Chemistry

Janet Raloff reports from Boston at a meeting of the American Chemical Society

Boning up on biodegradable implants

Though the body can replace bone lost to disease and injury, it often needs help. At the Army Institute of Dental Research in Washington, D.C., researchers are tailoring biodegradable polymer microcapsules to slowly release proteins that naturally induce bone growth. They are also developing a related family of nontoxic polymers to serve as biodegradable scaffolds for bridging large gaps in damaged bone. The drug-filled beads, used in conjunction with sheets, rods, plates or tubes of the scaffolding material, appear to help guide the natural rebuilding of bone, especially in the face and skull, reports Army analytical chemist Carla P. Desilets.

Her team seeks to develop a range of products that reconstructive surgeons can custom-shape to a wound using simple dental tools, then anchor in place with biodegradable screws or glue. For thin facial bones, such as those around the cheeks, the researchers embed the bone-growth-promoting proteins right into the scaffolding material. Tubes filled with the microencapsulated drugs span the gaps in thicker bones, serving as rigid spacers between adjacent bone stumps. As bone precursor cells migrate to each type of implant, they incubate in its time-released growth protein and transform into solid bone. During the months it takes for the new bone to develop, the synthetic scaffolding becomes porous, eventually falling apart.

Desilets says her group is focusing on polylactic and polyglycolic acids as scaffolding materials because these polymers have a 30-year history of safe use as biodegradable sutures. In animal tests, the Army researchers have found that bone regrowth spurred by prototype implants is as strong as the original and follows the former bone's contours. Similar tests in humans could begin in as little as three to five years, she adds.

At the Massachusetts Institute of Technology in Cambridge, researchers are focusing on polyanhydrides, a newer class of biodegradable plastics, for a range of bony applications. The first commercial application of these implants – one of which is now undergoing animal testing – may be for the slow, localized release of antibiotics to fight osteomyelitis, or bone infection, says MIT's Cato T. Laurencin. Osteomyelitis resists conventional treatment in some 10 to 15 percent of cases and occasionally requires amputation, he notes.

Biodegradable plastics may one day coat conventional joint prostheses, Laurencin adds. By seeding the slowly eroding coat with drugs, surgeons could combat the body's attempts to reject the implant while also speeding attachments between the prosthesis and adjacent bone, he says.

Recreating prehistoric enzymes

Cyril Ponnamperuma has spent much of the past 30 years stewing methane, nitrogen, water – and, most recently, a pinch of minerals – into primordial soups and sampling each batch for signs of life's chemical building blocks: the amino acids that make up proteins. While stalking the elusive recipe for creating life on Earth, he and others have demonstrated that "almost all the 20 [most common] amino acids can be produced – either directly or in a step-wise manner" – from these soups, says Ponnamperuma, who directs the Laboratory of Chemical Evolution at the University of Maryland in College Park. His latest efforts appear to have yielded a functionally new ingredient: a simple molecule, consisting of five or six amino acids, "that behaves like an enzyme," he says.

Alone and when bound to zinc or copper, this molecule appears to hasten the rate at which the protein cytochrome-C donates electrons to oxygen, Ponnamperuma reports. Cytochrome-C assists in electron transport during respiration and photosynthesis. Ponnamperuma is now screening his soups for evidence of a potentially more important enzyme: a polymerase, which combines small molecules into a long chain.

Earth Sciences

Loma Prieta's unfinished business

Astrologists must have loved it. On the anniversary of the great 1906 San Francisco earthquake, the San Andreas fault unleashed a series of moderate quakes near the town of Watsonville, Calif. The early-morning shakeup caught sleeping residents by surprise, but seismologists say they had anticipated that such quakes might occur although they could not predict when or where.

The April 18 tremors, the largest of which measured magnitude 5.4, actually qualify as aftershocks to the magnitude 7.1 Loma Prieta earthquake that broke the San Andreas fault in the Santa Cruz mountains last Oct. 17. They struck in a general zone defined by other Loma Prieta aftershocks, filling a gap along the southeastern end of the zone that had not broken during previous aftershocks.

From statistical studies, Paul A. Reasenberg of the U.S. Geological Survey (USGS) in Menlo Park, Calif., calculates that seven aftershocks of magnitude 5 or greater typically follow within a year after a quake the size of Loma Prieta. Only two struck within the first few days after the October main shock, so statistically speaking, scientists knew that more could come. On April 18, a third and fourth hit.

The northwest end of the Loma Prieta break – near the city of Los Gatos – also has potential for spawning an aftershock of magnitude 5 or larger, says USGS seismologist Lynn Dietz. But experts can't predict whether additional large aftershocks will ever hit. There could be eight more, or there might be none, says Allan Lindh of the USGS.

Antarctic ice potentially unstable

Recent changes in western Antarctica have led glaciologists to suspect they know far too little about the stability of the ice sheet there, including the odds of its collapsing into the ocean in the next few centuries – a catastrophic event that could raise global sea levels by 6 meters. A report issued last month, based on a workshop attended by 32 scientists, calls for more ice-sheet research to help define the hazard.

Glaciologists have assumed that ice sheets do not undergo rapid changes in behavior. But an ongoing study along the Antarctic coast near the Ross ice shelf has revealed a dramatically different beast, says workshop organizer Robert Bindschadler of the NASA Goddard Space Flight Center in Greenbelt, Md. The project examines large streams of glacial ice that flow down from the mountains and onto the floating ice shelf. To their surprise, investigators found that the movement of one stream has slowed markedly over the past decade. But even with this 20 percent reduction in speed, the stream carries ice to the coast about 40 percent faster than ice accumulates up at the stream's source. These observations "indicate possible instability and spur an urgent effort to understand the coupled system [of ice, air, ocean and rock] so as to predict its future behavior," the workshop scientists state in their report.

In recent years, scientists have focused much attention on whether the predicted global warming will increase melting in the Antarctic or even cause an ice-sheet collapse. Some researchers announced last year that they believed the ice sheet would not melt as quickly as previously expected, and they predicted it would remain stable for at least the next century. These assumptions led to estimates that the global ocean level will rise only about one-third as rapidly as earlier calculations had indicated (SN: 12/16/89, p.397).

Bindschadler, however, contends scientists don't know enough about the potential instabilities in the ice sheet to rule out collapse in the next century. Moreover, he says, experts lack sufficient Antarctic data to explain the present rate of sea level rise. With such uncertainty, "predicting [sea level] in the future is really out on thin ice," he says.

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