chemistry

Gathered at the 23rd International Congress of Pure and Applied Chemistry in Boston last week

Alcohol and enzyme inhibition

After 23 years of work on the enzyme mainly responsible for the first phase of alcohol (ethanol) combustion in mammals—liver alcohol dehydrogenase, or LADH—Dr. Hugo Theorell of the Karolinska Institute in Sweden has discovered a substance that specifically inhibits the action of LADH, 4-methyl-pyrazole. In experiments on both rats and man the enzyme inhibitor was found to reduce substantially the harmful effects of ethanol on metabolism of carbohydrates and fat. Because the enzyme inhibitor kept the ethanol molecules from being metabolized, volunteer alcoholic patients were able to maintain a high on limited alcohol and hence were not tempted to have another drink.

Other metabolic effects of damming up alcohol metabolism with 4-methyl-pyrazole, however, remain to be explored. Dr. Theorell prefers to move cautiously in the clinical use of 4-methyl-pyrazole for this reason; also to avoid the misunderstanding that he has a cure for alcoholism, and to keep the public from looking to 4-methyl-pyrazole injections as a means of prolonging an alcoholic high.

Metal enzyme action

An increasing number of enzymes are being found to contain metal ions. These metalloenzymes are believed to take part in a crucial bioenergetic process, the compounding of water from oxygen in cells by which they receive energy and breathe. The exact mechanism of metalloenzyme behavior in these reactions, however, has eluded detailed understanding.

Now Dr. B. G. Malmström of the University of Göteborg in Sweden has come up with some evidence of how one metalloenzyme, laccase, works. The enzyme contains four copper atoms. These take oxygen from the air and then transfer electrons from the oxygen to organic molecules. Although Dr. Malmström has not actually detected it, evidence suggests the formation of hydrogen peroxide (H_2O_2) as an intermediate stage during the transfer of electrons by the copper ions.

Dr. Malmström believes that a metalloenzyme that is far more crucial to the cell than laccase, cytochrome oxidase, which is involved in reception of energy by red blood cells, probably transfers electrons similarly. But unlike laccase, this enzyme has not yet been obtained in a form which allows study of its action.

Industrial enzymes

Molecular oxygen is an efficient oxidizing agent at ordinary temperatures, but at higher temperatures it will make materials burn explosively. Hence it would be to the advantage of industry to make enzymes that oxidize substances, because the enzymes would catalyze oxidation without explosion. The catalysts man has made so far, though, are far less efficient than natural enzymes because scientists have been unable to find out the details of the natural enzymes' interactions with the substrates they catalyze.

Synthesis of an enzyme that mimics natural ones may be a possibility now that scientists can see the molecular structures of enzymes in three dimensions and have a better view of the arrangement of the places on the molecules where catalytic action is localized and the spaces between them. The problem now becomes how to synthesize an enzyme with appropriate properties for particular substrates, says Dr. B. G. Malmström of the University of Göteborg in Sweden. Dr. Daniel Koshland of the University of California at Berkeley believes workable synthetic catalysts with some of the key properties of enzymes may be created in the next five years.

Oxidation, reduction and free radicals

Inorganic chemists compare the reactivities of atoms and ions in oxidation or reduction reactions by reference to a scale of "redox potentials," which lists the relative ease with which they lose electrons in oxidation or gain them in reduction. Now Dr. W. A. Waters of Oxford University has shown that organic free radicals—highly reactive, short-lived, combinations of elements that serve as intermediates in many chemical reactions—can be included quite consistently in this same scale. He used electron resonance studies to show directly that electrons are transferred in reactions between free radicals and inorganic ions or other organic molecules.

This confirmation of the way free radicals act and the incorporation of free radicals into the redox scale, should help clarify some biological oxidations that have been misunderstood. It may better explain and predict various catalytic reactions in the manufacture of petroleum, hydrocarbons and some foodstuffs. It could possibly lead to an explanation of free radicals' role in radiation damage and cancer and it may help diagnose precisely where, within living systems, undesirable food and drugs are likely to do harm.

Controlling the gypsy moth

Using DDT against gypsy moths was forbidden 10 years ago, and substitute pesticides that do not persist in the soil or animal tissue have proven ineffective. The moths have killed or damaged millions of trees from New England to New Jersey. They are now creating blights as far south as Florida, where they thrive even better in the warmer climate. Yet with luck a biological control, a sex chemical of the female moth synthesized two and a half years ago by Dr. Morton Beroza and Barbara Bierl of the U.S. Department of Agriculture at Beltsville, Md., may soon prove to be a useful replacement for DDT against the moth.

Natural extracts of the chemical were used last year to bring the moths out of hiding. This season traps containing the synthetic lure have been used in Pennsylvania and the synthetic lure has been sprayed in parts of Massachusetts and Alabama to jam the male moth's amorous guidance systems.

Although the effectiveness of the traps and lures will not be known until next year when the caterpillars of the gypsy moth emerge, they are expected to work best in areas of low manifestation, since the males spot their mates visually in heavily infested areas.