

*Carsten Schmuck, Helma Wennemers (Eds.)*

# **Highlights in Bioorganic Chemistry**

Methods and Applications



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*Carsten Schmuck, Helma  
Wennemers (Eds.)*

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## Foreword

There are two different aspects to the large field of Bioorganic Chemistry. In one of them we use organic chemistry to learn about and influence biology. This area, part of which is sometimes called Chemical Biology, includes the use of organic chemistry to determine the chemical constitution of biological systems, and to determine the chemical structures of the components. There is intellectual flow from chemistry into biology, as we study the chemical properties of isolated and organized biological systems in order to explain their properties in terms of ordinary chemistry. This is in line with the general belief that we will “understand” biology when we can explain it in chemical terms. However, as we study the properties of biological molecules we also expand our understanding of chemistry itself, so in this sense there is also intellectual flow from biology to chemistry.

Another part of the effort to use chemistry to understand and influence biology is seen in the field of medicinal chemistry. Here too there is intellectual flow in both directions across the chemistry-biology interface, as chemists take what is known about the biology of disease and invent cures using chemicals, usually synthetic chemicals. Success in this field for chemists involves both “listening” to biology and “speaking” with chemistry.

There is another important aspect of bioorganic chemistry in which chemists observe the processes of natural biology and then invent new chemistry inspired by what they see, in a field I have named Biomimetic Chemistry. This activity has been going on for a long time, as we admire what goes on in biology and accept the challenge to imitate it. The imitation normally involves the principles that Nature uses, not the exact details of the process. It has been said that a jumbo jet is not just a scaled up pigeon. From birds we learned the principle of wings, but did not imitate the detail of flapping them. Thus in biomimetic chemistry we expand the scope of chemistry by taking some inspiration from biology. The intellectual flow is from biology to chemistry.

This book, *Highlights in Bioorganic Chemistry*, describes exciting recent advances in all the aspects of the field. Part 1 deals with Biomolecules and their Conformations. Chapters on the natural chemistry of RNA, of  $\beta$ -amino acids, on binding to DNA, on nucleic acid polymerases, on ribozymes and proteases, are concerned with using chemistry tools to help us understand biological chemistry. Part 2 deals with Non-Covalent Intermolecular Interactions. Here there is work on

artificial receptors for natural molecules such as carbohydrates, amino acids, and peptides. Part 3 deals briefly with some aspects of Studies in Drug Development, addressing diseases such as cancer, Alzheimer's disease, and asthma. Part 4 of the book is labeled Studies in Diagnostic Developments, Part 5 is concerned with Catalysis by both natural and artificial enzymes, while part 6 covers Methodology, Bioengineering, and Bioinspired Assemblies, what we have called Biomimetic Chemistry. Its last chapter describes work on molecular motors, imitating the biological motors that drive the rotation of flagellae.

The editors Carsten Schmuck and Helma Wennemers are part of a new and exciting emphasis on bioorganic chemistry in Europe. The two met at Columbia University when Schmuck was in the Breslow lab and Wennemers was working with Clark Still, both in the area of biomimetic catalysis. The other authors are leaders in the field, largely from Germany but also including Switzerland and Austria and one each from Italy and Australia. They have produced a book that reflects the growing importance of bioorganic chemistry in Germany, Switzerland, and Austria. It should be required reading for students and others who want to see where chemistry is heading in the new century.

Ronald Breslow  
Columbia University



## Preface

Bioorganic Chemistry is a diverse research area that has attracted scientists from fields ranging from chemistry over biology, medicine to pharmaceutical science. The book presented here hence highlights research in nucleic acid chemistry, carbohydrates, peptides, molecular recognition, catalysis, biosynthesis and natural biosynthesis. It does not intend to give an exhaustive overview on the field of bioorganic chemistry but is a compilation of research interests by a new generation of scientists from Germany and the neighboring countries. All contributors are researchers from academia and industry who have attended the “Bioorganic Chemistry Symposium” during the years 1999–2002. This conference has been established 12 years ago as a platform to bring together young scientists working in the various fields of bioorganic chemistry and has ever since been an intriguing meeting with an open-minded exchange of ideas. Contributions from the earlier years of the conference have been published by Wiley-VCH in 1999 under the title “Bioorganic Chemistry” by U. Diederichsen, T. K. Lindhorst, B. Westermann and L. A. Wessjohann.

The main focus of bioorganic chemistry is the understanding of the underlying molecular basis of biological processes. These principles are the same for any class of biomolecules. We have therefore subdivided the present book in terms of structure, molecular interactions and function of biomolecules, rather than by the more traditional subdivision by different classes of biomolecules.

In addition to the research and review articles, more general topics and key words like “secondary structure of proteins”, “split-and-mix synthesis”, “molecular beacons”, “SELEX”, etc., that are usually regarded as “common knowledge” in bioorganic chemistry publications, are explained throughout the book in separate boxes. These definitions and background information are referenced with important reviews or seminal publications in the fields. They should allow students an easier access to the field of bioorganic chemistry and help all those teaching bioorganic chemistry. We hope that this book will be useful and inspiring to everybody interested in the ever growing and still developing field of bioorganic chemistry.

We thank all authors for their contributions to the book and our coworkers for their help in editing and merging the individual contributions into a single

manuscript. Finally we would like to thank Dr. Peter Gölitz for encouraging us to undertake the challenge of editing this book and Drs. Karen Kriese and Elke Maase of Wiley-VCH for their continuous motivation and support in getting this book published.

Carsten Schmuck  
Helma Wennemers

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