



Contents

<i>Preface: How to Use This Textbook</i>	<i>xiii</i>
<i>Acknowledgments</i>	<i>xv</i>
<i>Reviewers</i>	<i>xvii</i>
Chapter 1. Overview of the Nervous System	1
Overview	1
Major Components	1
Organization of the Nervous System	5
Organizational Systems	6
Cytoarchitecture Organization	6
Organization by Function	7
Terminology	10
Nervous System Cells	12
Neurons	14
Glial Cells	15
Structures and Landmarks	18
Lobes	21
Frontal Lobes	21
Parietal Lobes	21
Temporal Lobes	24
Occipital Lobes	24
Subcortical Structures	26
Basal Ganglia	26
Thalamus	28
Cerebellum	28
Brainstem	28
Summary	29
References	29
Chapter 2. Ventricular System: Cranium, Ventricles, and Meninges	31
Overview	31
Cranium, Cranial Vault, and Its Contents	31
Meningeal Layers	34
Dura Mater	34
Arachnoid Layer and Pia Mater	36
Ventricles	37
Cerebrospinal Fluid Path and Functions	37

vi Clinical Neuroscience for Communication Disorders: Neuroanatomy and Neurophysiology

Communication Through the Ventricular System	39
Disruptions to the Ventricular and Meningeal Systems	40
Hydrocephalus	40
Meningeal Damage	42
Summary	42
Additional Resources	43

Chapter 3. Neuron Anatomy and Physiology 45

Overview	45
Classification of Neurons	45
Neuronal Communication	46
Big Picture Overview	47
Membrane Potentials	47
Synaptic Transmission	49
Action Potentials	51
Myelinated Versus Unmyelinated Axons	54
Synaptic Transmission	54
Types of Neurotransmitters	57
Neurotransmitter Recovery and Degradation	59
Creating Meaning from Binary Signals	59
Patterns of Signals	59
Source of Signals	61
Region or Location	61
Conditions That Alter Synaptic Transmission	61
Neurologic Disorders and Diseases That Affect Synaptic Transmission	61
Parkinson Disease	61
Multiple Sclerosis	62
Myasthenia Gravis	62
Pharmacological Effects on Synaptic Transmission	63
Blocking Effects	63
Prolonging Effects	63
Mimicking Effect	64
Summary	64
Reference and Additional Resources	65

Chapter 4. Neuroembryology 67

Overview	67
The Neural Tube	70
Developmental (Embryologic) Precursors	70
Sulcus Limitans	72
Lamina Terminalis (Precursor to the Corpus Callosum)	72
Vesicles of the Neural Tube (CNS Precursors)	72
Landmark Timelines	74
Telencephalon and C-Shaped Development	76
Disruptions to Development and Consequences	78
Summary	79
References and Additional Resources	79

Chapter 5. Diencephalon	83
Overview	83
Diencephalic Structures	83
Thalamus	83
Thalamic Nuclei	84
Epithalamus	86
Subthalamus	87
Hypothalamus	87
Pituitary Gland	87
Damage to the Diencephalon	88
Summary	88
Chapter 6. Somatosensory Systems	91
Overview	91
Somatosensory System Structures	91
Sensory Receptors	91
Mechanoreceptors	94
Nociceptors	94
Proprioceptive Sensory Receptors	94
Thalamic Nuclei	95
Primary Somatosensory Cortex	95
Cortical Association Areas	95
Sensory Pathways	97
Dorsal Column–Medial Lemniscal Pathway	97
Spinothalamic Tracts	98
Spinocerebellar Tracts	101
Sensory Innervation	102
Damage to Somatosensory System Components	102
Spinal Cord Damage	102
Thalamic Damage	103
Cortical Damage	104
Summary	105
Chapter 7. Visual System	107
Overview	107
The Eye	107
Anterior Structures	107
Posterior Structures: The Retina	108
Visual Fields	109
Visual Pathway	111
Visual Cortex	113
Dorsal Pathway	114
Ventral Pathway	114
Damage to the Visual System	115
Visual Field Cuts	115
Cortical Damage	116
Summary	118

