

ACADEMIC PRESS

Heart Physiology and Pathophysiology

FOURTH EDITION

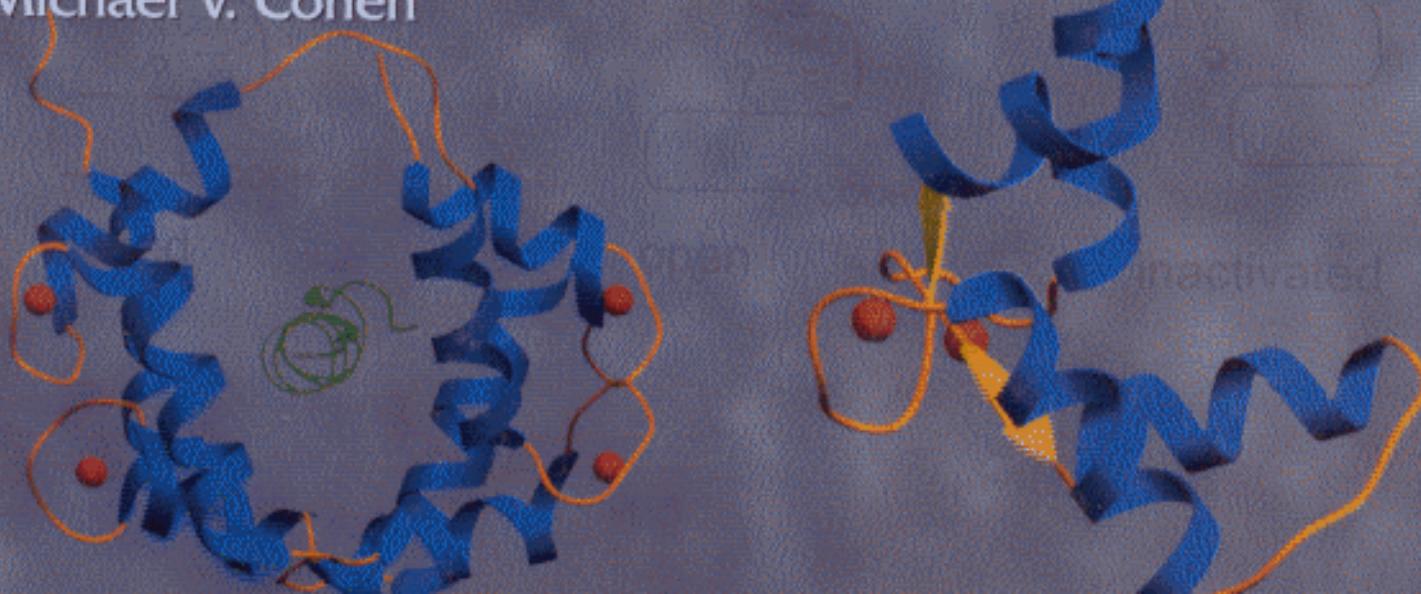
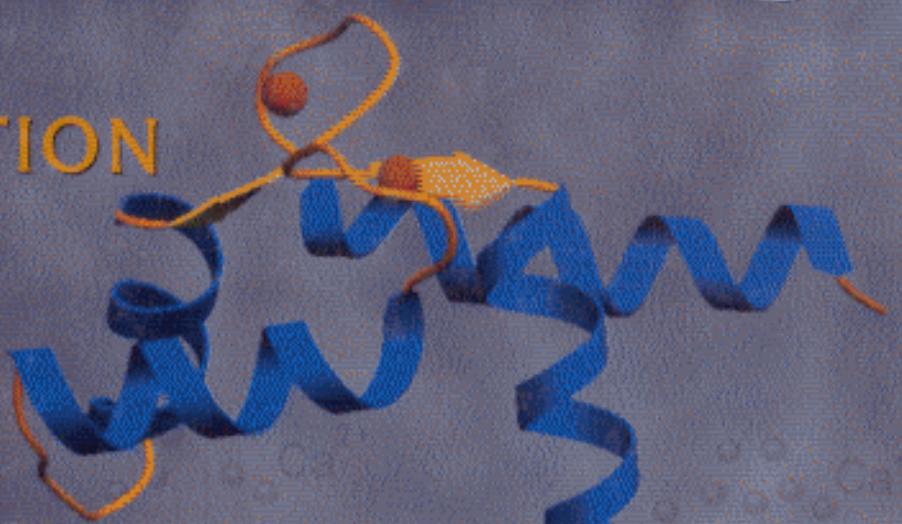
EDITED BY

Nicholas Sperelakis (Editor-in-Chief)

