
Neuroanatomy through Clinical Cases

NEUROANATOMY

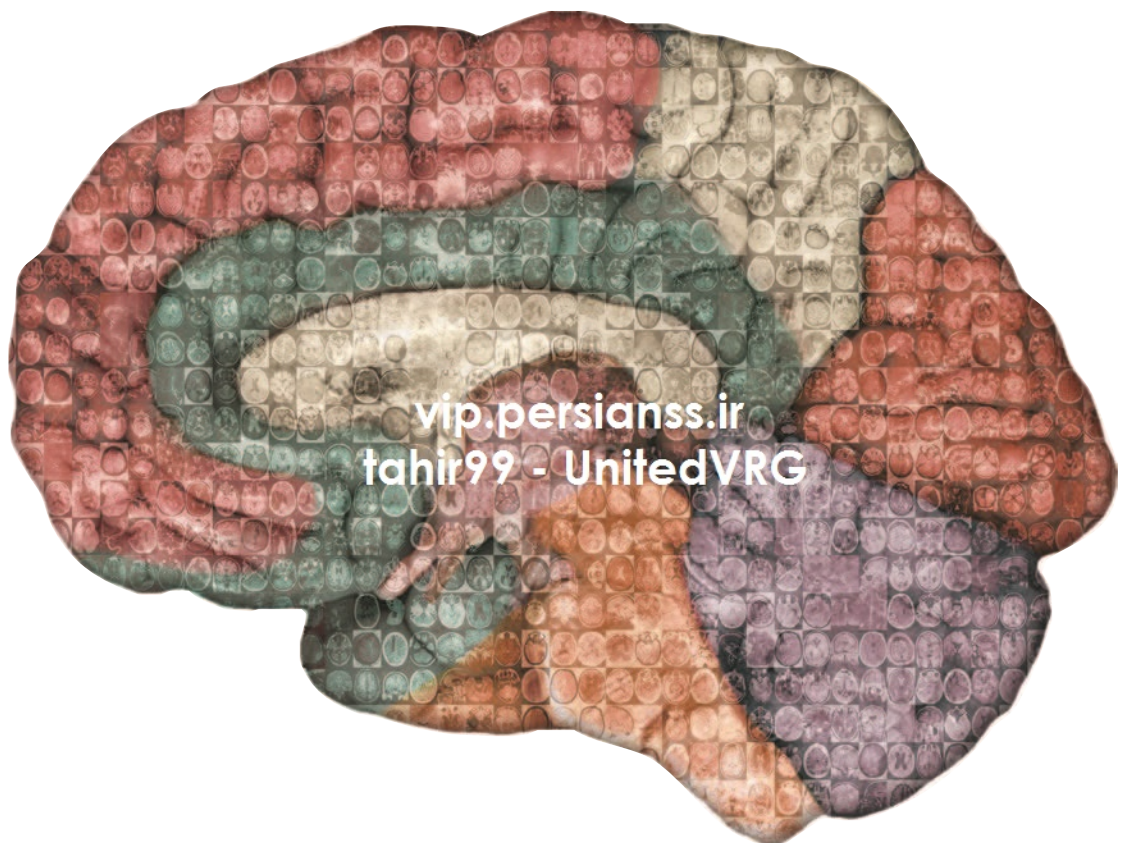
through

Clinical Cases

SECOND EDITION

HAL BLUMENFELD, M.D., Ph.D.

Yale University School of Medicine



Sinauer Associates, Inc. Publishers
Sunderland, Massachusetts

Note

The author and the publisher have made every effort to provide clinical information in this book that is up-to-date and accurate at the time of publication. However, diagnostic and therapeutic methods evolve continuously based on new research and clinical experience. Because medical standards are constantly changing, and because of the possibility of human error, neither the author, nor the publisher, nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions, or for clinical results obtained from use of the information contained in this work. Readers are strongly encouraged to consult other sources to confirm all clinical information when caring for patients, particularly in regard to medications, doses, and contraindications, which are subject to frequent changes and improvements, or when using new or infrequently used drugs.

The Cover

Base art for cover brain image modified with permission from the University of Washington Digital Anatomist Project.

***Neuroanatomy through Clinical Cases*, Second Edition**

Copyright © 2010 by Sinauer Associates, Inc.

All rights reserved. This book may not be reproduced in whole or in part without permission from the publisher.

For information, address Sinauer Associates, 23 Plumtree Road,
Sunderland, MA 01375 U.S.A.

www.sinauer.com

FAX: 413-549-1118

Email: publish@sinauer.com

Library of Congress Cataloging-in-Publication Data

Blumenfeld, Hal.

Neuroanatomy through clinical cases / Hal Blumenfeld. — 2nd ed.

p. ; cm.

Includes bibliographical references and indexes.

ISBN 978-0-87893-058-6 (alk. paper)

1. Neuroanatomy. 2. Neurologic examination—Case studies. I. Title.

[DNLM: 1. Nervous System Diseases—diagnosis—Case Reports. 2. Nervous System—pathology—Case Reports. WL 141 B658n 2010]

QM451.B68 2010

616.8'0475—dc22

2010001339

Printed in China

To Michelle
And I think to myself... what a wonderful world.

Brief Contents

- 1** Introduction to Clinical Case Presentations 3
 - 2** Neuroanatomy Overview and Basic Definitions 13
 - 3** The Neurologic Exam as a Lesson in Neuroanatomy 49
 - 4** Introduction to Clinical Neuroradiology 85
 - 5** Brain and Environs: Cranium, Ventricles, and Meninges 125
 - 6** Corticospinal Tract and Other Motor Pathways 223
 - 7** Somatosensory Pathways 275
 - 8** Spinal Nerve Roots 319
 - 9** Major Plexuses and Peripheral Nerves 357
 - 10** Cerebral Hemispheres and Vascular Supply 391
 - 11** Visual System 459
 - 12** Brainstem I: Surface Anatomy and Cranial Nerves 493
 - 13** Brainstem II: Eye Movements and Pupillary Control 565
 - 14** Brainstem III: Internal Structures and Vascular Supply 613
 - 15** Cerebellum 697
 - 16** Basal Ganglia 739
 - 17** Pituitary and Hypothalamus 791
 - 18** Limbic System: Homeostasis, Olfaction, Memory, and Emotion 819
 - 19** Higher-Order Cerebral Function 879
- Epilogue: A Simple Working Model of the Mind 972

