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Review of Sigel, A.; Freisinger, E.; Sigel, R.K.O. (2021) Metal ions in bio-imaging techniques

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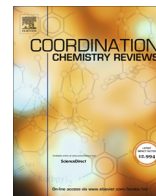
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Book review

Metals Ions in Bio-Imaging Techniques, Astrid Sigel, Eva Freisinger, Roland K. O. Sigel (Eds.). Vol. 22 of **Metal Ions in Life Sciences**, Walter de Gruyter, Berlin, Germany (2021). 503 + xlv pp., ISSN: 1559-0836; 1868-0402 (electronic). ISBN: 978-3-11-068556-5; 978-3-11-068570-1 (electronic PDF); 978-3-11-068578-7 (electronic EPUB). DOI: 10.1515/9783110685701

This volume is the latest one of the series **Metal Ions in Life Sciences** and describes recent developments in the field of Bioinorganic Chemistry. The series is the successor of **Metal Ions in Biological Systems** that begun in 1973, and for which 44 volumes had been produced (till 2005). The old and the new series have a strong reputation of Volumes and chapters written by top-scientists.

Both series form a singular achievement in scientific commissioning and editing started by Astrid and Helmut Sigel, and later joined by Roland Sigel and Eva Freisinger. This series has a focus on the understanding of the essential roles that metal compounds and metal ions play in living systems, be it human, or animal, or involving large ecosystems. The whole series is focused on authoritative and usually specialized reviews. With the explosion in the number of research papers in this field during the last decades, scientists will regularly need authoritative reviews to remain up-to-date. And this series no doubt has been playing a leading role in providing authoritative overviews for almost half a century. Of course, the broadness of the field requires input of highly qualified editors with a strong reputation who can detect and convince top-scientists that have to write the chapters. The present Volume starts with a very informative overview of all book titles till today, i.e. 44 Volumes "Metals ions in Biological Systems" and 21 preceding Volumes in the present series, including all chapter titles and authors. The theme of the latest Volume "Metal Ions in Bio-imaging Techniques" has generated a set of 17 excellent chapters, all of a high standard and written with great dedication to the subject.

The current volume 22 focuses on bioimaging using metal ions. In 17 chapters a comprehensive overview of the field has been reached. After an extensive introductory overview written by Shuvaev and Caravan on bio-imaging techniques using largely exogenous metal ions, 16 detailed chapters follow dealing with the use of over 40 different metal ions in imaging and therapy.

Chapter 2 deals with Gd-based contrast agents; this field started already in the 1980s, but is still an actual topic; the chapter is presented by a team of authors coordinated by Erno Brücher and Imre Tóth. They make clear that Gd is still crucial and will remain so, with some 450 million MRI exams per year, and especially dual-probe techniques and theranostic agents are predicted to develop. In Chapter 3 Lacerda, Ndiaya and Eva Tóth present a chapter on the status of using Mn(II) and Mn(III) compounds as possible alternatives for Gd, to use in contrast agents and MRI. Chapter 4 written by Rodriguez, Zaiss, Esteban, Angelovski and Platas-Iglesias is focused on the Paramagnetic Chemical Exchange Saturation Transfer Technique (ParaCEST), to generate optimal contrast, by

using lanthanoids and transition-metal compounds. Luminescent lanthanoid compounds used for optical imaging is a rather new application, and is discussed in Chapter 5 by Sørensen and Faulkner.

In a next group of chapters, radioactive isotopes are discussed. Chapter 6 reviews cyclotron generated synthetic Radiometals for Positron Emission Tomography (PET), using isotopes of e.g. Ga, Cu, Mn, lanthanoids. The chapter is written by Boros et al. They make clear that SPECT and PET are of great importance and even essential, worldwide-used tools. Technetium isotope imaging (^{99m}Tc) was introduced in the 1960s, and is perhaps the most well known, easily available routine radionuclide amongst imaging agents. Its principles and applications (over 11 million patients each year worldwide) are described and evaluated in detail by Alberto and Nadeem in Chapter 7.

