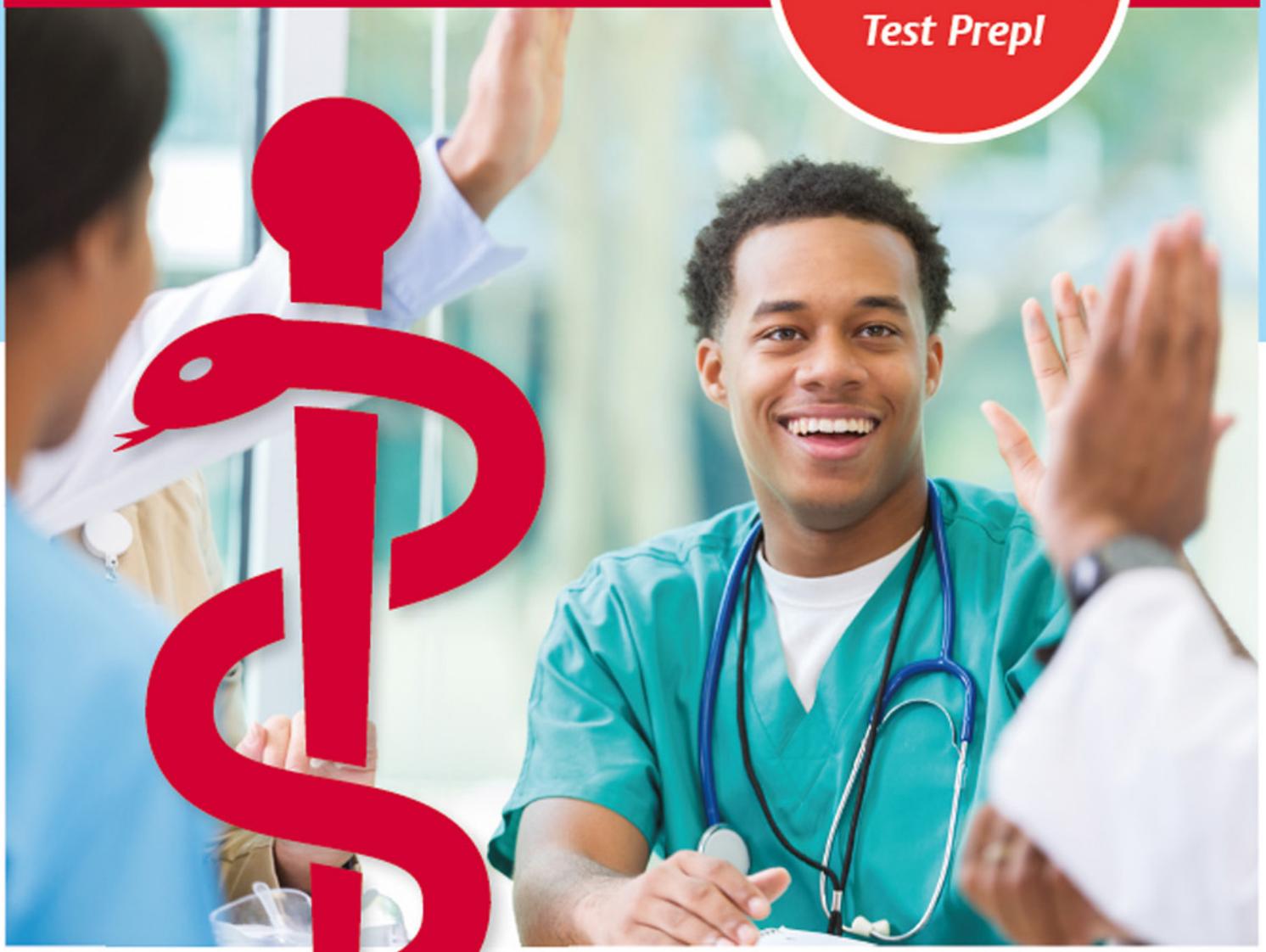
Thieme Test Prep for the USMLE®

Medical Neuroscience Q&A

Manas Das
Lee A. Baugh

FREE trial access to MedOne USMLE® Test Prep!



Thieme


Thieme

Medical Neuroscience Q&A

Manas Das, MD, MS
Associate Professor
Director of Clinical Anatomy (MS-3 & MS-4)
Director of Medical Embryology (MS-1 & MS-2)
Director of Medical Histology (MS-1 & MS-2)
Division of Translational Anatomy
Department of Radiology
University of Massachusetts Medical School
Worcester, Massachusetts

Lee A. Baugh, PhD
Associate Professor of Neuroscience
Division of Basic Biomedical Sciences
Director of Human Functional Imaging Core
Center for Genetics and Behavioral Health
Director, MS-1 Nervous Systems
Associate Director of Center for Brain and Behavior Research
Sanford School of Medicine
University of South Dakota
Vermillion, South Dakota

168 illustrations

Thieme
New York • Stuttgart • Delhi • Rio de Janeiro

Acquisitions Editor: Delia DeTurris
Managing Editor: Gaurav Prabhu
Director, Editorial Services: Mary Jo Casey
Production Editor: Shivika
International Production Director: Andreas Schabert
Editorial Director: Sue Hodgson
International Marketing Director: Fiona Henderson
International Sales Director: Louisa Turrell
Senior Vice President and Chief Operating Officer: Sarah Vanderbilt
President: Brian D. Scanlan

Library of Congress Cataloging-in-Publication Data
Names: Das, Manas, author. | Baugh, Lee A., author.
Title: Medical neuroscience Q&A / Manas Das, Lee A. Baugh.
Description: New York : Thieme, [2019] | Series: Thieme test prep for the USMLE |
Identifiers: LCCN 2018045373 (print) | LCCN 2018045693 (ebook) | ISBN 9781626235380 | ISBN 9781626235373 (paperback : alk. paper) | ISBN 9781626235380 (eISBN)
Subjects: | MESH: Nervous System Diseases | Diagnostic Techniques, Neurological | Examination Questions
Classification: LCC RC343.5 (ebook) | LCC RC343.5 (print) | NLM WL 18.2 | DDC 616.80076--dc23
LC record available at https://lccn.loc.gov/2018045373

Thieme Publishers New York
333 Seventh Avenue, New York, NY 10001 USA
+1 800 782 3488, customerservice@thieme.com

Thieme Publishers Stuttgart
Rüdigerstrasse 14, 70469 Stuttgart, Germany
+49 [0]711 8931 421, customerservice@thieme.de

Thieme Publishers Delhi
A-12, Second Floor, Sector-2, Noida-201301
Uttar Pradesh, India
+91 120 45 566 00, customerservice@thieme.in

Thieme Publishers Rio de Janeiro, Thieme Publicações Ltda.
Edifício Rodolpho de Paoli, 25º andar
Av. Nilo Peçanha, 50 – Sala 2508
Rio de Janeiro 20020-906, Brasil
+55 21 3172 2297

Cover design: Thieme Publishing Group
Typesetting by Thomson Digital

Printed in USA by King Printing Company, Inc. 5 4 3 2 1

ISBN 978-1-62623-537-3

Also available as an e-book:
eISBN 978-1-62623-538-0

To Swapna, Parimal, Seema, Tutun, Mimi, and Ryan
for being family

To all my students, past and present
for being the inspiration
—Manas

Contents

Preface

Neuroscience stands out for its rationality in medicine. It has fascinated the medical fraternity for ages, and it is one of the most important (and challenging) topics tested in competitive and standardized medical exams. This book presents a collection of multiple-choice questions that test neuroscientific competencies of an aspiring physician, consistent with the testing standards of USMLE Step 1.