Yoshihisa Kurachi

Andre Terzic

Michael V. Cohen



Contents

Contributors xiii
Foreword xix
Preface xxi

PART

I

PUMPING ACTION AND ELECTRICAL ACTIVITY OF THE HEART

1. Sequence of Cardiac Activation and Ventricular Mechanics 3

JAMES M. DOWNEY AND GERD HEUSCH

2. Coronary Circulation and Hemodynamics 19

JOS A. E. SPAAN, JAN J. PIEK, AND MARIA SIEBES

3. Neurohumoral Control of Cardiac Function 45

JEFFREY L. ARDELL

4. Control of Cardiac Output and its Alterations during Exercise and in Heart Failure 61

JAMES M. DOWNEY AND GERD HEUSCH

5. Ultrastructure of Cardiac Muscle and Blood Vessels 71

MICHAEL S. FORBES

6. Excitability and Impulse Propagation 99

MORTON F. ARNSDORF AND JONATHAN C. MAKIELSKI

7. Electrocardiogram and Cardiac Excitation 133

YORAM RUDY

8. Gap-Junction Channels and Healing-Over of Injury 149

DAVID C. SPRAY, SYLVIA O. SUADICANI,
MONIQUE J. VINK, AND MIDUTURU SRINIVAS

PART

II

CELLULAR ELECTROPHYSIOLOGY OF HEART AND VASCULAR SMOOTH MUSCLE

9. Electrogenesis of the Resting Potential 175

NICHOLAS SPERELAKIS, MASANORI SUNAGAWA, AND
MARIKO NAKAMURA

10. Cardiac Action Potentials 199

GORDON M. WAHLER

11. Electrophysiology of Vascular Smooth Muscle 213

JANE A. MADDEN AND NANCY J. RUSCH

12. Sodium Channels 229

KATSUSHIGE ONO AND MAKOTO ARITA

13. Voltage-Dependent Calcium Channels 247

LUBICA LACINOVÁ AND FRANZ HOFMANN

14. Voltage-Dependent K⁺ Channels 259

HAROLD C. STRAUSS, MICHAEL J. MORALES,
SHIMIN WANG, MULUGU V. BRAHMAJOTHI, AND
DONALD L. CAMPBELL

**15. Inwardly-Rectifying K⁺ Channels
in the Heart 281**

MASAYUKI TANEMOTO, AKIKAZU FUJITA, AND
YOSHIHISA KURACHI

**16. Voltage and Calcium-Activated K⁺
Channels of Coronary Smooth Muscle 309**

JURE MARIĆ AND LIGIA TORO

**17. Ion Channels in Vascular Smooth
Muscle 327**

JUN YAMAZAKI AND KENJI KITAMURA

18. Cardiac Pacemaker Currents 357

D. DIFRANCESCO, A. MORONI, M. BARUSCOTTI, AND
ERIC A. ACCILI

19. Chloride Channels in Heart 373

ROBERT D. HARVEY AND JOSEPH R. HUME

**20. Regulation of Cardiac Ion Channels
by Phosphorylation, Ca²⁺,
Cytoskeleton, and Stretch 389**

MASAYASU HIRAKA, YUJI HIRANO, SEIKO KAWANO, AND
TETSUSHI FURUKAWA

PART

III

PUMPS AND EXCHANGERS

21. Cardiac Na⁺/K⁺ Pump 407

JOSEPH R. STIMERS

**22. Cardiac Na⁺-Ca²⁺ Exchanger:
Pathophysiology and Pharmacology 417**

JUNKO KIMURA

**23. Na⁺/H⁺ Exchanger and pH
Regulation 427**

M. PUCÉAT

24. Transport in Nucleus 437

CARMEN M. PEREZ-TERZIC, A. MARQUIS GACY, AND
ANDRE TERZIC

**25. Sarcoplasmic Reticulum Ca²⁺
Transport 447**

ISTVAN EDES, GUOXIANG CHU, AND EVANGELIA G. KRANIAS

**26. Calcium Release from Cardiac
Sarcoplasmic Reticulum 461**

GERHARD MEISSNER

PART

IV

VASCULAR ENDOTHELIUM

27. Function of Vascular Endothelium 473

STEPHANIE H. WILSON AND AMIR LERMAN

**28. Ion Channels in Vascular
Endothelium 481**

BERND NILIUS AND GUY DROOGMANS

PART

V

**EXCITATION-CONTRACTION
COUPLING AND
PHARMACOMECHANICAL COUPLING**

**29. Electromechanical and
Pharmacomechanical Coupling in
Vascular Smooth Muscle Cells 501**

GUY DROOGMANS, BERND NILIUS, HUMBERT DE SMEIDT,
JAN B. PARYS, AND LUDWIG MISSIAEN

**30. Mechanisms Regulating Cardiac
Myofilament Response to Calcium 519**

R. JOHN SOLARO

**31. Vascular Smooth Muscle
Contraction 527**

GARY J. KARGACIN AND MICHAEL P. WALSH

P A R T

VI

METABOLISM AND ENERGETICS

32. Myocardial Energy Metabolism 543

PAUL F. KANTOR, GARY D. LOPASCHUK, AND LIONEL H. OPIE

**33. Metabolism and Energetics of Vascular
Smooth Muscle 571**

CHRISTOPHER D. HARDIN, TARA J. ALLEN, AND RICHARD J. PAUL

