

*Astrid Sigel, Helmut Sigel, Eva Freisinger,
Roland K. O. Sigel (Eds.)*

METAL IONS IN LIFE SCIENCES

About the Series ...

Metal Ions in Life Sciences links coordination chemistry and biochemistry in their widest sense and thus increases our understanding of the relationship between the chemistry of metals and life processes. The series reflects the interdisciplinary nature of *Biological Inorganic Chemistry* and coordinates the efforts of scientists in fields like biochemistry, inorganic chemistry, coordination chemistry, molecular and structural biology, biophysics, enzymology, environmental chemistry, physiology, toxicology, pharmacy, and medicine. Consequently, the volumes are an essential source for researchers active in these and related fields, as well as teachers preparing courses, e.g., in Bioinorganic Chemistry.

METAL IONS IN LIFE SCIENCES

Book Series edited (see also www.bioinorganic-chemistry.org/mils)

Scheduled (in preparation):

"Metal-Containing Molecules and Nanomaterials: From Diagnosis to Therapy":

Volume 26 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402)

Guest Editor: Ana de Bettencourt-Dias, University of Nevada, Reno, USA

Series Editors: Astrid Sigel, Helmut Sigel, Eva Freisinger, and Roland K. O. Sigel;
Taylor&Francis/CRC Press, Boca Raton, USA; 2023

"Modern Avenues in Metal-Nucleic Acid Chemistry":

Volume 25 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402)

Guest Editors: Jens Müller, Westfälische Wilhelms-Universität Münster, Münster, Germany and Bernhard Lippert, Technische Universität Dortmund, Dortmund, Germany

Series Editors: Astrid Sigel, Helmut Sigel, Eva Freisinger, and Roland K. O. Sigel;
Taylor&Francis/CRC Press, Boca Raton, USA; 2023

"Targeted Metallo-Drugs: Design, Development, and Mode of Action":

Volume 24 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402)

Guest Editors: Etelka Farkas, University of Debrecen, Hungary, and Celine J. Marmion, University of Medicine and Health Sciences, Dublin, Ireland

Series Editors: Astrid Sigel, Helmut Sigel, Eva Freisinger, and Roland K. O. Sigel;
Taylor&Francis/CRC Press, Boca Raton, USA; 2023

Scheduled (contents tentative):

"Molecular Bio-Sensors and the Role of Metal Ions" :

Volume 23 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402)

Guest Editor: Thomas J. Meade, Northwestern University, Evanston, USA

Series Editors: Astrid Sigel, Helmut Sigel, Eva Freisinger, and Roland K. O. Sigel;

Taylor&Francis/CRC Press, Boca Raton, USA; 2022

1. Metalloid-Sensing Transcriptional Regulatory Proteins

Jian Chen and Barry P. Rosen

2. Magnetic Resonance Imaging Biosensors for Calcium(II)

Goran Angelovski

3. Sensing Calcium Dynamics and Calcium Signaling
Li Tian, Xiaonan Deng, Susan Kleinfelter, Michael Kirberger, and Jenny Yang
4. Biosensors for Iron and Manganese
Jennifer Park, Jiansong Xu, and Joseph A. Cotruvo, Jr.
5. Fluorescent Probes for Zinc Ions and Their Applications in the Life Sciences
Tingwen Wei, Nahyun Kwon, Juyoung Yoon, and Xiaoqiang Chen
6. Chemo- and Bio-Sensors for Cu(I) and Cu(II) Species
Paramesh Jangili, Nem Singh, Ilwha Kim, Zehra Zunbul, and Jong Seung Kim
7. Molecular Design of Cadmium-Specific Fluorescent Sensors
Yuji Mikata
8. Molecular Biosensors and the Biological and Biomedical Activities of Vanadium
Nuttaport Samart, Deborah A. Roess, and Debbie Crans
9. Non-invasive Detection of Stem Cell Therapies Facilitated by Metal Ion-Based Contrast Agents
Meghan W. Dukes, Michel Modo and Thomas J. Meade
10. Optical and Electrochemical Metal-Based Sensors in Biological Systems
Patrick S. Barber, Ana de Bettencourt-Dias, and Jorge H. S. K. Monteiro

Published:

"Metal Ions in Bio-Imaging Techniques" :

