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# COMPREHENSIVE ANALYTICAL CHEMISTRY

EDITED BY  
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Applications of  
Advanced Omics Technologies:  
From Genes to Metabolites

**VIRGINIA GARCÍA-CAÑAS,  
ALEJANDRO CIFUENTES  
AND CAROLINA SIMÓ**

# Applications of Advanced Omics Technologies: From Genes to Metabolites

Comprehensive Analytical Chemistry

Volume 64

Edited by

**Virginia García-Cañas**

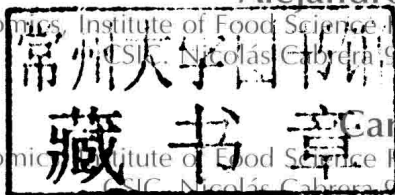
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# Applications of Advanced Omics Technologies: From Genes to Metabolites

Comprehensive Analytical Chemistry

Volume 64

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## Dedication

V. García-Cañas: *To my beloved parents: Julia and Manuel*  
*"For their unconditional love"*

A. Cifuentes: *To my treasured Claudia*  
*"Just keep swimming, just keep swimming"*

C. Simó: *This book is dedicated to my parents,*  
*M<sup>a</sup> Inmaculada and José Luis*

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## Series Editor's Preface

This volume, edited by C. Simó, A. Cifuentes and V. García-Cañas, is a direct consequence of the leading-edge analytical chemistry research carried out in Spain during the last 20 years. When my colleague at CSIC in Madrid and old friend Alejandro Cifuentes told me about his project, I immediately proposed that we include a book on it in the CAC series. Why? We did not have many titles on Omics in our series. In this respect we should consider this volume a follow up to volumes 46 and 52 on Proteomics and Peptidomics, and on Protein Mass Spectrometry, respectively. This new CAC volume on the applications of advanced omics technologies is an excellent addition to these two previous books and complements the volume on Fundamentals published earlier this year.

As mentioned by the editors in their introduction to Part A, this field was developed in tandem with the instrumental and methodological developments achieved at the end of the 20th Century. Powerful bioinformatic tools were also integrated in the systems, allowing us to understand the relevant mechanisms of protein synthesis. Omics tools are used nowadays for high throughput assessment of changes at genome (genomics), epigenome (epigenomics), transcript (transcriptomics), protein (proteomics) and metabolite (metabolomics) levels.

The book contains 16 chapters covering a broad range of topics. It contains a balanced cocktail of chapters on applications of new microarray technologies, proteomics, peptidomics and metabolomics. Other omics strategies, data treatment and systems biology are presented in the last chapters, showing the importance of these tools for omics technologies.

Although most of the applications are in the food science and nutrition area, cancer research and other clinical examples are also reported. In this respect the book offers a unique and comprehensive vision on the applications of omic technologies into two fields extremely important for humanity: food safety and clinical research. By incorporating these new tools better diagnostic solutions can be achieved for an improvement of human health. This is an excellent example of how investment in research, development and innovation on state-of-the art technologies over the last few years has lead to a better quality of life.

Finally, I would like to thank the editors and all the authors for their contributions to this needed state of the art book in the CAC series. I am sure it will enjoy success among the scientific community and I expect to see many citations in the literature in the next coming years.

**Prof. Dr. D. Barceló**

Barcelona, Spain, March 24, 2014

## Preface

As mentioned in the Preface to our previous book in this series, *Fundamentals of Advanced Omics Technologies: From Genes to Metabolites* (ISBN: 9780444626516), the impressive advances observed in omics tools in recent years have brought about new analytical instruments and methodologies for genomics, epigenomics, transcriptomics, proteomics, and metabolomics studies. These advances also include powerful bioinformatics tools to integrate and interrogate the multiple omic datasets usually generated in these studies, making it possible to investigate changes at the genome, epigenome, transcriptome, proteome, and metabolome level that were unthinkable a few years ago.

The interest of the scientific community in the development and application of these new omics technologies in different and hot areas of research is well documented in the 16 chapters of this book, *Applications of Advanced Omics Technologies: From Genes to Metabolites*. Namely, this volume covers recent applications of genomics, epigenomics, and transcriptomics (Chapters 1–5), proteomics and peptidomics (Chapters 6–9), and metabolomics (Chapters 10–12), and it includes updated information on other omics strategies, data treatment, data integration, and Systems Biology approaches (Chapters 13–16). More concretely, the application of functional gene microarrays for profiling microbial communities is presented in Chapter 1, while Chapter 2 presents an overview of current technologies and applications of microRNA profiling. The use of novel genotyping microarray technologies in cancer research is discussed in Chapter 3, while Chapters 4 and 5 present next-generation sequencing technologies to study the human microbiome and the use of emerging RNA-Seq applications in food science, respectively. The following three chapters review different proteomics approaches and their applications in plant proteomics for improved food safety (Chapter 6), in the study of prokaryotes (Chapter 7), or for food fingerprints with special emphasis on food quality and authenticity (Chapter 8). Salivary peptidomics and its clinical applications are discussed in Chapter 9. Metabolomics is shown as an impressive tool to discover new biomarkers related to Alzheimer's disease (Chapter 10), cardiovascular and renal diseases (Chapter 11), or together with proteomics to address new challenges in neonatal medicine (Chapter 12). The last four chapters are devoted to reviewing the use of omics technologies for profiling genetically modified organisms (Chapter 13), the latest advances and applications in MS-based lipidomics (Chapter 14), the fundamentals and recent

uses of Foodomics (Chapter 15), and the methods and applications for omics data integration in Systems Biology (Chapter 16).

Together the two books we have edited for this series should provide readers with the necessary background as well as relevant and updated information on the fundamentals and applications of modern omics technologies. We expect that these two volumes will be useful to a broad audience of experts working on (or studying) different topics related to omics technologies. This audience includes, among others, scientists, Ph.D. students, and technicians from control laboratories, universities, hospitals, research laboratories, and regulatory agencies.

We, the editors, would like to thank all the authors for their inspiring contributions, Damiá Barceló for inviting us to prepare this work; Derek Coleman, Susan Dennis, and Mohanapriyan Rajendran for their help and support; and to all the others at Elsevier whose efforts have contributed to the publication of this volume. *Gracias de nuevo!*

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