

Contents

Section 1 BASIC PRINCIPLES 1

Chapter 1 Introduction to the Nervous System 1

- Nerve Cells and Nerve Fibers 1
- Organization of Cells and Fibers in the Nervous System 3
- Functionally Defined Fiber Groups in the Peripheral Nerves 3
- Overview of the Gross Anatomy of the Nervous System 4
- Internal Anatomy of the Spinal Cord 9
- Development of the Nervous System 11

Chapter 2 Physiology of Nerve Cells 15

- Resting Membrane Potential 15
- Ion Channels Control Membrane Potential 16
- Action Potential 16
- Action Current 18
- Afterpotentials and Refractory Periods Follow the Action Potential 18
- Synapses 19
- Neuromuscular Junction 21

Section 2 PERIPHERAL NERVOUS SYSTEM 23

Chapter 3 Fibers of the Spinal Nerves 23

- Functional Classification 23
- Physiologic Classification 25

Chapter 4 Spinal Reflexes and Muscle Tone 27

- Spinal Reflexes 27
- Muscle Spindles 27
- Alpha, Beta, and Gamma Motoneurons of the Spinal Cord 29
- Stretch Reflex 30
- Golgi Tendon Organs and Their Reflexes 30
- Muscle Tone 31
- Reflexes of Cutaneous Origin 31

Chapter 5 Autonomic Nervous System 33

- The Autonomic Nervous System Has Two Divisions 33
- Sympathetic Nervous System 34
- Parasympathetic Nervous System 36
- Autonomic Innervation of the Genitourinary System 36
- Autonomic Reflexes of Other Pelvic Viscera 38

Section 3 ASCENDING AND DESCENDING PATHWAYS 41

Chapter 6 Pain and Temperature 41

- Somatic Sensation 41
- Overview of the Pathways for Pain, Thermal Sense, and Touch 42
- Dorsal Roots of the Spinal Nerves Supply Dermatomes 42
- Adjacent Spinal Nerves Form Peripheral Nerves 42
- Pain-Temperature Pathways 42
- Perception of Pain 47
- Temperature Sense 47
- Visceral Pain Pathways and Referred Pain 47
- Effect of Cutting the Spinothalamic Tract 48
- Sensory Effects of Dorsal Root Irritation 48
- Endogenous Analgesia 49
- Central Pain (Thalamic Syndrome) 49

Chapter 7 Proprioception, Touch, and Tactile Discrimination 51

- Central Nervous System Pathways 51
- Physiologic Aspects of Tactile Discrimination 57
- Effect of Spinal Cord Lesions on Touch Sensation 58

Chapter 8 Motor Pathways 60

- Motor Areas of the Cerebral Cortex 60

Descending Fibers from the Cerebral Cortex
and Brain Stem Influence Motor
Activity 61

Role of Lateral, Medial, and Propriospinal
Pathways in Spinal Cord Function 66

Chapter 9 Lesions of the Peripheral Nerves, Spinal Nerve Roots, and Spinal Cord 68

Degeneration and Regeneration of Nerve
Cells and Fibers after Injury 68

Clinical Consequences of Peripheral Nerve
Lesions 69

Lower Motoneuron Lesions: Hypotonic
Paralysis of Muscles 69

Lesions of Dorsal Roots 69

Upper Motoneuron Lesions: Spastic Paralysis
of Muscles 70

Abnormal Reflexes Associated with Lesions
of the Motor Pathway 72

Transection of the Spinal Cord 73

Hemisection of the Spinal Cord (Brown-
Séquard Syndrome) 73

Lesions of the Central Gray Matter of the
Spinal Cord 75

Lesions Involving the Ventral Horns and the
Corticospinal Tracts 75

Lesions Involving Dorsal and Lateral
Funiculi 75

Thrombosis of the Anterior Spinal
Artery 75

Tumors of the Spinal Cord 76

Section 4 BRAIN STEM AND CEREBELLUM 77

Chapter 10 Organization of the Brain Stem and Cranial Nerves 77

Surface Anatomy of the Brain Stem 77

Internal Structures at the Transition from
Spinal Cord to Brain Stem 82

Classification of Cranial Nerve Nuclei and
Fibers according to their Functions 83

Functionally Distinct Cranial Nerve Cell
Columns 84

Reticular Formation 86

Atlas of the Brain Stem: Transverse
Sections 88

Blood Supply to the Brain Stem and
Cerebellum 95

Chapter 11 Cranial Nerves of the Medulla 97

Hypoglossal Nerve (XII) 97

Accessory Nerve (XI) 97

Vagal System: Nervus Intermedius (VII),
Glossopharyngeal (IX), Vagus (X) and
Cranial Accessory (XI) Nerves 98