Volume 22 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402; ISBN: 978-3-11-068556-5; e-ISBN (PDF): 068570-1; e-ISBN (EPUB): 978-3-11-068570-7. DOI: 10.1515/9783110685701)
Editors: Astrid Sigel, Eva Freisinger, and Roland K. O. Sigel;

Walter de Gruyter, GmbH, Berlin, Germany; 2021

1. Metal Ions in Bio-Imaging Techniques: A Short Overview
Sergej Shuvaev and Peter Caravan
2. Gadolinium(III)-Based Contrast Agents for Magnetic Resonance Imaging: A Re-Appraisal
Gyula Tircsó, Enikő Tóth-Molnár, Tibor Csupász, Zoltán Garda, Richárd Botár, Ferenc K. Kálmán, Zoltán Kovács, Ernő Brücher, and Imre Tóth
3. Manganese Complexes as Contrast Agents for Magnetic Resonance Imaging
Sara Lacerda, Daouda Ndiaye, and Éva Tóth
4. Metal Ion Complexes in Paramagnetic Chemical Exchange Saturation Transfer (ParaCEST)
Aurora Rodríguez-Rodríguez, Moritz Zaiss, David Esteban-Gómez, Goran Angelovski, and Carlos Platas-Iglesias
5. Lanthanide Complexes Used for Optical Imaging
Thomas J. Sørensen and Stephen Faulkner
6. Radiometals for Positron Emission Tomography (PET) Imaging
Shion-Hye Ahn, Alexia G. Cosby, Angus J. Koller, Kirsten E. Martin, Apurva Pandey, Brett A. Vaughn, and Eszter Boros
7. ^{99m}Tc -Based Imaging Agents and Developments in ^{99}Tc Chemistry
Roger Alberto and Qaisar Nadeem
8. Paramagnetic Metal Ion Probes for ^{19}F Fluorine Magnetic Resonance Imaging
Petr Hermann, Jan Blahut, Jan Kotek, and Vit Herynek
9. Iron Oxide Nanoparticles for Bio-Imaging
Carlos F. G. C. Geraldés and Marie H el ene Delville

10. Magnetic Resonance Contrast Enhancement and Therapeutic Properties of Corrole Nanoparticles
James Teh and Lali Medina Kauwe
11. Theranostics as Driven by Positron Emission Tomography
Suresh Pandey, Giovanni B. Giovenzana, Dezső Szikra, and Zsolt Baranyai
12. Magnetic Resonance Theranostics: An Overview of Gadolinium(III)-Based Strategies and Magnetic Particle Imaging
Shaunna M. McLeod and Thomas J. Meade
13. Luminescence Imaging of Cancer Cells
Jorge Monteiro, Josiane A. Sobrinho, and Ana de Bettencourt-Dias
14. Iridium(III) Complexes in Bio-Imaging Including Mitochondria
Cai-Ping Tan, Jie Wang, Lian-Nian Ji, and Zong-Wan Mao
15. Imaging Bacteria with Contrast-Enhanced Magnetic Resonance
Casey J. Adams and Thomas J. Meade
16. Transition Metals and Imaging Probes in Neurobiology and Neurodegenerative Diseases
Ho Yu Au-Yeung and Ka Yan Tong
17. Heavy Elements for X-Ray Contrast
Yuxi C. Dong and David P. Cormode

Subject Index

"Metals, Microbes, and Minerals: The Biogeochemical Side of Life"
Volume 21 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402; ISBN: 978-3-11-058890-3; e-ISBN (PDF): 978-3-11-058977-1; e-ISBN (EPUB): 978-3-11-058893-4. DOI: 10.1515/9783110588903)
Guest Editors: **Peter M. H. Kroneck**, University of Konstanz, Germany, and **Martha E. Sosa Torres**, Universidad Nacional Autónoma de México, México
Series Editors: Astrid Sigel, Eva Freisinger, and Roland K. O. Sigel; Walter de Gruyter, GmbH, Berlin, Germany; 2021