Chapter 8. Auditory and Vestibular Systems	121
Overview	121
Auditory System	121
The Cochlea	123
Converting Sound Waves Into Neural Signals	125
Auditory Pathway	127
Frequency and Intensity Coding in the Auditory System	128
Localization of Sound	129
Auditory Processing in the Cortex	131
Hearing Impairment and Damage to the Auditory System	132
Conductive Hearing Loss	132
Sensorineural Hearing Loss	132
Vestibular System	133
Vestibular Pathways	134
Summary	135
Reference	136
Chapter 9. Chemical Senses: Smell and Taste	139
Olfaction	139
Olfaction: The Sense of Smell	139
Olfactory Pathway	139
Impairments of Olfaction	142
Gustation: The Sense of Taste	144
Gustatory Pathway	144
Factors Influencing Taste Perception	146
Impairments of Gustation	146
Summary	147
Reference	147
Chapter 10. Motor Systems	149
Overview	149
Motor System Structures	150
Primary Motor Strip	150
Premotor and Supplementary Motor Areas	150
Basal Ganglia	151
Cerebellum	155
Motor Pathways	158
Pyramidal Tracts	158
Cranial and Spinal Nerves	158
Corticospinal Tracts	159
Corticobulbar Tract	162
Extrapyramidal Tracts	162
Rubrospinal Tract	162
Tectospinal Tract	162
Vestibulospinal Tract	162
Reticulospinal Tract	163

Motor Units and Muscle Innervation	163
Clinical Implications	165
Motor Cortex	166
Motor Pathways	166
Neuromuscular Junction	167
Basal Ganglia	168
Cerebellum	169
Summary	169

Chapter 11. Cranial Nerves 173

Overview	173
General Functions	175
Cranial Nerve Pathways	179
Motor Pathways: Corticobulbar Tract	179
Sensory Pathways	179
Cranial Nerves III, IV, and VI: Oculomotor, Trochlear, and Abducens	179
Muscles of the Eye	179
Oculomotor Nerve	181
Trochlear Nerve	181
Abducens Nerve	181
Cranial Nerve V: Trigeminal Nerve	182
Cranial Nerve VII: Facial Nerve	185
Cranial Nerve IX: Glossopharyngeal	187
Cranial Nerve X: Vagus Nerve	187
Pharyngeal Branch of the Vagus	187
Superior Laryngeal Nerve of the Vagus	188
Recurrent Laryngeal Nerve of the Vagus	188
Pharyngeal Plexus	189
Cranial Nerve XI: Spinal Accessory Nerve	189
Cranial Nerve XII: Hypoglossal Nerve	190
Integration of Cranial Nerve Functions	190
Speech Production	190
Swallowing	192
Clinical Implications: Examinations of Speech and Swallowing Mechanisms	192
Cranial Nerve/Oral Mechanism Examination	192
Smell and Taste	192
Vision	193
Extraocular Movements (CNs III, IV, and VI)	193
Jaw Movements and Mastication (CN V)	193
Facial Sensation (CN V)	193
Muscles of Facial Expression and Oral Preparation (CN VII)	193
Hearing (CN VIII)	194
Velar Functions—Motor and Sensory (CNs V, IX, and X)	194
Laryngeal Functions—Motor and Sensory (CN X)	194
Spinal Accessory (CN XI)	194
Lingual Motor Functions (CN XII with a Little Help from CN X)	194
Lingual Sensation (CNs V and IX)	196
Oral and Laryngeal Diadochokinetic Rate	196

X Clinical Neuroscience for Communication Disorders: Neuroanatomy and Neurophysiology

Evidence for the Oral Mechanism Examination	196
Clinical Bedside Swallow Examination and Instrumental Assessment	196
Summary	197
Additional Resources	197

Chapter 12. Limbic System and Reticular Formation 199

Limbic System Structures and Functions	199
Homeostasis	200
Olfaction	202
Memory	204
Emotions	206
Integrating Limbic Information	209
Reticular Formation and Reticular Activating System	209
Summary	213
References and Additional Resources	214

