

Contents

Contributors	xi
Preface	xix
Acknowledgments	xxi

I

Introduction

1. Evolution of the cardiovascular autonomic nervous system in vertebrates	3
TOBIAS WANG, RENATO FILOGONIO AND WILLIAM JOYCE	
2. Central autonomic control	11
KAMAL SHOUMAN AND EDUARDO E. BENARROCH	
3. Peripheral autonomic nervous system	17
WAQAR WAHEED AND MARGARET A. VIZZARD	

II

Biochemical and pharmacological mechanisms

4. Noradrenergic neurotransmission	33
DAVID S. GOLDSTEIN	
5. Antidepressant-sensitive norepinephrine transporters: structure and regulation	39
MAUREEN K. HAHN	
6. α_1 -Adrenergic receptors	43
XENIA Kaidonis, MARION C. MOHL AND ROBERT M. GRAHAM	
7. α_2 -Adrenergic receptors.....	49
EDUARDO LISTIK AND QIN WANG	
8. β -Adrenergic receptors.....	53
VSEVOLOD V. GUREVICH	
9. Dopaminergic neurotransmission.....	57
GRAEME EISENHOFER, TIMO SIEPMANN AND HEINZ REICHMANN	
10. Dopamine receptors.....	63
SEAN M. PETERSON, NIKHIL URS AND MARC G. CARON	

11. Cholinergic neurotransmission	67
BRETT A. ENGLISH AND CARRIE K. JONES	
12. Acetylcholine and muscarinic receptors	73
KATHARINA BRANDL AND NORA LAIKEN	
13. Nicotinic acetylcholine receptors in the autonomic nervous system.....	77
URSULA H. WINZER-SERHAN	
14. Neuropeptide Y and the autonomic nervous system.....	81
CALUM ROBERTSON, DAVID J. PATERSON AND NEIL HERRING	
15. Serotonin receptors	89
CHARLES D. NICHOLS	
16. Purinergic neurotransmission and nucleotide receptors	93
SAMUEL J. FOUNTAIN	
17. Nitric oxide and the autonomic nervous system	99
ALFREDO GAMBOA	
18. Glutamatergic neurotransmission	103
DEBORAH BAUER AND MICHAEL B. ROBINSON	
19. Pharmacology: GABAergic neurotransmission.	109
KIRILL A. ZAVALIN AND ANDRE H. LAGRANGE	
20. Renin-angiotensin	113
AMY C. ARNOLD AND DEBRA I. DIZ	
21. Aldosterone, the mineralocorticoid receptor, and sympathetic nervous system.....	119
ELISE P. GOMEZ-SANCHEZ AND CELSO E. GOMEZ-SANCHEZ	
22. Vasopressin in central autonomic regulation....	123
SOLEDAD BAREZ-LOPEZ, DAVID MURPHY AND NINA JAPUNDŽIĆ-ŽIGON	
23. Calcitonin gene-related peptide and adrenomedullin.....	129
AMBRISH KUMAR, JAY D. POTTS AND DONALD J. DIPETTE	