1. Introduction: From Rocks to Living Cells
Martha E. Sosa Torres and Peter M. H. Kroneck
2. Microbes: Masters of the Global Element Cycles
Bernhard Schink
3. Biological Isotope Fractionation and Earth History: From Enzymes to Cells, to Ecosystems
Shawn E. McGlynn
4. Imaging Trace Metals in Biological Systems
Jiyao Yu, Shefali Harankhedkar, Arielle Nabatilan, and Christoph J. Fahrni
5. Minerals and the Emergence of Life
Simon Duval, Kilian Zuchan, Frauke Baymann, Barbara Schoepp-Cothenet, Elbert Branscomb, Michael J. Russell, and Wolfgang Nitschke
6. The Formation of Iron Biominerals in Magnetotactic Bacteria
René Uebe and Dirk Schüler
7. Living on Iron
Stefanie Becker, Allison M. L. Enright, and Andreas Kappler
8. Extracellular Redox Chemistry
Inês B. Trindade, Caterina M. Paquete, and Ricardo O. Louro
9. Coping with Toxic Metals
Zhiguang Xiao and Anthony G. Wedd
10. The Biochemistry of Rare Earth Elements
Lena J. Daumann and Huub J. M. Op den Camp

Subject Index

"Transition Metals and Sulfur: A Strong Relationship for Life"
Volume 20 of Metal Ions in Life Sciences (ISSN: 1559-0836; e-ISSN:

1868-0402. ISBN: 978-3-11-058889-7; e-ISBN (PDF): 978-3-11-058975-7; e-ISBN (EPUB): 978-3-11-058894-1. DOI: 10.1515/9783110588897)
Guest Editors: **Martha E. Sosa Torres**, Universidad Nacional Autónoma de México, México, and **Peter M. H. Kroneck**, University of Konstanz, Germany
Series Editors: Astrid Sigel, Eva Freisinger, and Roland K. O. Sigel; Walter de Gruyter, GmbH, Berlin, Germany; 2020

1. Introduction: Transition Metals and Sulfur
Martha E. Sosa Torres and Peter M. H. Kroneck
2. Sulfur, the Versatile Non-metal
Martha E. Sosa Torres, Alfonso Rito Morales, Alejandro Solano Peralta, and Peter M. H. Kroneck
3. The Type 1 Blue Copper Site: From Electron Transfer to Biological Function
Trinidad Arcos-López, Nils Schuth, and Liliana V. Quintanar
4. Purple Mixed-Valent Copper A
Marcos N. Morgada, Daniel H. Murgida, and Alejandro J. Vila
5. The Tetranuclear Copper-Sulfide Center of Nitrous Oxide Reductase
Sofia R. Pauleta, Marta S. P. Carepo, and Isabel Moura
6. Cytochrome P₄₅₀. The Dioxygen-Activating Heme Thiolate
F. Miguel Castro Martínez, R. Daniel Páez López, Pedro D. Sarmiento Pavía, Martha E. Sosa Torres, and Peter M. H. Kroneck
7. Basic Iron-Sulfur Centers
Claudia Andreini and Simone Ciofi-Baffoni
8. The Cofactors of Nitrogenases
Ivana Djurdjevic, Christian Trncik, Michael Rohde, Jakob Gies, Katharina Grunau, Florian Schneider, Susana L. A. Andrade, and Oliver Einsle
9. Molybdenum and Tungsten Cofactors and the Reactions They Catalyze
Khadanand KC and Martin L. Kirk

10. The Siroheme-[4Fe-4S] Coupled Center
Isabel Askenasy and M. Elizabeth Stroupe
11. Nickel, Iron, Sulfur Sites
Yulia Ilina, Berta M. Martins, Jae-Hun Jeoung, and Holger Dobbek
12. Zinc Fingers
Gaetano Malgieri, Luigi Russo, Gianluca D'Abrosca, Ilaria Baglivo, Paolo V. Pedone, Roberto Fattorusso, and Carla Isernia

Subject Index

"Essential Metals in Medicine: Therapeutic Use and Toxicity of Metal Ions in the Clinic"

Volume 19 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; e-ISSN: 1868-0402. ISBN: 978-3-11-052691-2; e-ISBN (PDF): 978-3-11-052787-2; e-ISBN (EPUB): 978-3-11-052698-1. DOI: 10.1515/9783110527872)
Guest Editor: **Peggy L. Carver**, University of Michigan, USA
Series Editors: Astrid Sigel, Eva Freisinger, and Roland K. O. Sigel;
Walter de Gruyter, GmbH, Berlin, Germany; 2019, 456 pages