Chapter 8 deals with a relatively new application of using paramagnetic metal ions as probes for ^{19}F MRI; the chapter is written by Hermann, Blahut, Kotek and Herynek. The principle of this technique is also very nicely illustrated at the book front cover. Nanoparticles of iron oxides as strong contrast enhancers used in bio-imaging (MPI, Magnetic Particle Imaging) is reviewed by Geraldes and Delville in Chapter 9. Teh and Kauwe describe in Chapter 10 how corrole-based nanoparticles can be used in therapy and magnetic resonance contrast enhancements.

A next group of chapters deals with Theranostics (earlier sometimes also called Theragnostics), a combination of therapy and diagnostic imaging. Theranostics driven by PET are reviewed in Chapter 11, by Baranyai and colleagues. Theranostic usage of Gd (III) is a rapidly evolving new development, as is made clear in Chapter 12, written by McLeod and Meade.

To image cancer cells, luminescence is now commonly used, and the major applications of it are reviewed in Chapter 13 by Monteiro, Sobrinho and Bettencourt-Dias. Bio-imaging making use of Iridium is not yet so common, but its application in fluorescence microscopic cell imaging is developing rapidly as described in Chapter 14 by Mao et al. nowadays the imaging of bacteria appears possible with contrast-enhanced magnetic resonance, as briefly reviewed by Adams and Meade in Chapter 15. Au-Yeung and Tong review the use of transition-metal compounds and imaging probes as applied in the field of neurobiology (Chapter 16).

The last chapter (17) written by Dong and Cormode reviews the use of heavy metals, (elements with high atomic number, Z) for X-ray contrast to assist in analysing soft tissues. After BaSO_4 and iodinated organic molecules no other elements are as yet in routine use, but several other elements like Ta, Bi, Ag and Au are being developed. For molecular imaging such isotopes can also be used as is nicely explained.

The book as a whole appears as comprehensive and balanced. It is well composed and high-quality edited. It for sure confirms the high reputation that this series has gained in the last decades. The book makes optimal use of high-quality color figures, and the edi-

torial accuracy is further illustrated by a carefully composed subject index. Moreover, each chapter has the same format and layout, including a brief abstract and a list of abbreviations. In fact each chapter can be used and read independently from the others, but also this Volume as a whole comprises the recent developments in this research field in an excellent way. "From imaging, to diagnosis and therapy using metal compounds" could perhaps have been a subtitle of the Volume. Anyway, a book that should be available in academic chemistry, medical and general science libraries.

Brief CV of author: Jan Reedijk (1943) studied chemistry at Leiden University from 1961 to 1968, where he completed his PhD. After a few years as junior lecturer at Leiden University he accepted a readership at Delft University of Technology in 1972. In 1979 he accepted a call for Professor of Chemistry at his alma mater, Leiden University. After 30 years of service, he retired from teaching in 2009.

In Leiden he has acted as chair of the Department of Chemistry, and in 1993 he became the founding director of the Leiden Institute of Chemistry.

His major research activities have been in Coordination Chemistry and Bioinorganic Chemistry, with research focusing on biomimetic catalysis, molecular materials and medicinal inorganic chemistry. On the occasion of his 65th birthday he was knighted by the Queen of the Netherlands to the order of the Dutch Lion. Jan Reedijk was elected member of the Royal Netherlands Academy of Sciences in 1996.

He has acted as Executive Secretary of the International Conferences of Coordination Chemistry



(1988–2012) and served IUPAC in the Division of Inorganic Chemistry as member and (vice/past) president from 2005 to 2018. After retirement he remained active as research consultant and in IUPAC activities, as well as in editorial jobs for Elsevier as Editor-in-Chief of the References Modules in Chemistry (2013–2019), and together with Ken Poeppelmeier for Comprehensive Inorganic Chemistry II (2008–2013) and Comprehensive Inorganic Chemistry III (2019–present). From 2018 to 2020 he co-chaired the worldwide celebrations of the International Year of the Periodic Table 2019. Jan Reedijk has published over 1200 papers (1965–2021), has supervised 90 PhD students, over 100 pdocs and over 250 MSc students.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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