Contents

Preface xvi

How to Use This Book xx

CHAPTER 1 *Introduction to Clinical Case Presentations* 3

Introduction 4

The General History and Physical Exam 4

Chief Complaint (CC) 5

History of the Present Illness (HPI) 5

Past Medical History (PMH) 6

Review of Systems (ROS) 6

Family History (FHx) 6

Social and Environmental History (SocHx/EnvHx) 6

Medications and Allergies 6

Physical Exam 6

Laboratory Data 7

Assessment and Plan 7

Neurologic Differential Diagnosis 7

Relationship between the General Physical Exam and the Neurologic Exam 8

Conclusions 10

References 10

CHAPTER 2 *Neuroanatomy Overview and Basic Definitions* 13

Basic Macroscopic Organization of the Nervous System 14

Main Parts of the Nervous System 14

Orientation and Planes of Section 16

Basic Cellular and Neurochemical Organization of the Nervous System 17

CNS Gray Matter and White Matter; PNS Ganglia and Nerves 21

Spinal Cord and Peripheral Nervous System 22

Cerebral Cortex: Basic Organization and Primary Sensory and Motor Areas 24

Lobes of the Cerebral Hemispheres 24

Surface Anatomy of the Cerebral Hemispheres in Detail 25

Primary Sensory and Motor Areas 28

Cell Layers and Regional Classification of the Cerebral Cortex 29

Motor Systems 32

Main Motor Pathways 32

Cerebellum and Basal Ganglia 34

Somatosensory Systems 34

Main Somatosensory Pathways 34

Thalamus 35

Stretch Reflex 37

Brainstem and Cranial Nerves 38

Limbic System 41

Association Cortex 41

Blood Supply to the Brain and Spinal Cord 44

Conclusions 46

References 46

CHAPTER 3 *The Neurologic Exam as a Lesson in Neuroanatomy* 49

Overview of the Neurologic Exam 50

neuroexam.com 52

The Neurologic Exam: Examination Technique and What Is Being Tested 52

1. Mental Status 52
2. Cranial Nerves 58
3. Motor Exam 63
4. Reflexes 66
5. Coordination and Gait 68
6. Sensory Exam 71

The Neurologic Exam as a Flexible Tool 72

Exam Limitations and Strategies 73

Coma Exam 74

General Physical Exam 74

1. Mental Status 75
2. Cranial Nerves 76
3. Sensory Exam and 4. Motor Exam 77
5. Reflexes 77
6. Coordination and Gait 79

Brain Death 79

Conversion Disorder, Malingering, and Related Disorders 79

The Screening Neurologic Exam 81

Conclusions 81

References 82

CHAPTER 4 *Introduction to Clinical Neuroradiology* 85

Introduction 86

Imaging Planes 86

Computerized Tomography 86

CT versus MRI 89

Magnetic Resonance Imaging 90

Neuroangiography 98

Functional Neuroimaging 99

Conclusions 101

NEURORADIOLOGICAL ATLAS 102

References 123

CHAPTER 5 *Brain and Environs: Cranium, Ventricles, and Meninges* 125

ANATOMICAL AND CLINICAL REVIEW 126

Cranial Vault and Meninges 126

Ventricles and Cerebrospinal Fluid 132

Blood–Brain Barrier 137

- KCC 5.1 Headache 139
- KCC 5.2 Intracranial Mass Lesions 141
- KCC 5.3 Elevated Intracranial Pressure 142
- KCC 5.4 Brain Herniation Syndromes 145
- KCC 5.5 Head Trauma 146
- KCC 5.6 Intracranial Hemorrhage 147
- KCC 5.7 Hydrocephalus 155
- KCC 5.8 Brain Tumors 157
- KCC 5.9 Infectious Disorders of the Nervous System 159
- KCC 5.10 Lumbar Puncture 167
- KCC 5.11 Craniotomy 169