1. Metals in Medicine: The Therapeutic Use of Metal Ions in the Clinic
Peggy L. Carver
2. Small Molecules: The Past or the Future in Drug Innovation?
Anne Robert, Françoise Benoit-Vical, Yan Liu, and Bernard Meunier
3. Iron Chelation for Iron Overload in Thalassemia
Guido Crisponi, Valeria M. Nurchi, and Joanna I. Lachowicz
4. Ironing out the Brain
Roberta J. Ward and Robert R. Crichton
5. Infections Associated with Iron Administration
Manfred Nairz and Guenter Weiss
6. Iron Oxide Nanoparticle Formulations for Supplementation
Amy B. Pai

7. Building a Trojan Horse: Siderophore-Drug Conjugates for the Treatment of Infectious Diseases
Elzbieta Gumienna-Kontecka and Peggy L. Carver
8. Developing Vanadium as an Antidiabetic or an Anticancer Drug: A Clinical and Historical Perspective
Debbie C. Crans, LeRee Henry, Gabriel Cardiff, and Barry I. Posner
9. Chromium Supplementation in Human Health, Metabolic Syndrome, and Diabetes
Wolfgang Maret
10. Manganese: Its Role in Disease and Health
Keith M. Erikson and Michael Aschner
11. Cobalt-Schiff Base Complexes: Preclinical Research and Potential Therapeutic Uses
Elizabeth A. Bajema, Kaleigh F. Roberts, and Thomas J. Meade
12. Copper Depletion as a Therapeutic Strategy in Cancer
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13. Metal Compounds in the Development of Antiparasitic Agents: Rational Design from Basic Chemistry to the Clinic
Dinorah Gambino and Lucia Otero
14. Chemical and Clinical Aspects of Metal-Containing Antidotes for Poisoning by Cyanide
Sigridur G. Suman and Johanna M. Gretarsdottir

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"Metallo-Drugs: Development and Action of Anticancer Agents"
Volume 18 of Metal Ions in Life Sciences (ISSN: 1559-0836; e-ISSN: 1868-0402. ISBN: 978-3-11-046984-4; e-ISBN (PDF): 978-3-11-047073-4; e-ISBN (EPUB): 978-3-11-046990-5; Set-ISBN: 978-3-11-047074-1. DOI: 10.1515/9783110470734)
Editors: Astrid Sigel, Helmut Sigel, Eva Freisinger, and Roland K. O.

Sigel; Walter de Gruyter, GmbH, Berlin, Germany; 2018, 630 pages

1. Cisplatin and Oxaliplatin: Our Current Understanding of Their Actions
Imogen A. Riddell and Stephen J. Lippard
2. Polynuclear Platinum Complexes. Structural Diversity and DNA Binding
Viktor Brabec, Jana Kasparikova, Vijay Menon, and Nicholas P. Farrell
3. Platinum(IV) Prodrugs
V. Venkatesh and Peter J. Sadler
4. Metalloglycomics
Nicholas P. Farrell, Anil K. Gorle, Erica J. Peterson, and Susan J. Berners-Price
5. The Deceptively Similar Ruthenium(III) Drug Candidates KP1019 and NAMI-A Have Different Actions. What Did We Learn in the Past 30 Years?
Enzo Alessio and Luigi Messori
6. Multinuclear Organometallic Ruthenium-Arene Complexes for Cancer Therapy
Maria V. Babak and Wee Han Ang
7. Medicinal Chemistry of Gold Anticancer Metallodrugs
Angela Casini, Raymond Wai-Yin Sun, and Ingo Ott
8. Coordination Complexes of Titanium(IV) for Anticancer Therapy
Edit Y. Tshuva and Maya Miller
9. Health Benefits of Vanadium and Its Potential as an Anticancer Agent
Debbie C. Crans, Lining Yang, Allison Haase, and Xiaogai Yang
10. Gallium Complexes as Anticancer Drugs
Christopher R. Chitambar

11. Non-covalent Metallo-Drugs: Using Shape to Target DNA and RNA Junctions and Other Nucleic Acid Structures
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12. Nucleic Acid Quadruplexes and Metallo-Drugs
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13. Antitumor Metallo-drugs that Target Proteins
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14. Metallointercalators and Metalloinsertors: Structural Requirements for DNA Recognition and Anticancer Activity
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15. Iron and Its Role in Cancer Defence: A Double-Edged Sword
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16. Copper Complexes in Cancer Therapy
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"Lead: Its Effects on Environment and Health"