Most of these clinically-oriented questions are presented in a patient-centered vignette style that is used by the National Board of Medical Examiners (NBME). These questions link various basic science concepts and should be helpful for the student to synthesize information that might be obtained from a wide range of disciplines.

All questions belong to type A, i.e., there is one best answer for each. Each question is provided with a difficulty level of easy, moderate, or hard. While "easy" questions require, for the most part, simple recall of information, harder questions will require analysis and application of information. A brief explanation follows each of these questions, indicating why the author-indicated correct answer outmatches the distractors.

Each question is tagged with a learning objective. It is a direct measure of the learning outcome for the concept that is necessary to achieve the desired level of LCME-outlined competencies.

The book comprises 24 chapters. These are organized primarily according to neuroanatomical structures.

High-quality images have been incorporated throughout the text. These should add to integration, challenge the ability to analyze and interpret, and meet appropriate standards.

The book is also available on Thieme's online platform. Searchable tags (symptoms, organs, structures, etc.) have been provided with each question for ease of navigation.

Finally, this book is not a substitute for textbooks. Nor is it intended to be used as the primary resource for neuroscience. As with any other question bank, the use of this book should follow an initial understanding of the concepts gained from reading textbooks and lecture notes. The information used in this book has been drawn from a pool of standard textbooks used in medical schools. It is highly advisable to return to the pool for concept clarification.

Manas Das, MD, MS
Lee A. Baugh, PhD

Acknowledgements

We would like to express our gratitude to everyone who saw us through this book.

First, we would like to extend special thanks to the faculty and the student reviewers of the book for their valuable suggestions.

I (Manas) would like to thank Max Rosen, the Chair, Department of Radiology, at the University of Massachusetts Medical School, for his constant support and encouragement.

I (Manas) would also like to thank my colleagues at the University of Massachusetts Medical School for their support. Special thanks to Lela Giannaris, Julie Jonassen, Cristopher Cerniglia and Susan Gagliardi for their endorsement and well wishes.

Finally, we would like to acknowledge the role of Delia DeTurris (Associate Acquisitions Editor, Thieme Publishers) toward this publication. We thank her for the constant support, flexibility, willingness to accommodate, and for keeping us on track. I also sincerely thank her for lending us permission to use the image database of Thieme Publishers, which accounts for a large proportion of images used in the book.

How to Use This Series

Question Difficulty Key
Green box = Easy question
Yellow box = Medium question
Red box = Hard question

Chapter Head

Section Header

Question Stem

Answer Options

1 Gross Anatomy

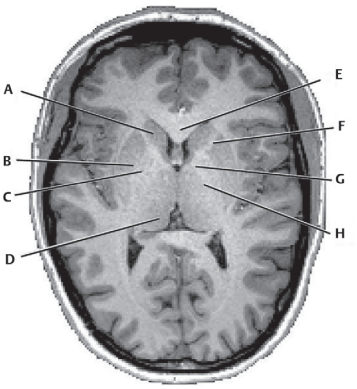
1.1 Questions

Easy | Medium | Hard

1. A 58-year-old man presents with right deviation of his tongue on protrusion. No other neurological abnormality is noted on physical examination. Which of the following might be the location of a tumor in his case?

A. Anterior median fissure; medulla
B. Anterolateral sulcus; medulla
C. Posterolateral sulcus; medulla
D. Posterior median sulcus; medulla
E. Cerebellopontine angle

Consider the following image for questions 2 to 6:



2. A 58-year-old right-handed male is admitted to the emergency department after being discovered unconscious on his kitchen floor when coworkers reported his unusual absence from an important business meeting. Initial diagnosis is an ischemic stroke affecting primarily the frontopontine tracts and the anterior thalamic peduncle. Which area of the labeled T1-weighted MRI image would you expect to see damaged?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E
F. Area F
G. Area G
H. Area H

3. A 46-year-old man is admitted to the hospital after his family reported he was having problems with both forming new memories and a significant loss of existing memories. Upon questioning, he displayed confabulation and his conversations consisted of sparse content. Further questioning of the family revealed he has been a heavy drinker for the previous 5 years. Which area of the brain is likely to show evidence of this patient's memory problems?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

4. A 59-year-old woman presented at the emergency department after developing right-sided weakness. After transfer to the department of rehabilitation 4 weeks after the acute event, she was alert, but had moderate cognitive impairment. Sensory function was intact, and deep tendon reflexes were normal. Muscle functions were normal for all extremities, and there was no spasticity present. She complained that her hand moved abnormally, often against her will. When prompted, she could grasp and release objects with the affected hand. Which area of the labeled MRI image would you most likely expect damage?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

5. A 78-year-old man presented to the emergency department with an asymmetrical smile and uvular deviation to the right. Suspecting a stroke, a CT scan was obtained. In which area would you expect the lesion to be located?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E
F. Area F
G. Area G
H. Area H