CLINICAL CASES 170

5.1 An Elderly Man with Headaches and Unsteady Gait 170

5.2 Altered Mental Status Following Head Injury 173

5.3 Delayed Unresponsiveness after Head Injury 180

5.4 Headache and Progressive Left-Sided Weakness 183

5.5 Sudden Coma and Bilateral Posturing during Intravenous Anticoagulation 187

5.6 Severe Head Injury 190

5.7 A Child with Headaches, Nausea, and Diplopia 195

5.8 Headaches and Progressive Visual Loss 203

5.9 An Elderly Man with Progressive Gait Difficulty, Cognitive Impairment, and Incontinence 208

5.10 A Young Man with Headache, Fever, Confusion, and Stiff Neck 212

Additional Cases 213

BRIEF ANATOMICAL STUDY GUIDE 214

A Scuba Expedition through the Brain 215

References 217

CHAPTER 6 *Corticospinal Tract and Other Motor Pathways* 223

ANATOMICAL AND CLINICAL REVIEW 224

Motor Cortex, Sensory Cortex, and Somatotopic Organization 224

Basic Anatomy of the Spinal Cord 226

Spinal Cord Blood Supply 229

General Organization of the Motor Systems 230

Lateral Corticospinal Tract 232

Autonomic Nervous System 238

KCC 6.1 Upper Motor Neuron versus Lower Motor Neuron Lesions 241

KCC 6.2 Terms Used to Describe Weakness 242

KCC 6.3 Weakness Patterns and Localization 242

KCC 6.4 Detecting Subtle Hemiparesis at the Bedside 250

KCC 6.5 Unsteady Gait 251

KCC 6.6 Multiple Sclerosis 252

KCC 6.7 Motor Neuron Disease 254

CLINICAL CASES 255

6.1 Sudden Onset of Right Hand Weakness 255

6.2 Sudden Onset of Left Foot Weakness 256

6.3 Sudden Onset of Right Face Weakness 257

6.4 Pure Motor Hemiparesis I 263

6.5 Pure Motor Hemiparesis II 264

6.6 Progressive Weakness, Muscle Twitching, and Cramps 267

Additional Cases 268

BRIEF ANATOMICAL STUDY GUIDE 269

References 270

CHAPTER 7 *Somatosensory Pathways* 275

ANATOMICAL AND CLINICAL REVIEW 276

Main Somatosensory Pathways 276

Posterior Column–Medial Lemniscal Pathway 279

Spinothalamic Tract and Other Anterolateral Pathways 280

Somatosensory Cortex 282

Central Modulation of Pain 282

The Thalamus 282

Relay Nuclei 284

Intralaminar Nuclei 286

Reticular Nucleus 286

KCC 7.1 Paresthesias 287

KCC 7.2 Spinal Cord Lesions 288

KCC 7.3 Sensory Loss: Patterns and Localization 290

KCC 7.4 Spinal Cord Syndromes 292

KCC 7.5 Anatomy of Bowel, Bladder, and Sexual Function 295

CLINICAL CASES 298

7.1 Sudden Onset of Right Arm Numbness 298

7.2 Sudden Onset of Right Face, Arm, and Leg Numbness 302

7.3 A Fall Causing Paraplegia and a Sensory Level 303

7.4 Left Leg Weakness and Right Leg Numbness 305

7.5 Sensory Loss over Both Shoulders 307

7.6 Body Tingling and Unsteady Gait 309

7.7 Hand Weakness, Pinprick Sensory Level, and Urinary Retention 311

Additional Cases 313

BRIEF ANATOMICAL STUDY GUIDE 313

References 315

CHAPTER 8 *Spinal Nerve Roots* 319

ANATOMICAL AND CLINICAL REVIEW 320

Segmental Organization of the Nervous System 320

Nerve Roots in Relation to Vertebral Bones, Discs, and Ligaments 321

Dermatomes and Myotomes 323

KCC 8.1 Disorders of Nerve, Neuromuscular Junction, and Muscle 327

KCC 8.2 Back Pain 330

KCC 8.3 Radiculopathy 331

Simplification: Three Nerve Roots to Remember in the Arm 334

Simplification: Three Nerve Roots to Remember in the Leg 334

KCC 8.4 Cauda Equina Syndrome 334

KCC 8.5 Common Surgical Approaches to the Spine 335

CLINICAL CASES 336

8.1 Unilateral Neck Pain and Tingling Numbness in the Thumb and Index Finger 336

- 8.2 Unilateral Occipital and Neck Pain 337
- 8.3 Unilateral Shoulder Pain and Weakness 337
- 8.4 Blisters, Pain, and Weakness in the Left Arm 340
- 8.5 Unilateral Shoulder Pain and Numbness in the Index and Middle Fingers 341
- 8.6 Unilateral Neck Pain, Hand Weakness, and Numbness in the Ring and Little Fingers 342
- 8.7 Pain and Numbness in the Medial Arm 343
- 8.8 Low Back Pain Radiating to the Sole of the Foot and the Small Toe 343

- 8.9 Unilateral Thigh Weakness with Pain Radiating to the Anterior Shin 345
- 8.10 Low Back Pain Radiating to the Big Toe 348
- 8.11 Saddle Anesthesia with Loss of Sphincteric and Erectile Function 349

Additional Cases 351

BRIEF ANATOMICAL STUDY GUIDE 351

References 353

CHAPTER 9 Major Plexuses and Peripheral Nerves 357

ANATOMICAL AND CLINICAL REVIEW 358

Brachial Plexus and Lumbosacral Plexus 358

Simplification: Five Nerves to Remember in the Arm 360

Simplification: Three Nerves Acting on the Thumb 362

Intrinsic and Extrinsic Hand Muscles 362

Simplification: Five Nerves to Remember in the Leg 363

KCC 9.1 Common Plexus and Nerve Syndromes 364

KCC 9.2 Electromyography (EMG) and Nerve Conduction Studies 367

CLINICAL CASES 369

- 9.1 Complete Paralysis and Loss of Sensation in One Arm 369
- 9.2 A Newborn with Weakness in One Arm 371
- 9.3 A Blow to the Medial Arm Causing Hand Weakness and Numbness 372
- 9.4 Nocturnal Pain and Tingling in the Thumb, Pointer, and Middle Finger 373

9.5 Hand and Wrist Weakness after a Fall 374

9.6 Numbness and Tingling in the Pinky and Ring Finger 375

9.7 Shoulder Weakness and Numbness after Strangulation 376

9.8 Unilateral Thigh Pain, Weakness, and Numbness in a Diabetic 377

9.9 Tingling and Paralysis of the Foot after a Fall 377

9.10 A Leg Injury Resulting in Foot Drop 379

9.11 Lateral Thigh Pain and Numbness after Pregnancy 381

9.12 Dysarthria, Ptosis, and Decreased Exercise Tolerance 381

9.13 Generalized Weakness and Areflexia 383

9.14 Mysterious Weakness after Dinner 385

Additional Cases 386

BRIEF ANATOMICAL STUDY GUIDE 386

References 387

CHAPTER 10 Cerebral Hemispheres and Vascular Supply 391

ANATOMICAL AND CLINICAL REVIEW 392

Review of Main Functional Areas of Cerebral Cortex 392

Circle of Willis: Anterior and Posterior Circulations 393

Anatomy and Vascular Territories of the Three Main Cerebral Arteries 395

Vascular Territories of the Superficial Cerebral Structures 395

Vascular Territories of the Deep Cerebral Structures 396

KCC 10.1 Clinical Syndromes of the Three Cerebral Arteries 400

KCC 10.2 Watershed Infarcts 402

KCC 10.3 Transient Ischemic Attack and Other Transient Neurologic Episodes 403

KCC 10.4 Ischemic Stroke: Mechanisms and Treatment 405

KCC 10.5 Carotid Stenosis 410

KCC 10.6 Dissection of the Carotid or Vertebral Arteries 411

Venous Drainage of the Cerebral Hemispheres 411

KCC 10.7 Sagittal Sinus Thrombosis 413

CLINICAL CASES 413

10.1 Sudden-Onset Worst Headache of Life 413

10.2 Left Leg Weakness and Left Alien Hand Syndrome 415

10.3 Decreased Vision on One Side 416

10.4 Transient Episodes of Left Eye Blurriness or Right Hand Weakness 425

10.5 Nonfluent Aphasia with Right Face and Arm Weakness 427

10.6 "Talking Ragtime" 429

10.7 Dysarthria and Hemiparesis 432

10.8 Global Aphasia, Right Hemiplegia, and Hemianopia 434

10.9 Left Face and Arm Weakness 437

10.10 Left Hemineglect 438

10.11 Left Hemineglect, Hemiplegia, and Hemianopia 439

- 10.12** Unilateral Proximal Arm and Leg Weakness 446
10.13 Right Frontal Headache and Left Arm Numbness in a Woman with Gastric Carcinoma 447

