

Table of Contents

- Part 1 Introduction
- Chapter 1. Principles of Signaling and Organization p. 3
 - Signaling in Simple Neuronal Circuits p. 4
 - Organization of the Retina p. 5
 - Signaling in Nerve Cells p. 9
 - Cellular and Molecular Biology of Neurons p. 19
 - Signals for Development of the Nervous System p. 20
 - Regeneration of the Nervous System after Injury p. 21
- Part 2 Signaling in the Nervous System
- Chapter 2. Ion Channels and Signaling p. 25
 - Properties of Ion Channels p. 26
 - Measurement of Single-Channel Currents p. 29
 - Box 2.1 Measuring Channel Conductance p. 37
- Chapter 3. Structure of Ion Channels p. 39
 - The Nicotinic Acetylcholine Receptor p. 41
 - A Receptor Superfamily p. 49
 - Voltage-Activated Channels p. 50
 - Other Channels p. 55
 - Diversity of Subunits p. 58
 - Conclusion p. 58
 - Box 3.1 Cloning Receptors and Channels p. 40
 - Box 3.2 Classification of Amino Acids p. 45
 - Box 3.3 Expression of Receptors and Channels in *Xenopus* Oocytes p. 46
- Chapter 4. Transport Across Cell Membranes p. 61
 - The Sodium-Potassium Exchange Pump p. 62
 - Calcium Pumps p. 64
 - Sodium-Calcium Exchange p. 66
 - Chloride Transport p. 69
 - Transport of Neurotransmitters p. 70
 - Molecular Structure of Transporters p. 72
 - Significance of Transport Mechanisms p. 74
- Chapter 5. Ionic Basis of the Resting Potential p. 77
 - A Model Cell p. 78
 - Membrane Potentials in Squid Axons p. 81
 - Changes in Membrane Potential p. 88
- Chapter 6. Ionic Basis of the Action Potential p. 91
 - Sodium and Potassium Currents p. 92
 - Voltage Clamp Experiments p. 94
 - Gating Currents p. 103
 - The Role of Calcium in Excitation p. 110
 - Box 6.1 The Voltage Clamp p. 95
- Chapter 7. Neurons as Conductors of Electricity p. 113
 - Passive Electrical Properties of Nerve and Muscle Membranes p. 114
 - Propagation of Action Potentials p. 121

- Conduction in Dendrites p. 128
- Pathways for Current Flow between Cells p. 128
- Box 7.1 Electrotonic Potentials and the Membrane Time Constant p. 120
- Box 7.2 Classification of Nerve Fibers in Vertebrates p. 125
- Box 7.3 Stimulating and Recording with External Electrodes p. 127
- Box 7.4 Current Flow between Cells p. 130
- Chapter 8. Properties and Functions of Neuroglial Cells p. 133
- Physiological Properties of Neuroglial Cell Membranes p. 137
- Functions of Neuroglial Cells p. 140
- Effects of Neuronal Activity on Glial Cells p. 146
- Glial Cells and the Blood-Brain Barrier p. 150
- Glial Cells and Immune Responses of the CNS p. 153
- Box 8.1 The Blood-Brain Barrier p. 151
- Chapter 9. Principles of Direct Synaptic Transmission p. 155
- Nerve Cells and Synaptic Connections p. 156
- Electrical Synaptic Transmission p. 158
- Chemical Synaptic Transmission p. 160
- Box 9.1 Electrical Model of the Motor End Plate p. 169
- Direct Synaptic Inhibition p. 171
- Chapter 10. Indirect Mechanisms of Synaptic Transmission p. 177
- Metabotropic Receptors and G Proteins p. 178
- Direct Modulation of Channel Function by G Proteins p. 180
- G Protein Activation of Cytoplasmic Second Messenger Systems p. 184
- Calcium as an Intracellular Second Messenger p. 193
- Prolonged Time Course of Indirect Transmitter Action p. 195
- Box 10.1 Identifying Responses Mediated by G Proteins p. 181
- Box 10.2 Cyclic AMP as a Second Messenger p. 187
- Box 10.3 Diacylglycerol and IP₃ as Second Messengers p. 190
- Box 10.4 Formation and Metabolism of Arachidonic Acid p. 192
- Chapter 11. Transmitter Release p. 199
- Characteristics of Transmitter Release p. 200
- Quantal Release p. 206
- Vesicle Hypothesis of Transmitter Release p. 213
- Chapter 13. Cellular and Molecular Biochemistry of Synaptic Transmission p. 243
- Chapter 12. Synaptic Plasticity p. 227
- Short-Term Changes in Signaling p. 229
- Long-Term Changes in Signaling p. 232
- Neurotransmitters p. 244
- Neurotransmitter Synthesis p. 247
- Storage of Transmitters in Synaptic Vesicles p. 254
- Axonal Transport p. 256
- Transmitter Release and Vesicle Recycling p. 258
- Transmitter Receptor Localization p. 264
- Removal of Transmitters from the Synaptic Cleft p. 265
- Box 13.1 The SNARE Hypothesis p. 262
- Chapter 14. Neurotransmitters in the Central Nervous System p. 271