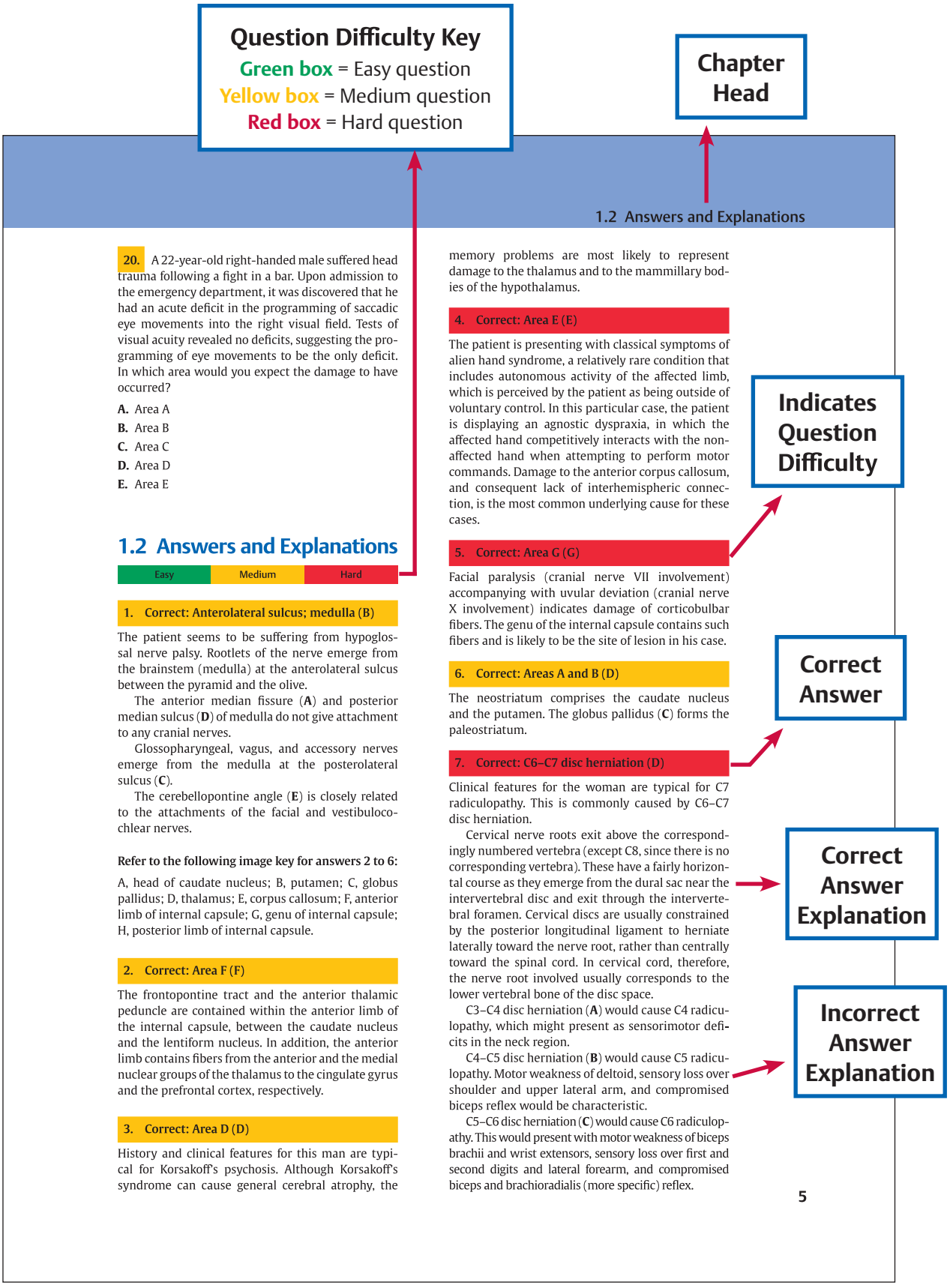
2

Difficulty Level Icon

In general, an easy question requires only a diagnosis based upon the question stem.

A medium question requires not just the diagnosis of the condition based upon the question stem, but knowledge about that diagnosis so as to answer a question about it.

Hard questions are a combination of medium questions with less commonly known material about the diagnosis.


Question Difficulty Key
Green box = Easy question
Yellow box = Medium question
Red box = Hard question
Chapter Head
1.2 Answers and Explanations
20. A 22-year-old right-handed male suffered head trauma following a fight in a bar. Upon admission to the emergency department, it was discovered that he had an acute deficit in the programming of saccadic eye movements into the right visual field. Tests of visual acuity revealed no deficits, suggesting the programming of eye movements to be the only deficit. In which area would you expect the damage to have occurred?
A. Area A
B. Area B
C. Area C
D. Area D
E. Area E
1.2 Answers and Explanations
Easy
Medium
Hard
1. Correct: Anterolateral sulcus; medulla (B)
The patient seems to be suffering from hypoglossal nerve palsy. Rootlets of the nerve emerge from the brainstem (medulla) at the anterolateral sulcus between the pyramid and the olive.
The anterior median fissure (A) and posterior median sulcus (D) of medulla do not give attachment to any cranial nerves.
Glossopharyngeal, vagus, and accessory nerves emerge from the medulla at the posterolateral sulcus (C).
The cerebellopontine angle (E) is closely related to the attachments of the facial and vestibulocochlear nerves.
Refer to the following image key for answers 2 to 6:
A, head of caudate nucleus; B, putamen; C, globus pallidus; D, thalamus; E, corpus callosum; F, anterior limb of internal capsule; G, genu of internal capsule; H, posterior limb of internal capsule.
2. Correct: Area F (F)
The frontopontine tract and the anterior thalamic peduncle are contained within the anterior limb of the internal capsule, between the caudate nucleus and the lentiform nucleus. In addition, the anterior limb contains fibers from the anterior and the medial nuclear groups of the thalamus to the cingulate gyrus and the prefrontal cortex, respectively.
3. Correct: Area D (D)
History and clinical features for this man are typical for Korsakoff's psychosis. Although Korsakoff's syndrome can cause general cerebral atrophy, the memory problems are most likely to represent damage to the thalamus and to the mammillary bodies of the hypothalamus.
4. Correct: Area E (E)
The patient is presenting with classical symptoms of alien hand syndrome, a relatively rare condition that includes autonomous activity of the affected limb, which is perceived by the patient as being outside of voluntary control. In this particular case, the patient is displaying an agnostic dyspraxia, in which the affected hand competitively interacts with the non-affected hand when attempting to perform motor commands. Damage to the anterior corpus callosum, and consequent lack of interhemispheric connection, is the most common underlying cause for these cases.
5. Correct: Area G (G)
Facial paralysis (cranial nerve VII involvement) accompanying with uvular deviation (cranial nerve X involvement) indicates damage of corticobulbar fibers. The genu of the internal capsule contains such fibers and is likely to be the site of lesion in his case.
6. Correct: Areas A and B (D)
The neostriatum comprises the caudate nucleus and the putamen. The globus pallidus (C) forms the paleostriatum.
7. Correct: C6–C7 disc herniation (D)
Clinical features for the woman are typical for C7 radiculopathy. This is commonly caused by C6–C7 disc herniation.
Cervical nerve roots exit above the correspondingly numbered vertebra (except C8, since there is no corresponding vertebra). These have a fairly horizontal course as they emerge from the dural sac near the intervertebral disc and exit through the intervertebral foramen. Cervical discs are usually constrained by the posterior longitudinal ligament to herniate laterally toward the nerve root, rather than centrally toward the spinal cord. In cervical cord, therefore, the nerve root involved usually corresponds to the lower vertebral bone of the disc space.
C3–C4 disc herniation (A) would cause C4 radiculopathy, which might present as sensorimotor deficits in the neck region.
C4–C5 disc herniation (B) would cause C5 radiculopathy. Motor weakness of deltoid, sensory loss over shoulder and upper lateral arm, and compromised biceps reflex would be characteristic.
C5–C6 disc herniation (C) would cause C6 radiculopathy. This would present with motor weakness of biceps brachii and wrist extensors, sensory loss over first and second digits and lateral forearm, and compromised biceps and brachioradialis (more specific) reflex.
5
Indicates Question Difficulty
Correct Answer
Correct Answer Explanation
Incorrect Answer Explanation

Abbreviations

ACA, anterior cerebral artery

ACommA, anterior communicating artery

ADC, apparent diffusion coefficient

ADH, antidiuretic hormone

AICA, anterior inferior cerebellar artery

ANT, anterior nucleus of thalamus

ATM, AT mutant

BAER, brainstem auditory evoked response

BPPV, benign positional paroxysmal vertigo

CBF, cerebral blood flow

CHARGE, *c*oloboma, congenital *h*eart disease, choanal *a*tresia, growth *r*etardation, *g*enital abnormalities, and *e*ar abnormalities