Additional Cases 453

BRIEF ANATOMICAL STUDY GUIDE 453

References 454

CHAPTER 11 *Visual System* 459

ANATOMICAL AND CLINICAL REVIEW 460

Eyes and Retina 460

Optic Nerves, Optic Chiasm, and Optic Tracts 463

Lateral Geniculate Nucleus and Extrageniculate Pathways 464

Optic Radiations to Primary Visual Cortex 465

Visual Processing in the Neocortex 467

Parallel Channels for Analyzing Motion, Form, and Color 467

Ocular Dominance Columns and Orientation Columns 469

KCC 11.1 Assessment of Visual Disturbances 470

KCC 11.2 Localization of Visual Field Defects 472

KCC 11.3 Blood Supply and Ischemia in the Visual Pathways 476

KCC 11.4 Optic Neuritis 477

CLINICAL CASES 478

11.1 A Dark Spot Seen with One Eye 478

11.2 Vision Loss in One Eye 479

11.3 Menstrual Irregularity and Bitemporal Hemianopia 481

11.4 Hemianopia after Treatment for a Temporal Lobe Tumor 483

11.5 Visual Changes Caused by Migraine Headaches? 485

11.6 Sudden Loss of Left Vision 486

Additional Cases 487

BRIEF ANATOMICAL STUDY GUIDE 487

References 491

CHAPTER 12 *Brainstem I: Surface Anatomy and Cranial Nerves* 493

ANATOMICAL AND CLINICAL REVIEW 494

Surface Features of the Brainstem 495

Skull Foramina and Cranial Nerve Exit Points 498

Sensory and Motor Organization of the Cranial Nerves 500

Functions and Course of the Cranial Nerves 503

CN I: Olfactory Nerve 505

KCC 12.1 Anosmia (CN I) 506

CN II: Optic Nerve 506

CN III, IV, and VI: Oculomotor, Trochlear, and Abducens Nerves 506

CN V: Trigeminal Nerve 508

Trigeminal Somatic Sensory Functions 509

Trigeminal Branchial Motor Functions 512

KCC 12.2 Trigeminal Nerve Disorders (CN V) 512

CN VII: Facial Nerve 513

KCC 12.3 Facial Nerve Lesions (CN VII) 516

KCC 12.4 Corneal Reflex and Jaw Jerk Reflex (CN V, VII) 518

CN VIII: Vestibulocochlear Nerve 518

Auditory Pathways 519

Vestibular Pathways 523

KCC 12.5 Hearing Loss (CN VIII) 525

KCC 12.6 Dizziness and Vertigo (CN VIII) 527

CN IX: Glossopharyngeal Nerve 530

CN X: Vagus Nerve 532

CN XI: Spinal Accessory Nerve 534

CN XII: Hypoglossal Nerve 534

KCC 12.7 Disorders of CN IX, X, XI, and XII 535

KCC 12.8 Hoarseness, Dysarthria, Dysphagia, and Pseudobulbar Affect 536

Review: Cranial Nerve Combinations 537

CLINICAL CASES 539

12.1 Anosmia and Visual Impairment 539

12.2 Cheek Numbness and a Bulging Eye 541

12.3 Jaw Numbness and Episodes of Loss of Consciousness 542

12.4 Isolated Facial Weakness 543

12.5 Hearing Loss and Dizziness 548

12.6 Hoarse Voice following Cervical Disc Surgery 549

12.7 Hoarseness, with Unilateral Wasting of the Neck and Tongue Muscles 553

12.8 Uncontrollable Laughter, Dysarthria, Dysphagia, and Left-Sided Weakness 555

Additional Cases 559

BRIEF ANATOMICAL STUDY GUIDE 559

References 561

CHAPTER 13 *Brainstem II: Eye Movements and Pupillary Control* 565

ANATOMICAL AND CLINICAL REVIEW 566

Extraocular Muscles, Nerves, and Nuclei 566

Extraocular Muscles 566

Extraocular Nerves and Nuclei 568

KCC 13.1 Diplopia 571

KCC 13.2 Oculomotor Palsy (CN III) 572

KCC 13.3 Trochlear Palsy (CN IV) 574

KCC 13.4 Abducens Palsy (CN VI) 575

The Pupils and Other Ocular Autonomic Pathways 576

KCC 13.5 Pupillary Abnormalities 579

KCC 13.6 Ptosis 582

Cavernous Sinus and Orbital Apex 583

KCC 13.7 Cavernous Sinus Syndrome (CN III, IV, VI, V₁) and Orbital Apex Syndrome (CN II, III, IV, VI, V₁) 584

Supranuclear Control of Eye Movements 584

Brainstem Circuits for Horizontal Eye Movements 585

KCC 13.8 Brainstem Lesions Affecting Horizontal Gaze 586

Brainstem Circuits for Vertical and Vergence Eye Movements 587

KCC 13.9 Parinaud's Syndrome 588

Control of Eye Movements by the Forebrain 588

KCC 13.10 Right-Way Eyes and Wrong-Way Eyes 589

Cerebellar, Vestibular, and Spinal Control of Voluntary and Reflex Eye Movements 590

CLINICAL CASES 591

13.1 Double Vision and Unilateral Eye Pain 591

13.2 A Diabetic with Horizontal Diplopia 593

13.3 Vertical Diplopia 594

13.4 Left Eye Pain and Horizontal Diplopia 595

13.5 Unilateral Headache, Ophthalmoplegia, and Forehead Numbness 596

13.6 Ptosis, Miosis, and Anhidrosis 598

13.7 Wrong-Way Eyes 602

13.8 Horizontal Diplopia in a Patient with Multiple Sclerosis 603

13.9 Headaches and Impaired Upgaze 604

Additional Cases 605

BRIEF ANATOMICAL STUDY GUIDE 607

References 610

CHAPTER 14 *Brainstem III: Internal Structures and Vascular Supply* 613

ANATOMICAL AND CLINICAL REVIEW 614

Main Components of the Brainstem 614

Brainstem Sections 615

Cranial Nerve Nuclei and Related Structures 622

Long Tracts 624

KCC 14.1 Locked-In Syndrome 625

Cerebellar Circuitry 625

Reticular Formation and Related Structures 626

The Consciousness System 627

Widespread Projection Systems of Brainstem and Forebrain: Consciousness, Attention, and Other Functions 630

Anatomy of the Sleep–Wake Cycle 637

KCC 14.2 Coma and Related Disorders 640

Reticular Formation: Motor, Reflex, and Autonomic Systems 646

Brainstem Vascular Supply 648

KCC 14.3 Vertebrobasilar Vascular Disease 654

CLINICAL CASES 661

14.1 Face and Contralateral Body Numbness, Hoarseness, Horner's Syndrome, and Ataxia 661

14.2 Hemiparesis Sparing the Face 663

14.3 Dysarthria and Hemiparesis 668

14.4 Unilateral Face Numbness, Hearing Loss, and Ataxia 669

14.5 Locked In 673

14.6 Wrong-Way Eyes, Limited Upgaze, Decreased Responsiveness, and Hemiparesis with an Amazing Recovery 675

14.7 Diplopia and Unilateral Ataxia 682

14.8 Intermittent Memory Loss, Diplopia, Sparkling Lights, and Somnolence 683

14.9 Intractable Hiccups 687

Additional Cases 688

BRIEF ANATOMICAL STUDY GUIDE 692

References 693

CHAPTER 15 *Cerebellum* 697

ANATOMICAL AND CLINICAL REVIEW 698

Cerebellar Lobes, Peduncles, and Deep Nuclei 698

Microscopic Circuitry of the Cerebellum 703

Cerebellar Output Pathways 705

Cerebellar Input Pathways 708

Vascular Supply to the Cerebellum 711

KCC 15.1 Cerebellar Artery Infarcts and Cerebellar Hemorrhage 713

KCC 15.2 Clinical Findings and Localization of Cerebellar Lesions 714

KCC 15.3 Differential Diagnosis of Ataxia 719

CLINICAL CASES 720

15.1 Sudden Onset of Unilateral Ataxia 720

15.2 Walking Like a Drunkard 721

15.3 A Boy with Headaches, Nausea, Slurred Speech, and Ataxia 725

15.4 Nausea, Progressive Unilateral Ataxia, and Right Face Numbness 727

15.5 A Family with Slowly Progressive Ataxia and Dementia 731

Additional Cases 732

BRIEF ANATOMICAL STUDY GUIDE 733

References 736

CHAPTER 16 *Basal Ganglia* 739

ANATOMICAL AND CLINICAL REVIEW 740

Basic Three-Dimensional Anatomy of the Basal Ganglia 740

Input, Output, and Intrinsic Connections of the Basal Ganglia 748

Inputs to the Basal Ganglia 748

Outputs from the Basal Ganglia 749

Intrinsic Basal Ganglia Connections 749

Hyperkinetic and Hypokinetic Movement Disorders 751

Parallel Basal Ganglia Pathways for General Movement, Eye Movement, Cognition, and Emotion 752