- Mapping Transmitter Distribution p. 273
- Peptide Transmitters in the CNS p. 280
- Regulation of Central Nervous System Function by Biogenic Amines p. 282
- Box 14.1 Molecular Methods and CNS transmitters p. 272
- Part 3 Integrative Mechanisms
- Chapter 15. Cellular Mechanisms of Integration and Behavior in Leeches, Ants, and Bees p. 291
 - From Neurons to Behavior and Vice Versa p. 292
 - Navigation by Ants and Bees p. 304
 - Why Should One Work on Invertebrate Nervous Systems? p. 313
- Chapter 16. Autonomic Nervous System p. 315
 - Functions under Involuntary Control p. 316
 - Synaptic Transmission by Postganglionic Axons p. 321
- Box 16.1 The Path to Understanding Sympathetic Mechanisms p. 323
- Chapter 17. Transduction of Mechanical and Chemical Stimuli p. 333
 - Stimulus Coding by Mechanoreceptors p. 334
 - Transduction of Mechanical Stimuli p. 340
 - Olfaction p. 347
 - Mechanisms of Taste (Gustation) p. 350
 - Transduction of Nociceptive and Thermal Stimuli p. 352
- Box 17.1 Sensory Epithelia of the Inner Ear p. 342
- Box 18.1 Brodmann's Areas p. 364
- Chapter 18. Processing of Somatosensory and Auditory Signals p. 355
 - The Somatosensory System: Tactile Recognition p. 356
 - The Auditory System: Encoding Sound Frequency p. 366
- Chapter 19. Transduction and Signaling in the Retina p. 379
 - The Eye p. 380
 - The Retina p. 381
 - Visual Pigments p. 384
 - Transduction by Photoreceptors p. 387
 - Transmission from Photoreceptors to Bipolar Cells p. 394
 - Receptive Fields of Ganglion Cells p. 399
- Box 19.1 Adaptation of Photoreceptors p. 391
- Chapter 20. Signaling in the Lateral Geniculate Nucleus and the Primary Visual Cortex p. 407
 - The Lateral Geniculate Nucleus p. 408
 - Cytoarchitecture of the Cortex p. 411
 - Strategies for Exploring the Cortex p. 414
- Chapter 21. Functional Architecture of the Visual Cortex p. 427
 - Ocular Dominance Slabs and Orientation Columns p. 428
 - Parallel Processing of Form, Motion, and Color p. 432
 - The Integration of Visual Information p. 439
 - Where Do We Go from Here? p. 442
- Box 21.1 Color Constancy p. 438
- Box 21.2 Corpus Callosum p. 444
- Chapter 22. Cellular Mechanisms of Motor Control p. 447

- The Motor Unit p. 449
- Spinal Reflexes p. 453
- Generation of Coordinated Movement p. 456
- The Organization of Motor Pathways p. 462
- Motor Cortex and the Execution of Voluntary Movement p. 464
- The Cerebellum p. 468
- The Basal Ganglia p. 473
- Box 22.1 Extracellular Recording of Motor Activity p. 465
- Part 4 Development of the Nervous System
- Chapter 23. Development of the Nervous System p. 479
 - Early Neural Morphogenesis p. 481
 - Regional Specification of Neural Tissue p. 485
 - Determination of Neuronal and Glial Cell Identity p. 488
 - Axon Outgrowth p. 497
 - Axon Guidance p. 500
 - Target Innervation p. 506
 - Synapse Formation p. 506
 - Growth Factors and Survival of Neurons p. 512
 - Competitive Interactions during Development p. 516
 - General Considerations of Neural Specificity p. 520
 - Box 23.1 Discovery of Nerve Growth Factor p. 513
- Chapter 24. Denervation and Regeneration of Synaptic Connections p. 525
 - Changes in Axotomized Neurons and the Surrounding Glial Cells p. 526
 - Effects of Denervation on Postsynaptic Cells p. 528
 - Regeneration in the Vertebrate Peripheral Nervous System p. 536
 - Role of Basal Lamina at Regenerating Neuromuscular Synapses p. 538
 - Regeneration in the Mammalian CNS p. 541
- Chapter 25. Critical Periods in Visual and Auditory Systems p. 549
 - The Visual System in Newly Born Monkeys and Kittens p. 550
 - Effects of Abnormal Experience in Early Life p. 555
 - Requirements for Maintenance of Functioning Connections in the Visual System p. 560
- Part 5 Conclusion
 - Cellular and Molecular Mechanisms of Deprivation Changes p. 563
 - Critical Periods in the Auditory System p. 567
 - Critical Periods for Higher Functions p. 570
- Chapter 26. Open Questions p. 575
- Appendix A. Current Flow in Electrical Circuits p. 1
- Appendix B. Metabolic Pathways for the Synthesis and Inactivation of Low-Molecular-Weight Transmitters p. 1
- Appendix C. Structures and Pathways of the Brain p. 1
 - Glossary p. 1
 - Bibliography p. 1
 - Index p. 1