Book Review

Book Review of Ribozymes and RNA Catalysis

Victoria J. DeRose

J. Am. Chem. Soc., **2008**, 130 (42), 14017-14017 • DOI: 10.1021/ja806587z • Publication Date (Web): 27 September 2008

Ribozymes and RNA Catalysis. Edited by David M. J. Lilley (University of Dundee, U.K.) and Fritz Eckstein(Max-Planck-Institut for Experimental Medicine, Göttingen, Germany).Royal Society of Chemistry: Cambridge. 2008. xx + 318 pp. $169.00. ISBN 978-0-85404-253-1.

The term "ribozyme" was coined by Nobel Laureate Thomas Cech and co-workers 26 years ago to describe an RNA that was able to self-splice and, thus, apparently catalyze chemical reactions. As described in Cech's Foreword to *Ribozymes and RNA Catalysis* edited by Eckstein and Lilley, this discovery led to several predictions about enzyme-like RNA properties that launched careers in this novel field. Less than three decades later, many of these properties are taken for granted by biochemists: RNA, like proteins, can fold into specific structures that precisely position substrates within a catalytic pocket that contains conserved functional groups. Moreover, the breadth of RNA-based catalysis in biology and in vitro, while not vast, has increased to the extent that the activity of ribozymes must be considered as a potential avenue for any process involving RNA or RNA-proteins that includes chemical bond activation. That said, the exact details of how ribozymes use RNA functional groups, cation cofactors, and solvent to effect reactions have been quite difficult to establish even with the aid of higher-resolution RNA structures and sophisticated enzymology. With reviews that bring together the most recent information from biochemistry, structural biology, and phylogenetic analyses, this book is a timely update on the current state of knowledge concerning the mechanisms of ribozymes. Appropriate for an active field, this book includes both up-to-date reviews of the well-studied ribozymes and introductions to newly discovered ones, including the *CPEB3* ribozyme recently found in the human genome. In all cases, the individual chapters are written by experts in the field and provide insightful and, in many cases, quite entertaining reads that include interesting historical perspectives on the field as well as the newest information. In general each chapter is a self-contained description of a ribozyme, including its biological context, structural models, and current mechanistic hypotheses. Although there are many separate authors, a good effort has been made to integrate the chapters with references to other sections of the book where appropriate.

The book begins with two introductory chapters and then covers the major classes of ribozymes, roughly in order of increasing complexity, before closing with a chapter on RNA folding. An "Introduction and Primer" by editors Lilley and Eckstein provides a broad overview of the chemical reactions and RNA reactants that would make a good, brief introduction for any biochemistry lecture on this subject. Following is an in-depth discussion entitled "Proton Transfer in Ribozyme Catalysis" by Bevilacqua that includes general physical organic background material followed by a description of how RNA nucleobases might effect proton transfer in RNA catalysis. Relevant evidence is then summarized for each of the "small" nucleolytic ribozymes that are featured in depth in subsequent chapters. These chapters define a clear forefront challenge in this field, which is to understand how RNA microenvironments and cation cofactors might influence the pK_a's of nucleobases. Space constraints do not allow all chapters to be described in this book review (see also Silverman, *ChemBioChem* **2008**, *9*, 1509−1510, and Harris, *RNA* **2008**, *14*, 1003−1004), but it should be noted that Golden provides a particularly helpful overview of the current state of mainly converging biochemical and structural data on mechanisms for Group I Intron catalysis that include at least two and possibly three metal ions. In this context, as has been noted by previous reviewers of this book, a surprising omission is a chapter concerning active-site metal−RNA interactions that could have made a nice complement to that on nucleobases. A chapter that does provide another important general overview is that by Woodson on RNA folding and kinetic traps, including a general description of cations and RNA. Although found at the end of the book, for someone new to the field, it would be best to read this chapter early or at least before the reviews of the "large" Group I and Group II Intron ribozymes.

