

Contents

Preface	V
Introduction	
The First Biological Sonderforschungsbereich at the Ruhr-Universität Bochum	1
<i>Johann Schwartzkopff</i>	
1 Signal Processing at the Cellular Level	5
1.1 Overview: The Research Groups, Their Central Topics and Main Results	5
<i>Hans Christoph Lüttgau</i>	
1.1.1 Ion Channels in Native Membranes and Reconstituted Planar Bilayers	6
1.1.2 Skeletal Muscle	9
1.1.3 Cardiac Muscle	13
1.1.4 Ciliates	15
1.1.5 Photoreceptors in Invertebrates (Projektbereich B)	17
1.1.6 Immunocytochemical Evaluation of Gap Junction Proteins	24
References	25
1.2 Electrogenic Cation Transports and Cardiac Excitation	30
<i>Hefried G. Glitsch, Lutz Pott</i>	
1.2.1 Introduction	30
1.2.2 The Electrogenic Na Pump	31
1.2.2.1 Identification of the Na Pump Current	31
1.2.2.2 The Coupling Ratio	31
1.2.2.3 Activator Cations of the Electrogenic Na Pump	32
1.2.2.4 Energy Source for Electrogenic Na Pumping and the Reversal Potential of the Pump	33
1.2.2.5 The Pump Current-Voltage Relation	34
1.2.2.6 The Contribution of Electrogenic Na Pumping to the Cardiac Resting Potential	35

1.2.2.7	Electrogenic Na Pumping and the Shape of the Cardiac Action Potential	35
1.2.2.8	Modulation of Cardiac Pacemaker Activity by Electrogenic Na Pumping	37
1.2.3	Na/Ca Exchange	37
1.2.3.1	Energy Source and Stoichiometry of Na/Ca Exchange	37
1.2.3.2	The Exchange Current	38
1.2.3.3	Methods for Studying I_{NaCa} in Single Myocytes	38
1.2.3.4	A Transient Inward Current Caused by Changes of the Exchange Current	40
1.2.3.5	Interaction between Exchange Current and Membrane Potential	40
1.2.4	Concluding Remarks	42
	References	43
1.3	Ion Channels and Behaviour: Ciliates as Cellular Models	45
	<i>Joachim W. Deitmer, Hans Machemer</i>	
1.3.1	Introduction	45
1.3.2	Mechanoreceptor Channels	46
1.3.2.1	Anterior Channel	47
1.3.2.2	Posterior Channel	49
1.3.3	Voltage-Dependent Channels	49
1.3.3.1	Calcium Channels	52
1.3.3.2	Potassium Channels	53
1.3.4	Behavioural Significance of the Ion Channels	55
1.3.5	Perspectives	58
1.3.6	Synopsis	60
	References	60
1.4	Insect Photoreception	
	I. Primary Mechanisms of Visual Excitation	64
	<i>Kurt Hamdorf, Reinhard Paulsen, Joachim Schwemer</i>	
1.4.1	Introduction	64
1.4.2	Photochemistry of Visual Pigments	66
1.4.3	Receptor Response and its Relation to Visual Pigment Activation	68
1.4.4	The Biochemical Amplification Cascade of Phototransduction	73
1.4.5	Metabolic Energy Required for Receptor Excitation	78
	References	80
1.5	Insect Photoreception	
	II. Mechanisms of Adaptation and Visual Pigment Renewal	83
	<i>Kurt Hamdorf, Joachim Schwemer, Reinhard Paulsen</i>	
1.5.1	Introduction	83
1.5.2	Light and Dark Adaptation	83
1.5.3	Renewal of Visual Pigment	95
	References	103

2	Integrative Aspects of Signal Processing	105
2.1	Overview: The Research Groups, Their Central Topics and Main Results	105
	<i>Johann Schwartzkopff, Reinhold Necker</i>	
2.1.1	Hearing in Insects and Birds	106
2.1.2	Visual System of Birds	108
2.1.3	Thermal Signals and Temperature Regulation	110
2.1.4	Chemical Signals and the Control of Breathing	112
	References	119
2.2	Neural Asymmetries and Visual Behaviour in Birds	122
	<i>Onur Guntürkün, Jacqueline Emmerton, Juan D. Delius</i>	
2.2.1	Introduction	122
2.2.2	The Retina of the Pigeon	122
2.2.3	Functional Differences in Visual Fields	124
2.2.4	Colour Vision	125
2.2.5	Visual Perimetry and Spectral Sensitivity	126
2.2.6	Intraocular Transfer	129
2.2.7	The Retinal Projections	129
2.2.8	Ascending Visual Pathways	132
2.2.8.1	Tectofugal Pathway	132
2.2.8.2	Thalamofugal Pathway	132
2.2.8.3	Evolution of Functional Differences between the Visual Pathways	133
2.2.9	Visual Lateralization	134
2.2.9.1	Visual Lateralization During Feeding	135
2.2.9.2	Stimulus Invariance of Visual Lateralization	135
2.2.9.3	Sex and Visual Lateralization	137
2.2.9.4	Neuronal Mechanisms of Visual Lateralization/ Transections of Telencephalotectal Tracts	137
2.2.9.5	Ontogeny and Maintenance of Visual Lateralization	142
2.2.10	Epilogue	143
	References	144
2.3	Hearing in Insects and its Adaptation to Environmental Constraints	146
	<i>Heiner Römer, Jürgen Rheinlaender</i>	
2.3.1	Acoustic Signals and Their Representation in the Central Nervous System	146
2.3.1.1	Frequency Analysis in the Insect Ear and the CNS	146
2.3.1.2	Frequency Analysis and Distance Perception	150
2.3.2	Sound Localization in the Laboratory and Outdoors	153
2.3.2.1	Behavioural Studies in the Laboratory	153
2.3.2.2	Neurophysiological Correlates of Directional Hearing	156
2.3.2.3	Directional Hearing Outdoors	159
	References	161

2.4	Distributed Signal Processing and Effector Control in the Thermoregulatory System	163
	<i>Jürgen Werner</i>	
2.4.1	Introduction	163
2.4.2	Distributed Signal Processing: Evidence from Neurophysiological Studies in Rats	164
2.4.3	Distributed Effector Control: Evidence from Regulatory and Simulation Studies in Man	168
2.4.3.1	Warm Defence in Man	168
2.4.3.2	Cold Defence in Man	172
	List of Symbols	175
	References	176
2.5	Competitive Signal Processing in Feedback Control Systems: Interrelation of Circulation, Respiration and Thermoregulation	178
	<i>Werner Rautenberg</i>	
2.5.1	Introduction	178
2.5.2	Shivering Thermogenesis	179
2.5.3	Shivering Thermogenesis under Hypoxic Conditions	183
2.5.4	Shivering Thermogenesis after Vagotomy	185
2.5.5	Conclusion: Shivering versus Cardiorespiration	186
2.5.6	Thermal Panting	187
2.5.7	Thermal Panting and Cardiorespiratory Responses	188
2.5.8	Conclusion: Thermoregulation versus Cardiorespiration	189
	References	190
3	Appendix: Documentation of the Sonderforschungsbereich 114	193
3.1	Institutions Involved in the Sonderforschungsbereich 114	193
3.2	Organization of the Sonderforschungsbereich 114	193
3.3	Members of the Sonderforschungsbereich 114	196
3.4	Foreign Guests	198
3.5	International Symposia, Organized by Members of the Sonderforschungsbereich 114	200
3.6	Funding	200