chemistry

From our reporters at the American Chemical Society meeting last week in Washington

Liquid crystals in nature

Liquid crystals, organic compounds with the molecular structure of solid crystals and the mechanical properties of liquids, are the subject of one of the most rapidly expanding areas of chemical research. The molecules of most liquids move about constantly in random fashion; the molecules in a liquid crystal arrange themselves in an orderly pattern resembling the lattice structure of crystals. The unusual properties of such compounds (some of them form lenses in the presence of an electric field, for example) have suggested them for a wide variety of practical uses, such as in electronic clocks.

Ahmed Atallah and Harold J. Nicholas of the St. Louis University School of Medicine report that compounds capable of forming mesophases (semi-crystalline states) are widely distributed naturally throughout the plant kingdom. Examination of a variety of plant tissues revealed many substances that form mesophases in such plants as Spanish moss and dandelions.

There is some evidence, from studies of grapefruit, pineapple, cantaloupe and lemon, says Atallah, that such compounds may be concentrated in peripheral tissues, such as the peels.

Heat capacity and molecular defects

As metals are heated to near their melting point, their heat capacity—the quantity of heat required to raise the temperature of a body by one degree—increases exponentially. This anomalous increase cannot be explained by the factors normally considered to contribute to heat capacity.

J. H. Meiser of Ball State University in Indiana and W. G. Lawless and J. E. Davison of the University of Dayton demonstrated that the increase in heat capacity with increasing temperature can be partially attributed to defects in the metal's molecular lattice structure. Though the energy required to displace atoms from their normal lattice positions has been considered to contribute to heat capacity, the energy involved in the actual migration of displaced atoms to other locations has largely been overlooked, says Meiser.

The researchers multiplied the energy of migration by the number of lattice defects in a crystal. The resulting heat capacity due to migration of atoms was then combined with heat capacity due to displacement of atoms. They report that calculations for silver, aluminum, copper, sodium, lead, platinum, titanium and tungsten show better agreement between theoretical and experimental results.

Arrangements of water molecules

The molecules of ice are held together in a tetrahedron-shaped arrangement. It is assumed that molecules of liquid water must also be grouped in some structure, and a number of speculative theories have been advanced.

The theories have two points in common, says Mu Shik Jhon of the University of Utah: that water consists mainly of different kinds of clusters and that the hydrogen bonds in water may be bent. Jhon and two colleagues, Henry Eyring of the University of Utah and Ung-In Cho of the Korea Institute of Science and Technology in Seoul, propose that water is composed of small domains of about 46 molecules. This structure, says Jhon, explains the thermodynamic, dielectric, surface and transport properties of water. According to the theory, the cluster's size does not change appreciably with temperature, but its concentration does.

The researchers calculated the potential energy of the 46-molecule domain. The calculations show that such a domain is the most probable energetically and confirm the theory that cluster size is independent of temperature.

Primitive earth conditions for life

Efforts are under way to build basic cell chemicals under simulated ancient earth conditions to better understand the way life evolved (SN: 6/19/71, p. 421). Amino acids, the building blocks of peptides and ultimately proteins, have in the past been formed under simulated conditions by passing electric discharges through gaseous ammonia, methane and water vapor. But chemists at Wayne State University have now obtained much higher yields of amino acids by carrying out the discharge over a body of water.

Their research affirms the apparently vital role the primordial ocean played as a reaction site for the formation of organic compounds leading to the origin of life.

Some scientists believe there was an abundance of phosphates on the primitive earth. W. K. Park and his colleagues at Wayne State have also produced evidence that some inorganic phosphates may have played a central role in the polymerization of amino acids into peptides. They performed experiments based on this assumption and believe they have developed a plausible model for condensation of amino acids to peptides on the primitive earth.

Pesticide synergists and liver defense

Synergists, chemical compounds combined to boost their effectiveness, have been widely used commercially to control insect pests. It is well known that living organisms have trouble degrading synergists, thus allowing them to exert unusually long-lasting toxicity. However the exact metabolic action of synergists was unknown.

Now R. M. Philpot and Ernest Hodgson of the National Institute of Environmental Health Sciences in North Carolina have found that pesticide synergists exert their especially toxic effectiveness by blocking the protective liver enzyme Cytochrome P-450. Cytochrome P-450 is found not only in insects but also in animals and man (SN: 7/24/71, p. 55).

Thus, if man were exposed to a synergistic pesticide, it is conceivable that it would block his Cytochrome P-450 enzymes, just as the synergist would do on target insects, and exert a similarly intense, prolonged toxic action. For this reason, Hodgson said, "There is now ground for caution in using synergists in a widespread way."