

Methods in Enzymology

Volume 293

Ion Channels
Part B

EDITED BY

P. Michael Conn

OREGON REGIONAL PRIMATE RESEARCH CENTER
BEAVERTON, OREGON

Editorial Advisory Board

John Adelman

Richard Aldrich

Stephen F. Heinemann



ACADEMIC PRESS

San Diego London Boston New York Sydney Tokyo Toronto

Table of Contents

| | |
|--------------------------------------|------|
| CONTRIBUTORS TO VOLUME 293 | ix |
| PREFACE | xiii |
| VOLUMES IN SERIES | xv |

Section I. Assembly

| | | |
|--|-----------------------------------|----|
| 1. Methods Used to Study Subunit Assembly of Potassium Channels | JIA XU AND MIN LI | 3 |
| 2. Assembly of Ion Channels | ZUFANG SHENG AND CAROL DEUTSCH | 17 |
| 3. Analysis of K ⁺ Channel Biosynthesis and Assembly in Transfected Mammalian Cells | JAMES S. TRIMMER | 32 |

Section II. Genetics

| | | |
|--|--|-----|
| 4. Site-Directed Mutagenesis | TAKAHIRO M. ISHII, PATRICIA ZERR, XIAO-MING XIA, CHRIS T. BOND, JAMES MAYLIE, AND JOHN P. ADÉLMAN | 53 |
| 5. Molecular Physiology of Human Cardiovascular Ion Channels: From Electrophysiology to Molecular Genetics | SYLVAIN RICHARD, PHILIPPE LORY, EMMANUEL BOURINET, AND JOËL NARGEOT | 71 |
| 6. Studying Ion Channels Using Yeast Genetics | ROBERT L. NAKAMURA AND RICHARD F. GABER | 89 |
| 7. Identification of Ion Channel-Associated Proteins Using the Yeast Two-Hybrid System | MARTIN NIETHAMMER AND MORGAN SHENG | 104 |
| 8. Substituted-Cysteine Accessibility Method | ARTHUR KARLIN AND MYLES H. AKABAS | 123 |
| 9. Explorations of Voltage-Dependent Conformational Changes Using Cysteine Scanning | RICHARD HORN | 145 |
| 10. Assessment of Distribution of Cloned Ion Channels in Neuronal Tissues | KOHJI SATO AND MASAYA TOHYAMA | 155 |

Section III. Electrophysiology

| | | |
|---|---|-----|
| 11. Patch-Clamp Studies of Cystic Fibrosis Trans-membrane Conductance Regulator Chloride Channel | JOHN W. HANRAHAN, ZIE KONE, CERI J. MATHEWS, JIEXIN LUO, YANLIN JIA, AND PAUL LINDSELL | 169 |
| 12. Identification of Ion Channel Regulating Proteins by Patch-Clamp Analysis | THOMAS J. NELSON, PAVEL A. GUSEV, AND DANIEL L. ALKON | 194 |
| 13. Tight-Seal Whole-Cell Patch Clamping of <i>Caenorhabditis elegans</i> Neurons | SHAWN R. LOCKERY AND M. B. GOODMAN | 201 |
| 14. Low-Noise Patch-Clamp Techniques | RICHARD A. LEVIS AND JAMES L. RAE | 218 |
| 15. Giant Membrane Patches: Improvements and Applications | DONALD W. HILGEMANN AND CHIN-CHIH LU | 267 |
| 16. Electrophysiologic Recordings from <i>Xenopus</i> Oocytes | WALTER STÜHMER | 280 |
| 17. Cut-Open Oocyte Voltage-Clamp Technique | ENRICO STEFANI AND FRANCISCO BEZANILLA | 300 |
| 18. Cut-Open Recording Techniques | SHUJI KANEKO, AKINORI AKAIKE, AND MASAMICHI SATOH | 319 |
| 19. Gating Currents | FRANCISCO BEZANILLA AND ENRICO STEFANI | 331 |
| 20. Calcium Influx during an Action Potential | J. GERARD G. BORST AND FRITJOF HELMCHEN | 352 |
| 21. Combined Whole-Cell and Single-Channel Current Measurement with Quantitative Ca ²⁺ Injection or Fura-2 Measurement of Ca ²⁺ | L. DONALD PARTRIDGE, HANNES ULRICH ZEILHOFER, AND DIETER SWANDULLA | 371 |
| 22. Determining Ion Channel Permeation Properties | TED BEGENISICH | 383 |
| 23. Voltage-Dependent Ion Channels: Analysis of Nonideal Macroscopic Current Data | RÜDIGER STEFFAN, CHRISTIAN HENNESTHAL, AND STEFAN H. HEINEMANN | 391 |
| 24. Signal Processing Techniques for Channel Current Analysis Based on Hidden Markov Models | SHIN-HO CHUNG AND PETER W. GAGE | 420 |
| 25. Investigating Single-Channel Gating Mechanisms through Analysis of Two-Dimensional Dwell-Time Distributions | BRAD S. ROTHBERG AND KARL L. MAGLEBY | 437 |

Section IV. Expression Systems

| | | |
|---|--|-----|
| 26. Expression of Ligand-Gated Ion Channels Using Semliki Forest Virus and Baculovirus | KATHRYN RADFORD AND GARY BUELL | 459 |
| 27. Recombinant Adenovirus-Mediated Expression in Nervous System of Genes Coding for Ion Channels and Other Molecules Involved in Synaptic Function | MARKUS U. EHRENGRUBER, MARKUS LANZREIN, YOUFENG XU, MARK C. JASEK, DAVID B. KANTOR, ERIN M. SCHUMAN, HENRY A. LESTER, AND NORMAN DAVIDSON | 483 |
| 28. <i>In Vivo</i> Incorporation of Unnatural Amino Acids into Ion Channels in <i>Xenopus</i> Oocyte Expression System | MARK W. NOWAK, JUSTIN P. GALLIVAN, SCOTT K. SILVERMAN, CESAR G. LABARCA, DENNIS A. DOUGHERTY, AND HENRY A. LESTER | 504 |
| 29. High-Level Expression and Detection of Ion Channels in <i>Xenopus</i> Oocytes | THEODORE M. SHIH, RAYMOND D. SMITH, LIGIA TORO, AND ALAN L. GOLDIN | 529 |
| 30. Unidirectional Fluxes through Ion Channels Expressed in <i>Xenopus</i> Oocytes | PER STAMPE AND TED BEGENISICH | 556 |
| 31. Transient Expression of Heteromeric Ion Channels | ALISON L. EERTMOED, YOLANDA F. VALLEJO, AND WILLIAM N. GREEN | 564 |

Section V. Model Simulations

| | | |
|--|---|-----|
| 32. Molecular Modeling of Ligand-Gated Ion Channels | MICHAEL J. SUTCLIFFE, ALLISTER H. SMEETON, Z. GALEN WO, AND ROBERT E. OSWALD | 589 |
| 33. Use of Homology Modeling to Predict Residues Involved in Ligand Recognition | SEAN-PATRICK SCOTT AND JACQUELINE C. TANAKA | 620 |
| 34. Ion Channels: Molecular Modeling and Simulation Studies | MARK S. P. SANSON | 647 |
| 35. Computer Simulations and Modeling of Ion Channels | MICHAEL E. GREEN | 694 |
| 36. Kinetic Models and Simulation: Practical Approaches and Implementation Notes | VLADIMIR AVDONIN AND TOSHINORI HOSHI | 724 |
| AUTHOR INDEX | | 761 |
| SUBJECT INDEX | | 789 |