Superconductors: A dimpled beauty

X-ray diffraction and neutron diffraction are two standard techniques crystallographers use to determine the structures of crystals. The first neutron diffraction studies of the new high-temperature superconducting materials are now being reported, one by a group working at Argonne (Ill.) National Laboratory, the other by scientists working at the Rutherford Appleton Laboratory in Didcot, England. According to Ivan K. Schuller of Argonne, neutron diffraction is important because it is more sensitive to the precise location of oxygen atoms, and oxygen is an important building block in these materials.

The Argonne neutron diffraction study, which involved the compound $YBa_2Cu_3O_7$, found a structure that the scientists say is different in important respects from what X-ray diffraction had previously shown. Both the Rutherford Appleton work, which used $La_{1.85}Ba_{0.15}CuO_4$, and an Argonne X-ray diffraction study of the yttrium-barium-copper oxide show that temperature variations can cause changes in the crystalline arrangement between orthorhombic (having three unequal axes at right angles to each other) and tetragonal structures.

Results of previous studies of the yttrium-barium material by X-ray diffraction had differed over whether the structure, which belongs to the class of crystals called perovskites, had tetragonal or orthorhombic symmetry. The neutron diffraction study found an orthorhombic structure. This structure has "something for everybody," Schuller says. "There are two-dimensional planes, one-dimensional chains—the planes may or may not be coupled depending on the point of view one wishes to adopt." According to the report, the basic structure consists of planar layers of CuO_2 that are joined together by "fencelike" chains of CuO_3.

However, this study finds that the CuO_2 layers are not flat or "corrugated," as previous reports have held, but "dimpled." Also the locations of the yttrium and barium ions are different. Says Schuller, " . . . this unique structure is important for the superconductivity, and I would dare to say it has some esthetic value."

The Argonne report opines that this structure could show highly anisotropic electronic properties—that is, properties dependent on direction. In fact, as this work was being prepared for publication, scientists at IBM reported very anisotropic conductivity in related materials (SN: 5/16/87, p.308).

The Argonne X-ray diffraction study reports that the yttrium-barium material undergoes a transition from orthorhombic to tetragonal structure as it is heated through a temperature of 750 kelvins. If this change is frozen in by quenching and the material cooled toward the superconducting temperature range, the transition temperature for superconductivity is depressed substantially below the 92.5 kelvins previously found for this material. The experimenters say this suggests that the one-dimensional copper oxide chains characteristic of the orthorhombic structure are necessary for high superconducting temperatures.

The Rutherford Appleton researchers found a transition for the lanthanum barium material from tetragonal to orthorhombic at 180 K. They also found "subtle, anomalous structural instabilities" at lower temperatures. They say their experiments demonstrate a relation between the structural anomalies and changes in electrical resistivity.

The Argonne neutron diffraction study, done by scientists from Argonne, Illinois Institute of Technology in Chicago and Western Michigan University in Kalamazoo, will appear in Applied Physics Letters. The Argonne X-ray diffraction work, by scientists from Argonne, the University of Leuven, Belgium, and Illinois Institute of Technology will appear in Solid State Communications. The Rutherford Appleton work, by D. McK. Paul of the University of Warwick in Coventry, England, and others appears in the May 11 Physical Review Letters.

—D. E. Thomsen

Protein defect in diabetes?

An absence of protein activity that affects the transfer of chemicals across cell membranes—including the interaction of the hormone insulin with liver cells—may be responsible for many of the medical problems associated with diabetes, researchers reported this week.

Using diabetic rats, scientists at the University of Glasgow in Scotland, Rockefeller University in New York City and the National Institute of Diabetes in Bethesda, Md., found that a protein called G_i appears to be inactive in the animals' livers. The protein is one of several grouped under the name "G proteins," which play a role in the movement of chemical signals between a cell's interior and the outside.

Previous research had shown that G_i is one of two G proteins that serve as a link between a cellular enzyme called adenylate cyclase and hormone receptors found on the cell surface: In a complex regulatory process, G_s stimulates and G_i inhibits adenylate cyclase's response to hormones. However, in diabetic rats with very low blood levels of insulin, there apparently is no G_i activity; thus, part of the normal feedback process is missing, the scientists say in the May 21 Nature.

Using specially prepared antibodies, the scientists found that the amount of one G_i subunit is abnormally low in liver cell membranes from diabetic rats. Although the activity of G_i is restored when the diabetic animals are injected with insulin, it is unclear how the low levels of insulin seen in type I diabetes are related to the deficiency in G_i, say the authors. Nonetheless, given adenylate cyclase's broad influence on cellular metabolism, the authors suggest that the loss of inhibitory activity by G_i could account for many diabetic complications, including those of the nervous, immune and cardiovascular systems.

—D.D. Edwards

Eat to remember

Even an old dog can learn new tricks if enticed with enough food. Now, researchers at the Veterans Administration Medical Center in Sepulveda, Calif., have discovered *how* the reward of food may facilitate such learning in animals.

James F. Flood, Gary E. Smith and John E. Morley suggest in the May 15 Science that a gastrointestinal hormone released in mice during feeding can enhance memory by activating fibers in the peripheral nervous system. While in past work the hormone, cholecystokinin (CCK), has been associated with enhanced memory, says Morley, this is the first proposed mechanism for that link.

In their studies, the researchers first showed that hungry mice, fed immediately after learning a task, later remembered how to complete that task much better than did other mice, some of which were hungry and fed three hours after learning, others of which were well fed prior to the experiment.

Flood's group also showed that CCK injected in the mice's abdomens mimicked the memory effects of feeding. The question then, says Morley, was how CCK, which is too large to cross the blood-brain barrier, is able to influence the brain. The researchers discovered that CCK enhanced memory only when a mouse's vagus nerve was intact. This nerve is part of the peripheral nervous system and is anatomically connected to a memory region of the brain. The researchers believe that CCK affects memory by activating vagus fibers leading from the gut toward the brain.

They suspect that the link between gastrointestinal hormones and memory has given animals an evolutionary edge by helping them remember how they successfully found food in the past. As for humans, Morley says the lesson is that to be most memorable, the after-dinner speech should be given before dinner.

—S. Weisburd