe.

— S. Weisburd

Mud map: A sedimental journey

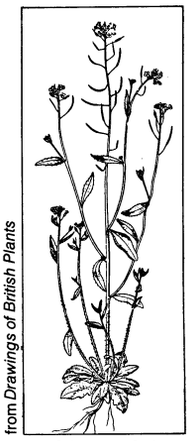


Over the last 35 years, the amount of mud released by the Mississippi River into the Gulf of Mexico has dropped by more than half, two U.S. Geological Survey hydrologists report in the agency's latest National Water Summary. But the river still discharges more sediment into the ocean than any other U.S. river, and its sediment load is ranked about sixth in the world.

Scientists attribute the decrease to the construction of several large, sediment-trapping dams on the Missouri River during the 1950s and 1960s. The drop in sediments upstream may be responsible for the erosion of shorelines downstream on the Mississippi Delta.

The recent water summary also documents sediment flow in other rivers. For example, the Cowlitz River in southwest Washington, which received 140 million tons of sediment after the 1980 Mt. St. Helens eruption, now transports 30 million tons per year.

Bouquet of mustard for new genetics



from *Drawings of British Plants*

Animal geneticists owe their success to mice and the fruit fly *Drosophila;* microbial geneticists are indebted to the bacterium *E. coli.* Now molecular biologists propose that a small weed will prove to be a similar boon to plant geneticists.

Plant genetics has lagged behind other fields in the recent rapid progress in understanding mechanisms of inheritance and in applying that knowledge to genetic engineering. The explanation often given for this lag is the amount and complexity of the genetic material, called the genome. Plants have large amounts of repetitive DNA — sequences of unknown function present in thousands of copies and scattered throughout the chromosomes. In addition, plants often have extra copies of their entire set of chromosomes.

A plant in the mustard family may allow geneticists to work with a much simpler genome. This harmless weed, *Arabidopsis thaliana,* which grows to about 5 inches tall, contains about 1 percent the amount of DNA in wheat, and less than 0.5 percent the amount of repetitive sequence. In addition, it is well suited for research: Its life cycle is only five weeks; one plant can produce thousands of seeds; and dozens of plants can be grown in a 2-inch-diameter pot. More than 75 genetic mutations have already been described and assembled into a map of the plant's five chromosomes.

Initial work on the molecular genetics of *Arabidopsis* is described in the Sept. 20 SCIENCE. Elliot M. Meyerowitz and Robert E. Pruitt of Caltech in Pasadena report that the individual genes of *Arabidopsis* are similar to those of other flowering plants. They predict that genes of interest can be easily located in the small genome of *Arabidopsis* and then used to pick out the corresponding genes in more complex plants of economic interest. Proteins encoded by large gene families in other species are encoded in *Arabidopsis* by a single gene or a few genes. For example, there are three genes in *Arabidopsis* for the light-harvesting chlorophyll protein. In contrast, in petunias this protein has 16 or more genes. Preliminary work in other laboratories suggests that it will be possible to do genetic engineering on *Arabidopsis,* using the gene carrier (the Ti plasmid) now employed for more complex plants.

At least a dozen laboratories are working on, or have plans to work on, the molecular genetics of *Arabidopsis,* Meyerowitz says. He and Pruitt conclude, "Our hope is that *Arabidopsis* will soon join the other organisms for which a combined genetic and molecular approach has led to both fundamental and practical scientific advances." *— J.A. Miller*

TMI tests trashed

Control room operators at Three Mile Island (Pa.) Unit 2 discarded the results of more than half the safety tests they conducted in the year before the reactor's 1979 accident, and in some instances falsified them, according to a report issued last week by the plant's owner, General Public Utilities Nuclear Corp. (GPU Nuclear).

But, the report contends, "evidence does not establish that management personnel above the level of the operations department participated in or consciously tolerated improper test practices."

In February 1984, GPU Nuclear pleaded guilty to criminal charges that it had falsified tests designed to detect water leakage from the reactor's cooling system. According to Edwin Stier, the Somerville, N.J., attorney who conducted the 15-month investigation for the corporation, this report represents the first attempt to document the extent to which those tests were falsified.

Comments Ellen Weiss, an attorney for the Cambridge, Mass.-based Union of Concerned Scientists, which has been involved in a legal battle to prevent the start-up of Unit 2's undamaged twin reactor (SN: 9/7/85, p. 150), "There's a great deal about that report that raises questions in my mind about the people still at GPU Nuclear." □