Much of this book can be appreciated by a general biochemistry audience. It is obviously most appropriate for graduate students and other researchers in the RNA field, but some chapters could be enjoyed by scientists generally interested in biocatalysis, structural biology, or biopolymers. Members of the chemical biology community might be particularly interested in the description by Link and Breaker of the mRNA-embedded *glmS* ribozymes from gram-positive bacteria. These ribozymes govern gene expression in response to cellular metabolite levels by binding the metabolite and inducing self-cleavage. Also of particular interest to the bioorganic or physical organic chemist, a chapter by Rodnina outlines the current state of peptidyl transfer chemistry as catalyzed within the ribosome. She focuses heavily on comparing the chemical reaction within and outside of an RNA active site and critically reviews current experimental and structural evidence in a thorough mechanistic analysis of this ribozyme that seems ready for the textbooks.

In some cases, readers not intimately familiar with individual ribozymes will come across in-depth descriptions, with unfamiliar nomenclature conventions, that are difficult to follow; these sections are appropriate only for their specific audiences. Overall, however, this is a book that certainly should be found in every laboratory investigating RNA catalysis and can serve as a valuable reference for anyone teaching modern biochemistry.

Victoria J. DeRose, *University of Oregon*

JA806587Z

10.1021/ja806587z

Organic Synthesis: State of the Art 2005−2007. By Douglass F. Taber (University of Delaware, Newark). John Wiley & Sons, Inc.: Hoboken, NJ. 2008. xii + 228 pp. $125. ISBN 978-0-470-28849-8.

This book features articles on important developments in the field of organic synthesis that were originally published in

Unsigned book reviews are by the Book Review Editor.

10.1021/ja806587z CCC: $40.75

Taber's weekly online column, "Organic Chemistry Highlights", from 2005−2007 (see http://www.organic-chemistry.org/Highlights). It follows the first volume in the series, *Organic Synthesis: State of the Art 2003−2005*, and includes cumulative author and reaction indices to both. As a reference and overview of current developments in the field, e.g., asymmetric organocatalysis and C−H functionalization, it should be both useful and valuable to all practitioners of organic synthesis.

JA806854Z

10.1021/ja806854z

Phosphorus Ligands in Asymmetric Catalysis: Synthesis and Applications, Volumes 1−3. Edited by Armin Börner (Universität Rostock). WILEY-VCH Verlag GmbH & Co. KGaA: Weinheim. 2008. xl +1506 pp. $720. ISBN 978-3-527-31746-2.

Chiral trivalent phosphorus compounds are important ligands in metal-catalyzed asymmetric syntheses. According to Börner's introduction, tens of thousands of these ligands have been prepared and tested, while, in a later chapter, Thommen and Blaser quote typical large-scale prices for commercial ligands of $5000 to more than $40,000 per kg. Although a 1991 review on the subject required only 51 pages (see Kagan, H. B.; Sasaki, M. Optically Active Phosphines: Preparation, Uses and Chiroptical Properties. In *The Chemistry of Organophosphorus Compounds*; Hartley, F. R., Ed.; John Wiley and Sons, Ltd.: Chichester, 1990; Vol. 1, pp 51−102), the huge size of this three-volume set reveals recent interest in this class of compounds. It could have been even longer: for example, in Shang and Zhang's 42-page chapter on chiral phosphacycles, they note that a word limit precluded complete coverage, and the 47-page review on P/NR_2 ligands by McManus et al. is also described as not comprehensive. However, some duplication is avoided by the citation of other reviews, and the three volumes present both broad coverage and considerable detail.

These books succeed in the goals of the editor "to summarize the current state of the art in the synthesis of P-ligands" and to pair the synthetic routes that are discussed with "some typical catalytic applications". In contrast to some other reviews that focus on catalytic applications—especially in asymmetric hydrogenation—these volumes are organized by the types of P-ligands, with an emphasis on methods for their preparation. In addition, Volume 3 ends with some valuable chapters on the properties of phosphorus ligands and their use in industrial asymmetric catalysis. Although some readers may be familiar with this information, it would have been better pedagogically to place these reviews at the start of Volume 1, because an important theme in most chapters is the rational design of P-ligand structure to control the properties of a metal complex used in asymmetric catalysis. A chapter on NMR characterization of P-ligands and their complexes, although useful for active researchers in this field, also appears somewhat out of place, given the emphasis on synthesis, while one on organocatalysis with nucleophilic phosphines better fits the theme of the set.