CN, cranial nerve

CNS, central nervous system

CSF, cerebrospinal fluid

CT, computed tomography

DM, dorsomedial

DRG, dorsal root ganglion

DTR, deep tendon reflex

DVN, dorsal vagal nucleus

DWI, diffusion weighted imaging

ER, emergency room

18F-FDG, fluorodeoxyglucose

FEF, frontal eye field

FLAIR, fluid-attenuated inversion recovery

FSH, follicle-stimulating hormone

GBS, Guillain–Barré syndrome

GFAP, glial fibrillary acidic protein

GI, gastrointestinal

GnRH, gonadotropin-releasing hormone

H&E, hematoxylin and eosin

HMSN, hereditary motor and sensory neuropathies

ICP, intracranial pressure

INO, internuclear ophthalmoplegia

IV, intravenous

LGB, lateral geniculate body

LH, luteinizing hormone

LMN, lower motor neuron

MALT, mucosa-associated lymphoid tissue

MCA, middle cerebral artery

MCP, middle cerebellar peduncle

MGB, medial geniculate body

MLF, medial longitudinal fasciculus

MRI, magnetic resonance imaging

MS, multiple sclerosis

MSO, medial superior olive

NTD, neural tube defect

OCD, obsessive compulsive disorder

oVEMP, ocular vestibular-evoked myogenic potential

PAG, periaqueductal gray

PCA, posterior cerebral artery

PCommA, posterior communicating artery

PET, positron emission tomography

PICA, posterior inferior cerebellar artery

PMP22, peripheral myelin protein-22

PNS, peripheral nervous system

PPRF, paramedian pontine reticular formation

PTSD, posttraumatic stress disorder

riMLF, rostral interstitial nucleus of medial longitudinal fasciculus

SCA, superior cerebellar artery

SCDS, superior canal dehiscence syndrome

SCP, superior cerebellar peduncle

SIADH, syndrome of inappropriate antidiuretic hormone

SSRI, selective serotonin reuptake inhibitor

STN, subthalamic nucleus

SVA, special visceral afferent

TRN, thalamic reticular nucleus

UMN, upper motor neuron

VA, ventral anterior

VAmc, ventral anterior nucleus, magnocellular part

VApc, ventral anterior nucleus, parvocellular part

VL, ventral lateral

VLc, ventral lateral nucleus pars caudalis

VLo, ventral lateral nucleus pars oralis

VLPO, ventral lateral preoptic nucleus

VP, ventral posterior

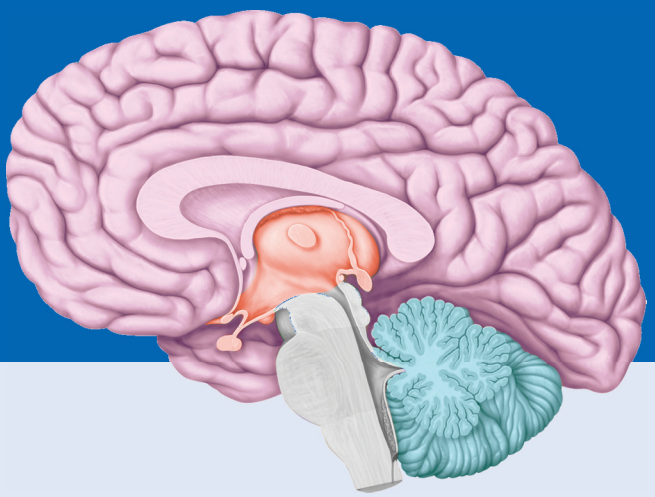
VPL, ventral posterolateral

VPM, ventral posteromedial

WBC, while blood cell

Chapter 1

Gross Anatomy of the Nervous System



LEARNING OBJECTIVES

- Identify external features of brainstem through which cranial nerves emerge.
- Identify the location of the anterior limb of the internal capsule on a T1-weighted anatomical axial slice MRI. Describe the contents of the parts of the internal capsule.
- Recognize the role of the thalamus in the formation and recall of memory. Locate the thalamus on a T1 anatomical axial MRI image. Analyze the clinical features of Korsakoff's psychosis.
- Analyze the role of the corpus callosum in interhemispheric communication. Locate the corpus callosum on a T1-weighted anatomical MRI axial slice.
- Locate the genu of the internal capsule on a T1 anatomical MRI axial slice. Describe the contents of the parts of the internal capsule.
- Classify nuclei within the basal ganglia. Locate the neostriatum on at T1-anatomical MRI axial slice.
- Describe the supply for spinal nerve roots. Describe spinal nerve root involvement with disc herniation.
- Describe the origin, course, distribution, function, and effects of lesion for the abducens nerve.
- Describe the pathways for the corneal reflex. Identify external features of brainstem through which cranial nerves emerge.
- Trace visceromotor and viscerosensory sympathetic fibers for thoracic and abdominal organs.
- Trace the secretomotor pathway for lacrimation.
- Describe the innervation of the muscles of mastication. Identify the location of the pons on a T1-weighted anatomical MRI sagittal slice.
- Define the role of the cingulate gyrus within the limbic system. Locate the cingulate gyrus on a T1-weighted anatomical MRI sagittal slice.
- Analyze the inverted unilateral relationship between visual fields and primary visual cortex. Identify the location of the inferior bank of the calcarine sulcus on a T1-weighted anatomical MRI sagittal slice.
- Define the role of posterior paracentral lobule as the sensory area for the lower limbs and genitals.
- Define the boundaries of the fourth ventricle.
- Define the role of the posterior parietal cortex in attentional mechanisms. Identify the posterior parietal cortex on a T1-weighted anatomical MRI sagittal slice.
- Define the role of orbitofrontal cortex in emotion and executive functions. Identify orbitofrontal cortex on a T1-weighted anatomical MRI sagittal slice.
- Define the role of the frontal eye fields in the programming of horizontal saccades. Identify the location of the frontal eye fields on a T1-weighted anatomical MRI sagittal slice.

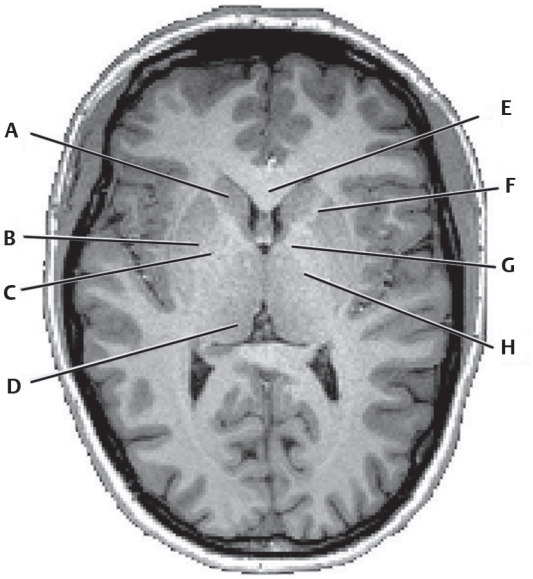
1.1 Questions

Easy | Medium | Hard

1. A 58-year-old man presents with right deviation of his tongue on protrusion. No other neurological abnormality is noted on physical examination. Which of the following might be the location of a tumor in his case?

