Foreword

In 1975 – over 30 years ago (!) – J. M. Wood from the Freshwater Biological Institute of the University of Minnesota published an article from which I would like to cite one of his – then provocative – statements: “If you think that biochemistry is the organic chemistry of living systems, then you are misled; biochemistry is the coordination chemistry of living systems.” (Naturwissenschaften 1975, 62, 357). I find Wood’s point of view as valid today as it was in 1975, and the present book, Concepts and Models in Bioinorganic Chemistry (editors Heinz-Bernhard Kraatz and Nils Metzler-Nolte) is proof that this area of bioinorganic chemistry is flourishing. It is exciting that the word “model” today includes computational efforts to understand the mode of action of enzymes (modeling in silico). Coordination chemistry still is at the heart of new developments and advancements of our understanding of enzymes and other interactions of transition metal ions with biological systems. Biology still amazes and surprises coordination chemists as we try to learn from the spectroscopic features of biological systems how these systems might actually work. Inevitably, this has led – and will continue to lead – to new coordination chemistry (or inorganic chemistry), and the excitement of genuine discovery is undiminished. The present compilation of chapters written by renowned experts provides a vivid impression of the problems and successes in this truly interdisciplinary field.

The big problems in bioinorganic chemistry always seem to involve the activation of small and often very unreactive molecules by the active sites of metalloproteins. Our understanding of the underlying basic chemistry is, in many cases, quite advanced, but some important problems remain to be solved, such as water oxidation in photosystem II and the conversion of dinitrogen to ammonia. Despite the fact that these problems in understanding the mechanistic details will stay with us, now is the time for synthetically oriented inorganic and organic chemists to begin to model functionality. Artificial photosynthesis is still a buzzword which needs substantiation! I hope that this book will inspire many young scientists to go to the bench and synthesize such functional models to take “Bioinorganic model chemistry” to the next stage.

Karl Wieghardt
Preface

In spring 2004, Heinz-Bernhard Kraatz spent a sabbatical within the research group of Nils Metzler-Nolte, in Heidelberg. The visit was the starting point of a fruitful scientific collaboration. In order to ensure that students benefited from Bernie’s often overwhelming enthusiasm for all kinds of problems in chemistry (and not least to rescue some of his precious equipment from the same enthusiasm...), Nils convinced Bernie to join him in a lecture on “Bioinorganic Chemistry” that he was, at the time, giving to second-year BSc students in molecular biotechnology. These students had a solid background not only in chemistry but also in biochemistry and biology. For both lecturers and the students, it was very clear from the outset that there was no textbook available which corresponded to the course content. While specialized review articles presented too many details, the excellent textbooks on “Bioinorganic Chemistry” were too broad in their biology and chemistry backgrounds, and did not present sufficient detail with respect to the individual classes of enzymes. Perhaps more importantly, the available textbooks did not present inorganic model systems in a systematic manner that would be appropriate for advanced students with a solid chemistry background. Consequently, over a few pints of beer on a hot summer evening in Heidelberg, the plan for this book was conceived.

The idea quickly materialized into a set of tentative chapter titles and authors. The first half of the book covers what we call “Concepts” in Bioinorganic Chemistry – that is, the more general subjects such as medicinal inorganic chemistry, metal ion toxicology, bioorganometallic chemistry, and the use of theoretical methods. The second half is organized in terms of the biologically important metal ions, passing roughly from left to right through the Periodic Table. Each author was advised to be selective, and to present rather fewer – albeit instructive – examples. Clearly, a textbook such as this can never be comprehensive, and we have made no attempt even to try. We encouraged each author to be biased and to personalize their chapter, and consequently we must take the blame for eliminating all their efforts to provide comprehensive and complete reviews of their respective fields. What we hope to provide here is a first insight, in a chemically and spectroscopically sound way, into specific topics in bioinorganic chemistry, or an overview of the biologically relevant coordination chemistry of a certain metal ion.

This book is intended for advanced undergraduates and graduate students, as well as their University lecturers, for both class-room use and private study. A basic knowledge of chemistry is required, as well as a general familiarity with
spectroscopic methods and concepts of biology. Because many excellent books provide exactly these backgrounds, none of this is further elaborated here.

In this book, each chapter starts with a “Timeline” to provide the student with an historical perspective. Many of the chapters also contain what is termed a “Table 1”, in which details are presented of some selected enzymes that are relevant to that chapter. As crystal structures are today available for almost all entries that the authors deem relevant, it also attests to the tremendous impact of crystallography on the field. Finally, each chapter summarizes key concepts and highlights open questions. It is hoped that these in particular will stimulate students and young researchers to take the field further and to seek answers to those questions. References were deliberately limited to about 50 for each chapter. Again, they are intended to serve as a starting point for those with deeper interest, rather than as a comprehensive list for the initiated.

For those whose appetite has been wetted, there are, of course, specialized reviews or books for many of the topics provided here. In addition to references in the individual chapters, *Chemical Reviews* has published issues on “Bioinorganic Enzymology” (1996), “Medicinal Inorganic Chemistry” (1999), “Biomimetic Inorganic Chemistry” (2004), and “Inorganic and Bioinorganic Mechanisms” (2005). The series *Metal Ions in Biological Systems* is worth considering for in-depth coverage. Also, *Comprehensive Coordination Chemistry II, Volume 8, “From Biology to Nanotechnology”* contains excellent reviews and concept articles.

Finally, we wish to thank all authors for their input, their time, and their accuracy in preparing the individual chapters. It is an exceedingly difficult task to give a multi-author textbook a unified “look-and-feel”. In as much as we, as editors, were a pest to the authors with requests and comments for (what we believe were) improvements towards this goal, we owe equally much to the publisher and in particular our copy-editor, Bill Down, who was an essential help in unifying text and style. Great thanks go to Gudrun Walter at Wiley-VCH, Weinheim, who encouraged us in the initial stages, and to Bettina Bems and Tim Kersebohm for their perfect guidance through the production process. Finally, we owe a big “Thank You!” to Karin Weiß from the Heidelberg group for logistics support throughout the process of planning, writing, editing, and producing this book. And last – but not least – we hope that you, the readers and students, will enjoy reading and using the book and get the interdisciplinary spirit that lives in “Bioinorganic Chemistry”!

May 2006

Heinz-Bernhard Kraatz

Nils Metzler-Nolte