24. Leptin signaling and energy homeostasis 135 MICHAEL M. SCOTT AND KEVIN W. WILLIAMS	39. The splanchnic circulation 223 GREGORY D. FINK AND JOHN W. OSBORN	
25. The endothelin system 141 NATHANNE S. FERREIRA AND ERNESTO L. SCHIFFRIN	40. Autonomic control of the kidney 227 EDWIN KERRY JACKSON	
26. Pharmacology of the neurotransmission of the baro- and chemoreflex in the Nucleus Tractus Solitarius 147 DAVID D. KLINE, BENEDITO H. MACHADO AND DANIELA ACCORSI-MENDONÇA	41. Autonomic control of the lower urinary tract .. 235 TAKEYA KITTA AND NAOKI YOSHIMURA	
III		
Autonomic physiology		
27. Rhythms in sympathetic nerve activity 157 SUSAN M. BARMAN	42. Bladder function in health and disease 241 MARCUS J. DRAKE AND BRIAN A. PARSONS	
28. Circadian rhythms and autonomic function 161 DIEGO A. GOLOMBÉK AND DANIEL E. VIGO	43. Physiology and pathophysiology of female sexual function 247 MAX J. HILZ AND RUIHAO WANG	
29. Cardiorespiratory interactions in health and disease 165 DANIEL B. ZOCCAL, BENEDITO H. MACHADO AND DAVI J.A. MORAES	44. Regulation of sweating 253 ELIZABETH A. COON AND PHILLIP A. LOW	
30. Baroreceptor reflexes 171 MARK W. CHAPLEAU	45. Autonomic innervation of the skeleton 257 FLORENT ELEFTERIOU, PRESTON J. CAMPBELL AND MARIA-BERNADETTE MADEL	
31. Cardiac and other visceral afferents 179 HAN-JUN WANG, JOSEPH HADAYA AND JEFFREY L. ARDELL	46. Regulation of metabolism by the autonomic nervous system 263 CHRISTOPHER BELL	
32. Sympathetic control of the heart 185 JAKUB TOMEK, NEIL HERRING AND DAVID J. PATERSON	47. Sex differences in autonomic function 267 QI FU	
33. Cardiac vagal ganglia 193 DAVID J. ADAMS, JESSE L. ASHTON AND JOHANNA M. MONTGOMERY	48. Autonomic control during pregnancy 273 VIRGINIA L. BROOKS	
34. Physiology of the upright posture 199 WOUTER WIELING AND VICTORIA E. CLAYDON	49. Aging and the autonomic nervous system 279 RALF HABERMANN AND ITALO BIAGGIONI	
35. Cerebral circulation 203 RONALD SCHONDORF	50. Autonomic function in sleep and sleep deprivation 283 IAN M. GREENLUND AND JASON R. CARTER	
36. Autonomic control of the pupil 209 KAREN M. JOOS AND REID LONGMUIR	51. Telemetric autonomic monitoring 287 CAROLYN J. BARRETT, SARAH-JANE GUILD AND FIONA D. MCBRYDE	
37. Gastrointestinal function 213 MICHAEL CAMILLERI	IV	
38. Extrinsic control of gastrointestinal function 219 KIRSTEEN N. BROWNING AND R. ALBERTO TRAVAGLI	Autonomic response to environmental challenges	
	52. Exercise 295 MEREDITH BRYARLY, QI FU AND BENJAMIN D. LEVINE	
	53. Psychological stress and the autonomic nervous system 301 VIKTOR OUBAID	

54. Hypoglycemia	305
ITALO BIAGGIONI	
55. Autonomic response to hypovolemic shock.....	309
VICTOR A. CONVERTINO AND NATALIE J. KOONS	
56. Physiology of thermoregulation: central and peripheral mechanisms	315
NISHA CHARKOUDIAN AND SHAUN F. MORRISON	
57. Effects of high altitude	323
ULRICH LIMPER	
58. Space physiology.....	329
GILLES CLÉMENT AND SCOTT WOOD	
59. Noise, air pollution, and the autonomic nervous system.....	333
JENS JORDAN AND EVA-MARIA ELMENHORST	

V

Pathophysiological mechanisms

60. The autonomic inflammatory reflex	341
ROBIN M. MCALLEN, MICHAEL J. MCKINLEY AND DAVIDE MARTELLI	
61. Reactive oxygen species and oxidative stress....	345
RHIAN M. TOUYZ AND LIVIA L. CAMARGO	
62. Insulin resistance and the autonomic nervous system.....	353
ALFREDO GAMBOA, ITALO BIAGGIONI AND ELISABETH LAMBERT	
63. Salt sensitivity of blood pressure.....	357
CHERYL L. LAFFER AND FERNANDO ELIJOVICH	
64. Airway afferent nerves	367
JOYCE S. KIM AND BRADLEY J. UNDEM	

VI

Evaluation of autonomic function

65. Clinical evaluation of autonomic disorders.....	375
PAOLA SANDRONI	
66. Autonomic function testing.....	379
WOLFGANG SINGER AND PHILLIP A. LOW	
67. Tilt table testing	385
BRENNAN A. BALLANTYNE AND SATISH R. RAJ	

68. Patient symptom and rating scales: OHQ, COMPASS, UMSARS	391
WOLFGANG SINGER	
69. Sympathetic microneurography and clinical applications.....	395
VAUGHAN G. MACEFIELD	
70. Assessment of the autonomic control of the cardiovascular system by a frequency domain approach.....	403
ANDRE DIEDRICH AND RAFFAELLO FURLAN	
71. Evaluation of sudomotor function	409
ELIZABETH A. COON	
72. Plasma catechols.....	415
DAVID S. GOLDSTEIN	
73. Imaging cortical and subcortical sites involved in cardiovascular control.....	421
VAUGHAN G. MACEFIELD AND LUKE A. HENDERSON	
74. Clinical sympathetic neuroimaging	427
GUILLAUME LAMOTTE AND DAVID S. GOLDSTEIN	
75. Cutaneous autonomic innervation: assessment by skin biopsy	433
CHRISTOPHER H. GIBBONS	
76. Sympatho-effector transduction.....	439
JAMES P. FISHER, LAURO C. VIANNA AND PAUL J. FADEL	