Volume 17 of Metal Ions in Life Sciences (ISSN: 1559-0836; e-ISSN: 1868-0402. ISBN: 978-3-11-044107-9; e-ISBN (PDF): 978-3-11-043433-0; e-ISBN (EPUB): 978-3-11-043301-2; Set-ISBN: 978-3-11-043434-7. DOI: 10.1515/9783110434330)

Editors: Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; Walter de Gruyter, GmbH, Berlin, Germany; 2017, 596 pages

1. The Bioinorganic Chemistry of Lead in the Context of Its Toxicity
Wolfgang Maret
2. Biogeochemistry of Lead. Its Release to the Environment and Its Chemical Speciation

Jay T. Cullen and Jason McAlister

3. Analytical Methods for the Determination of Lead in the Environment
Peter C. Hauser
4. Smart Capsules for Lead Removal from Industrial Wastewater
Bartosz Tylkowski and Renata Jastrzab
5. Lead Speciation in Microorganisms
Theodora J. Stewart
6. Human Biomonitoring of Lead Exposure
Kathrin Klotz and Thomas Göen
7. Solid State Structures of Lead Complexes with Relevance for Biological Systems
Katsuyuki Aoki, Kazutaka Murayama, and Ning-Hai Hu
8. Lead(II) Complexes of Amino Acids, Peptides, and Other Related Ligands of Biological Interest
Etelka Farkas and Péter Buglyó
9. Lead(II) Binding in Metallothioneins
Daisy L. Wong, Maureen E. Merrifield-MacRae, and Martin J. Stillman
10. Lead(II) Binding in Natural and Artificial Proteins
Virginia Cangelosi, Leela Ruckthong, and Vincent L. Pecoraro
11. Complex Formation of Lead(II) with Nucleotides and Their Constituents
Astrid Sigel, Bert P. Operschall, and Helmut Sigel
12. The Role of Lead(II) in Nucleic Acids
Joana Palou-Mir, Miquel Barceló-Oliver, and Roland K. O. Sigel
13. Historical View on Lead: Guidelines and Regulations
Hana R. Pohl, Susan Z. Ingber, and Henry G. Abadin

14. Environmental Impact of Alkyl Lead(IV) Derivatives:
Perspective after Their Phase-out
Montserrat Filella and Josep Bonet
15. Lead Toxicity in Plants
Hendrik Küpper
16. Toxicology of Lead and Its Damage to Mammalian Organs
Samuel Caito, Ana Carolina B. Almeida Lopez, Monica M. B. Paoliello, and Michael Aschner

Subject Index

"The Alkali Metal Ions: Their Role for Life" (ISBN: 978-3-319-21755-0; e-book: 978-3-319-21756-7) (DOI: 10.1007/978-3-319-21756-7)
Volume 16 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; electronic: 1868-0402)

Editors: Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; Springer International Publishing, Cham, Switzerland; 2016, 669 pages

1. Bioinorganic Chemistry of the Alkali Metal Ions
Youngsam Kim, Thuy-Tien Nguyen, David G. Churchill
2. Determination of Alkali Ions in Biological and Environmental Samples
Peter C. Hauser
3. Solid State Structures of Alkali Metal Ion Complexes Formed by Low-Molecular-Weight Ligands of Biological Relevance
Katsuyuki Aoki, Kazutaka Murayama, and Ning-Hai Hu
4. Discriminating Properties of Alkali Ions Towards the Constituents of Proteins and Nucleic Acids.
Conclusions from Gas-Phase and Theoretical Studies
Mary T. Rodgers and Peter B. Armentrout

5. Alkali Metal Ion Complexes with Phosphates, Nucleotides, Amino Acids, and Related Ligands of Biological Relevance.
Their Properties in Solution
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6. Sodium and Potassium Interactions with Nucleic Acids
Pascal Auffinger, Luigi D'Ascenzo, and Eric Ennifar
7. The Role of Alkali Metal Ions in G-Quadruplex Nucleic Acid Structure and Stability
Eric Largy, Jean-Louis Mergny, and Valérie Gabelica
8. Sodium and Potassium Ions in Proteins and Enzyme Catalysis
Milan Vašák and Joachim Schnabl
9. Roles and Transport of Sodium and Potassium in Plants
Manuel Nieves-Cordones, Fouad Razzaq Al Shiblawi, and Hervé Sentenac
10. Potassium *versus* Sodium Selectivity in Monovalent Ion Channel Selectivity Filters
Carmay Lim and Todor Dudev
11. Sodium as Coupling Cation in Respiratory Energy Conversion
Günter Fritz and Julia Steuber
12. Sodium-Proton (Na^+/H^+) Antiporters: Properties and Roles in Health and Disease
Etana Padan and Meytal Landau
13. Proton-Potassium (H^+/K^+) ATPases: Properties and Roles in Health and Disease
Hideki Sakai, Takuto Fujii, and Noriaki Takeguchi
14. Bioinspired Artificial Sodium and Potassium Channels
Nuria Rodríguez-Vázquez, Alberto Fuertes, Manuel Amorín, and Juan R. Granja