Ansa Lenticularis, Lenticular Fasciculus, and the Fields of Forel 754

KCC 16.1 Movement Disorders 755

KCC 16.2 Parkinson's Disease and Related Disorders 762

KCC 16.3 Huntington's Disease 766

KCC 16.4 Stereotactic Surgery and Deep Brain Stimulation 768

CLINICAL CASES 770

16.1 Unilateral Flapping and Flinging 770

16.2 Irregular Jerking Movements and Marital Problems 771

16.3 Asymmetrical Resting Tremor, Rigidity, Bradykinesia, and Gait Difficulties 775

16.4 Bilateral Bradykinesia, Rigidity, and Gait Instability with No Tremor 779

Additional Cases 784

BRIEF ANATOMICAL STUDY GUIDE 785

References 786

CHAPTER 17 *Pituitary and Hypothalamus* 791

ANATOMICAL AND CLINICAL REVIEW 792

Overall Anatomy of the Pituitary and Hypothalamus 792

Important Hypothalamic Nuclei and Pathways 794

Major Hypothalamic Nuclei 794

Hypothalamic Control of the Autonomic Nervous System 795

Hypothalamic-Limbic Pathways 796

Other Regionalized Functions of the Hypothalamus 796

Endocrine Functions of the Pituitary and Hypothalamus 797

KCC 17.1 Pituitary Adenoma and Related Disorders 800

KCC 17.2 Diabetes Insipidus and SIADH 803

KCC 17.3 Panhypopituitarism 804

CLINICAL CASES 805

17.1 Moon Facies, Acne, Amenorrhea, and Hypertension 805

17.2 Impotence, Anorexia, Polyuria, Blurred Vision, Headaches, and Hearing Loss 809

17.3 A Child with Giggling Episodes and Aggressive Behavior 811

Additional Cases 815

BRIEF ANATOMICAL STUDY GUIDE 815

References 816

CHAPTER 18 *Limbic System: Homeostasis, Olfaction, Memory, and Emotion* 819

ANATOMICAL AND CLINICAL REVIEW 820

Overview of Limbic Structures 821

Olfactory System 827

Hippocampal Formation and Other Memory-Related Structures 829

Hippocampal Formation and Parahippocampal Gyrus 830

Intrinsic Circuitry of the Hippocampal Formation 834

Input and Output Connections of the Medial Temporal Lobe Memory System 835

The Fornix and Medial Diencephalic Memory Pathways 836

KCC 18.1 Memory Disorders 838

The Amygdala: Emotions, Drives, and Other Functions 845

Other Limbic Pathways 847

KCC 18.2 Seizures and Epilepsy 848

KCC 18.3 Anatomical and Neuropharmacological Basis of Psychiatric Disorders 856

CLINICAL CASES 859

18.1 Sudden Memory Loss after a Mild Head Injury 859

18.2 Progressive Severe Memory Loss, with Mild Confabulation 860

18.3 Transient Diplopia, Lethargy, and Hemiparesis, Followed by a Sustained Memory Deficit 863

18.4 Episodes of Panic, Olfactory Hallucinations, and Loss of Awareness 865

18.5 Episodes of Staring, Lip Smacking, and Unilateral Semipurposeful Movements 868

Additional Cases 870

BRIEF ANATOMICAL STUDY GUIDE 874

References 875

CHAPTER 19 *Higher-Order Cerebral Function* 879

ANATOMICAL AND CLINICAL REVIEW 880

KCC 19.1 The Mental Status Exam 880

Unimodal and Heteromodal Association Cortex 881

Principles of Cerebral Localization and Lateralization 883

The Dominant Hemisphere: Language Processing and Related Functions 885

Anatomy of Language Processing 885

KCC 19.2 Differential Diagnosis of Language Disorders 888

KCC 19.3 Bedside Language Exam 889

KCC 19.4 Broca's Aphasia 889

KCC 19.5 Wernicke's Aphasia 891

KCC 19.6 Simplified Aphasia Classification Scheme 892

KCC 19.7 Other Syndromes Related to Aphasia 894

KCC 19.8 Disconnection Syndromes 897

The Nondominant Hemisphere: Spatial Processing and Lateralized Attention 898

Lateralized Aspects of Attention 898

Spatial Analysis and Integration 899

KCC 19.9 Hemineglect Syndrome 900

KCC 19.10 Other Clinical Features of Nondominant Hemisphere Lesions 905

The Frontal Lobes: Anatomy and Functions of an Enigmatic Brain Region 906

Regional Anatomy of the Frontal Lobes 906

Connections of the Prefrontal Cortex 907

Functions of the Frontal Lobes 908

KCC 19.11 Frontal Lobe Disorders 908

Visual Association Cortex: Higher-Order Visual Processing 913

KCC 19.12 Disorders of Higher-Order Visual Processing 914

KCC 19.13 Auditory Hallucinations 917

The Consciousness System Revisited: Anatomy of Attention and Awareness 918

General Mechanisms of Attention 919

Anatomy of Attention 920

Awareness of Self and Environment 922

KCC 19.14 Attentional Disorders 924

KCC 19.15 Delirium and Other Acute Mental Status Disorders 926

KCC 19.16 Dementia and Other Chronic Mental Status Disorders 928

CLINICAL CASES 937

19.1 Acute Severe Aphasia, with Improvement 937

19.2 Nonsensical Speech 939

19.3 Aphasia with Preserved Repetition 940

19.4 Impaired Repetition 942

19.5 Inability to Read, with Preserved Writing Skills 948

19.6 Left Hemineglect	949	19.11 Progressive Dementia, Beginning with Memory Problems	963
19.7 Abulia	952	Additional Cases	964
19.8 Blindness without Awareness of Deficit	956	BRIEF ANATOMICAL STUDY GUIDE	966
19.9 Sudden Inability to Recognize Faces	960	References	968
19.10 Musical Hallucinations	961		

Epilogue: A Simple Working Model of the Mind 972

Case Index 977

Subject Index 983

Preface

Neuroanatomy is a living, dynamic field that can bring both intellectual delight and aesthetic pleasure to students at all levels. However, by nature, it is also an exceedingly detailed subject, and herein lies the tragic pitfall of all too many neuroanatomy courses. Crushing amounts of memorization are often required of students of neuroanatomy, leaving them little time to step back and gain an appreciation of the structural and functional beauty of the nervous system and its relevance to clinical practice.

