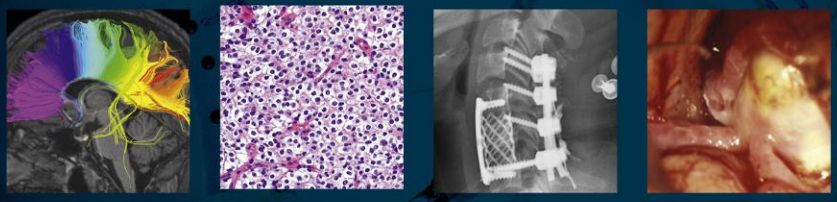
Get Full Access and More at ExpertConsult.com

Neurosurgery Self-Assessment

Questions and Answers



Rahul S. Shah
Thomas A. D. Cadoux-Hudson
Jamie J. Van Gompel
Erlick A. C. Pereira

Foreword by Edward C. Benzel

eBook version included:
Contains all 1000+ questions from print and over 300 bonus questions

ELSEVIER

NEUROSURGERY SELF-ASSESSMENT

This page intentionally left blank

NEUROSURGERY SELF-ASSESSMENT

Questions and Answers

Rahul S. Shah, BSc(Hons), MBChB(Hons), MRCS(Eng)
Specialty Registrar in Neurosurgery and
Wellcome Trust Clinical Research Fellow
University of Oxford
Oxford, UK

Thomas A.D. Cadoux-Hudson, DPhil, FRCS, MB BS
Honorary Consultant Neurosurgeon
Department of Neurosurgery
Oxford University Hospitals NHS Trust
Oxford, UK

Jamie J. Van Gompel, MD
Associate Professor of Neurosurgery and Otolaryngology
Mayo Clinic College of Medicine
Rochester, MN, USA

Erlick A.C. Pereira, MA, BM BCh, DM, FRCS(Neuro.Surg), SFHEA
Senior Lecturer in Neurosurgery and Consultant Neurosurgeon
Atkinson Morley Neurosciences Centre, St George's Hospital
St George's, University of London
London, UK

Foreword by

Edward C. Benzel, MD
Chairman, Department of Neurosurgery
Center for Spine Health, Cleveland Clinic
Cleveland, OH, USA

For additional online content visit **ExpertConsult.com**

ELSEVIER
Edinburgh London New York Oxford Philadelphia St Louis Sydney Toronto 2017

ELSEVIER

© 2017, Elsevier Inc. All rights reserved.

The right of Drs. Rahul S. Shah, Thomas A.D. Cadoux-Hudson, Jamie J. Van Gompel, Erlick A.C. Pereira to be identified as author of this work has been asserted by them in accordance with the Copyright, Designs and Patents Act 1988.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

With respect to any drug or pharmaceutical products identified, readers are advised to check the most current information provided (i) on procedures featured or (ii) by the manufacturer of each product to be administered, to verify the recommended dose or formula, the method and duration of administration, and contraindications. It is the responsibility of practitioners, relying on their own experience and knowledge of their patients, to make diagnoses, to determine dosages and the best treatment for each individual patient, and to take all appropriate safety precautions.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

ISBN: 978-0-323-37480-4

Printed in China

Last digit is the print number: 9 8 7 6 5 4 3 2 1

Content Strategist: Lotta Kryhl
Content Development Specialist: Humayra Rahman Khan
Project Manager: Srividhya Vidhyashankar
Design: Miles Hitchen
Illustration Manager: Lesley Frazier
Marketing Manager: Rachael Pignotti

