EDITORIAL

Frontiers in Chemistry

From time to time *Science* presents special issues that are designed to display some of the excitement generated by discoveries in specific fields and to expose the wider scientific community to these advances. This issue of *Science* features chemistry, a particularly appropriate subject because of its significant overlap with physics and biology and because of its impact on our life-style, economy, and environment.

Chemists make molecules and materials; they isolate, analyze, and study substances to elucidate their structure and understand their properties. Chemistry is too diverse and changing too rapidly to be covered by six articles, so the topics selected are representative examples of state-of-the-art research rather than comprehensive overviews of all of the latest discoveries. The kind of research described is often not "directed" toward a specific economic goal, although in many cases ultimate future applications can be put forward.

Organic and inorganic chemistry come together in the area of organometallic chemistry. Casey describes some of the organometallic chemistry of rhenium, the last of the nonradioactive elements. Because of its many oxidation states and its strong bonds to carbon, rhenium exhibits a rich and complex chemistry, including some unusual reaction mechanisms that in certain cases can avoid high-energy intermediates and can exert control over stereochemistry.

Solid-state synthesis is especially important for generating new materials such as molecular sieves and high-temperature superconductors. However, special problems arise because the typically high temperatures required and the inability to influence the structures of products often results in a lack of control over the final outcome—the process is sometimes described as "shake and bake." Stein, Keller, and Mallouk discuss how mechanistic solid-state synthesis can lead to the rational design of structure through low-temperature routes.

Rational drug design, in which molecules are targeted against particular sites of biological action, is gaining increased recognition. Marshall and Caruthers describe one effort in this area, the synthesis of deoxyoligonucleotide analogs. Phosphorodithioate-linked oligonucleotides bind tightly to DNA at the active site for primer templates. Antisense molecules that can bind to DNA in this way have potential therapeutic value in inhibiting viral enzymes, such as HIV reverse transcriptase.

Weak chemical interactions, such as hydrogen bonds, play a major role in chemistry and biology, but because they are so weak, their specific influence on structure and bonding is hard to elucidate. Saykally and Blake use tunable far-infrared lasers to probe the spectroscopy of weakly bound clusters. Studies of tunneling dynamics have revealed insights into the water dimer and trimer, which are important model structures for water, as well as into the nature of the ammonia dimer and of the interaction of water with hydrocarbons.

Complex biological structures are especially interesting because, having evolved over long times and being optimized for specific functions, they can exhibit properties that are not found in simpler molecules or systems. Their complexity, however, poses a major challenge. Solomon and Lowery describe copper proteins with unusual geometrical and electronic structures that contribute to their special reactivity, including long-range electron transfer and multielectron transfer reduction of oxygen to water.

Finally, Warren, Rabitz, and Dahleh describe progress in an area that has been an elusive goal in chemistry and physics. If it were possible to excite molecules and molecular motions in a coherent way, then one could specify the products of chemical reactions through choosing a particular pattern of excitation. Advances in theory and in experimental technique now make it likely that we may one day control chemistry in this way with specially designed laser pulse sequences.

New chemistry: drugs, superconductors, materials, catalysts, as well as insights into physical, chemical, and biological behavior. The intellectual and scientific value of this research is clear; the applications remain to be realized. While we can be certain that some of it will have practical value, none of us can confidently predict which of these advances and areas is destined to have the most impact. We should be very careful not to ruin our scientific support system in our attempts to improve it. We have chosen a conservative investment path by supporting a wide range of endeavors that have been judged important and interesting through the peer-review process. We cannot afford to risk too short a time for investment or to limit ourselves to a narrow field of vision.

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