This book has a different point of view: instead of making the mastery of anatomical details the main goal and then searching for applications of this knowledge, actual clinical cases are used as both a teaching instrument and motivating force to encourage students to delve into further study of normal anatomy and function. Through this approach, structural details take on immediate relevance as they are being learned. In addition, each clinical case is an ideal way to integrate knowledge of disparate functional systems, since a single lesion may affect several different neural structures and pathways.

Over 100 clinical cases, accompanied by neuroradiological images, are presented in this text, and I am grateful to many neurologists, neurosurgeons, and neuroradiologists at the Columbia, Harvard, and Yale medical schools for helping me to amass enough material to present clinically relevant discussions of the entire nervous system. I have used this book's diagnostic method to teach neuroanatomy at these medical schools, and both students and faculty greeted the innovation enthusiastically. Through publication of *Neuroanatomy through Clinical Cases* I hope that students and faculty at many additional institutions will find this to be an enjoyable and effective way to learn neuroanatomy and its real-life applications.

Acknowledgments for First Edition

First and foremost, I must thank my wife Michelle, and our children Eva and Jesse, for their enthusiasm and support throughout the writing and publication of this book.

This project has spanned a number of years, and stints at several academic centers, so there is a formidable list of people who I must thank for their important contributions. This book was conceived while I was teaching neuroanatomy as an M.D., Ph.D. student at Columbia Medical School, where I was inspired by my teachers Eric Kandel, Jack Martin, and Steven Siegelbaum. They have remained invaluable sources of inspiration and advice ever

since. I would also like to thank the following individuals who served as mentors, benefactors, or role models during my training as a neurologist and neuroscientist: Raymond D. Adams, Bernard Cohen, C. Miller Fisher, Jack Haimovic, Walter Koroshetz, Terry Krulwich, Elan Louis, Stephan Mayer, David McCormick, Thomas McMahon, Timothy Pedley, Pasko Rakic, Susan Spencer, Dennis Spencer, Stephen Waxman, Anne Young, and George Zubal. I would also like to offer special thanks to those who were my closest colleagues and friends during my neurology residency: Jang-Ho Cha, Mitchell Elkind, Martha Herbert, David Jacoby, Michael Lin, Guy Rordorff, Diana Rosas, and Gerald So.

The focus and main strength of this book is its clinical cases. Therefore, I am very grateful to the many colleagues who suggested the clinical cases used in this book: Robert Ackerman, Claudia Baldassano, Tracy Batchelor, Flint Beal, Carsten Bonneman, Lawrence Borges, Robert Brown, Jeffrey Bruce, Brad Buchbinder, Ferdinando Buonanno, William Butler, Steve Cannon, David Caplan, Robert Carter, Verne Caviness, Jang-Ho Cha, Paul Chapman, Chinfei Chen, Keith Chiappa, In Sup Choi, Andrew Cole, Douglas Cole, G. Rees Cosgrove, Steven Cramer, Didier Cros, Merit Cudkowicz, Kenneth Davis, Rajiv Desai, Elizabeth Dooling, Brad Duckrow, Mitchell Elkind, Emad Eskandar, Stephen Fink, Seth Finkelstein, Alice Flaherty, Robert Friedlander, David Frim, Zoher Ghogawala, Michael Goldrich, Jonathan Goldstein, R. Gilberto Gonzalez, Kimberly Goslin, Steven Greenberg, John Growdon, Andrea Halliday, E. Tessa Hedley-Whyte, Martha Herbert, Daniel Hoch, Fred Hochberg, J. Maurice Hourihane, Brad Hyman, Michael Irizarry, David Jacoby, William Johnson, Raymond Kelleher, Philip Kistler, Walter Koroshetz, Sandra Kostyk, Kalpathy Krishnamoorthy, James Lehigh, Simmons Lessell, Michael Lev, Susan Levy, Michael Lin, Elan Louis, David Louis, Jean Lud-Cadet, David Margolin, Richard Mattson, Stephan Mayer, James Miller, Shawn Murphy, Brad Navia, Steven Novella, Edward Novotny, Christopher Ogilvy, Robert Ojemann, Michael Panzara, Dante Pappano, Stephen Parker, Marie Pasinski, John Penney, Bruce Price, Peter Riskind, Guy Rordorff, Diana Rosas, Tally Sagie, Pamela Schaefer, Jeremy Schmahmann, Lee Schwamm, Michael Schwarzschild, Saad Shafqat, Barbara Shapiro, Aneesh Singhal, Michael Sisti, Gerald So, Robert Solomon, Marcio Sotero, Dennis Spencer, Susan Spencer, John Stakes, Marion Stein, Divya Subramanian-Khurana, Brooke Swearingen, Max Takeoka, Thomas Tatemichi, Fran Testa, James Thompson, Mark Tramo, Jean Paul Vonsattel, Shirley Wray, Anne Young, and Nicholas Zervas.

I am deeply indebted to the many individuals who provided critical reviews of one or more chapters, greatly enhancing the accuracy and clarity of the material in this book: Raymond D. Adams, Joshua Auerbach, William W. Blessing, Laura Blumenfeld, William Boonn, Lawrence Borges, Michelle Brody, Richard Bronen, Joshua Brumberg, Thomas N. Byrne, Mark Cabelin, Jang-Ho Cha, Jaehyuk Choi, Charles Conrad, Rees Cosgrove, Merit Cudkowicz, Mitchell Elkind, C. M. Fisher, David Frim, Darren R. Gitelman, Jonathan Goldstein, Gil Gonzalez, Charles Greer, Stephan Heckers, Tamas Horvath, Gregory Huth, Michael Irizarry, Joshua P. Klein, Igor Koralnick, John Krakauer, Matthew Kroh, Robert H. LaMotte, John Langfitt, Steven B. Leder, Elliot Lerner, Grant Liu, Andres Martin, John H. Martin, Ian McDonald, Lyle Mitzner, Hrachya Nersesyan, Andrew Norden, Robert Ojemann, Stephen Parker, Huned Patwa, Howard Pomeranz, Bruce Price, Anna Roe, David Ross, Jeremy Schmahmann, Mark Schwartz, Ted Schwartz, Michael Schwarzschild, Barbara Shapiro, Scott Small, Arien Smith, Adam Sorscher, Susan Spencer, Stephen M. Strittmatter, Larry Squire, Mircea Steriade, Ethan Taub, Timothy Vollmer, and Steven U. Walkley. I express my gratitude for their helpful suggestions, but accept full responsibility for any errors in this text.

