

# Advances in Experimental Medicine and Biology

## Microbial Endocrinology

Mark Lyte, Texas Tech University Health Sciences Center,  
Abilene, TX, USA

## Volume 817

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Mark Lyte • John F. Cryan  
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# Microbial Endocrinology: The Microbiota-Gut-Brain Axis in Health and Disease

 Springer

*Editors*

Mark Lyte  
Department of Immunotherapeutics  
and Biotechnology  
Texas Tech University Health Sciences  
Center  
Abilene, TX, USA

John F. Cryan  
Department of Anatomy and Neuroscience  
University College  
Cork, Ireland

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*Prof. Mark Lyte: "To my loving wife and my two remarkable sons who are my pillars of strength"*

*Prof. John F. Cryan: "To Colleen, Oisín & Alannah: For constant support and patience"*



# Foreword

This book is the second volume of a continuing series. The first volume published by Springer in 2010, “Microbial Endocrinology: Interkingdom Signaling in Infectious Disease and Health”, contained little in regard to brain and behavior, but instead focused almost exclusively on aspects of infectious disease. Health consequences as such were mainly concerned with the role that stress could play in altering the interface between host and microbiota. The present volume is therefore a testament to the great strides during the intervening years which have illuminated the myriad ways in which microbiota interfaces with the host. It is anticipated that future volumes in this series will reflect the ever increasing acceleration of research into the microbiota–gut–brain axis.

Abilene, TX, USA  
January 2014

Mark Lyte  
*Series Editor*





# Preface

If one was to ask whether a book dealing with the ability of the microbiota to influence the brain, and ultimately cognition and behavior, would have been possible just a few short years ago, the answer would most likely be no. A simple search of PubMed using the index words “microbiota AND gut AND brain” reveals only 134 publications as of 16th January 2014. However, this would not be an accurate reflection of the work that has been ongoing for many decades, but yet remained on the outer fringes of the disciplines that constitute the study of the mechanisms by which the microbiota and the brain communicate with each other. A comprehensive series of articles by Bested and colleagues [1] catalog the numerous studies going back over a century which amply demonstrate that the investigation of the role of the microbiota in brain function, and by extension mental health, has a long and varied (some may say checkered) scientific history. During this time it remained, for large measure, outside mainstream scientific inquiry following an initial burst of enthusiasm both in the scientific and public arenas at the turn of the twentieth century. That such scientific skepticism remained, and in many cases became entrenched, in the very scientific disciplines that form the basis of the microbiota–gut–brain axis is owed to a number of factors. One of these is surely the increasing specialization that occurred within each discipline over the years and the inherent lack of interdisciplinary thought that accompanied such specialization. With the advent of the concerted research into the microbiota and the microbiome, as best evidenced by the tremendous strides that the Human Microbiome Project has made over the last decade in cataloging the incredible diversity in the microbiota in health and disease, the realization that the microbiota has a role to play in the development and function of the nervous system and hence behavior and cognition, has once again entered into mainstream scientific and medical thought. However, old beliefs die hard. The recent experience of one of us (ML) as described in the prologue to Chap. 1 is but one example of the resistance that is still being encountered today for a role of the microbiota in the functioning of the brain. In many conservative Learned Societies the concept that the gut and indeed the gut microbiota can have such an influence on brain & behavior is still looked upon with incredulity. However, this is changing.

This book represents the realization that any attempt to understand the ability of the microbiota to interface with the brain (and by association any part of the host's neurophysiology) must attempt to address multiple disciplines, such as microbiology, anatomic neuropathology, and endocrinology to name but a few, that while on the first examination appear to be rather disparate from each other but on further examination are in fact highly interconnected as evidenced, for example, by the development of the field of microbial endocrinology itself. As described in Chap. 1, as well as detailed in a chapter in the first book of this series [2], the field of microbial endocrinology developed out of need to understand the paradox in which stress resulted in increased death from a bacterial challenge at the same time greatly increasing the phagocytic activity of the immune system. In considering the microbiota as an interactive player in the host that can both respond to signals from the host and influence the host through the provision of the very same host signaling molecules (i.e., neurochemicals) that are more commonly associated only with vertebrates, but in fact have a long evolutionary history involving the prokaryotes, the potential role of the microbiota in brain functioning and its potential for treatment of mental disorders becomes apparent.

