Handbook of Experimental Pharmacology

Volume 194

Brendan J. Canning • Domenico Spina
Editors

Sensory Nerves

Contributors

R. Baron, S. Benemei, S.K. Bhangoo, L.A. Blackshaw, S.D. Brain, G. Burnstock, B.J. Canning, J.G. Capone, F. De Cesaris, D.N. Cortright, W.C. de Groat, R.J. Docherty, S.R. Eid, C.E. Farmer, E.S. Fernandes, P. Holzer, L.-W. Fu, P. Geppetti, T.D. Gover, N.G. Jones, H. Jung, J.C. Longhurst, F. Marchand, S.B. McMahon, R.J. Miller, T.H. Moreira, P. Nicoletti, A.J. Page, S.M. Schmidhuber, J.N. Sengupta, V.S. Seybold, D. Spina, C. Stein, D. Weinreich, F.A. White, N. Yoshimura, C. Zöllner

Springer

Editors
Dr. Brendan J. Canning
Johns Hopkins Asthma & Allergy Center
Dept. Medicine
5501 Hopkins Bayview Circle
Baltimore MD 21224
USA
bjc@jhmi.edu

Dr. Domenico Spina
King's College London
School of Biomedical & Health Sciences
Sackler Inst. Pulmonary
Pharmacology Guy's Campus
London
5th Floor, Hodkin Bldg.
United Kingdom SE1 9RT
domenico.spina@kcl.ac.uk

ISSN 0171-2004
ISBN 978-3-540-79089-1 e-ISBN 978-3-540-79090-7
DOI: 10.1007/978-3-540-79090-7

Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2009926022

Cover design: SPi Publishers Services

Printed on acid-free paper

Springer-Verlag Berlin Heidelberg (www.springer.com)

Preface

The intention of this book is to provide a comprehensive and contemporary review of the biology of sensory nerves. In keeping with the theme of the *Handbook of Experimental Pharmacology* series, emphasis will be placed on the actions of drugs, transmitters and autacoids that initiate or inhibit sensory nerve activation (through actions on ion channels and receptors at their peripheral terminals) or modulate the release or actions of the transmitters released from the central terminals of sensory nerves. On the basis of extensive supportive evidence in the literature, it is our view that many diseases are characterized by alterations in sensory nerve function (e.g. pain, cardiovascular disease and migraine). It is our belief that this book will be unique, as it will comprehensively cover the role of sensory nerves across many therapeutic areas. To address directly one of the editorial board queries, this is not intended to be a book about the pharmacology of pain. That said, to most pharmacologists, pain is the most obvious indication for a role or sensory nerves in disease. We believe that the lessons learnt from the study of neuropathic pain will be invaluable for researchers in the other therapeutic areas covered in this volume. Since most interest has focused on the role of sensory nerves in neuropathic pain, we have added a number of chapters devoted to this subject.

The book is organized in three parts, covering the types and roles of sensory nerves in somatic and visceral disorders (Part I), specific targets on sensory nerves relevant to pain and visceral disorders (Part II) and a description of current and future therapeutic strategies for targeting sensory nerves (Part III).

The first two chapters in Part I are devoted to describing the clinical features of neuropathic pain and visceral pain. Our intention is for the authors to provide a clinical viewpoint on the features of these conditions and the advantages/disadvantages of current treatment modalities. The next five chapters in Part I focus on the role of sensory nerves in other pathological conditions. Several common themes will emerge in this part, including the mode of sensory nerve activation in various tissues and organs, the alterations in sensory nerve excitability associated with disease, and the importance of inflammation and inflammatory mediators in initiating altered sensory nerve function in disease.