Working together to grow libraries in developing countries

www.elsevier.com • www.bookaid.org

Contents

Foreword, vii

Preface, ix

How to Pass Neurosurgical Examinations, xi

PART I
BASIC SCIENCE

1 Neuroanatomy, 1

2 Embryology, 22

3 Neurophysiology, 34

4 Neuropathology I: Basics, 55

5 Neuropathology II: Gross Pathology, 66

6 Neuropathology III: Histology, 86

7 Pharmacology, 121

PART II
CARE OF THE NEUROSURGICAL PATIENT

8 Neurology and Stroke, 127

9 Neuro-Ophthalmology, 161

10 Neuro-otology, 176

11 Neurointensive and Perioperative Care, 185

12 Infection, 201

13 Seizures, 203

14 Neuroradiology, 216

15 Radiotherapy and Stereotactic Radiosurgery, 226

16 Neuropsychology and Neurological Rehabilitation, 236

17 Statistics, 241

18 Professionalism and Medical Ethics, 242

19 Surgical Technology and Practice, 256

PART III
CRANIAL NEUROSURGERY

20 General Neurosurgery and CSF Disorders, 257

21 Cranial Trauma, 268

22A Cranial Vascular Neurosurgery I: Aneurysms and AVMs, 290

22B Cranial Vascular Neurosurgery II: Cerebral Revascularization and Stroke, 306

23 Cranial Oncology, 322

24 Skull Base and Pituitary Surgery, 340

25 Cranial Infection, 354

PART IV
SPINAL NEUROSURGERY

26 Spine: General Principles, 364

27 Scoliosis and Spinal Deformity, 377

28 Spinal Trauma and Acute Pathology, 386

29 Degenerative Spine, 403

30 SPINAL INFECTION, 418

31 SPINAL ONCOLOGY, 424

32 SPINAL VASCULAR NEUROSURGERY, 440

PART V
FUNCTIONAL NEUROSURGERY

33 PAIN SURGERY, 448

34 ADULT AND PEDIATRIC EPILEPSY SURGERY, 459

35 ADULT MOVEMENT DISORDERS, 471

36 SURGERY FOR PSYCHIATRIC DISORDERS, 485

PART VI
PERIPHERAL NERVE SURGERY

37 PERIPHERAL NERVE, 489

PART VII
PEDIATRIC NEUROSURGERY

38 PEDIATRIC NEUROSURGERY: GENERAL PRINCIPLES AND NORMAL DEVELOPMENT, 513

39 CRANIOSYNOSTOSIS, 521

40 CONGENITAL CRANIAL AND SPINAL DISORDERS, 527

41 PEDIATRIC NEUROSURGERY: GENERAL AND HYDROCEPHALUS, 546

42 PEDIATRIC NEURO-ONCOLOGY, 557

43 PEDIATRIC HEAD AND SPINAL TRAUMA, 569

44 PEDIATRIC VASCULAR NEUROSURGERY, 584

45 PEDIATRIC MOVEMENT DISORDERS AND SPASTICITY, 589

46 NEUROSURGERY AND PREGNANCY, 593

INDEX, 600

FOREWORD

Neurosurgery Self-Assessment: Questions and Answers by Shah, Cadoux-Hudson, Van Gompel and Pereira is a true masterpiece. All neurosurgeons need 'refreshers'; some for certification, some for maintenance of certification, and others for the mere need to 'keep up'. With over 1000 questions and 700 images available both in print and interactively online, this volume provides an extensive coverage of neurosurgery from top to bottom, and all points in between. Multiple choice questions are used to test foundation of knowledge and, most importantly, educate.

As adults, we learn most efficiently and effectively when our minds are exercised and stressed. When multiple modalities are employed (such as questions, answers and explanations), learning becomes more efficient, with a greater long term retention of the newly acquired information. This becomes particularly relevant to those who are to soon be 'tested' in the form of certification or maintenance of certification examinations. Reading, thinking, answering, and then the contemplation of answers and their rationales makes the multiple choice question strategy employed by the authors particularly relevant to modern day foundational neurosurgery information acquisition and retention.

I commend the authors for their tried and true, but uncommonly used, approach to education. It takes the agony out of reading a chapter. It minimizes the laborious efforts required to gather information via searches and other strategies. It brings the art and craft of neurosurgery to life in an enjoyable and relatively painless format. Finally, it provides a near complete coverage of the field – at least as complete as is humanly possible in the space afforded.

So, whether you have an impending examination, or you simply desire to 'spiff up' on your neurosurgical foundations, this book is for you. Use it as one might use a bedside novel. Use it to prepare. Use it to simply stay at the top of your field. This book can truly fulfill all of these needs – and much, much more.