A. Anterior median fissure; medulla
B. Anterolateral sulcus; medulla
C. Posterolateral sulcus; medulla
D. Posterior median sulcus; medulla
E. Cerebellopontine angle

Consider the following image for questions 2 to 6:



2. A 58-year-old right-handed male is admitted to the emergency department after being discovered unconscious on his kitchen floor when coworkers reported his unusual absence from an important business meeting. Initial diagnosis is an ischemic stroke affecting primarily the frontopontine tracts and the anterior thalamic peduncle. Which area of the labeled T1-weighted MRI image would you expect to see damaged?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E
F. Area F
G. Area G
H. Area H

3. A 46-year-old man is admitted to the hospital after his family reported he was having problems with both forming new memories and a significant loss of existing memories. Upon questioning, he displayed confabulation and his conversations consisted of sparse content. Further questioning of the family revealed he has been a heavy drinker for the previous 5 years. Which area of the brain is likely to show evidence of this patient's memory problems?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

4. A 59-year-old woman presented at the emergency department after developing right-sided weakness. After transfer to the department of rehabilitation 4 weeks after the acute event, she was alert, but had moderate cognitive impairment. Sensory function was intact, and deep tendon reflexes were normal. Muscle functions were normal for all extremities, and there was no spasticity present. She complained that her hand moved abnormally, often against her will. When prompted, she could grasp and release objects with the affected hand. Which area of the labeled MRI image would you most likely expect damage?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

5. A 78-year-old man presented to the emergency department with an asymmetrical smile and uvular deviation to the right. Suspecting a stroke, a CT scan was obtained. In which area would you expect the lesion to be located?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E
F. Area F
G. Area G
H. Area H

6. A 62-year-old woman presents with abrupt and jerky movements of her limbs. Neuroimaging reveals extensive degeneration of her neostriatum. Which of the area(s) is/are affected in her case?

A. Area A
B. Area B
C. Area C
D. Areas A and B
E. Areas B and C
F. Areas A and C

7. A 21-year-old woman presents with sensory loss affecting the left middle finger. There was considerable weakness noted for her left triceps muscle, and her triceps jerk was severely diminished. Which of the following might be the cause for her symptoms?

A. C3–C4 disc herniation
B. C4–C5 disc herniation
C. C5–C6 disc herniation
D. C6–C7 disc herniation
E. C7–C8 disc herniation

8. A 38-year-old man presents with medial deviation of his right eyeball. He walks forward with his head rotated toward his right shoulder. No other neurological abnormality is noted on physical examination. Which of the following locations might be spared during a radiological search for localizing a tumor in his case?

A. Midline pons, just beneath the fourth ventricle
B. Horizontal sulcus, medial pontomedullary junction
C. Horizontal sulcus, lateral pontomedullary junction
D. Cavernous sinus
E. Superior orbital fissure

9. A 28-year-old woman presents with an abnormal blink reflex during routine neurological testing. When her right cornea was touched with a wisp of cotton, her left but not the right eye blinked. Which of the following is true for the affected nerve in her case?

A. The nucleus is located in the midbrain at the level of superior colliculus.
B. The nucleus is located in the midbrain at the level of inferior colliculus.
C. The nerve emerges from the brainstem at the level of mid pons.
D. The nerve emerges from the brainstem via the horizontal sulcus at the medial aspect of the pontomedullary junction.
E. The nerve emerges from the brainstem via the horizontal sulcus at the lateral aspect of the pontomedullary junction.

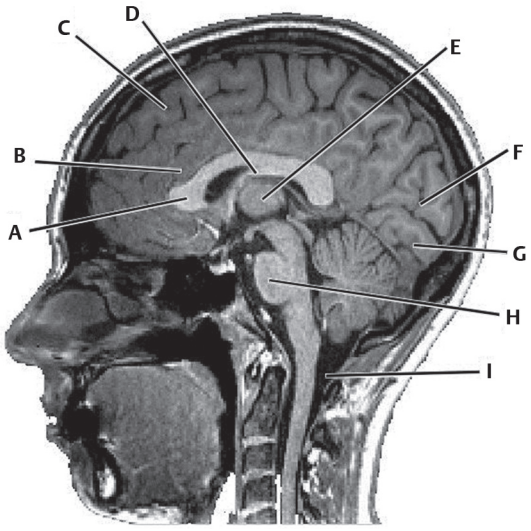
10. A 21-year-old man presents with tachycardia. A senior resident explains to her intern the pathway for the sympathetic fibers to reach the pacemaker cells of the heart. Which of the following structures should be brought up in their discussion?

A. Dorsal root of T1 spinal nerve
B. Dorsal rami of T1 spinal nerve
C. Gray rami communicantes
D. White rami communicantes
E. Greater splanchnic nerve

11. A 12-year-old girl presents with dry eyes consequent to lack of lacrimation. Which of the following structures might be the site of lesion in her case?

A. Ciliary ganglion
B. Pterygopalatine ganglion
C. Otic ganglion
D. Superior cervical ganglion
E. Gasserian ganglion

Consider the following image for questions 12 to 14:



12. A 54-year-old man was admitted to the emergency department with deviated jaw. Physical examination revealed a lower motor neuron type of paralysis of the right lateral pterygoid muscle. Which of the following areas might be damaged in this patient?

A. Area A
B. Area B
C. Area C
D. Area E
E. Area H

13. You are referred a patient from a local psychiatrist for a neurological consult. The patient was described as having undergone an extreme change in mood. The 17-year-old boy was described as having been a happy, responsible, and quiet teenager. However, in recent months, he has been impulsive, prone to anger, and has been getting into fights at school. The psychiatrist believes these changes in behavior are not a result of "teenage angst." You order an MRI and a cortical tumor was found. What is the most likely location for this tumor?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

14. A 77-year-old woman presents to the ophthalmologist with an upper quadrantanopia. A subsequent MRI revealed she had suffered from a cerebrovascular event. In which area would you expect the lesion to be?

A. Area C
B. Area D
C. Area E
D. Area F
E. Area G

15. A 48-year-old man presents with a 2-year history of severe, transient, and stabbing pain that initiates in the right side of throat. It gradually radiates to the base of tongue, right ear, and occasionally beneath the angle of right jaw. The paroxysmal attacks are frequently precipitated by swallowing of cold drinks. Which of the following might be the location of nerve irritation in his case?

A. Anterior median fissure; medulla
B. Anterolateral sulcus; medulla
C. Posterolateral sulcus; medulla
D. Posterior median sulcus; medulla
E. Cerebellopontine angle

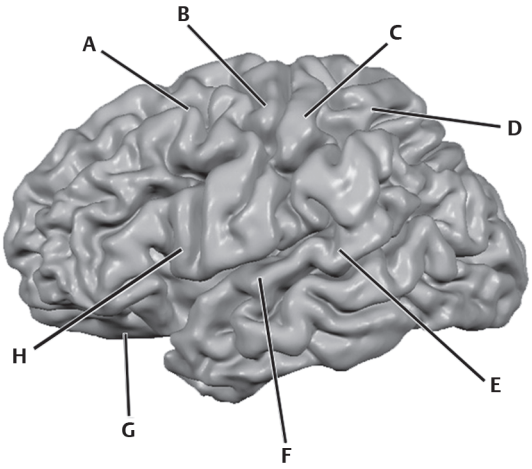
16. A 56-year-old man presents with anesthesia of his leg, foot, and genitals. Which of the following might be the location of a cortical tumor in him?

A. Precentral gyrus, lateral hemisphere
B. Postcentral gyrus, lateral hemisphere
C. Anterior paracentral lobule
D. Posterior paracentral lobule
E. Superior parietal lobule

17. A 52-year-old man presents with a tumor affecting the roof of the fourth ventricle. Which of the following structures will be directly related to the tumor?

