Ordering the Membrane-Cytoskeleton Trilayer

Guest Editors Mark S. Mooseker Jon S. Morrow



Current Topics in Membranes, Volume 38



Current Topics in Membranes, Volume 38

Ordering the Membrane-Cytoskeleton Trilayer

Current Topics in Membranes, Volume 38

Yale Series Editors

Joseph F. Hoffman and Gerhard Giebisch

Department of Cellular and Molecular Physiology Yale University School of Medicine New Haven, Connecticut

Murdoch Ritchie

Department of Pharmacology Yale University School of Medicine New Haven, Connecticut

Series Editors

Arnost Kleinzeller

Department of Physiology University of Pennsylvania School of Medicine Philadelphia, Pennsylvania

Douglas M. Fambrough

Department of Biology Johns Hopkins University Baltimore, Maryland Current Topics in Membranes, Volume 38

Ordering the Membrane-Cytoskeleton Trilayer

Guest Editors

Mark S. Mooseker

Department of Biology Yale University New Haven, Connecticut

Jon S. Morrow

Department of Pathology Yale University School of Medicine New Haven, Connecticut

Volume 38 is part of the series from the Yale Department of Cellular and Molecular Physiology.

ACADEMIC PRESS, INC.

Harcourt Brace Jovanovich, Publishers San Diego New York Boston London Sydney Tokyo Toronto This book is printed on acid-free paper. \odot

Copyright © 1991 BY ACADEMIC PRESS, INC.

All Rights Reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Academic Press, Inc. San Diego, California 92101

United Kingdom Edition published by ACADEMIC PRESS LIMITED 24-28 Oval Road, London NW1 7DX

Library of Congress Catalog Card Number: 70-117091

ISBN 0-12-153338-7 (alk. paper)

 PRINTED IN THE UNITED STATES OF AMERICA

 91
 92
 93
 94
 9
 8
 7
 6
 5
 4
 3
 2
 1

Contents

Contributors xi Foreword xv Preface xvii Previous Volumes in Series xix

CHAPTER 1 Molecular Genetic Analyses of Drosophila Kinesin

Russell J. Stewart and Lawrence S. B. Goldstein

- I. Introduction 1
- II. Kinesin Structure 2
- III. Kinesin Function 6
- IV. Conclusion 9 References 9

CHAPTER 2 Acanthamoeba Myosin I: Past, Present, and Future *Edward D. Korn*

- I. Discovery 13
- II. Multiplicity of Isoforms 15
- III. Heavy Chain Sequences 16
- IV. Structural Basis of the Actin-Activated ATPase Activity 17
- V. Mechanochemical Properties and Their Structural Basis 19
- VI. Regulation 21
- VII. Intracellular Localization 22
- VIII. Concluding Remarks 25 References 27

CHAPTER 3 Structural and Functional Dissection of a Membrane-Bound Mechanoenzyme: Brush Border Myosin I

Mark S. Mooseker, Joseph S. Wolenski, Thomas R. Coleman, Steven M. Hayden, Richard E. Cheney, Enilza Espreafico, Matthew B. Heintzelman, and Michelle D. Peterson

- I. Introduction: Is There a Superfamily of Myosin Genes? 32
- II. The Structural and Functional Properties of Brush Border Myosin I: An Overview 33
- III. Probing the Function of Brush Border Myosin I Calmodulin Light Chains 45
- IV. The Interaction of Brush Border Myosin I with the Microvillar Membrane 48
- V. Some Notions Regarding Brush Border Myosin I Function 51 References 53

CHAPTER 4 Protein Interactions Linking Actin to the Plasma Membrane in Focal Adhesions

Keiko O. Simon, Carol A. Otey, Fredrick M. Pavalko, and Keith Burridge

- I. Introduction 57
- II. Interaction between α -Actinin and β_1 Integrin 59
- III. Interaction between Talin and Actin 61
- IV. Conclusion 61 References 63

CHAPTER 5 Ankyrins: A Family of Proteins That Link Diverse Membrane Proteins To the Spectrin Skeleton

Vann Bennett, Ed Otto, Jonathan Davis, Lydia Davis, and Ekaterini Kordeli

- I. Introduction 65
- II. Ankyrin Structure 66
- III. Ankyrins Are a Multigene Family 68
- IV. Functional Diversity of Ankyrin due to Alternative Splicing of mRNA 71
- V. Mapping the Binding Sites of Ankyrin 72
- VI. Summary and Future Perspectives 75
 - References 76

CHAPTER 6 Contractile and Cytoskeletal Proteins in *Drosophila* Embryogenesis

Daniel P. Kiehart

- I. Introduction 79
- II. Movements of Early Embryogenesis 80

- III. Cell Shape Change Requires Remodeling of the Actin Cytoskeleton 83
- IV. Non-Muscle Myosins 84
- V. Spectrins 89
- VI. Summary 92 References 93