Ed Benzel

This page intentionally left blank

Preface

Neurosurgical training is delivered worldwide with the goal of producing a surgeon who is safe for independent practice. Today, neurosurgical residents and their trainers are trying to achieve this goal in the face of reduced working hours, increasing demand on services, individual surgeon outcome publication, and increasing litigation, to name but a few challenges. In this environment, the value of targeted learning materials and advanced surgical simulation is clear. The content of this question book aims to reflect the evolving expectations placed on residents in an age of evidence-based practice, subspecialization, and multidisciplinary teams: one must also be familiar with allied specialties advancing just as fast as our own.

As a counterpoint to currently available self-assessment books, we have organized questions by the highly specific topic areas outlined in most modern neurosurgical textbooks and training curricula. Furthermore, most questions are accompanied by in-depth answers and, where appropriate, suggestions for further reading. We hope this will enable junior trainees to use it as a learning aid and for focused revision prior to rotating onto particular neurosurgical firms. For senior trainees or those about sit their examinations who require a mix of questions (in terms of both topic and difficulty), this is provided by the interactive question bank accessed via the online Inkling platform and smartphone app. This book consists of single best answer (SBA) and extended matching item (EMI) questions constructed according to the guidelines from the US National Medicine Licensing Board and the UK Joint Committee on Intercollegiate Examinations, to enable the user to become familiar with the respective formats before the exam. While SBA- and EMI-style questions are not yet universal in postgraduate neurosurgical examinations across the world, we hope all trainees find them valuable and cost-effective for self-study.

Finally, I would like to thank Elsevier—their support has ensured that this book could also serve as a comprehensive and representative catalogue of commonly examined clinical images and investigation results in a single resource for neurosurgical residents. I hope you enjoy using it!

Rahul S. Shah
Oxford
July 2016

This page intentionally left blank

How to Pass Neurosurgical Examinations

LEARNING BY MULTIPLE CHOICE QUESTIONS

The World Federation of Neurosurgical Societies estimates that there are 30,000 neurosurgeons worldwide. In the United States, there are approximately 3500 board certified neurosurgeons and 800 neurosurgical residents. In the United Kingdom, there are close to 300 consultants and 200 trainees, with a total of approximately 8000 qualified neurosurgeons and trainees in Europe. Due to international collaboration through research and education, neurosurgical training curricula have become increasingly standardized across most countries. Both UK and US-style examinations are well established in other countries (e.g. India and Brazil, respectively), and recently developed training programs in Africa have based their examinations on the UK format. Additionally, the need for already qualified neurosurgeons to demonstrate continuing professional development for revalidation purposes has also increased the demand for courses and objective self-assessment tools in neurosurgery.

Although the duration of postgraduate neurosurgical training varies by country, completion of training usually requires the candidate to pass both written and oral examinations set by the relevant national training board or committee. For the written examinations, questions are generally multiple choice and cover the basic and clinical sciences; short answer and essay questions are used in some regions. Topics include neuroanatomy, neurophysiology, neuropharmacology, critical care, fundamental clinical skills, neuroradiology, neuropathology, neurology, neurosurgery, and other disciplines deemed suitable and important (e.g. statistics, medical law, medical ethics). Questions relating to clinical neurosurgery also cover the main subspecialties, including trauma, neuro-oncology, skull base and pituitary surgery, vascular neurosurgery, spinal surgery, pediatric neurosurgery, peripheral nerve surgery, and functional/epilepsy/pain surgery.

For the vast majority of multiple choice questions (MCQs) in this book, we provide a detailed explanation of the correct answer with references to current evidence-based data where appropriate. Like the real examinations, questions test the reader's knowledge of basic and clinical neurosciences and neurosurgery, and are arranged by topic to be useful to doctors in neurology, neuroradiology, and neuropathology, and medical students. Illustrations include anatomical pictures, graphs, tables, radiology images, and histology slides in questions and answers where required.