Marty Wonsiewicz, John Dolan, Greg Huth, John Butler, and Amanda Sver were helpful in the early stages of editorial development of this book. Michael Schlosser and Tasha Tanhehco helped gather the references, and Jason Freeman and Susan Vanderhill helped obtain copyright permissions. Wendy Beck and BlackSheep Marketing designed and implemented the neuroexam.com website. The video segments for neuroexam.com and *The NeuroExam Video* were filmed by Douglas Forbush and Patrick Leone at Yale, and edited by Evan Jones of RBY Video. Milena Pavlova provided helpful suggestions, and played the role of the patient.

Finally, I thank the entire staff at Sinauer Associates for their tremendously helpful collaboration in all stages of producing this book. I have enjoyed working with, and am especially grateful to, Andrew D. Sinauer, Peter Farley, Kerry Falvey, Christopher Small, and Jefferson Johnson, but I extend my deep appreciation to all other members of the Sinauer staff as well. It is a pleasure to work with people who truly care about creating a fine book.

Additional Acknowledgments for Second Edition

My family again comes first in my acknowledgments, as they stood closest by me through the long process of revising and updating this book. I thank Michelle for her advice and support, and our children Eva, Jesse, and Lev for their enthusiasm and for always bringing a smile to my face. Also, none of this would have been possible without my parents who continue to be a source of inspiration. My sister, “the real writer in the family,” and many other family members and close, lifelong friends complete the list of those most precious.

In addition to those listed in the Acknowledgments for the First Edition, I would also like to thank the following outstanding colleagues for their suggested cases or critical chapter reviews: Nazem Atassi, Joachim Baehring, Margaret Bia, William Blessing, Richard Bronen, Franklin Brown, Joshua Brumberg, Gordon Buchanan, Ketan Bulsara, Louis Caplan, Michael Carrithers, Jang-Ho Cha, Michael Crair, Merit Cudkowicz, Robin De Graaf, Daniel DiCapua, Mitchell Elkind, Carl Faingold, Susan Forster, Robert Fulbright, Karen Furie, Glenn Giesler, Darren Gitelman, Charles Greer, Stephen Grill, Noam Harel, Joshua Hasbani, Elizabeth Holt, Bahman Jabbari, Jason Klenoff, Igor Koralnack, Randy Kulesza, Robert LaMotte, Steven Leder, Ben Legesse, Robert Lesser, Albert Lo, Grant Lui, Steve Mackey, Andres Martin, Graeme Mason, Andrew Norden, Haakon Nygaard, Kyeong Han Park, Stephen Parker, Huned Patwa, Howard Pomeranz, Stephane Poulin, Sashank Prasad, Bruce Price, Diana Richardson, George Richerson, Anna Roe, David Russell, Robert Sachdev, Gerard Sanacora, Joseph Schindler, Michael Schwartz, Theodore Schwartz, Alan Segal, Nutan Sharma, Gordon Shepherd, Scott Small, Adam Sorscher, Joshua Steinerman, Daryl Story, Ethan Taub, Kenneth Vives, Darren Volpe, Jonathan Waitman, Howard Weiner, Norman Werdiger, Michael Westerveld, and Shirley Wray.

Medical students contributed in an important way to this edition by helping me find new cases and images. Wenya Linda Bi, Alexander Park, April Levin, Matthew Vestal, Kathryn Giblin, Alexandra Miller, Joshua Motelow, and Amy Forrestel spent many early morning hours reviewing case materials for this book. Dragonfly Media Group contributed to art revisions, Picture Mosaics created the cover mosaic, Jean Zimmer provided copy editing, and Nathan Danielson helped draft the concept for the cover design.

Once again, I am very grateful to the entire staff of Sinauer Associates for their outstanding attention to high-quality publishing, and for their collaboration in all aspects of producing this book. I have enjoyed working on the Second Edition with Sydney Carroll, Graig Donini, Joan Gemme, Christopher Small, Jason Dirks, Linda Vandendolder, Marie Scavotto, Dean Scudder, and Andrew D. Sinauer. Having worked on two editions with Sinauer, I have an ever deepening appreciation of the success of this group in producing excellent books.

How to Use This Book

The goal of this book is to provide a treatment of neuroanatomy that is comprehensive, yet enables students to focus on the most important “take-home messages” for each topic. This goal is motivated by the recognition that, while access to detailed information is often useful in mastering neuroanatomy, certain selected pieces of information carry the most clinical relevance, or are most important for exam review.

General Outline

The first four chapters of the book contain introductory material that will be especially useful to students who have little previous clinical background. Chapter 1 is an introduction to the standard format commonly used for presenting clinical cases, including an outline of the medical history, physical examination, neuroanatomical localization, and differential diagnosis. Chapter 2 is a brief overview of neuroanatomy which includes definitions and descriptions of basic structures that will be studied in greater detail in later chapters. Chapter 3 builds on this knowledge by describing the neurologic examination. It includes a summary of the structures and pathways tested in each part of the exam, which is essential for localizing the lesions presented in the clinical cases throughout the remainder of the book. Much of the material in this chapter is also covered on the neuroexam.com website described below, which provides video demonstrations for each part of the exam. For readers who are unfamiliar with neuroimaging techniques, Chapter 4 contains a concise introduction to CT, MRI, and other imaging methods. This chapter also includes a *Neuroradiological Atlas* showing normal CT, MRI, and angiographic images of the brain. Chapters 5–19 cover the major neuroanatomical systems and present relevant clinical cases.

Chapters 5–19

Chapters 5–19 have a common structure. An “Anatomical and Clinical Review” at the beginning of the chapters presents relevant neuroanatomical structures and pathways, and generously sized, carefully labeled color illustrations are used to vividly depict spatial relationships. The first part of each chapter also includes numbered sections called “Key Clinical Concept,” or “KCC,” which cover common disorders of the system being discussed.

CLINICAL CASES The second part of each chapter is a “Clinical Cases” section that describes patients seen by the author and colleagues, each presented in a numbered color box. Full-length cases include complete findings from the neurologic examination, while “Minicases” have a briefer format. Each case begins with a narrative of how the patient’s symptoms developed and what deficits were found on neurologic examination. For example, one patient in Chapter 10 suddenly developed weakness in the right hand and lost the ability to speak. Another, in Chapter 14, experienced double vision and lapsed into a coma. Important symptoms and signs are indicated in boldface type. The reader is then challenged through a series of questions to deduce the neuroanatomical location of the patient’s lesion and the eventual diagnosis.