A. Medulla oblongata
B. Pons
C. Cerebellum
D. Thalamus
E. Hypothalamus

Consider the following image for questions 18 to 20:



18. A 77-year-old left-handed woman is brought to the emergency department displaying severe right-sided hemispatial neglect. Which of the following area is most likely to be damaged resulting in this condition?

A. Area A
B. Area B
C. Area D
D. Area G
E. Area H

19. Following a motorcycle accident, a 17-year-old male is suspected of having undergone a traumatic brain injury. During psychological testing, he displays poor performance on the Wisconsin Card Sorting Task, and is prone to anger. Additionally, he scores poorly on general intellectual skills assessments. Which area best accounts for these symptoms, and therefore, was likely damaged in the motorcycle crash?

A. Area A
B. Area C
C. Area D
D. Area E
E. Area G

20. A 22-year-old right-handed male suffered head trauma following a fight in a bar. Upon admission to the emergency department, it was discovered that he had an acute deficit in the programming of saccadic eye movements into the right visual field. Tests of visual acuity revealed no deficits, suggesting the programming of eye movements to be the only deficit. In which area would you expect the damage to have occurred?

A. Area A
B. Area B
C. Area C
D. Area D
E. Area E

1.2 Answers and Explanations

Easy | Medium | Hard

1. Correct: Anterolateral sulcus; medulla (B)

The patient seems to be suffering from hypoglossal nerve palsy. Rootlets of the nerve emerge from the brainstem (medulla) at the anterolateral sulcus between the pyramid and the olive.

The anterior median fissure (**A**) and posterior median sulcus (**D**) of medulla do not give attachment to any cranial nerves.

Glossopharyngeal, vagus, and accessory nerves emerge from the medulla at the posterolateral sulcus (**C**).

The cerebellopontine angle (**E**) is closely related to the attachments of the facial and vestibulocochlear nerves.

Refer to the following image key for answers 2 to 6:

A, head of caudate nucleus; B, putamen; C, globus pallidus; D, thalamus; E, corpus callosum; F, anterior limb of internal capsule; G, genu of internal capsule; H, posterior limb of internal capsule.

2. Correct: Area F (F)

The frontopontine tract and the anterior thalamic peduncle are contained within the anterior limb of the internal capsule, between the caudate nucleus and the lentiform nucleus. In addition, the anterior limb contains fibers from the anterior and the medial nuclear groups of the thalamus to the cingulate gyrus and the prefrontal cortex, respectively.

3. Correct: Area D (D)

History and clinical features for this man are typical for Korsakoff's psychosis. Although Korsakoff's syndrome can cause general cerebral atrophy, the memory problems are most likely to represent damage to the thalamus and to the mammillary bodies of the hypothalamus.

4. Correct: Area E (E)

The patient is presenting with classical symptoms of alien hand syndrome, a relatively rare condition that includes autonomous activity of the affected limb, which is perceived by the patient as being outside of voluntary control. In this particular case, the patient is displaying an agnostic dyspraxia, in which the affected hand competitively interacts with the non-affected hand when attempting to perform motor commands. Damage to the anterior corpus callosum, and consequent lack of interhemispheric connection, is the most common underlying cause for these cases.

5. Correct: Area G (G)

Facial paralysis (cranial nerve VII involvement) accompanying with uvular deviation (cranial nerve X involvement) indicates damage of corticobulbar fibers. The genu of the internal capsule contains such fibers and is likely to be the site of lesion in his case.

6. Correct: Areas A and B (D)

The neostriatum comprises the caudate nucleus and the putamen. The globus pallidus (**C**) forms the paleostriatum.

7. Correct: C6–C7 disc herniation (D)

Clinical features for the woman are typical for C7 radiculopathy. This is commonly caused by C6–C7 disc herniation.

Cervical nerve roots exit above the correspondingly numbered vertebra (except C8, since there is no corresponding vertebra). These have a fairly horizontal course as they emerge from the dural sac near the intervertebral disc and exit through the intervertebral foramen. Cervical discs are usually constrained by the posterior longitudinal ligament to herniate laterally toward the nerve root, rather than centrally toward the spinal cord. In cervical cord, therefore, the nerve root involved usually corresponds to the lower vertebral bone of the disc space.

C3–C4 disc herniation (**A**) would cause C4 radiculopathy, which might present as sensorimotor deficits in the neck region.

C4–C5 disc herniation (**B**) would cause C5 radiculopathy. Motor weakness of deltoid, sensory loss over shoulder and upper lateral arm, and compromised biceps reflex would be characteristic.

C5–C6 disc herniation (**C**) would cause C6 radiculopathy. This would present with motor weakness of biceps brachii and wrist extensors, sensory loss over first and second digits and lateral forearm, and compromised biceps and brachioradialis (more specific) reflex.

C7–C8 disc herniation (**E**) would cause C8 radiculopathy. This will result in weakness of digit flexors and sensory loss affecting the ring and little fingers for the digits.

8. Correct: Horizontal sulcus, lateral pontomedullary junction (C)

The patient is suffering from abducens nerve palsy. This can be inferred from a paralyzed lateral rectus muscle (causing medial deviation of the eyeball). These patients turn the head horizontally toward the ipsilateral shoulder for forward vision. The abducens nerve is not related to the lateral part of the horizontal sulcus at the pontomedullary junction and therefore will be spared in the case of a tumor affecting this location.

The abducens nucleus is located in the pons just beneath the fourth ventricle (**A**). The nerve emerges from the pontomedullary junction near the midline at the horizontal sulcus (**B**). It then courses through the cavernous sinus (**D**) to enter the orbit through the superior orbital fissure (**E**). Tumors located in each of these locations therefore could affect the nerve.

9. Correct: The nerve emerges from the brainstem via the horizontal sulcus at the lateral aspect of the pontomedullary junction. (E)

Corneal (blink) reflex consists of bilateral eye closure in response to stimulation of either cornea. The afferent limb of this reflex is formed by the ophthalmic division of the trigeminal nerve. The efferent limb comprises motor fibers that begin in the sensory nucleus of trigeminal, project bilaterally on facial motor nuclei, and supply orbicularis oculi muscles. A lesion of trigeminal nerve abolishes both ipsilateral and contralateral eye closure. A lesion of the facial nerve, as in this case, abolishes only ipsilateral eye closure. Facial nerve emerges from the brainstem via the horizontal sulcus at the lateral aspect of the lateral pontomedullary junction.

Oculomotor and trochlear nerve nuclei are located in the midbrain at the levels of superior (**A**) and inferior (**B**) colliculi, respectively. The trigeminal nerve emerges from the brainstem at the level of mid pons (**C**). The abducens nerve (**D**) emerges from the brainstem via the horizontal sulcus at the medial aspect of the pontomedullary junction.

10. Correct: White rami communicantes (D)

Preganglionic sympathetic fibers arise from the lateral horn cells of T1–T5 spinal segments, travel via the ventral roots and the ventral rami of the spinal nerves, and reach the corresponding thoracic sympathetic ganglia via white rami communicantes. Some of these fibers reach the cervical sympathetic ganglia by running up the sympathetic trunk. Postganglionic fibers from the cervical and the thoracic ganglia reach the heart via cardiac splanchnic nerves.

