Read & Win: Metallomics

Metallomics can be defined as the comprehensive analysis of metals in cells, cell compartments, or a specific tissue type. In most cases, mass spectrometry plays a key role in the speciation analysis. The reader gets acquainted with relevant instrumental as well as application aspects of metallomics approaches, paving the road to understanding fate, pathway, and action of metals in environment and organisms. The observation of shifts in metal balances in the cell is a key to understand the pathogenesis of various diseases such as cancer or Alzheimer's disease.

Interview with the author:

G.I.T.: What is your main focus in research, what is your main scientific interest?
Michalke: The research interests of Bernhard Michalke can be structured in methodical research for element speciation, quality control and certification of reference materials and elements and element speciation related to neurodegeneration. Methodical research focused on development on reliable speciation methods and improvement of hyphenated speciation techniques throughout the whole research period up to now. This included novel set-up of reliable couplings of capillary electrophoresis to ICP-MS as high-resolving speciation tool. Furthermore, pre-analytical steps, being prone to disrupt native speciation information, were in research focus and optimized to maintain and prove species stabilities during sample preparation. Analytical quality control for total element determinations and for speciation has been an issue throughout his professional work. Notably, his laboratory is reference laboratory for the G-EQUAS QC system and for certification of certified reference materials mainly from JRC/IRMM of EU. Based on such reliable speciation methods an additional focus of research are element speciation studies in neurodegenerative diseases, i.e. idiopathic and Mn-dependent Parkinsonism and Se-speciation in cerebrospinal fluid of ALS patients. Specifically, changes of metal speciation at neural barriers are matter of investigation combined with metabolomics studies examining redox metal balances together with oxidative stress and lipid peroxidation markers in brain.

G.I.T.: **What was the reason to write the book?**

The Metallomics field is developing fast.

When reading respective literature, however, I more and more realized, that the original ideas from the ending 1980ieth, that metals (or elements in general) do not act just as metals as such but always act in a specific form (metal species) or oxidation state, get lost. Such differentiated point of view was often replaced by simplified views where molecular biological effects were simply related to an increase/absence of a metal as such. The already developed, sophisticated methods for differentiation (typically present in analytical chemical institutes) were unknown to researchers with a bio-molecular-medical background. The book thus was planned to introduce these available methods, their unquestionable high potential and some limitations and their wide field of beneficial applications in environment, nutrition, biology and medicine.

G.I.T.: **What is the target audience for the book?**

Analytical Chemists who intend to work interdisciplinary in the fields of medicine and biology and vice versa, medical doctors, epidemiologist, biologists who want to
profit from new approaches and exciting possibilities from analytical chemistry. Aside from this audience the book may be interesting for nutritional and pharmaceutical industry. The book is also be very relevant for teaching.

G.I.T.: **What knowledge is prerequisite for the book?**

The book is designed in a way that the reader should have some basic knowledge about analytical techniques.

G.I.T.: **What is the structure of the book?**

This book is intended to provide specifically recent knowledge in the Metallomics field based on sophisticated techniques from metal speciation, spatial distribution of metals e.g. in tissue or even cells analyzed by novel and advanced approaches in metallo-bio-imaging techniques and analysis of metallic nano-particles (NPs).

Following this intention the book starts with a methodical section including chapters on how positioning Metallomics within the ‘Omics’-field, and a comprehensive chapter introducing modern speciation techniques and quality control. Another chapter gives an overview on spatial localization of metals and metal mapping in tissues.

The second section describes Metallomics investigations in Environment and Nutrition. In these chapters specifically speciation of the elements selenium, arsenic, chromium, tin, aluminium, mercury and platinum are in focus, aside from a chapter about nanoparticles.

As a third section the biomedical and health section of the book starts with a comprehensive overview on metallo-proteins and goes on with a biomedical-analytical view about metal species as biomarkers used for medical diagnosis and about metallo-drugs. Also Metallomics research in Alzheimer disease or investigations about metallo-drugs in diabetes and anti-cancer therapy are in focus. Finally, the book closes with chapters on anti-bacterial silver species and Ag-nanoparticles in wound healing and with a chapter related to neurodegeneration with a focus on manganese and iron speciation.

G.I.T.: **When will Metallomics become a standard method in the healthcare sector?**

Today this is hard to answer. While selected medical research groups - spread world-wide- recognize the potential for their research in specific health issue, many other bio-medical research groups are less familiar with Metallomics techniques and their potential, including the speciation approach. Aside from that, the
techniques are typically cost-intensive and need operation at facilities with appropriate infra-structure and highly educated staff. It will need some more time to develop simple-low cost tools which first have to be evaluated against the present techniques before being spread into regular healthcare.

G.I.T.: What is - in your opinion - the most promising field of the ‘omics’ methods?

Most promising will be the smart combination of the three fields genomics, proteomics and metabolomics. Metallomics covers parts of metabolomics (metallo-metabolites and ionome) and proteomics (enzymes with specific metals in their reactive center) in a more detailed manner specifically for metallo-compounds. Increasingly it turns out that a combination of the omics-specific technologies – reaching from molecular biology set-ups to highly sophisticated hyphenated techniques comprising chromatography coupled to different mass spectrometry methods –will promise the highest output and benefit.

G.I.T.: How important is the automated analysis of spectra in your research?

An automated spectra analysis is important to handle the big data amount coming e.g. from FT-ICR-MS spectrometers, however, aside computer-based (high-throughput) handling also the critical view of the scientist should always be present to avoid possible misinterpretation.

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200 peer reviewed articles, 11 book chapters and edited a book on metallomics.