We suggest the following approach to using this book and learning by MCQs:

- Firstly, start early! Learning throughout one's training will lead to reinforcement and consolidation of deep knowledge not easily forgotten. Use books like this at the beginning, middle, and end of training, and relate them to your clinical practice.
- Secondly, let this book be a guide to consolidate the information learnt. Annotate material from other resources like comprehensive textbooks. Use the "red," "amber," and "green" gradings to distinguish between lower-yield and more difficult questions and high-yield easy questions. Make connections between different subspecialties and general principles, and focus on material most likely to be tested. Remember that this is neither a comprehensive review book nor a panacea for inadequate preparation in the last few months before the exam.
- Thirdly, prime your memory by returning to challenging and annotated questions in the final days before the exam. This book can serve as a useful way of retaining key associations and refreshing important facts fresh in your memory for the exam. Finally, contribute to the book to enable active learning. Email us if you find errors or see ways in which the book can be updated.

HOW TO TACKLE SINGLE BEST ANSWER (SBA) AND EXTENDED MATCHING ITEM (EMI) QUESTIONS

Test performance is influenced not just by your knowledge but also by your test-taking skills. You can improve your performance by honing your test-taking skills and strategies well in advance of the exam so that you can concentrate on the information and your knowledge during the test itself. The following strategies may be useful.

Try to deal with each question in turn, identifying it as easy, workable or impossible from your own perspective; our green, amber, and red classification provides an approximate examiner's guide to difficulty for someone having completed their neurosurgical training. Aim to answer all the easy questions, resolve the workable ones in reasonable time, and make quick educated guesses at any apparently impossible ones. There are different techniques for question reading that include reading the stem, thinking of the answer, and turning to the choices or skimming the answer choices and the last part of the question before returning to the stem. Try different techniques to see what work best for you and yields the highest marks. Our online testing area should help with that.

Set a good pace for answering the questions. Divide the total time for the exam by the number of questions and be strict with yourself. If you are taking too long then mark the question, pick your best answer, and come back to it later if you have time at the end. Avoid burnout by practicing timed tests to develop endurance. Use extra time to check marked questions. Never give up—take a short one-minute break and come back to the test if too disheartened.

Answer all test questions—even if it means guessing! Whereas in the past many neurosurgical examinations were negatively marked, that process has largely been superseded by only positively marked exams, so there is no harm in an educated or instinctive guess, or even just a blind punt. If you have to guess, go on a hunch and pick an answer you are vaguely familiar with rather than something you have never heard of.

COMPUTER-BASED TESTING

The UK FRCS (Neurological Surgery) examination has been using computer-based testing for several years, the American Board of Neurological Surgery moved to a web-based format for the Primary Examination in 2015, and the EANS Part 1 remains a pencil-and-paper test. The UK exam takes place in dedicated test centers found in most cities in front of desktop computers with headphones, pencil, and paper available, and the software is controlled by a mouse. Residents taking the US examination use certified laptops provided by the residency program. Both have high-quality, distinct images, and sometimes include audio and video material.

Given the artificial environment of computer-based testing, it is important to become familiar with it before the actual exam. Most examination boards offer a downloadable or interactive mock examination with a few sample questions to familiarize yourself with the environment. Skipping the tutorial on the exam day sometimes adds extra time to answer the actual questions in the test itself. Learn how to mark questions, go back to them and if there are any rules preventing going back to previous blocks. Become familiar with how to view images and spot the icons for playing audio and video clips. Be vigilant that some multipart questions prevent changing the answer to the first part of the question once the second part has been revealed.

US, UK, AND EUROPEAN NEUROSURGICAL EXAMINATION STRUCTURE

MCQ tests generally form the first part of most neurosurgical examinations, with the subsequent parts being a combination of oral and clinical examinations. The 2015 ABNS Primary Examination consisted of 350 questions (in 6 h 45 min), while the UK FRCS Written Examination is in two parts, the first consisting of 135 SBA questions (in 2 h) and the second part of 110 EMI questions (in 2.5 h). The European Association of Neurosurgical Societies Part 1 examination consists of approximately 200 MCQs to be answered in 3 h. Questions in all three examinations cover neuroanatomy, neurobiology, neuropathology, neurology, neuroradiology, clinical neurosurgery (including subspecialties), fundamental clinical skills, and other disciplines deemed suitable and important.