Chapter 13. Cerebrovascular System 217

Overview	217
Blood Supply and Functional Organization	217
Circle of Willis	218
Cerebral Blood Supply Distributions	222
Blood Supply to the Thalamus and Basal Ganglia	226
Blood Supply to the Cerebellum	226
Brainstem and Spinal Cord Distributions	228
Midbrain	228
Pons	229
Medulla	229
Spinal Cord	229
Blood–Brain Barrier	230
Disruptions to Blood Supply	231
Summary	234
References and Additional Resources	234

Chapter 14. Communication and Cognition 237

Overview	237
Common Developmental Disruptions	238
Developmental Language Disorders	238
Autism Spectrum Disorder	238
Down Syndrome	239
Fragile X Syndrome	239
Common Neurologic Insults and Diseases	240
Traumatic Brain Injury	240
Degenerative Diseases and Tumors	240
Communication	241
Language	243
Networks	243

Development	245
Lesions and Disorders	246
Pragmatics and Social Cognition	248
Networks	248
Development	249
Lesions and Disorders	250
Cognition	251
Executive Functions	251
Networks	251
Development	252
Lesions and Disorders	252
Memory	252
Networks	253
Development	253
Lesions and Disorders	254
Attention	255
Networks	255
Development	255
Lesions and Disorders	257
Summary	257
References and Additional Resources	258

Chapter 15. Neuroplasticity **263**

Overview	263
Neural (Cellular) Plasticity	263
Behavioral Plasticity	265
Intensity and Dosage	269
Factors That Contribute to Participation	270
Functional Reactivation Versus Functional Reorganization	271
Summary	271
References and Additional Resources	272

Chapter 16. Clinical Cases **275**

Overview	276
Approach to Solving (Thinking Through) Cases	276
Section 1: Acquired Cases	277
Case 16–1: 48-Year-Old Female With Traumatic Brain Injury	277
Case 16–2: 32-Year-Old Male With Postural Headaches and Mixed Upper/Lower Motor Neuron Signs	277
Case 16–3: 56-Year-Old Female With Progressive Onset of Dysphagia and Speech Impairments	278
Case 16–4: 17-Year-Old Female with Traumatic Brain Injury	279
Case 16–5: 63-Year-Old Male With Aphasia and Right Hemiparesis	279
Case 16–6: 86-Year-Old Male With Insidious Onset of Cognitive–Communication Changes	280
Case 16–7: 45-Year-Old Female With Acute Onset of Confusion and Language Impairment	281

xii Clinical Neuroscience for Communication Disorders: Neuroanatomy and Neurophysiology

Case 16–8: 62-Year-Old Male With Acute Onset of Lethargy and Impaired Attention	282
Case 16–9: 52-Year-Old With Acute Onset of “Slurred” Speech and “Drunken” Gait	283
Case 16–10: 70-Year-Old Male With Acute Onset of Dysarthria, Vertigo, Nausea, and Double Vision	283
Case 16–11: 22-Year-Old Male With Acute Onset of Weakness and Respiratory Distress	284
Case 16–12: 62-Year-Old Female With Gradual Onset of Speech and Swallowing Impairments	285
Case 16–13: 78-Year-Old Female With Gradual Onset of Speech and Gait Disturbances	285
Case 16–14: 52-Year-Old Female With Declining Cognition, Speech, and Swallowing Function	286
Case 16–15: 86-Year-Old Female With Memory and Swallowing Difficulties	288
Case 16–16: 73-Year-Old Male With Right Facial and Tongue Atrophy	290
Section 2: Pediatric and Developmental Cases	291
Case 16–17: 5-Year-Old Male With Shunt Malfunction	291
Case 16–18: 4-Year-Old Male With Fetal Alcohol Syndrome	293
Case 16–19: 30-Year-Old Female With Agenesis of the Corpus Callosum	294
Case 16–20: 11-Year-Old Male With Brainstem Tumor	296
Case 16–21: 11-Year-Old Female with Traumatic Brain Injury	296
Case Question Answers	298
Reference	310

Appendix	Review of Head and Neck Anatomy	313
	Review	313
	Face	313
	Facial Skeleton and Cranium	313
	Facial Muscles	315
	Velum	317
	Tongue	319
	Pharynx	319
	Larynx	319
	Neck	322
	<i>Index</i>	325