For these volumes, Börner assembled a distinguished team of mostly European authors, several of whom have written previous reviews in these areas and/or developed the chemistry themselves. In most cases the chapters cover the literature through 2006, with a few 2007 references. As usual in a multivolume work, there is occasional overlap among chapters, as in coverage of phospholanes or ligand libraries. This redundancy serves to reinforce certain points and is actually valuable in the sections on peptide-based ligands, as different authors present information with a different focus. The chemical structures are uniformly clear and consistently drawn. The 33-page index is useful but does not seem to be complete. For example, the entry on peptides refers to a chapter on P-ligands bound to chiral biomolecules but not to a later section on libraries of peptide-based P-ligands. Similarly, the index leads to the ligand QuinoxP* on p 1327 but not on p 1208 (however, reference to this page is provided in the index under the unwieldy full name of the phosphine). The table of contents is reproduced in all three volumes, but the index appears only in the last one, which is inconvenient.

In both the text and the schemes, there are relatively few typographical errors, which usually do not obscure the intended meaning. One striking example is the title of the attractive cover picture, which is referred to as "A Golden Tread" in one place and "Threat" in another, instead of the correct "Thread". More serious are occasional errors in content, such as confusing the ligands BoPhoz and BozPhos; including the wrong structure for DuanPhos; referring several times to kinetic resolution, when optical resolution is intended; and illustrating the synthesis of Trichickenfootphos, but showing a related ligand, MiniPhos, as the product, both in the scheme and in the accompanying text. From these examples, it appears that the appendix with a "short collection of the most typical phosphorus compounds discovered so far," advertised on the back cover of each volume, but not present would have been a useful addition. Despite these caveats, the quality of the reviews is generally high, and they succeed in illustrating the remarkable diversity of known ligand structures. Readers can also learn about such interesting concepts as metal-containing organocatalysts, isotope effects on enantioselectivity observed on changing from a $P-C_6H_5$ to a $P-C_6D_5$ ligand, and the application of combinatorial ligand libraries, described as "reasonable protocols because they help to funnel serendipity".

In summary, these books will certainly be useful for researchers working on the synthesis and application of chiral phosphorus ligands. They will also be valuable for chemists who want to prepare ligands that are structurally related to those already investigated in catalysis, and they provide a good starting point for readers with a general interest in asymmetric catalysis. The three-volume set is recommended for libraries, but the high price will probably keep it out of individual laboratories.

David S. Glueck, *Dartmouth College*

JA8067758

10.1021/ja8067758

The Inorganic Radiochemistry of Heavy Elements: Methods for Studying Gaseous Compounds. By Ivo Zvára (Joint Institute for Nuclear Research, Dubna, Russian Federation). Springer Science + Business Media B.V.: http://www.springer-sbm.de. xxviii + 226 pp. $279. ISBN 978-1-4020-6601-6.

This is an interesting and well-prepared book. However, it covers only the gas-phase chemistry of elements of atomic numbers greater than $Z = 103$. As a result, it will be of interest to very few readers of *JACS*. Also, since only a few, very short-

lived atoms of these elements are made, the chemistry is very limited, as the time for study is seconds. In the six brief chapters, the limited data are well evaluated and presented. However, given the few *JACS* readers who would be interested in the subject and its irrelevance to the chemistry of the normal $Z < 103$ elements, this book will appeal to only a very narrow scientific audience.

Gregory R. Choppin, *Florida State University*

JA807013H

10.1021/ja807013h

Nanomaterials Chemistry: Recent Developments and New Directions. Edited by C. N. R. Rao (Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India), A. Müller (University of Bielefeld, Germany), and A. K. Cheetham (University of California, Santa Barbara). Wiley-VCH, GmbH & Co. KGaA: Weinheim. 2007. xvi + 404 pp. $200. ISBN 978-3-527-31664-9.