VII

Cardiovascular disorders

77. Neurally mediated syncope (Autonomically mediated syncope)	447
BRENNAN A. BALLANTYNE AND SATISH R. RAJ	
78. Orthostatic hypotension.....	453
ITALO BIAGGIONI	
79. Spectrum of orthostatic hypotension.....	457
WOLFGANG SINGER AND PHILLIP A. LOW	
80. Baroreflex failure.....	461
JENS JORDAN	
81. Essential hypertension.....	467
GINO SERAVALLE AND GUIDO GRASSI	

82. Obesity-associated hypertension 471
ALFREDO GAMBOA, LUIS E. OKAMOTO,
CYNDYA A. SHIBAO AND ITALO BIAGGIONI
83. Pheochromocytoma and paraganglioma 475
CHRISTINA PAMPORAKI, JACQUES W.M. LENDERS
AND GRAEME EISENHOFER
84. Autonomic dysfunction in heart failure 483
MARK B. BADROV AND JOHN S. FLORAS
85. Myocardial stunning and takotsubo
cardiomyopathy 489
LUCY NORCLIFFE-KAUFMANN
86. The autonomic nervous system and cardiac
arrhythmias 495
AADHAVI SRIDHARAN, PETER HANNA AND
KALYANAM SHIVKUMAR

VIII

Congenital autonomic disorders

87. Deficiencies of tetrahydrobiopterin, tyrosine
hydroxylase, and aromatic L-amino acid
decarboxylase 503
KEITH HYLAND AND LAUREN A. HYLAND
88. Congenital disorders of noradrenergic
neurotransmission 507
ITALO BIAGGIONI, EMILY M. GARLAND AND
CYNDYA A. SHIBAO
89. Monoamine oxidase deficiency 513
JACQUES W.M. LENDERS AND GRAEME EISENHOFER
90. Congenital central hypoventilation syndrome
(CCHS) and *PHOX2B* pathogenic variants 515
DEBRA E. WEESE-MAYER, CASEY M. RAND AND
KAI LEE YAP
91. Hereditary autonomic neuropathies 521
KAMAL SHOUMAN
92. Familial dysautonomia (Riley—Day syndrome) ... 527
LUCY NORCLIFFE-KAUFMANN AND HORACIO KAUFMANN

IX

Autonomic synucleinopathies

93. α -Synuclein and neurodegeneration 535
NADIA STEFANOVA

94. Multiple system atrophy 539
GUILLAUME LAMOTTE AND ELIZABETH A. COON
95. Parkinson disease 549
JOHN Y. FANG
96. Dementia with Lewy bodies 553
FABIAN LEYS, ALESSANDRA FANCIULLI AND
GREGOR K. WENNING
97. Pure autonomic failure 559
HORACIO KAUFMANN AND DAVID S. GOLDSTEIN

X

Peripheral autonomic disorders

98. Small fiber neuropathy 565
AMANDA C. PELTIER
99. Diabetic autonomic dysfunction 569
AMANDA C. PELTIER AND STEPHEN N. DAVIS
100. Amyloidosis and autonomic failure 575
PITCHA CHOMPOOPONG AND MICHELLE L. MAUERMANN
101. Autoimmune autonomic syndromes 585
STEVEN VERNINO AND PHILLIP A. LOW
102. Paraneoplastic autonomic dysfunction 591
ANDREW MCKEON AND JENNIFER A. TRACY
103. Autonomic disturbances following spinal
cord injury 599
CHRISTOPHER J. MATHIAS, DAVID A. LOW AND
VICTORIA E. CLAYDON
104. Drug-induced autonomic dysfunction 607
AMR WAHBA AND JAMES M. LUTHER

XI

Autonomic syndromes

105. Postural tachycardia syndrome.
Pathophysiological mechanisms 613
ITALO BIAGGIONI AND JULIAN STEWART
106. Postural tachycardia syndrome (POTS) 619
GUILLAUME LAMOTTE AND PHILLIP A. LOW
107. Joint hypermobility and dysautonomia 623
MOHAMMED RUZIEH AND BLAIR P. GRUBB

108. Mast cell activation and autonomic disorders ... 627
JOHN M. FAHRENHOLZ, II AND CYNDYA A. SHIBAO
109. Chronic fatigue syndrome and the autonomic nervous system 631
LAUREN E. STILES AND LUIS E. OKAMOTO