Whilst the first part focuses on the clinical and/or systems physiology, Part II has its focus at the cell and molecular level. This part highlights the current understanding of proteins/ion channels/mediators that have created the most intense recent interest in the area of sensory nerve biology. Together, these chapters will give the reader important knowledge about how sensory nerve function can be altered pharmacologically. The last chapter in this part describes the processes that give rise to altered neural reflexes at the central level. The mechanisms described in these chapters reinforce the role of proteins/mediators highlighted in the preceding chapters. The role of these cellular, molecular and physiological processes in the diseases discussed in Part 1 are emphasized.

The aim of Part III is to highlight potential drug targets that might alter sensory nerve function. Most of the work has been devoted to the treatment of neuropathic pain and so this part heavily emphasizes this subject. However, as will be apparent from Part I, many of these targets could be utilized in other therapeutic areas that implicate sensory nerves in their pathophysiological processes. The focus of the chapters is on opioids and modulators of ion channels and then the final chapter is devoted to future treatment strategies for neuropathic pain.

Finally, we would like to thank all the contributors, including co-authors, who agreed to write chapters for this book and the publishers, especially Susanne Dathe, for their patience and assistance.

Baltimore *B.J. Canning*
London *D. Spina*

Contents

Contributors

Ralf Baron
Sektion Neurologische Schmerzforschung und Therapie, Klinik für Neurologie, Christian-Albrechts-Universität Kiel, Schittenhelmstr. 10, 24105 Kiel, Germany, r.baron@neurologie.uni-kiel.de

Silvia Benemei
Centre for the Study of Headache and Department of Preclinical and Clinical Pharmacology University of Florence, Florence, Italy

Sonia K. Bhangoo
Molecular Pharmacology and Structural Biochemistry, Northwestern University, Chicago, IL, USA

L. Ashley Blackshaw
Nerve Gut Research Laboratory, Level 1 Hanson Institute, Frome Road, Adelaide, SA 5000, Australia, ashley.blackshaw@adelaide.edu.au

Susan D. Brain
Cardiovascular Division, Franklin-Wilkins Building, Waterloo Campus, King's College London, London SE1 9NH, UK, sue.brain@kcl.ac.uk

Geoffrey Burnstock
Autonomic Neuroscience Centre, Royal Free and University College Medical School, Rowland Hill Street, London NW3 2PF, UK, g.burnstock@ucl.ac.uk

B.J. Canning
Johns Hopkins Asthma and Allergy Center, 5501 Hopkins Bayview Circle, Baltimore, MD 21224, USA, bjc@jhmi.edu

Jay G. Capone
Headache Center, University Hospital S.Anna, Ferrara, Italy

D.N. Cortright
Department of Biochemistry and Molecular Biology, Neurogen Corporation, 35 N.E. Industrial Road, Branford, CT, USA

Francesco De Cesaris
Centre for the Study of Headache and Department of Preclinical and Clinical Pharmacology University of Florence, Florence, Italy

William C. de Groat
Department of Pharmacology, West 1352 Starzl Biomedical Science Tower, University of Pittsburgh School of Medicine, Pittsburgh, PA 15261, USA, degroat@server.pharm.pitt.edu

Reginald J. Docherty
Neurorestoration Group, Wolfson CARD, King's College London, London SE1 9RT, UK, reginald.docherty@kcl.ac.uk

S.R. Eid
Department of Pain Research, Neuroscience Drug Discovery, Merck Research Laboratories, West Point, Philadelphia, USA, samer_eid@merck.com

Clare E. Farmer
Department of Molecular Neuroscience, Institute of Neurology, University College London, UK, c.farmer@ion.ucl.ac.uk

Elizabeth S. Fernandes
Cardiovascular Division, Franklin-Wilkins Building, Waterloo Campus, King's College London, London SE1 9NH, UK

Peter Holzer
Research Unit of Translational Neurogastroenterology, Institute of Experimental and Clinical Pharmacology, Medical University of Graz, Universitätsplatz 4, A-8010 Graz, Austria, peter.holzer@meduni-graz.at

Liang-Wu Fu
Department of Medicine, Susan Samueli Center for Integrative Medicine, School of Medicine, University of California, Irvine, CA 92697, USA