Chapter 12 Cranial Nerves of the Pons and Midbrain 104

Abducens Nerve (VI) 104

Trochlear Nerve (IV) 105

Oculomotor Nerve (III) 105

Facial Nerve (VII) 106

Trigeminal Nerve (V) 107

Chapter 13 Lesions of the Brain Stem 111

Principles of Localization 111

Lesions of the Medulla 112

Lesions of the Pons 114

Lesions of the Midbrain 116

Brain Stem Lesions Causing Coma and
"Locked-in" Syndrome 118

Chapter 14 Hearing 119

Ear 119

Central Auditory Pathways 122

Diagnosing Hearing Deficits from Nerve
Damage and from Conductive
Defects 124

Auditory Reflexes 125

Chapter 15 Vestibular System 127

Vestibular Portion of the Inner Ear 127

Vestibular Nerve and Its Central
Connections 129

Vestibulocerebellar Connections 130

Vestibulospinal Tracts 130

Vestibulo-ocular Systems 131

Vestibulothalamocortical Pathway 133

Sensory Aspects of Vestibular
Stimulation 133

Chapter 16 Cerebellum 135

Overview of Cerebellar Function 135

Cerebellar Anatomy 135

Peduncles 139

Major Circuits 141

Integration of the Cerebellum and Cerebral
Cortex in Movement and Cognition 143

Clinical Signs of Cerebellar

Dysfunction 144

Diseases 145

Section 5 FOREBRAIN 147

Chapter 17 Basal Ganglia 147

Overview 147

Components	149
Connections of the Dorsal Striatum and Pallidum with the Cerebral Cortex	150
Connections of the Pallidum with the Brain Stem	154
Ventral Striatum and Pallidum	154
Function and Dysfunction	154
Chapter 18 Vision	158
Overview of the Visual Pathways	158
Retina	158
Visual Pathways	161
Information Processing in the Visual Pathways	163
Effects of Lesions Interrupting the Visual Pathway	164
Chapter 19 Optic Reflexes and Eye Movements	167
Light Reflexes	167
Reflexes Associated with the Near-Point Reaction	168
Disorders of Pupillary Function	168
Eye Movements	169
Chapter 20 Cerebral Cortex and Thalamocortical Connections	174
Cerebral Cortex	174
Cortical Cell Layers: The Basis for Structure and Function Relationships within and between Cortical Areas	174
Cortical Networks and Information Processing	177
Thalamus	177
Thalamocortical Connections	180
Functional Cortical Regions	182
Disorders of Cortical Networks	189
Chapter 21 Limbic System	193
Overview	193
Telencephalic Limbic System	193
Hypothalamus	197
Hypothalamic Functions	200
Epithalamus	202
Chapter 22 Olfaction	204
Olfactory Receptors	204
Olfactory Bulbs and Their Projections	204
Olfactory Cortical Areas	206
Damage to Olfactory Structures	206

Chapter 23 Chemical Neuroanatomy 207

Characteristics of Neurotransmitter Molecules	207
Functional Characterization of Neurotransmitter Receptors	207
Acetylcholine	208
Monoamines	209
Neuropeptides	214
Amino Acids	218

Section 6 CIRCULATION OF BLOOD AND CEREBROSPINAL FLUID 221

Chapter 24 Cerebral Arteries Supplying the Forebrain 221

Anterior Circulation	221
Internal Carotid Artery and Its Branches	221
Posterior Cerebral Artery and Its Branches	223
Formation of the Circle of Willis and Its Central Branches	225

Chapter 25 Cerebrospinal Fluid 227

Formation and Circulation	227
Composition and Function	228
Blood-Brain Barrier	229
Pressure	229

Section 7 APPROACHES TO PATIENTS WITH NEUROLOGIC SYMPTOMS 233

Chapter 26 Clinical Evaluation of Neurologic Disorders 233

Patient History	234
Physical Examination	236
Neurologic Examination	236

Chapter 27 Neurologic Diagnostic Tests 241

Cerebrospinal Fluid Analysis	241
Electroencephalography and Evoked-Potential Studies	242
Nerve Conduction Studies, Electromyography, and Muscle and Nerve Biopsy	243
Anatomic Imaging Studies	244
Physiologic Imaging Studies	245

Suggested Readings 247

Index 249