XII

Special clinical conditions

110. Neuroleptic malignant syndrome..... 637
AMY E. BROWN, ANDREW GIRITHARAN AND FENNA T. PHIBBS
111. Migraine and autonomic nervous system 641
PIETRO CORTELLI, UMBERTO PENSATO AND GIULIA PIERANGELI
112. Autonomic regulation in epilepsy 645
DMITRY ZHURAVLEV, ALLA GUEKHT AND MAX J. HILZ
113. Autonomic complications of acute brain injury and stroke..... 651
ALEJANDRO A. RABINSTEIN
114. Sleep apnea..... 657
THOMAS KONECNY AND VIREND SOMERS
115. Panic disorder: Autonomic nervous mechanisms of risk 663
MURRAY ESLER, GAVIN LAMBERT, DAVID KAYE, ELISABETH LAMBERT, ROSEMARY ESLER, LING GUO AND MARLIES ALVARENGA
116. Disorders of sweating..... 671
ELIZABETH A. COON AND ROBERT D. FEALEY
117. Complex regional pain syndrome 679
WILFRID JÄNIG
118. Abdominal pain and cyclic vomiting..... 685
GISELA CHELIMSKY AND THOMAS C. CHELIMSKY
119. Male erectile dysfunction..... 691
DOUGLAS F. MILAM

XIII

Management of neurogenic orthostatic hypotension

120. Management of orthostatic hypotension.
Introduction..... 699
ITALO BIAGGIONI

121. Physical measures 705
WOUTER WIELING AND ROLAND D. THIJS
122. Dietary sodium and fludrocortisone 709
CYNDYA A. SHIBAO, ITALO BIAGGIONI AND ROSE MARIE ROBERTSON
123. Water and the osmopressor response..... 713
JENS JORDAN
124. Midodrine 717
JOSE-ALBERTO PALMA AND HORACIO KAUFMANN
125. Droxidopa 721
JOSE-ALBERTO PALMA AND HORACIO KAUFMANN
126. Pyridostigmine in autonomic disorders..... 729
GUILLAUME LAMOTTE, PHILLIP A. LOW AND WOLFGANG SINGER
127. Norepinephrine transporter inhibitors in autonomic disorders..... 733
CYNDYA A. SHIBAO
128. Acarbose and octreotide for the treatment of postprandial hypotension 737
CYNDYA A. SHIBAO
129. Management of supine hypertension in patients with autonomic failure 741
LUIS E. OKAMOTO AND ITALO BIAGGIONI
130. Anesthetic considerations in patients with autonomic dysfunction 747
JOHN R. SHANNON
131. Chronic constitutional hypotension..... 753
GIRIS JACOB AND RAFFAELLO FURLAN

XIV

Autonomic neuromodulation as a treatment strategy

132. Renal denervation as therapeutic intervention 759
MURRAY ESLER, GAVIN LAMBERT, ELISABETH LAMBERT, LING GUO AND MARKUS SCHLAICH
133. Baroreflex amplification by carotid sinus stimulation 767
JENS JORDAN AND JENS TANK

134. Targeting carotid body chemoreceptors as a therapeutic intervention 771	139. Mapping the autonomic nervous system: the SPARC project..... 807
EMMA N. BARDSLEY, HAROLD D. SCHULTZ, PIOTR NIEWIŃSKI AND JULIAN F.R. PATON	MAHYAR OSANLOUY, MABELLE LIN, ELIAS SOLTANI AND PETER HUNTER
135. Bionic baroreflex..... 779	140. Autonomic nervous system-gut-microbiome axis in chronic diseases 815
TAKAYUKI SATO, ANDRÉ DIEDRICH AND KENJI SUNAGAWA	JASENKA ZUBCEVIC AND MOHAN K. RAIZADA
136. Therapeutic targeting of splanchnic nerves 785	141. Novel fluid biomarkers in synucleinopathies .. 821
ABU BAKER SHEIKH, ABDUL MANNAN KHAN MINHAS AND MARAT FUDIM	WOLFGANG SINGER AND PHILLIP A. LOW
XV	
Novel approaches in autonomic neuroscience	
137. Modeling the autonomic nervous system 795	142. Novel disease-modifying treatments for synucleinopathies..... 825
ALONA BEN-TAL	WOLFGANG SINGER, JOSE-ALBERTO PALMA, HORACIO KAUFMANN AND PHILLIP A. LOW
138. Optogenetics: application to central autonomic regulatory pathways 801	Index 831
ANDREW M. ALLEN AND CLÉMENT MENUET	