As such, the book is organized along three thematic lines which will provide the reader not only a fuller understanding of the capabilities of the microbiota to interface with the brain and form the microbiota–gut–brain axis, but will also provide detailed examination of the consequences of the microbiota-driven gut-to-brain communication for both health and disease. The first four chapters cover the “Basic Concepts Underlying the Microbiota–Gut–Brain Axis”; the next eight chapters examine the “Mechanistic Factors Influencing the Microbiota–Gut–Brain Axis” and the concluding seven chapters address the “Microbiota–Gut–Brain Axis in Health and Disease”.

We have assembled a group of contributors who are recognized to be at the front of their respective fields to review the state of the art of this growing field. As the chapters in this book amply demonstrate, the field of microbiota–gut–brain axis is still in its infancy although its origins are now over a century old. With the advent of modern techniques ranging from deep pyrosequencing of the microbiota to brain imaging, the tools are in place to address those questions which were raised many decades ago. Given our evolving understanding of the complexity of the microbiota which when one couples that to the complexity of the brain and nervous system, this book represents only one more chapter in what promises to be a long and challenging story.

Abilene, TX, USA  
Cork, Ireland  
January 2014

Mark Lyte  
John F. Cryan

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# List of Contributors

**Yasser Al Omran, BSc (Hons)** Centre for Digestive Diseases, Wingate Institute of Neurogastroenterology, Blizard Institute, Barts and The London School of Medicine and Dentistry, Queen Mary, University of London, London, UK

**Carmen Alonso, MD, PhD** Neuro-Immuno-Gastroenterology Group, Digestive Diseases Research Unit, Gastroenterology Department, Hospital Universitari Vall d'Hebron, Vall d'Hebron Research Institute, Barcelona, Spain

Department of Medicine, Universitat Autònoma de Barcelona, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (Ciberehd), Barcelona, Spain

**Qasim Aziz, MRCP, PhD, FRCP** Centre for Gastroenterology, The Wingate Institute of Neurogastroenterology, Bart's and The London NHS Trust, London, UK

**Michael T. Bailey, PhD** Institute for Behavioral Medicine Research, College of Medicine, The Ohio State University, Columbus, OH, USA

**Premysl Bercik, MD** Medicine, McMaster University, Hamilton, ON, Canada

**John Bienenstock, MBBS, FCRP, FCRP(C)** Pathology and Molecular Medicine, Brain-Body Institute, McMaster University, St. Joseph's Healthcare, Hamilton, ON, Canada

**Yuliya E. Borre, PhD** Neurogastroenterology Lab, Alimentary Pharmabiotic Center, University College Cork, Cork, Ireland

**Brid P. Callaghan** Anatomy and Neuroscience, University of Melbourne, Parkville, VIC, Australia

**Gerard Clarke, PhD** Department of Psychiatry and Laboratory of NeuroGastroenterology Alimentary Pharmabiotic Centre, University College Cork, Cork, Ireland

**Hyun-Jung Cho, PhD** Anatomy and Neuroscience, University of Melbourne, Parkville, VIC, Australia

**Stephen M. Collins, MD** Medicine, McMaster University, Hamilton, ON, Canada

**John F. Cryan, PhD** Department of Anatomy and Neuroscience, University College Cork, Cork, Ireland

**Timothy G. Dinan, MD, PhD** Psychiatry, University College Cork, Cork, Ireland

**Aitak Farzi, MD** Institute of Experimental and Clinical Pharmacology, Medical University of Graz, Graz, Austria

**Gerald F. Fitzgerald, PhD, DSc** Microbiology and Alimentary Pharmabiotic Centre, University College Cork, Cork, Ireland

**Anthony Fodor, PhD** Bioinformatics and Genomics, UNC Charlotte, Charlotte, NC, USA

**Paul Forsythe, PhD** Medicine, McMaster University, Hamilton, ON, Canada

**John B. Furness** Anatomy and Neuroscience, University of Melbourne, Parkville, VIC, Australia

**Mélanie G. Gareau, PhD** Department of Medicine, University of California San Diego, La Jolla, CA, USA

**Peter Holzer, MSc, PhD** Experimental Neurogastroenterology, Institute of Experimental and Clinical Pharmacology, Medical University of Graz, Graz, Austria

**Michail H. Karavolos, PhD** Centre for Bacterial Cell Biology, Institute for Cell and Molecular Biosciences, Newcastle University, Newcastle upon Tyne, UK

**C.M. Anjam Khan, PhD** Centre for Bacterial Cell Biology, Institute for Cell and Molecular Biosciences, Newcastle University, Newcastle upon Tyne, UK