Pierangelo Geppetti
Centre for the Study of Headache and Department of Preclinical and Clinical Pharmacology University of Florence, Florence and Headache Center, Department of Neuroscience, Azienda Universita-Ospedale S. Anna, Ferrara, Italy, pierangelo.geppetti@unifi.it

T.D. Gover
Department of Pharmacology and Experimental Therapeutics, University of Maryland, School of Medicine, Baltimore, MD 21201-1559, USA

Nicholas G. Jones
King's College London, Neurorestoration, CARD Wolfson Wing, Hodgkin Building, Guy's Campus, London Bridge, London, SE1 1UL, UK

Hosung Jung
Molecular Pharmacology and Structural Biochemistry, Northwestern University, Chicago, IL, USA

John C. Longhurst
Department of Medicine, Department of Physiology and Biophysics, Susan Samueli Center for Integrative Medicine, School of Medicine, C240 Medical Sciences I, University of California, Irvine, CA 92697, USA, jcl@uci.edu

Fabien Marchand
King's College London, Neurorestoration, CARD Wolfson Wing, Hodgkin Building, Guy's Campus, London Bridge, London, SE1 1UL, UK

Stephen B. McMahon
King's College London, Neurorestoration, CARD Wolfson Wing, Hodgkin Building, Guy's Campus, London Bridge, London, SE1 1UL, UK,
stephen.mcmahon@kcl.ac.uk

Richard J. Miller
Molecular Pharmacology and Structural Biochemistry, Northwestern University, Chicago, IL, USA, r-miller10@northwestern.edu

T.H. Moreira
Office of Science and Engineering Laboratories FDA/CDRH, 10903 New Hampshire Avenue, Building 62, Room 1229, Silver Spring, MD 20993-0002, USA

Amanda J. Page
Nerve Gut Research Laboratory, Level 1 Hanson Institute, Frome Road, Royal Adelaide Hospital, Discipline of Medicine and Discipline of Physiology, School of Molecular and Biomedical Sciences, University of Adelaide, Adelaide, SA 5000, Australia

Paola Nicoletti
Centre for the Study of Headache and Department of Preclinical and Clinical Pharmacology University of Florence, Florence, Italy

Sabine M. Schmidhuber
Cardiovascular Division, Franklin-Wilkins Building, Waterloo Campus, King's College London, London SE1 9NH, UK

V.S. Seybold
Department of Neuroscience, University of Minnesota, 6-145 Jackson Hall, 321 Church St., S.E., Minneapolis, MN 55455, USA, vseybold@umn.edu

Jyoti N. Sengupta
Division of Gastroenterology and Hepatology, Medical College of Wisconsin, 8701 Watertown Plank Road, Meilwaukee, WI 53051, USA, sengupta@mcw.edu

Domenico Spina
The Sackler Institute of Pulmonary Pharmacology, Division of Pharmaceutical Science, 5th Floor Hodgkin Building, King's College London, London SE1 1UL, UK, domenico.spina@kcl.ac.uk

Christoph Stein
Klinik für Anaesthesiologie und operative Intensivmedizin, Freie Universität Berlin, Charité – Campus Benjamin Franklin, 12200 Berlin, Germany, christoph.stein@charite.de

Daniel Weinreich
Department of Pharmacology and Experimental Therapeutics, University of Maryland, School of Medicine, Baltimore, MD 21201-1559, USA, dweinrei@umaryland.edu

Fletcher A. White
Cell Biology, Neurobiology & Anatomy, Anesthesiology, Loyola University, Chicago, Maywood, IL, USA

Naoki Yoshimura
Department of Urology, 700 Kaufman Building, University of Pittsburgh School of Medicine, Pittsburgh, PA 15261, USA

Christian Zöllner
Klinik für Anaesthesiologie und operative Intensivmedizin, Freie Universität Berlin, Charité – Campus Benjamin Franklin, 12200 Berlin, Germany