A discussion follows each case, beginning with a summary of the key symptoms and signs. Answers to the questions are provided which refer to anatomical and clinical material presented in the first half of the chapter that is demonstrated by the case. Continual improvements in imaging technology have allowed us to make clear and detailed radiographs of the nervous system *in vivo*, and one of the most exciting features of the book is the inclusion of large-format, labeled CT, MRI, or other scans that show the lesion for each patient, and serve as a central tool for teaching neuroanatomy. These images reveal, with striking clarity, both the lesion’s location and the anatomy of the system being studied. In addition, these radiographs help the reader develop skill in interpreting the kinds of diagnostic images employed on the wards. The neuroimaging studies for each case are provided in special boxes at least one page turn away from the case questions, so the answers to the questions are not “given away” by the imaging (see below).

The clinical course is also provided for each patient, and includes a discussion of how the patient was managed, and what outcome followed. Thus, by the end of each case, students learn the relevant material by application and diagnostic sleuthing rather than by rote memorization.

Special Features for Focused Study and Review

Since one of the goals of this book is to enable students to either read the material in depth, or to distill it down to the most clinically relevant points or to material most commonly covered on the national boards or other examinations, several special features have been included to expedite focused study and review:

- **Boldface type** is used rather differently than in most texts. In addition to identifying the text for all important topics and definitions, boldface is also used to facilitate rapid or focused reading.
- **Review Exercises** appear in the margins throughout the text, highlighting the most important anatomical concepts in each chapter, and providing practice exam questions.
- Helpful **mnemonics** are provided throughout the text, and these are flagged in the margins by a special icon (shown at right) showing a section of the hippocampus (a structure important in memory formation).
- A **Brief Anatomical Study Guide** appears at the end of each chapter, which summarizes the most important neuroanatomical material, and refers to the appropriate figures and tables needed for focused exam review.
- The **Neuroradiological Atlas** in Chapter 4 also provides a useful review of neuroanatomical structures in three-dimensional space, and can be used for reference and comparison to lesions seen in clinical cases.

REVIEW EXERCISE



MNEMONIC



Rapid hand movements

- The neuroexam.com website includes much of the text from Chapter 3 describing the neurologic exam and its anatomical interpretation, and also features video demonstrations of each part of the exam that are cited in the text (e.g., “see [neuroexam.com Video 37](#)”). Selected video frames are also shown in the book margins, as shown at right, to illustrate relevant portions of the neurologic exam. Students or instructors who prefer to view a full-length video of the neurologic exam can obtain *The NeuroExam Video* from Sinauer Associates (www.sinauer.com).
- The **Key Clinical Concept (KCC)** sections provide a comprehensive introduction to clinical topics in neurology and neurosurgery, and enable an efficient review of these topics.
- Finally, the **Clinical Cases** can be used by themselves for study and review, since they consist of anatomical puzzles that reinforce the subject matter for each chapter in the most clinically relevant context. As noted above, the neuroimaging studies for each case are deliberately placed at least one page turn away from the case questions; the location of the images for each case are indicated by page numbers provided immediately after the images are cited in the text.
- The **Additional Cases** section at the end of each chapter, and the **Case Index** at the end of the book provide further cases relevant to the topics in each chapter.
- **Online review materials** will include many more clinical cases, images, and questions and answers for review.

Suggested Course Use

Neuroanatomy through Clinical Cases is intended primarily for first- or second-year medical students enrolled in a course in neuroanatomy or neuroscience, but it is a versatile text that could be used in many settings.

The topics covered in the book include all neuroanatomical material required for the medical school board examinations. Although fundamental concepts are emphasized, some advanced subject matter is also provided. Because the book includes chapters on peripheral nerves, students will also find this book useful in their general gross anatomy course in which peripheral nerves are usually covered. The Key Clinical Concept sections in this book also cover the major neurologic and neurosurgical disorders at a level appropriate for medical school pathophysiology courses, clinical rotations, and residents early in their training.

Students of other health professions, especially physical therapy, occupational therapy, nursing, dentistry, speech therapy, and neuropsychology will find this textbook useful as well, and it may also be of interest to graduate students of neuroscience. In addition to those learning neuroanatomy, it is hoped that the cases in this book will serve as a resource for advanced medical students in their clinical rotations, and residents in neurology, neurosurgery, and neuroradiology seeking examples of “typical” cases of neurologic disorders. Because each case is a real patient, the clinical cases in this book are, in effect, a collection of case reports that can serve as a useful resource, especially for teaching purposes and board review. It should be noted, however, that the cases presented here are highly selected for their teaching value and do not constitute an unbiased sampling of the kinds of cases found in clinical practice.

Here are some suggestions for using *Neuroanatomy through Clinical Cases* in various courses and curricula:

- For a comprehensive course in **medical school neuroanatomy**, students should read Chapters 2 and 5–18, with selected topics from Chapters 1, 3, 4 and 19. Reading assignments and large class lectures could focus on the Anatomical and Clinical Review sections at the beginning of each chapter. The clinical cases are most effectively discussed in small groups of students, where instructors can help students puzzle through the anatomical localization and diagnosis, and then discuss the neuroradiology and clinical outcome. An **Instructor's Resource Library** is available which contains material that will be useful for lectures, and **additional clinical cases** not found in the book or in the student Online Review and Study Guide, ideal for use in small group teaching.
- For medical school courses covering neuroanatomy and other topics in **neuroscience**, additional readings from neuroscience texts such as *Neuroscience* by Purves et al. (2008, Sinauer Associates) or *Principles of Neural Science* by Kandel et al. (2000, McGraw-Hill) should be provided.
- For a comprehensive course in **clinical disorders of the nervous system**, students should read Chapters 3 and 4, and the Key Clinical Concept sections in Chapters 5–19. *The NeuroExam Video* should be viewed in class, and students referred to neuroexam.com for review. Clinical cases could then be presented in small groups, as described above.
- For a course focusing on **neuropsychological disorders** and anatomical correlations, students should read Chapters 2, 10, 18 and 19 and selected parts of Chapters 14 and 16.
- Finally, for a more **basic course in clinical neuroanatomy**, readings could be confined to selected topics in Chapters 2, 5–7, 10–16, and 18.

- [Elementary Go Series, Volume 3: Tesuji for free](#)
- [read online Draw 50 Flowers, Trees, and Other Plants: The Step-by-Step Way to Draw Orchids, Weeping Willows, Prickly Pears, Pineapples and Many More...](#)
- [download online Militant \(Updated & Expanded\)](#)
- [read online Lighting the Nude: Top Photography Professionals Share Their Secrets](#)

- <http://pittiger.com/lib/The-Secret-of-Chimneys--Superintendent-Battle--Book-1-.pdf>
- <http://transtrade.cz/?ebooks/The-Neuro-Image--A-Deleuzian-Film-Philosophy-of-Digital-Screen-Culture--Cultural-Memory-in-the-Present-.pdf>
- <http://bestarthritiscare.com/library/Militant--Updated---Expanded-.pdf>
- <http://monkeybubblemedia.com/lib/Lighting-the-Nude--Top-Photography-Professionals-Share-Their-Secrets.pdf>