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EDITORIAL

Bioinorganic Chemistry

Some scientific activity is long-lived, but much of it changes with time. Older areas change and newer areas develop. One of the exciting changes in chemistry has been the renaissance of inorganic chemistry, especially in the area of bioinorganic chemistry. New molecules, new concepts, an understanding of important biology, and the application of new principles to nonbiological problems are among the hallmarks of this field. The remarkable growth of bioinorganic chemistry and its insights that have led to new research in chemistry present an important lesson in the development of science. In this issue, we present a Perspective by Lippard that provides a thoughtful overview of this field and four general articles that delineate some recent developments.

Metals play many important roles in biological systems. Aside from their properties as independent ions and charge carriers, they can act as structural components—holding complex structures together with very specific geometries—and as catalytic centers. Metals have a profound effect in accomplishing many chemical transformations. Almost everyone recognizes the role of iron in the oxygen carrier, hemoglobin, and the role of cobalt in vitamin B_{12} is well known, but the tale is infinitely richer even than these remarkable examples would suggest.

Karlin discusses metalloenzymes—metal-containing proteins that act as catalysts. Basic recurring structures have been found that have been fine-tuned in different proteins in order to carry out specific functions. Understanding these important compounds involves structure elucidation, spectroscopy, mechanistic studies, and biomimetic modeling. Each of these aspects of chemistry are themselves important areas of activity. When all of the pieces are put together, an extremely rich picture results.

In one of the most startling recent discoveries in chemistry and biology, we have learned that RNA can itself be a catalyst. Pyle describes the surprising and extraordinarily interesting phenomena of RNA as a metalloenzyme. Ribozymes require and depend on divalent metal cations for their activity. The metals are crucial for structure by holding the catalyst in the optimum geometry for activity. They also participate in the catalytic reactions of RNA phosphodiester linkages.

Metals play a special role in gene expression. O'Halloran discusses metalloregulatory proteins—how they function and why. Zinc finger proteins are now recognized as among the most pervasive and important structural features in biology. Some pertinent examples of regulation, including the control mechanism for ferritin production and its relation to aconitase activity, are analyzed.

Finally, Abrams and Murrer describe the use of metals in diagnostic reagents and in drugs. Metals can have spectroscopic emission or absorption in regions which are otherwise transparent, so metal-containing diagnostic reagents would appear to be ideal, provided their toxicity can be controlled. Specific biological molecules and organs often show great specificity and binding affinity for certain metals. Consequently, the idea of incorporating metals into diagnostic reagents and into drugs is an important and active area of research. Currently, many imaging methods, such as radiodiagnosis or paramagnetic-enhanced proton relaxation, depend specifically on metals. Similarly, the combination of affinity and chemical reactivity makes cisplatin and related compounds particularly powerful drugs.

The ultimate application of many of the compounds and the principles now being uncovered is sure to be significant. Oxygen carriers modeled on hemoglobin, oxidizing reagents modeled on cytochrome P-450s, reducing reagents modeled on nitrogenase, new diagnostic reagents, and new drugs will benefit all of us in the long run. The perceptive reader will recognize the value of research in new areas such as bioinorganic chemistry and will recognize that directing this research too closely can only be detrimental. Nature still has many secrets for us to discover and unlock, but we have not yet learned enough to know exactly where and how to look.

John I. Brauman