CHEMISTRY

Julie Ann Miller and Susan West report from Washington at the meeting of the American Chemical Society

Sun and soap sort isotopes

Pure samples of rare isotopes are valuable in medical diagnosis and industrial research, as well as for nuclear fuel. Currently the separation of isotopes, based on their slight weight differences, requires costly equipment and thousands of megawatts of power. Columbia University chemists now report development of techniques in which isotopes separate themselves without use of lasers or other sophisticated equipment.

The new methods are based on the magnetic properties of some isotopes. For example, the rare isotopes carbon-13, oxygen-17 and uranium-235 are magnetic, whereas carbon-12, oxygen-16, oxygen-18 and uranium-238 are not. The different numbers of neutrons in their nuclei determine the charge distribution geometry and thus the magnetism.

Nicholas Turro and Bernhard Kraeutler discovered chemical reactions in which a magnetized isotope has an advantage over a nonmagnetized one. To concentrate carbon-13, for example, they begin with dibenzyl ketone, a compound containing mostly carbon. Initially one percent of the carbon is carbon-13; 99 percent is carbon-12. Turro and Kraeutler trap the compound in aggregates of soap molecules (micelles) to restrict its movement. "Evidently the motions and time scales within the micelle's restricted area of space are just right for the spontaneous sorting of carbon-12 from carbon-13," Turro says. One of the chemical bonds of the dibenzyl ketone is next split by sunlight. Of the resulting fragments, most of those containing carbon-12 undergo a series of chemical reactions and eventually escape from the soap aggregate. The small magnetic force of carbon-13, however, affects the spin of a nearby unpaired electron so that two fragments can recombine into dibenzyl ketone. "The net result is a spectacular enrichment of carbon-13 in the ketone that we recover from the micelle solution," Turro says.

For oxygen-17, conventional mechanical techniques are unable to separate the isotope because its weight falls between that of oxygen-16 and oxygen-18. Turro has recently devised a scheme that can concentrate oxygen-17 on the basis of its magnetism, opening the way for the first commercial production of that isotope. Heat applied to a specific ring-shaped compound breaks a chemical bond involving an oxygen atom. The magnetic force of the oxygen-17 changes the electron spin of an unpaired electron, resulting in a different chemical fate for molecules containing that isotope. Turro says these methods may lead to simple, inexpensive techniques for separating other magnetic isotopes. The most important procedure would be one that separates magnetic uranium-235 (for use as fuel in a nuclear reactor) from the nonmagnetic uranium-238, which makes up more than 99 percent of the element in nature.

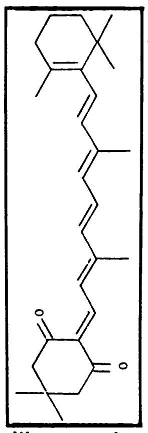
Artificial pancreas with cellular works

A barrier that passes insulin and nutrients but not antibodies may be the key to using insulin-producing cells in an artificial pancreas. Clark K. Colton of Massachusetts Institute of Technology described a device that can control blood sugar levels in diabetic dogs and rats. He predicts that it will take at least five years before the implant will be ready for general human use, but he believes that the major technical obstacles have been surmounted. Results thus far indicate that the device can maintain normal blood sugar concentrations in diabetic animals.

The implantable artificial pancreas consists of insulin-producing cells growing on the outside surface of a tubular membrane. The device is implanted in an animal as a shunt between an artery and a vein. Blood coursing through the semipermeable tube provides oxygen and nutrients to the cells. Antibodies and white blood cells, however, cannot cross the membrane to attack the foreign cells. The implanted cells — in experiments Colton and collaborators used neonatal rat pancreatic cells — respond to glucose from the recipient's blood and produce insulin, which lowers glucose production. Soon after insertion of the device, the blood glucose level begins to fall to the normal level where it is maintained. When the device is removed, the blood glucose concentration rises back to the diabetic range.

The most recent advance in the "hybrid" artificial pancreas is fabrication of acrylic copolymer tubing of wider diameter. The initial studies used bundles of narrow hollow fibers with internal diameters of 0.2 millimeter. Recently Barry A. Solomon at the Amicon Corp. in Lexington, Mass. developed a technique to produce semipermeable tubes with a 2.5-millimeter diameter. The wider tubes are better able to avoid clotting problems.

Low-risk, chemical, cancer protection



Vitamin A and some related chemicals can prevent cancer of the lung, skin, bladder and breast in experimental animals. However, most of those compounds are far too toxic to consider for human use. In addition the liver, which sequesters many Vitamin A derivatives, may prevent the chemicals from reaching their targets.

Nancy Acton of the National Institutes of Health now reports a class of Vitamin A derivatives that appear less toxic and that do not accumulate in the liver. She and Arnold Brossi found that some compounds of the group called retinylidene-1,3-diketones reverse "premalignancy" characteristics of cells in the laboratory and, in preliminary tests, protect animals against chemically induced cancers. About two dozen retinylidene-1,3-diketones have been made and tested. Retinylidene dimedone (above) was chosen for further evaluation. Rats fed large doses of that compound for six months show no ill effects. Acton says the preliminary results are encouraging because they indicate that compounds with antitumor properties need not be toxic.

Life and a lump of clay

Among the limited ingredients present on earth at the time of the origin of life were clays. Scientists have observed that clays can play a catalytic role in the formation of organic polymers from monomers; thus they may have figured in the beginnings of life by linking together larger and larger molecules. Scientists have also proposed that clays may have provided a sort of "scaffolding" for concentrating organic molecules. Moreover, they suggest, clays may have been able to adsorb only certain amino acids and only certain structural forms, or isomers, of those amino acids (SN: 10/29/77, p. 277). If so, they propose clays may have "selected" the amino acids that are typical of living systems.

Despite their willingness to accept such a hypothesis, Elaine Friebele, Akira Shimoyama and Cyril Ponnamperuma of the Laboratory of Chemical Evolution at the University of Maryland could find no proof. Friebele and co-workers exposed a single purified clay to matched pairs of protein and nonprotein amino acids and to pairs of right-handed and left-handed protein amino acids. (Only right-handed amino acids — molecules that bend polarized light to the right — exist in living tissue.) The researchers found "no selective adsorption of protein amino acids" — but a slight preference for nonprotein amino acids — and "no impressively large" preference for right- over left-handed forms. Even so, Friebele says, such experiments are "simplifications of nature" and the results may vary with more complex clays or longer exposures.