P A R T

VII

SIGNALING SYSTEMS

**34. Adrenergic Receptors in the
Cardiovascular System 599**

JON W. LOMASNEY AND LEE F. ALLEN

35. Cardiac Action of Angiotensin II 609

MASAO ENDOH

**36. ATP and Adenosine Signal
Transductions 633**

AMIR PELLEG, GUY VASSORT, AND JOHN A. AUCHAMPACH

**37. Kinase Signaling in the
Cardiovascular System 657**

JUN-ICHI ABE, CHEN YAN, JAMES SURAPISITCHAT, AND
BRADFORD C. BERK

38. Calcium Signaling 679

DEREK TERRAR, STEVAN RAKOVIC, AND ANTONY GALIONE

**39. Diadenosine Polyphosphate Signaling in
the Heart 693**

ALEKSANDAR JOVANOVIC, SOFIJA JOVANOVIC, AND
ANDRE TERZIC

P A R T

VIII

**DEVELOPMENTAL CHANGES
AND AGING**

**40. Cardiac Development and Regulation of
Cardiac Transcription 705**

FRÉDÉRIC CHARRON AND MONA NEMER

**41. Developmental Changes of Ion
Channels 719**

HISASHI YOKOSHIKI AND NORITSUGU TOHSE

42. Aging of the Cardiovascular System 737

EDWARD G. LAKATTA, YING-YING ZHOU, RUI-PING XIAO, AND
MARVIN BOLUYT

**43. Changes in Autonomic Responsiveness
during Development 761**

RICHARD B. ROBINSON, MICHAEL R. ROSEN, AND
SUSAN F. STEINBERG

P A R T

IX

**MECHANISM OF ACTION OF
CARDIOACTIVE DRUGS**

**44. Inotropic Mechanism in Cardiac
Muscle 779**

DONALD M. BERS

**45. Mechanisms of Action of
Calcium Antagonists 789**

HELMUT A. TRITTHART

46. Cyclic Nucleotides and Protein Phosphorylation in Vascular Smooth Muscle Relaxation 805

GIOVANNI M. PITARI, DONALD H. MAURICE, BRIAN M. BENNETT,
AND SCOTT A. WALDMAN

47. K⁺ Channel Openers 829

ARSHAD JAHANGIR, WIN-KUANG SHEN, AND ANDRE TERZIC

48. Mode of Action of Antiarrhythmic Drugs 837

AUGUSTUS O. GRANT AND VIJAY S. CHAUHAN

PART

X**PATHOPHYSIOLOGY****49. Cellular Mechanisms of Cardioprotection 853**

MASAFUMI KITAKAZE AND MASATSUGU HORI

50. Ischemic Preconditioning: Description, Mechanism, and Significance 867

MICHAEL V. COHEN AND JAMES M. DOWNEY

51. Cardioplegia and Surgical Ischemia 887

D. J. CHAMBERS AND D. J. HEARSE

52. Apoptosis 927

ARMIN HAUNSTETTER AND SEIGO IZUMO

53. Calcium Overload in Ischemia/Reperfusion Injury 949

NARANJAN S. DHALLA, RANA M. TEMSAH,
THOMAS NETTICADAN, AND MANJOT S. SANDHU

54. Coronary Atherosclerosis and Restenosis 967

SHMUEL BANAI, ADI KURGAN, AND S. DAVID GERTZ

55. Diabetic Vascular Disease 1011

WILLIAM G. MAYHAN

56. Angiogenesis and Coronary Collateral Circulation 1031

WOLFGANG SCHAPER AND JUTTA SCHAPER

57. Molecular Pathophysiology of Cardiomyopathies 1045

ALI J. MARIAN AND ROBERT ROBERTS

58. Signal Transduction of Cardiac Myocyte Hypertrophy 1065

HIROKI AOKI AND SEIGO IZUMO

59. Electrophysiological Changes in Hypertrophy 1087

VALENTINO PIACENTINO III AND STEVEN R. HOUSER

60. Molecular Basis of Inherited Long QT Syndromes and Cardiac Arrhythmias 1097

DENIS ESCANDE, MILOU D. DRICI, AND
JACQUES BARHANIN

61. Molecular Mechanisms of Atrial Fibrillation 1107

DAVID R. VAN WAGONER AND JEANNE M. NERBONNE

62. Lipids Released during Ischemia and Arrhythmogenesis 1125

GARY D. LOPASCHUK

63. Ion Channels in the Heart 1137

ROBERT S. KASS, HUGUES ABRIEL, AND ILARIA RIVOLTA

64. Cardiac Arrhythmias: Reentry and Triggered Activity 1153

CHARLES ANTZELEVITCH AND ALEXANDER BURASHNIKOV

**65. Myocardial Reperfusion Injury—
Role of Free Radicals and Mediators
of Inflammation 1181**

BENEDICT R. LUCCHESI

66. Cardiac Toxicology 1211

ROSITA J. RODRIGUEZ AND DANIEL ACOSTA, JR.

**67. Regulation of Gene Expression
by Hypoxia 1225**

ANDREW P. LEVY

**68. Gene Transfer in Cardiovascular
Therapy 1233**

IFTIKHAR J. KULLO AND ROBERT D. SIMARI

Index 1245