Dorsal roots (**A**) contain central processes of afferent fibers from skin and viscera; dorsal rami (**B**) contain motor fibers to skeletal muscles and sensory fibers for skin of the back; gray rami communicantes (**C**) contain postganglionic sympathetic fibers for blood vessels, sweat glands, and arrector pili muscles; and greater splanchnic nerves (**E**) contain preganglionic visceromotor and peripheral processes of viscerosensory sympathetic fibers for abdominal organs.

11. Correct: Pterygopalatine ganglion (B)

The pterygopalatine ganglion contains cell bodies for the postganglionic neurons that supply secretomotor fibers to the lacrimal, nasal, and palatine glands.

The ciliary ganglion (**A**) is involved in pupillary constriction, and contains cell bodies for the postganglionic neurons that supply the sphincter pupillae and ciliary muscles.

The otic ganglion (**C**) is involved in salivation, and contains cell bodies for the postganglionic neurons that supply secretomotor fibers for the parotid gland.

The superior cervical ganglion (**D**, a sympathetic ganglion formed by fusion of the upper four cervical paravertebral sympathetic ganglia) and gasserian ganglion (**E**, a sensory ganglion of the trigeminal nerve) are not involved in lacrimation.

12. Correct: Area H (E)

The basilar portion of the pons (H in the image) contains the motor trigeminal nucleus, which contains the cell bodies for the lower motor neurons that supply the muscles of mastication (including the lateral pterygoid muscle). Damage to this area would result in jaw deviation.

Area A (**A**) in the sagittal slice corresponds to the anterior corpus callosum. It provides the major pathways for interhemispheric communication, with damage possibly resulting in alien hand syndrome, alexia without agraphia, and other clinical manifestations of split-brain.

Area B **(B)** represents the anterior cingulate gyrus. Damage to the area is associated with problems in error detection, task switching, attention deficits, appreciation of reward, emotional instability, and social anxiety.

Area C **(C)** in the labeled sagittal slice corresponds to the medial frontal gyrus. Damage to this region typically results in dysfunctions of working memory and decision-making.

Area E **(D)** in the sagittal slice corresponds to the thalamus. Thalamic damage often results in Dejerine–Roussy syndrome, which involves unilateral, contralesional, dysesthesia, and allodynia.

13. Correct: Area B (B)

The cingulate gyrus is part of the limbic system, which is heavily involved in the regulation of emotional behavior. Tumors within this region can result in drastic changes in personality.

Area A **(A)** in the sagittal slice corresponds to the anterior corpus callosum. It provides the major pathways for interhemispheric communication, with damage possibly resulting in alien hand syndrome, alexia without agraphia, and other clinical manifestations of split-brain.

Area C **(C)** in the labeled sagittal slice corresponds to the medial frontal gyrus. While damage to this region could result in personality changes, it is more commonly linked to dysfunctions of working memory and decision-making.

Area D **(D)** in the sagittal slice indicates the fornix, the major output formation of the hippocampal system. As part of the limbic system, disruption of these fibers is most often associated with memory loss, in particular recalling long-term episodic memory.

Area E **(E)** in the sagittal slice corresponds to the thalamus. Thalamic damage often results in Dejerine–Roussy syndrome, which involves unilateral, contralesional, dysesthesia, and allodynia.

14. Correct: Area G (E)

Primary visual cortex is located on the superior and inferior banks of the calcarine sulcus and receives information from the lateral geniculate nucleus pertaining to the contralateral visual field. The inferior bank represents the superior visual field. Therefore, an upper quadrantanopia would be associated with a unilateral lesion of the inferior bank of the calcarine sulcus (area G [**E**]).

Area C **(A)** in the labeled sagittal slice corresponds to the medial frontal gyrus. While damage to this region could result in personality changes, it is more commonly linked to dysfunctions of working memory and decision-making.

Area D (**B**) in the sagittal slice indicates the fornix, the major output formation of the hippocampal system. As part of the limbic system, disruption of these fibers is most often associated with memory loss, in particular recalling long-term episodic memory.

Area E (**C**) in the sagittal slice corresponds to the thalamus. Thalamic damage often results in Dejerine–Roussy syndrome, which involves unilateral, contralesional, dysesthesia, and allodynia.

Damage to area F (**D**) in the labeled image (the superior bank of the calcarine sulcus) would result in a visual deficit of the inferior visual field.

15. Correct: Posterolateral sulcus; medulla (C)

The clinical features of the patient are typical of glossopharyngeal neuralgia. The glossopharyngeal nerve emerges from the medulla at the posterolateral sulcus.

Rootlets of the hypoglossal nerve emerge from the brainstem (medulla) at the anterolateral sulcus (**B**) between the pyramid and the olive.

The anterior median fissure (**A**) and posterior median sulcus (**D**) of medulla do not give attachment to any cranial nerves.

The cerebellopontine angle (**E**) is closely related to the attachments of the facial and vestibulocochlear nerves.

16. Correct: Posterior paracentral lobule (D)

The posterior paracentral lobule (postcentral gyrus on the medial hemisphere) represents the cortical area for sensation of the lower limbs and genitals.

The precentral gyri on the lateral (**A**) and the medial (**C**, anterior paracentral lobule) hemispheres are related to motor areas for the upper and lower body, respectively.

The postcentral gyrus on the lateral hemisphere (**B**) represents the cortical area for sensation of the upper limbs and trunk.

The superior parietal lobule (**E**) lies posterior to the postcentral gyrus and is a complex sensory association area. A lesion to this region might produce astereognosis and other forms of agnosia but anesthesia would be uncommon.

17. Correct: Cerebellum (C)

The fourth ventricle is formed as a cavity within the hindbrain or rhombencephalon. The cerebellum can be conceptualized as the roof of the fourth ventricle, while both the pons (**B**) and medulla oblongata (**A**) lie on its floor. The thalamus (**D**) and hypothalamus (**E**) derive from diencephalon and are not related to the fourth ventricle.

18. Correct: Area D (C)

The posterior parietal cortex (area D [**C**]) plays a large role in the modulation of visual attention. Therefore, damage to the area may result in failures to orient attention toward the contralesional hemifield.

Area A (**A**) in the labeled image corresponds to the lateral aspect of the superior frontal gyrus. Damage to this region is most likely to result in a loss of horizontal eye movements (due to the superior frontal gyrus' role in producing conjugate deviation of the eyes, ultimately through innervation of the superior colliculus).

The primary motor cortex responsible for control of the arm (area B [**B**]) projects axons to the spinal cord and activity within this region directly correlates with volitional movement. Damage to this region would result in an upper motor neuron lesion of the contralateral arm.

Area G (**D**) in the labeled image corresponds to the orbitofrontal cortex, which plays a prominent role in higher order intellectual functions and some aspects of emotional behavior.

Broca's area (area H, inferior frontal gyrus [**E**]) has a prominent role in speech production.

19. Correct: Area G (E)

The orbitofrontal cortex (area G [**E**]) is involved in higher order intellectual functions and some emotional behavior. Following damage to this region, changes in personality and emotions are possible.

Area A (**A**) corresponds to the lateral aspect of the superior frontal gyrus. Damage to this region is most likely to result in a loss of horizontal eye movements (due to the superior frontal gyrus' role in producing conjugate deviation of the eyes, ultimately through innervation of the superior colliculus).