This is a very timely book that will prove to be a valuable resource both for those entering the field of nanomaterials chemistry and for those already well established in it. It is an edited volume consisting of 11 chapters on a range of subtopics, all written by leaders in this important emerging field of materials science. Each chapter is relatively self-contained.

The volume begins with a number of chapters on chemical synthesis, e.g., "Recent Developments in the Synthesis, Properties and Assemblies of Nanocrystals" by Thomas and O'Brien and "Nonaqueous Sol-Gel Routes to Nanocrystalline Metal Oxides" by Niederberger and Antonietti, and ends with an excellent chapter on the physics of "Nanoscale Electronic Inhomogeneities in Complex Oxides" by Shenoy et al. A comprehensive survey of carbon and inorganic-based nanotubes and nanowire materials is also provided by Vivekchand et al., with over 460 references from 2005 and 2006 alone.

For those interested in applications, there are several chapters that more than satisfy this need. In "Applications of Nanostructured Hybrid Materials for Supercapacitors", Murugan and Vijayamohanan describe advances in this rapidly developing alternative method for the storage of electrical energy where nanomaterials could have a major impact. There is also a chapter by Jayaraman on dendrimers and their applications as chemical and biochemical nanoscale sensors. Narayan and Dutta provide an interesting chapter on "Molecular Approaches in Organic/Polymeric Field-effect Transistors". These low-cost devices could have a major impact in the electronics industry in the near future. In the following chapter, "Supramolecular Approaches to Molecular Machines", Grossel describes the synthesis and properties of catenanes and rotaxanes. For those with a biochemical bent, there is a short chapter by Reches and Gazit on recent developments in peptide-based nanomaterials.

Some chapters are tutorial in character and very educational. For example, the chapters on "Growth of Nanocrystals in Solution" by Viswanatha and Sarma and "Surface Plasmon Resonances in Nanostructured Materials" by Thomas thoroughly cover the concepts, principles, and theories behind these important phenomena.

With over 400 pages, the volume is modestly priced at $200.00. I highly recommend it both for individual researchers and for institutional libraries.

Richard D. Adams, *University of South Carolina*

JA806755N

10.1021/ja806755n

Annual Review of Materials Research. Volume 38, 2008. Edited by David R. Clarke (University of California, Santa Barbara), Manfred Rühle (Max-Planck Institute for Metals Research, Stuttgart), and Guest Editor, Antoni P. Tomsia (Lawrence Berkeley National Laboratory, Berkeley). Annual Reviews: Palo Alto, CA. 2008. xiv + 588 pp. $89.00. ISBN 978-0-8243-1738-6.

This book is a collection of 23 reviews in different areas of materials research, including a special 12-chapter section on the state-of-the-art in low- and high-temperature wetting. A sampling of reviews in this section includes "Anisotropy in Wetting" by Chatain and "Wetting in Soldering and Microelectronics" by Matsumoto and Nogi. The remaining section titled "Current Interest" hosts a range of topics from "Bamboo and Wood in Musical Instruments" by Wegst, to "Formation and Properties of Quasicrystals" by Louzguine-Luzgin and Inoue, to "Trends in the Development of New Mg Alloys" by Bamberger and Dehm. A cumulative index of contributing authors from Volumes 34−38 completes the book.

JA807114V

10.1021/ja807114v

DNA Interactions with Polymers and Surfactants. Edited by Rita S. Dias and Bjorn Lindman(Lund University, Sweden). John Wiley & Sons, Inc.: Hoboken, NJ. 2008. xviii + 408 pp. $150. ISBN 978-0-470-25828-7.

The physical interactions of DNA with polymers and surfactants are of interest due to the potential benefits in biotechnology and the use of DNA as a building block in self-assembled structures. Although the book contains information about the characterization of cationic polymers and lipids as nonviral gene delivery vehicles, at its core it focuses primarily on the physical interaction and modeling of DNA with small molecules, polymers, surfactants, and with itself. In particular, this book begins with an investigation of DNA as a polyelectrolyte and a description of its biophysical properties in solution and as a single molecule. The interaction of DNA with surfactants, cationic polymers, and lipids is covered next, with the focus first being on single molecule models and then on interactions in solution. The information presented provides molecular models of what the different structures of DNA with these molecules would look like. Finally, the book gives an overview of how DNA is compacted and decompacted inside the nucleus by investigating a simple charged cylinder model.