**Wolfgang A. Kunze, PhD** Psychiatry and Behavioural Neuroscience, St. Joseph Healthcare, Hamilton, ON, Canada



**Jennifer S. Labus, PhD** Division of Digestive Diseases, Department of Medicine, Center for Neurobiology of Stress, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

**Beatriz Lobo, MD, PhD** Neuro-Immuno-Gastroenterology Group, Digestive Diseases Research Unit, Gastroenterology Department, Hospital Universitari Vall d'Hebron, Vall d'Hebron Research Institute, Barcelona, Spain

Department of Medicine, Universitat Autònoma de Barcelona, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (Ciberehd), Barcelona, Spain

**Christopher A. Lowry, PhD** Department of Integrative Physiology, Center for Neuroscience, University of Colorado Boulder, Boulder, CO, USA

**Mark Lyte, PhD, MS, MT(ASCP)** Department of Immunotherapeutics and Biotechnology, Texas Tech University Health Sciences Center, Abilene, TX, USA

**Rachel D. Moloney, PhD** Laboratory of NeuroGastroenterology, Alimentary Pharmabiotic Centre, University College Cork, Cork, Ireland

Department of Psychiatry, University College Cork, Cork, Ireland

**Angela Moya-Pérez, BSc** Microbial Ecology, Nutrition & Health, National Research Council (IATA-CSIC), Paterna-Valencia, Spain

**Marc Pigrau, MD, PhD** Neuro-Immuno-Gastroenterology Group, Digestive Diseases Research Unit, Gastroenterology Department, Hospital Universitari Vall d'Hebron, Vall d'Hebron Research Institute, Barcelona, Spain

Department of Medicine, Universitat Autònoma de Barcelona, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (Ciberehd), Barcelona, Spain

**Eamonn M.M. Quigley, MD, FRCP, FACP, FACG, FRCPI** Division of Gastroenterology and Hepatology, Medicine Department, Houston Methodist Hospital, Houston, TX, USA

**Charles L. Raison, MD** Department of Psychiatry, College of Medicine and Norton School of Family and Consumer Sciences, College of Agriculture and Life Sciences, University of Arizona, Tucson, AZ, USA

**Jens F. Rehfeld, MD, DMSc, DSc** Department of Clinical Biochemistry, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

**Leni R. Rivera, PhD** Anatomy and Neuroscience, University of Melbourne, Parkville, VIC, Australia

**Graham A.W. Rook, BA, MB, BChir, MD** Centre for Clinical Microbiology, UCL (University College London), London, UK

**R. Paul Ross, PhD, DSc** Alimentary Pharmabiotic Centre, Teagasc Moorepark Food Research Centre, Fermoy, Cork, Ireland

**Javier Santos, MD, PhD** Neuro-Immuno-Gastroenterology Group, Digestive Diseases Research Unit, Gastroenterology Department, Hospital Universitari Vall d'Hebron, Vall d'Hebron Research Institute, Barcelona, Spain

Department of Medicine, Universitat Autònoma de Barcelona, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (Ciberehd), Barcelona, Spain

**Yolanda Sanz, PhD** Microbial Ecology, Nutrition & Health, National Research Council (IATA-CSIC), Paterna-Valencia, Spain

**Fergus Shanahan, MD, FRCP, FCCP, FRCPI** Department of Medicine, Alimentary Pharmabiotic Centre, University College Cork, Cork, Ireland

**Catherine Stanton, PhD, DSc** Alimentary Pharmabiotic Centre, Teagasc Moorepark Food Research Centre, Fermoy, Cork, Ireland

**Nobuyuki Sudo, MD, PhD** Department of Psychosomatic Medicine, Kyushu University, Fukuoka, Japan

**Kirsten Tillisch, MD** Division of Digestive Diseases, Department of Medicine, Center for Neurobiology of Stress, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

**María Vicario, PhD** Neuro-Immuno-Gastroenterology Group, Digestive Diseases Research Unit, Gastroenterology Department, Hospital Universitari Vall d'Hebron, Vall d'Hebron Research Institute, Barcelona, Spain

Department of Medicine, Universitat Autònoma de Barcelona, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (Ciberehd), Barcelona, Spain

**Rebecca Wall, PhD** Alimentary Pharmabiotic Centre, Teagasc Moorepark Food Research Centre, Fermoy, Cork, Ireland