The primary somatosensory cortex is immediately adjacent to the central sulcus (area C [**B**]). Damage to this region would result in a loss of sensation (vibration, tactile, and pressure) of the contralateral body part. The precise location of the deficit would depend on the portion of sensory homunculus affected.

Area D (**C**), the superior parietal lobule, is involved in the attention. Damage to this region can cause a hemispatial neglect for contralesional visual space and other disorders of attention, such as tactile agnosia.

Area E (**D**) marks the dorsal border of the superior temporal gyrus, and in combination with adjacent portions of parietal cortex makes up Wernicke's area. This region is critical for the understanding of both written and spoken words.

20. Correct: Area A (A)

The frontal eye fields, located on the superior and middle frontal gyri (area A [**A**]), send signals to the superior colliculus to initiate eye movements. Damage to this region usually results in an inability to produce saccades into the contralesional visual field.

The primary motor cortex responsible for control of the arm (area B [**B**]) projects axons to the spinal cord, and activity within this region directly correlates with volitional movement. Damage to this region would result in an upper motor neuron lesion of the contralateral arm.

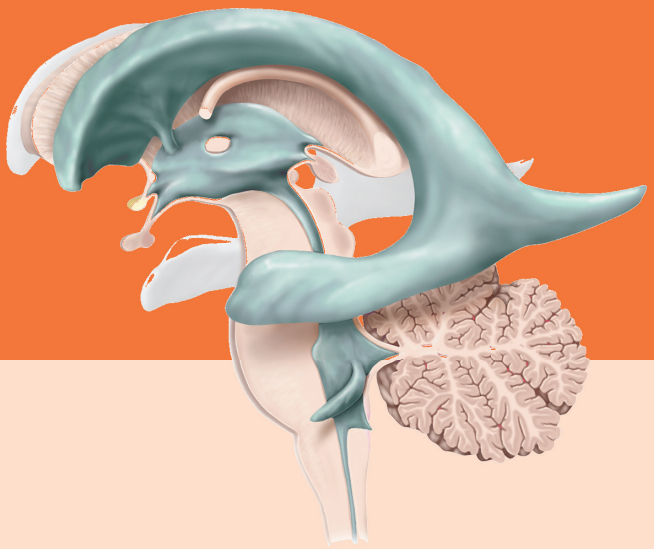
The primary somatosensory cortex is immediately adjacent to the central sulcus (area C [**C**]). Damage to this region would result in a loss of sensation (vibration, tactile, and pressure) of the contralateral body part. The precise location of the deficit would depend on the portion of sensory homunculus affected.

Area D (**D**), the superior parietal lobule, is involved in the attention. Damage to this region can cause a hemispatial neglect for contralesional visual space and other disorders of attention, such as tactile agnosia.

Area E (**E**) marks the dorsal border of the superior temporal gyrus, and in combination with adjacent portions of parietal cortex makes up Wernicke's area. This region is critical for the understanding of both written and spoken words.

Chapter 2

Meninges and CSF



LEARNING OBJECTIVES

- Describe the disposition of the dural folds.
- Analyze the pathophysiology and the clinical features of meningitis. Distinguish between bacterial and viral meningitis.
- Describe the location and contents for the primary subarachnoid cisterns.
- Analyze the clinical features of uncal herniation.
- Describe the attachments for the dural folds.
- Describe the locations and blood supply for the choroid plexus.
- Analyze the etiopathogenesis of normal pressure hydrocephalus.
- Describe the location and contents for the primary subarachnoid cisterns.
- Describe the disposition of the dural folds.
- Identify the layers of the meninges.
- Localize the subdural space. Identify the layers of the meninges.
- Localize the subarachnoid space.
- Illustrate the pathway for the flow of CSF.
- Describe the disposition of the dural folds. Identify cerebral venous sinuses that are contained within folds of dura mater.
- Interpret CSF analysis and recognize values outside of the normal range.
- Analyze the etiologies for enlarged retrocerebellar space.
- Identify the clinical features associated with a subfalcial herniation.
- Describe the attachments for the dural folds.
- Illustrate the pathway for the flow of CSF. List the primary and secondary brain vesicles and trace their derivatives in human.

2.1 Questions

Easy | Medium | Hard

1. A 58-year-old man presents with a brain herniation involving the tentorium cerebelli. Which of the following structures are separated by this meningeal fold?

A. Cerebral hemispheres
B. Cerebellar hemispheres
C. Cerebellum and pons
D. Cerebellum and medulla
E. Cerebellum and cerebral hemisphere

2. A 14-year-old girl was brought to the emergency department following a day of worsening headache, fever, periods of confusion, and stiff neck. The patient's mother reported that she awoke at ~3 am with chills and body aches. By ~11 am, she was breathing quickly and had nausea and vomiting. Physical examination revealed a temperature of 101.5F, marked rigidity within the neck, and the appearance of nonblanching, purplish 2-mm-sized petechiae scattered on the arms, legs, and chest. A lumbar puncture was performed and CSF analysis showed normal opening pressure, elevated white blood cells, total protein, and lactate, and a low glucose level. What was the most likely cause of this patient's symptoms?

A. Ventricular stenosis
B. Viral meningitis
C. Beta-amyloid plaque deposits
D. Bacterial meningitis
E. Scarring of arachnoid granulations

3. A 6-month-old infant presents with medial deviation of his right eyeball. MRI indicates a huge cyst located within a subarachnoid cistern pressing on to the contained structures. Which of the following structures might also be involved?

A. Vertebral artery
B. Basilar artery
C. Posterior inferior cerebellar artery
D. Posterior communicating arteries
E. Middle cerebral arteries

4. A 33-year-old right-handed male presents with third cranial nerve palsy and weakness, affecting the same side of the body. Which of the following forms of brain herniation would you suspect in him?

A. Subfalcial
B. Uncal
C. Tonsillar-foramen magnum
D. Abducens herniation

5. A 51-year-old right-handed woman undergoes a CT scan, with the suspicion of having a tear in the dural fold at the point of its attachment to the crista galli of the ethmoid bone. Which of the following dural folds is affected?

A. Falx cerebri
B. Tentorium cerebelli
C. Falx cerebelli
D. Diaphragma sellae

6. A 2-month-old infant presents with hydrocephalus. He has been crying intermittently and has vomited several times in the past 24 hours. MRI reveals a choroid plexus papilloma in the roof of the third ventricle. Which of the following arteries is the principal feeder for the tumor?

A. Anterior choroidal artery
B. Medial posterior choroidal artery
C. Lateral posterior choroidal artery
D. Anterior inferior cerebellar artery
E. Posterior inferior cerebellar artery

7. An 81-year-old right-handed male presents to a neurologist accompanied by his wife. She says that her husband has become clumsier, resulting in several falls over the last few months. Additionally, he has been having periodic urinary incontinence. However, in recent days, he has become increasingly forgetful, and she now fears that he may be developing Alzheimer's disease, a condition that runs prevalent in his family. Physical examination reveals the patient has an abnormal gait. CSF analysis shows an opening pressure of 120 mm H_2O, total protein of 20 mg/dL, and WBC count < 5. It is determined that this patient is suffering from normal pressure hydrocephalus. Which of the following is the most likely cause for his symptoms?

A. Ventricular stenosis
B. Viral infection
C. Beta-amyloid plaque deposits
D. Bacterial meningitis
E. Scarring of arachnoid granulations