The marking of such MCQ examinations is now quite standardized and relies upon principles of statistics and psychology. Many examination boards use the modified Angoff method, whereby experts are briefed then allowed to take part or all of the test with the performance levels in mind. They are then asked to provide estimates for each question of the proportion of minimally acceptable candidates that they would expect to get the question correct. The final determination of the cut score is then made by averaging the estimates. Controversial questions—those that polarized the candidates' answers between two

answers or those that candidates scoring highly overall got wrong whereas those scoring poorly overall got right—are scrutinized and potentially removed from the overall scoring at examiners' standard setting meetings. It is good practice for a trainee representative who has sat the examination to participate in the whole process.

Whereas the written examination explores an applicant's knowledge in various relevant disciplines, the oral examination explores knowledge and judgment in clinical neurosurgical practice after an applicant has been an independent practitioner. The oral examination is accomplished in a series of face-to-face examinations. The applicant is presented with a series of clinical vignettes using real patients, clinical descriptions, radiographs, computerized images, anatomical models, and/or diagrams. The examiners grade the applicant on specific tasks including diagnostic skills, surgical decision-making, and management of complications.

STANDARDS FOR INDEPENDENT NEUROSURGICAL PRACTICE

The credibility of professional examinations taken at the end of surgical training rests on their ability to satisfy patients and colleagues that those passing have attained a minimum standard of basic and applied science knowledge and clinical decision-making to practice independently. Oral examinations are crucial in this process as they assess communication skills, clinical skills, and decision-making and professionalism in a high-pressure environment. In contrast, MCQs focus on assessing knowledge and analytical and decision-making skills. More clinically integrative questions test higher orders of Bloom's taxonomy and are more effective than simple factual questions in assessing and developing the clinical problem-solving skills of trainee surgeons.

Patients fundamentally wish for their treating surgeon to be as independent as possible in order to maximize their chances for an excellent outcome. Therefore, when setting minimum standards for independent practice, an expert peer group of examiners is accountable to patients, other neurosurgeons and healthcare professionals, and the general public. Postgraduate medical examinations have therefore generally evolved to become as standardized and fair as possible, while maintaining rigor, expanding, and adapting as trends change in clinical practice.

This page intentionally left blank

PART I
BASIC SCIENCE

CHAPTER 1

NEUROANATOMY

SINGLE BEST ANSWER (SBA) QUESTIONS

1. From inferior to superior (i.e. ascending), what is the 4th branch of the external carotid artery in the neck?
   a. Maxillary artery
   b. Occipital artery
   c. Facial artery
   d. Lingual artery
   e. Posterior auricular artery

2. The pathway best describing how sympathetic fibers of the autonomic nervous system exit the spinal cord is:
   a. Via the dorsal roots and white rami communicans
   b. Via the ventral roots and white rami communicans
   c. Via the dorsal roots and gray rami communicans
   d. Via the ventral roots and gray rami communicans
   e. Via the ventral roots and spinal nerves

3. The left vertebral artery usually arises from the:
   a. Arch of the aorta
   b. Brachiocephalic trunk
   c. Left common carotid
   d. Left subclavian artery
   e. Costocervical trunk

4. Hemiballismus results from lesioning which basal ganglia target?
   a. Globus pallidus interna
   b. Subthalamic nucleus
   c. Substantia nigra pars reticularis
   d. Striatum
   e. Pedunculopontine nucleus

5. Lesion of which structure increases extensor tone?
   a. Dentate nucleus
   b. Pedunculopontine nucleus
   c. Red nucleus
   d. Ventral tegmentum
   e. Superior olive

6. Which one of the following drain into the cavernous sinus?
   a. Superior ophthalmic vein
   b. Superior petrosal sinus
   c. Inferior petrosal sinus
   d. Basal vein of Rosenthal
   e. Vein of Labbé

7. Persistent trigeminal artery is commonly:
   a. Found in 3-5% of people
   b. Found to connect to the proximal basilar artery
   c. Found to branch off from the ICA just proximal to the meningohypophyseal trunk
   d. Found to have a vascular abnormality in approximately 50% of cases
   e. Found in conjunction with internal carotid artery aplasia