This book would be of great interest to scientists investigating materials for gene delivery, as well as to molecular biologists, polymer chemists, and biophysicists interested in the interaction

of DNA with polymers and surfactants and the physical characterization of DNA.

Tatiana Segura, *University of California*

JA807118R

10.1021/ja807118r

Carbons and Carbon Supported Catalysts in Hydroprocessing. By Edward Furimsky (IMAF Group, Ottawa, Canada). Royal Society of Chemistry: Cambridge. 2008. xiv + 160 pp. $199. ISBN 978-0-85404-143-5.

The contents of this book cover recent developments in carbons and carbon-supported catalysts in hydroprocessing, with particular focus on the potential application of supports such as carbon black and activated carbon. The applications of other materials, such as carbon fibers, carbon nanotubes, and fullerenes, are examined as well. Using model compounds and real feeds under variable conditions, the author also compares the activity and stability of carbon-supported catalysts with oxidic-supported catalysts, particularly γ-Al_2O_3, and discusses the future promise of carbon-supported catalysts during hydroprocessing. A subject index completes the book.

JA807116W

10.1021/ja807116w

Organic Nanostructures. Edited by Jerry L. Atwood (University of Missouri-Columbia, USA) and Jonathan W. Steed(University of Durham, U.K.). Wiley-VCH GmbH & Co. KGaA: Weinheim. 2008. xviii + 352 pp. $200. ISBN 978-3-527-31836-0.

Organic nanostructures, as is now known, are an integral part of ecology and life. Yet, understanding them at a molecular level and creating them by assembling various components remain a challenge in the 21st century. There have been significant efforts in recent years to design various organic nanostructures and tailor their properties for use in various molecular devices. This book is timely because it draws contributions from experts in molecular assemblies, solid-state materials, crystal engineering, and inorganic−organic hybrid materials. The chapters are thematically organized to illustrate small-scale molecular concepts leading to "synthesize-up" nanostructures and nanoassemblies. The contributions of various experts provide a perspective of recent developments in the area of organic nanostructures and encourage cross-fertilization into other disciplines.

Balzani leads off with a chapter on supramolecular photochemistry and the progress in artificial photochemical devices. He not only describes the basics of photochemistry but also discusses strategies to develop molecular structures and manipulate photoinduced energy and electron transfer processes. This is followed by chapters on strategies to build metal−organic frameworks and molecular machines using rotaxanes as ligands, anion templates for assembly of interlocked structures, and the design of nanotubes using calixarenes. The chapters on molecular gels, nanoporous crystals, and polymorphs from crystals provide insight into crystal engineering of molecular assemblies in nanometric dimensions. The structure and function of polyoxometalate nanocapsules and organometallic complexes open up new ways to design inorganic−organic hybrid assemblies. The book concludes with a chapter on organic nanocapsules that encapsulate probe molecules in stable hydrogen-bonded hexameric units.

While most of the attention has been directed in recent years toward the design and development of inorganic nanomaterials, this book by Atwood and Steed provides the fundamental aspects of molecular design of organic nanostructures. The book's focus is toward the design of various nanostructures based on molecular architecture. However, a discussion of molecular electronics, organic nanostructure-based devices, and the application of these systems in biological systems would have been useful. A couple of chapters on these topics would have expanded the book's scope and provided a basis for cross-fertilization into other areas of research. Still, the chapters are clearly written by leading experts and provide molecular-based strategies to design organic nanostructures and nanoassemblies. Overall, this book is a welcome addition to the chemical literature that should serve as a ready reference for graduate students and scientists who wish to pursue research in designing organic nanostructures.

Prashant V. Kamat,
University of Notre Dame

JA8072935

10.1021/ja8072935