15. Lithium in Medicine: Pharmacology and Mechanism of Action
Duarte Mota de Freitas, Brian D. Levenson, and Jesse L. Goossens
16. Sodium and Potassium Relating to Parkinson's Disease and
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*Yonghwang Ha, Jeong A. Jeong, Youngsam Kim, and David G.
Churchill*

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"Sustaining Life on Planet Earth: Metalloenzymes Mastering

Dioxygen and Other Chewy Gases" (ISBN: 978-3-319-12414-8; e-
book: 978-3-319-12415-5) (DOI: 10.1007/978-3-319-12415-5)

Volume 15 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; electronic:
1868-0402)

Guest Editors: **Peter M. H. Kroneck**, University of Konstanz, Germany,
and **Martha E. Sosa Torres**, Universidad Nacional Autónoma de México,
México

Series editors: Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel;
Springer International Publishing, Cham, Switzerland; 2015, 364 pages

1. The Magic of Dioxygen
*Martha E. Sosa Torres, Juan P. Saucedo-Vázquez, and
Peter M. H. Kroneck*
2. Light-Dependent Production of Dioxygen in Photosynthesis
*Junko Yano, Jan Kern, Vittal K. Yachandra, Håkan Nilsson,
Sergey Koroidov, and Johannes Messinger*
3. Production of Dioxygen in the Dark: Dismutases of Oxyanions
Jennifer L. DuBois and Sunil Ojha
4. Respiratory Conservation of Energy with Dioxygen: Cytochrome *c*
Oxidase
Shinya Yoshikawa, Atsuhiko Shimada, and Kyoko Shinzawa-Itoh
5. Transition Metal Complexes and the Activation of Dioxygen
Gereon M. Yee and William B. Tolman

6. Methane Monooxygenase: Functionalizing Methane at Iron and Copper

Matthew H. Sazinsky and Stephen J. Lippard

7. Metal Enzymes in “Impossible” Microorganisms Catalyzing the Anaerobic Oxidation of Ammonium and Methane

Joachim Reimann, Mike S. M. Jetten, and Jan T. Keltjens

Subject Index

"The Metal-Driven Biogeochemistry of Gaseous Compounds in the Environment" (ISBN: 978-94-017-9268-4; e-book: 978-94-017-9269-1) (DOI: 10.1007/978-94-017-9269-1)

Volume 14 of Metal Ions in Life Sciences (ISSN: 1559-0836; electronic: 1868-0402)

Guest Editors: **Peter M. H. Kroneck**, University of Konstanz, Germany, and **Martha E. Sosa Torres**, Universidad Nacional Autónoma de México, México

Series editors: Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; Springer SBM, Dordrecht, The Netherlands; 2014, 368 pages

1. The Early Earth Atmosphere and Early Life Catalysts
Sandra I. Ramírez Jiménez
2. Living on Acetylene. A Primordial Energy Source
Felix ten Brink
3. Carbon Monoxide. Toxic Gas and Fuel for Anaerobes and Aerobes: Carbon Monoxide Dehydrogenases
Jae-Hun Jeoung, Jochen Fesseler, Sebastian Goetzl, and Holger Dobbek
4. Investigations of the Efficient Electrocatalytic Interconversions of Carbon Dioxide and Carbon Monoxide by Nickel-Containing Carbon Monoxide Dehydrogenases
Vincent C.-C. Wang, Stephen W. Ragsdale, and Fraser A. Armstrong
5. Understanding and Harnessing Hydrogenases, Biological Dihydrogen Catalysts