CHAPTER 7 Dominant Mutations of Cytoskeletal Proteins in *Xenopus* Embryos

Jan L. Christian, Gregory M. Kelly, and Randall T. Moon

- I. Introduction 99
- II. The Role of Membrane Skeleton Protein 4.1 during Embryogenesis 101
- III. Dissecting the Functions of Vimentin during Embryonic Development 102
- IV. Discussion 105 References 107

CHAPTER 8 The Animal Models of Duchenne Muscular Dystrophy: Windows on the Pathophysiological Consequences of Dystrophin Deficiency Eric P. Hoffman and Jose Rafael M. Gorospe

- I. Introduction 113
- II. The Animal Models of Duchenne Dystrophy: Biochemical and Genetic Homology 118
- III. Human Duchenne Dystrophy: Progressive Histopathology Leading to Muscle Wasting 121
- IV. The mdx Mouse: Nonprogressive Histopathology Resulting in Hypertrophy 124
- V. The xmd Dog: Rapidly Progressive Histopathology Leading to Muscle Wasting 125
- VI. The Dystrophin-Deficient Cat: Semiprogressive Histopathology with No Loss of Muscle Fibers 126
- VII. Phase I. The Primary Cellular Consequence of Dystrophin Deficiency: Generalized Leakage of the Plasma Membrane Buffered by the Syncytial Cytoplasm? 127
- VIII. Phase I Conclusion: An Integrated Model Featuring Ca²⁺ 130
 - IX. Phase II: Progressive Pathology and Clinical Weakness Specific to Humans and Dogs 134
 - X. The Development of Progressive Histopathology: Could Basic Fibroblast Growth Factor Have a Major Role? 143

XI. Conclusion: An Integrated Model and Its Consequences on the Development of Therapeutics 144 References 148

CHAPTER 9 Mutant Cytoskeletal Proteins in Hemolytic Disease

Sally L. Marchesi

- I. Introduction: Membrane/Skeleton Symposium 155
- II. Detection and Characterization of Spectrin Mutants in Hereditary Elliptocytosis 157
- III. Mutant Forms of Protein 4.1 in Hereditary Elliptocytosis 167
- IV. Hereditary Spherocytosis 169 References 171

CHAPTER 10 Dynamics of Intestinal Epithelial Tight Junctions

James L. Madara

- I. Introduction 175
- II. Tight Junctions (Zonula Occludens) as Potentially Regulated Barriers 176
- III. Intestinal Zonula Occludens as a Regulated Transport Pathway 179
- IV. Intestinal Zonula Occludens Function in Model Disease States 180
- V. Conclusions 181 References 182

CHAPTER 11 Regulation of Actin and Myosin II Dynamics in Living Cells

John Kolega and D. Lansing Taylor

- I. Introduction 187
- II. Quiescent Fibroblasts as a Model System 188
- III. The Multimode Approach 190
- IV. Actomyosin Dynamics in Serum-Starved 3T3 Fibroblasts 192
- V. Regulation of Stress Fiber Contraction 195
- VI. Stress Fiber Movement and Cell Motility 198
- VII. Some Future Prospects 199 References 202

CHAPTER 12 Expression and Function of Genetically Engineered Actin-Binding Proteins in *Dictyostelium*

Walter Witke, Michael Schleicher, Helmut Einberger, Wolfgang F. Neubert, and Angelika A. Noegel

- I. The Microfilament System of Dictyostelium discoideum 208
- II. F-Actin Cross-Linking Proteins in Dictyostelium discoideum 209
- III. Genetic Manipulation of α-Actinin in Escherichia coli and Dictyostelium discoideum 210 References 214

CHAPTER 13 Interaction of Profilins with Membrane Lipids

Thomas D. Pollard, Laura Machesky, and Pascal Goldschmidt-Clermont

- I. Binding of Profilin to Phospholipids 217
- II. Profilin Inhibits Soluble Phospholipase C 219
- III. Interaction of Profilin with Actin 221
- IV. What Does Profilin Actually Do in a Cell? 222 References 224

CHAPTER 14 Polarized Assembly of Spectrin and Ankyrin in Epithelial Cells

Jon S. Morrow, Carol D. Cianci, Scott P. Kennedy, and Stephen L. Warren

- I. Introduction: The Red Cell Paradigm 227
- II. The Unexpected Spatial Polarization of the Nonerythroid Spectrin Cytoskeleton 229
- III. The Interaction of Spectrin and Ankyrin with Basolateral Na⁺/K⁺-ATPase 231
- IV. Does Polarized Membrane Skeletal Assembly Require Ankyrin? 233
- V. Models for the Role of the Nonerythroid Spectrin-Actin Cytoskeleton 237 References 242

Index 245

This Page Intentionally Left Blank

Contributors

Numbers in parentheses indicate the pages on which the authors' contributions begin.

