Chemistry

Janet Raloff reports from Toronto at the Third Chemical Congress of North America

Preserving fruit with a chitin coat

Chitin is second only to cellulose as the most abundant natural polymer (long-chain molecule). Made from a series of linked glucose-based units, it is the primary structural ingredient in the exoskeleton of insects, in the shells of crustaceans and in the cell walls of fungi and yeasts. One reason behind the slow commercial development of this strong, biodegradable and nonallergenic material, Ernest R. Hayes believes, has been its insolubility "in practical solvents" – especially water. But the chemist from Acadia University in Wolfville, Nova Scotia, has eliminated that obstacle with a two-step process that transforms chitin into a water-soluble compound. Its first application, scheduled for commercial introduction within a year or two, is a semipermeable film to coat fruit.

Because oxygen and warmth promote ripening, the fresh-fruit industry often uses low-oxygen vaults kept near 0°C to extend the useful life of picked fruit. But this storage is costly, Hayes says. And as soon as the fruit is removed from the low-oxygen environment, it begins ripening quickly. The NOCC (N,O-carboxymethylchitosan) Hayes developed replaces low-oxygen storage by providing treated fruit – including pears, peaches and plums – a gas-permeable coating that largely excludes oxygen. Moreover, it tends to retain the fruit's carbon dioxide, which can retard ripening. This coating stays on the fruit until washed off in warm water. Preliminary data indicate it is nontoxic.

Hayes' patented NOCC-forming process treats chitin with heat and a caustic chemical such as lye or sodium hydroxide, then reacts the product it forms with monochloroacetic acid. The Canadian government already has approved NOCC's use as a preservative film for apples that will be washed and peeled before use–about one-third of Canada's apple market. The fruit will be sprayed or dipped in an aqueous solution containing 0.7 to 2 percent NOCC. Hayes and two chemistry professors from St. Mary's College in Halifax, Nova Scotia, have incorporated as Nova Chem Ltd. to produce the preservative.

Toward synthetic kidneys and livers

Thomas M.S. Chang, director of McGill University's Artificial Cells and Organs Research Centre in Montreal, has spent 30 years developing tailor-made artificial cells to replace or augment specific functions performed by the body's own cells, such as clearing toxic substances from the blood. His living-cell-sized chemical-reaction centers encapsulate enzymes, detoxicants, peptides, even other cells within a semipermeable membrane. Now under design are multi-enzyme units to take over where his commercially available activated-charcoal-based blood-cleanup cells leave off. The new systems will convert the toxic urea and ammonia that build up in people with kidney and liver failure into useful amino acids.

The prototype cells – 10 to 50 microns in diameter – contain one enzyme (urease) to convert urea into ammonia, another (dehydrogenase) to transform ammonia into three essential amino acids (leucine, isoleucine and valine), and a "cofactor" that activates the dehydrogenase. A third enzyme (glucose dehydrogenase), which frees up the cofactor for reuse, completes the mix.

In test-tube experiments, the new cells converted 50 to 60 percent of the urea into amino acids within two hours. Further refinements underway should speed and increase the conversion, Chang told SCIENCE NEWS. The cells, which he says could be ready for animal testing within about nine months, will eventually be incorporated into a column through which blood is filtered. Chang believes these cells, together with the activated-charcoal-based cleanup cells, could function as artificial organs to convert into useful products the toxic wastes that build up in patients with liver or kidney failure.

Earth Sciences

Origin of the oceans' largest plateau

A 2,300-kilometer-long mystery known as the Kerguelen plateau stretches across the southern Indian Ocean near Antarctica. This structure, the world's largest submerged plateau, has long invited speculation and debate concerning its origins. But scientists who spent March and April drilling into the plateau retrieved hard evidence to help them reconstruct its history for the last 100 million years.

Because of the plateau's large size, some geoscientists thought it might be a fragment of Antarctica that splintered off when the Indian Ocean began to form. However, when the crew on Leg 120 of the Ocean Drilling Program bored into the basement rock of the submerged plateau, they found no evidence of continental material, says staff scientist Amanda Palmer of Texas A&M University in College Station. Instead, the basement turned out to be basalt, the typical oceanic crust formed from molten mantle rock that rises to the surface. In chemical composition, the Kerguelen plateau basalts are a rare intermediate between two types of basalt: those that flow out of midocean ridges and those that erupt out of hotspot locations such as Hawaii. It remains unclear what kind of volcanic activity formed the plateau, says Palmer.

While more than a kilometer's depth of water now covers the plateau in all but three locations, the researchers believe these basement basalts erupted when the area was either above water or very close to the surface about 97 million years ago. Soil and vegetation probably covered parts of the plateau because there are claystones, siltstones and small pieces of wood in the sediments blanketing the basalts.

The plateau then apparently began sinking slowly into the ocean. Limestones containing fossils of urchin-like creatures and other animals testify that the plateau was once at a shallow depth. Over the last 60 million to 70 million years, however, this area has subsided more rapidly. At some time, the ocean over the plateau began to cool as a continent-circling ocean current started to seal off the Antarctic climate, sending it into its current deep-freeze state. It appears that icebergs from a glacial cap on Antarctica first reached the Kerguelen plateau during the early Oligocene period, which began 37 million years ago.

Siamese-twin snowflakes

Knight/Bull. Am. Meteo. Soc.

At about the same time schoolchildren learn to make a dozen identical snowflakes by folding and cutting a piece of paper, they learn the seemingly contradictory maxim that no two snowflakes are alike. Now a researcher who studies snow crystals – the more general scientific term – has found two that *are* alike, and not just on paper.

Nancy Knight of the National Center for Atmospheric Research in Boulder, Colo., has identified "two snow crystals, which, if not identical, are certainly very much alike," she reports in the May BULLETIN of the AMERICAN METEOROLOGICAL SOCIETY. These crystals (at right in photo) are columnar structures–an ordinary crystal form–and were collected on a slide attached to an airplane. They are extraordinary, says Knight, because they seem attached as well as nearly identical. She speculates they grew together, perhaps budding off of adjacent tips on a star-shaped crystal.