Alison Parkin

6. Biochemistry of Methyl-Coenzyme M Reductase: The Nickel Metalloenzyme that Catalyzes the Final Step in Synthesis and the First Step in Anaerobic Oxidation of the Greenhouse Gas Methane
Stephen W. Ragsdale
7. Cleaving the N,N Triple Bond: The Transformation of Dinitrogen to Ammonia by Nitrogenases
Chi Chung Lee, Markus W. Ribbe, and Yilin Hu
8. No Laughing Matter: The Unmaking of the Greenhouse Gas Dinitrogen Monoxide by Nitrous Oxide Reductase
Lisa K. Schneider, Anja Wüst, Anja Pomowski, Lin Zhang, and Oliver Einsle
9. The Production of Ammonia by Multiheme Cytochromes *c*
Jörg Simon and Peter M. H. Kroneck
10. Hydrogen Sulfide: A Toxic Gas Produced by Dissimilatory Sulfate and Sulfur Reduction and Consumed by Microbial Oxidation
Larry L. Barton, Marie-Laure Fardeau, and Guy D. Fauque
11. Transformations of Dimethylsulfide
Ulrike Kappler and Hendrik Schäfer

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"Interrelations between Essential Metal Ions and Human Diseases"
(ISBN: 978-94-007-7499-5; e-book: 978-94-007-7500-8) (DOI:
10.1007/978-94-007-7500-8)

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1868-0402)

edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; Springer
SBM, Dordrecht, The Netherlands; 2013, 610 pages

1. Metal Ions and Infectious Diseases. An Overview from the Clinic
Peggy L. Carver

2. Sodium and Potassium in Health and Disease
Hana R. Pohl, John S. Wheeler, and H. Edward Murray
3. Magnesium in Health and Disease
Andrea M. P. Romani
4. Calcium in Health and Disease
Marisa Brini, Denis Ottolini, Tito Calì, and Ernesto Carafoli
5. Vanadium. Its Role for Humans
Dieter Rehder
6. Chromium: Is It Essential, Pharmacologically Relevant, or Toxic?
John B. Vincent
7. Manganese in Health and Disease
Daiana Silva Avila, Robson Luiz Puntel, and Michael Aschner
8. Iron: Effects of Overload and Deficiency
Robert C. Hider and Xiaole Kong
9. Cobalt: Its Role in Health and Disease
Kazuhiro Yamada
10. Nickel and Human Health
Barbara Zambelli and Stefano Ciurli
11. Copper: Effects of Deficiency and Overload
Ivo Scheiber, Ralf Dringen, and Julian F. B. Mercer
12. Zinc and Human Disease
Wolfgang Maret
13. Molybdenum in Human Health and Disease
Guenter Schwarz and Abdel A. Belaidi
14. Silicon: The Health Benefits of a Metalloid
Keith R. Martin

15. Arsenic. Can this Toxic Metalloid Sustain Life?
Dean E. Wilcox
16. Selenium. Role of the Essential Metalloid in Health
Suguru Kurokawa and Marla J. Berry

Subject Index

"**Metallomics and the Cell**" (ISBN: 978-94-007-5560-4; e-book: 978-94-007-5561-1) (DOI: 10.1007/978-94-007-5561-1)
Volume 12 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; electronic: 1868-0402)

Guest Editor: **Lucia Banci**, University of Florence, Italy
Series editors: Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel;
Springer SBM, Dordrecht, The Netherlands; 2013, 645 pages

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Volume 11 of *Metal Ions in Life Sciences* (ISSN: 1559-0836; electronic: 1868-0402)

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edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; The Royal Society of Chemistry, Cambridge, UK; 2011, 422 pages

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edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; The Royal Society of Chemistry, Cambridge, UK; 2009, 543 pages

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Volume 4 of *Metal Ions in Life Sciences* (ISSN: 1559-0836)

edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; John Wiley & Sons, Ltd.; Chichester, UK; 2008, 671 pages

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edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; John Wiley & Sons, Ltd.; Chichester, UK; 2007, 652 pages

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edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; John Wiley & Sons, Ltd.; Chichester, UK; 2007, 702 pages

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edited by Astrid Sigel, Helmut Sigel, and Roland K. O. Sigel; John Wiley & Sons, Ltd.; Chichester, UK; 2006, 463 pages

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Volume 39 of Metal Ions in Biological Systems (ISSN: 0161-5149)
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