- Vann Bennett (65), Department of Biochemistry and the Howard Hughes Medical Institute, Duke University Medical Center, Durham, North Carolina 27710
- Keith Burridge (57), Department of Cell Biology and Anatomy, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599
- Richard E. Cheney (31), Department of Biology, Yale University, New Haven, Connecticut 06510
- Jan L. Christian (99), Department of Pharmacology, University of Washington, School of Medicine, Seattle, Washington 98195
- Carol D. Cianci (227), Department of Pathology, Yale University School of Medicine, New Haven, Connecticut 06510
- Thomas R. Coleman (31), Department of Biology, Yale University, New Haven Connecticut 06510
- Jonathan Davis (65), Department of Biochemistry and the Howard Hughes Medical Institute, Duke University Medical Center, Durham, North Carolina 27710
- Lydia Davis (65), Department of Biochemistry and the Howard Hughes Medical Institute, Duke University Medical Center, Durham, North Carolina 27710
- Helmut Einberger (207), Max-Planck-Institute for Biochemistry, D-8033 Martinsried, Germany
- Enilza Espreafico (31), Department of Biology, Yale University, New Haven, Connecticut 06510 and Departmento de Biochiumica, de Faculdade de Medicina de Ribeirao Preto, Universidade de São Paulo, 05508 São Paulo, Brazil.
- **Pascal Goldschmidt-Clermont** (217), Department of Cell Biology and Anatomy, The Johns Hopkins Medical School, Baltimore, Maryland 21205
- Lawrence S. B. Goldstein (1), Department of Cell and Developmental Biology, Harvard University, Cambridge, Massachusetts 02138
- Jose Rafael M. Gorospe (113), Departments of Molecular Genetics and Bio-

chemistry, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania 15261

- Steven M. Hayden (31), Department of Biology, Yale University, New Haven, Connecticut 06510
- Matthew B. Heintzelman (31), Department of Biology, Yale University, New Haven, Connecticut 06510
- Eric P. Hoffman (113), Departments of Molecular Genetics and Biochemistry, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania 15261
- Gregory M. Kelly (99), Department of Pharmacology, University of Washington, School of Medicine, Seattle, Washington 98195
- Scott P. Kennedy (227), Department of Pathology, Yale University School of Medicine, New Haven, Connecticut 06510
- **Daniel P. Kiehart** (79), Department of Cellular and Developmental Biology, Harvard University, The Biological Laboratories, Cambridge, Massachusetts 02138
- John Kolega (187), Department of Biologial Sciences and Center for Fluorescence Research in Biomedical Sciences, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213
- **Ekaterini Kordeli** (65), Department of Biochemistry and the Howard Hughes Medical Institute, Duke University Medical Center, Durham, North Carolina 27710
- Edward D. Korn (13), Laboratory of Cell Biology, National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, Maryland 20892
- Laura Machesky (217), Department of Cell Biology and Anatomy, The Johns Hopkins Medical School, Baltimore, Maryland 21205
- James L. Madara (175), Department of Pathology, Brigham and Women's Hospital, and Harvard Medical School, and the Harvard Digestive Disease Center, Boston, Massachusetts 02115
- Sally L. Marchesi (155), Department of Pathology and Laboratory Medicine, Yale Medical School, New Haven, Connecticut 06510
- Randall T. Moon (99), Department of Pharmacology, University of Washington, School of Medicine, Seattle, Washington 98195
- Mark S. Mooseker (31), Department of Biology, Yale University, New Haven, Connecticut 06510

- Jon S. Morrow (227), Department of Pathology, Yale University School of Medicine, New Haven, Connecticut 06510
- Wolfgang F. Neubert (207), Max-Planck-Institute for Biochemistry, D-8033 Martinsried, Germany
- Angelika A. Noegel (207), Max-Planck-Institute for Biochemistry, D-8033 Martinsried, Germany
- Carol A. Otey (57), Department of Cell Biology and Anatomy, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599
- Ed Otto (65), Department of Biochemistry and the Howard Hughes Medical Institute, Duke University Medical Center, Durham, North Carolina 27710
- Fredrick M. Pavalko (57), Department of Cell Biology and Anatomy, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599
- Michelle D. Peterson (31), Department of Biology, Yale University, New Haven, Connecticut 06510
- Thomas D. Pollard (217), Department of Cell Biology and Anatomy, The Johns Hopkins Medical School, Baltimore, Maryland 21205
- Michael Schleicher (207), Max-Planck-Institute for Biochemistry, D-8033 Martinsried, Germany
- Keiko O. Simon (57), Department of Cell Biology and Anatomy, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599
- Russell J. Stewart (1), Department of Cell and Developmental Biology, Harvard University, Cambridge, Massachusetts 02138
- **D. Lansing Taylor** (187), Department of Biologial Sciences and Center for Fluorescence Research in Biomedical Sciences, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213
- Stephen L. Warren (227), Department of Pathology, Yale University School of Medicine, New Haven, Connecticut 06510
- Walter Witke (207), Max-Planck-Institute for Biochemistry, D-8033 Martinsried, Germany
- Joseph S. Wolenski (31), Department of Biology, Yale University, New Haven, Connecticut 06510