

Preface

Bioinorganic chemistry as a discipline is now two and a half decades old, if we consider its birth to be the first International Conference on Bioinorganic Chemistry (ICBIC) held in Florence, Italy in 1983. I wrote one of the earliest books on the subject, *Bioinorganic Chemistry, an Introduction* (Allyn and Bacon) in 1977. The emphasis there was on physicochemical data and their interpretations. Since then the scope of research on bioinorganic chemistry has greatly expanded, diversified, and deepened, and the quantity of the literature has exploded.

This book does not attempt to summarize the current status of research in all the various areas of the field. It also omits discussion of the methods of research, and hardly deals with biophysical data. For experimental methods, readers are referred to works such as L. Que's *Physical Methods in Bioinorganic Chemistry* (2000) and an ACS publication, "Spectroscopic Methods in Bioinorganic Chemistry" (2003); and some textbooks including the ones by J. Cowan, *Inorganic Biochemistry*, 3rd ed., Wiley-VCH (2007) and R. M. Roat-Malone, *Bioinorganic Chemistry*, Wiley-Interscience (2002). Instead of research details, this book aims to provide general readers as well as specialists with an understanding of the basic chemistry of interactions of inorganic substances with biological systems at the molecular level (as much as possible), and also a perspective on the subject, as the subtitle "A Survey" implies.

Since living organisms and the biosphere they constitute are both open systems, they are in contact with and constantly exchanging energy and material with their environments. The environments experienced by a single organism include all the other organisms and the physical environment, which is composed of inorganic substances. This fundamental situation inevitably entails the inclusion of almost all inorganic elements in living organisms. Hence bioinorganic chemistry, or rather what it implies, is not a novelty but a necessity, and should be universal. Indeed we are increasingly being made aware of the fact that inorganic compounds are intimately associated with all biological phenomena.

My second book (*The General Principles of Biochemistry of the Elements*, Plenum Press, 1987) attempted to lay down several basic principles in order to answer some fundamental questions such as why iron is used for this purpose, and not copper. The present work is to try to extend these ideas while incorporating some of the more recent discoveries.

This book looks at the entire picture of the existence of organisms on Earth in terms of chemistry—molecules/compounds, their interactions and reactions, and the roles that inorganic elements play and why. The Introduction and the first two chapters give fundamentals of interactions between the biosphere and inorganic compounds from the molecular level to the geochemical level. The Introduction is a brief review of basic concepts of biochemistry, and can be skipped or can be used as a Glossary. Chapter 1 is an overview of biogeochemical aspects of bioinorganic chemistry, and Chapter 2 gives a brief introduction to relevant inorganic chemistry.

Chapter 3 is a discussion of the basic issue of why enzymes are so efficient. The information discussed here is not indispensable for understanding the rest of the book, so it can be skipped if circumstances require. Chapters 4 through 9 are concerned mainly with the chemical bases of functions of inorganic elements associated with enzymes and proteins. Chapter 10 deals with workings of inorganic compounds at physiological levels, and Chapter 11 treats the environmental issues including toxicity associated with inorganic elements. The last chapter deals with the medicinal applications of inorganic elements.

Two different kinds of exercises are provided at the end of each chapter—review questions and problems to explore. Both types of exercises are in line with the spirit of this book; they concern chemical principles of the interactions of inorganic chemicals with the biological systems at a molecular level, without discussing experimental data. Therefore, no question is provided regarding experimental data such as kinetic and spectroscopic data. Such questions, if necessary and appropriate, need to be provided by the instructors.

As the volume of relevant literature has become enormous and more details have become available, a single author surely has the difficulty of being sufficiently versed in each and every area of current research. No single book would be able to cover every aspect of the bioinorganic chemistry of even a single element such as calcium in full detail, let alone that of all the significant elements. However, that is in essence what I have tried to do, but not in full detail. In writing this book, I have relied heavily on some excellent summaries in the form of review articles written by experts in each field. I am much indebted to them, and would like to express my gratitude to all those researchers who have contributed to a better understanding of these fascinating aspects of chemical biology.

One of the results of technical advances made in recent decades is an increase in the structural data on proteins (and nucleic acids), and their accessibility through the PDB (Protein Data Bank). Individual researchers and students alike can now explore protein structures in detail. The availability of the PDB has been of enormous help in writing this book. In addition, several other Internet sites have proven very useful; in particular, the general literature search engines called Scopus and ScienceDirect have been indispensable in writing a book of this nature. I would like to express my gratitude to those individuals and organizations that are responsible for providing such readily accessible databases.

This book concludes my efforts over the last three decades to survey the fascinating subject of bioinorganic chemistry. I gratefully acknowledge the comments and suggestions by reviewers: R. J. P. Williams of Oxford University, C. Frank Shaw, III. of Illinois State University, and Murray S. Davies of James Cook Univeristy, Australia. Their comments have improved the manuscript. I also acknowledge gratefully the assistance of J. Woodling of Juniata College Library in finding literature.