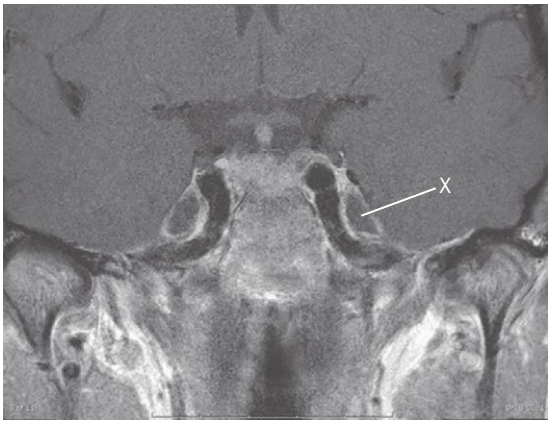
8. The afferent loop of the Hering-Breuer inflation and deflation reflexes is mediated by:
   a. CN XIII
   b. CN IX
   c. CN X
   d. CN XI
   e. C2

9. Which one of the following nerves is outside the annulus of Zinn?
   a. Abducens
   b. Nasociliary
   c. Trochlear
   d. Oculomotor (superior division)
   e. Oculomotor (inferior division)

10. The C2 vertebra has how many secondary ossification centers?
   a. 2
   b. 3
   c. 4
   d. 5
   e. 6

11. A line drawn between the highest point of the iliac crests across the back usually denotes:
   a. L1/2 interspace
   b. L2/3 interspace
   c. L3/4 interspace
   d. L4/5 interspace
   e. L5/S1 interspace

12. Which one of the following is labeled X in the image below?



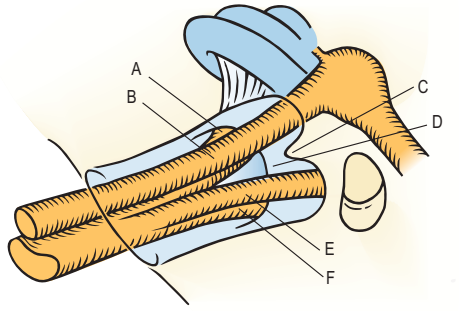
   a. Ophthalmic division of the trigeminal nerve
   b. Meckel's cave
   c. Oculomotor nerve
   d. Maxillary division of trigeminal nerve
   e. Abducens nerve

13. Which one of the following statements about the sympathetic nervous system is FALSE?
   a. Innervation of thoracic viscera arises from T1-T4 spinal segments
   b. Splanchnic nerves are unmyelinated
   c. Preganglionic fibers enter the sympathetic chain via white rami communicans
   d. Sensory afferent fibers are important for visceral pain sensation
   e. Preganglionic fibers synapse in either the sympathetic chain or prevertebral ganglia

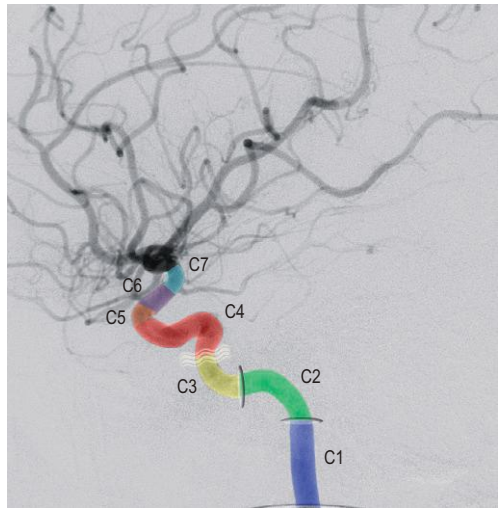
14. Nervi erigentes are responsible for:
   a. Inhibition of the external anal sphincter
   b. Inhibition of the internal vesicle sphincter
   c. Inhibition of the internal anal sphincter
   d. Inhibition of the external vesicle sphincter
   e. Inhibition of the rectal muscles

15. Parasympathetic sensory afferents terminate in which one of the following?
   a. Nucleus ambiguus
   b. Solitary nucleus
   c. Edinger-Westphal nucleus
   d. Red nucleus
   e. Superior colliculus

16. Which one of the labels in the diagram below of the internal auditory canal identifies the facial nerve?



17. Blood supply to the posterior pituitary gland arises from branches of which internal carotid artery segment?



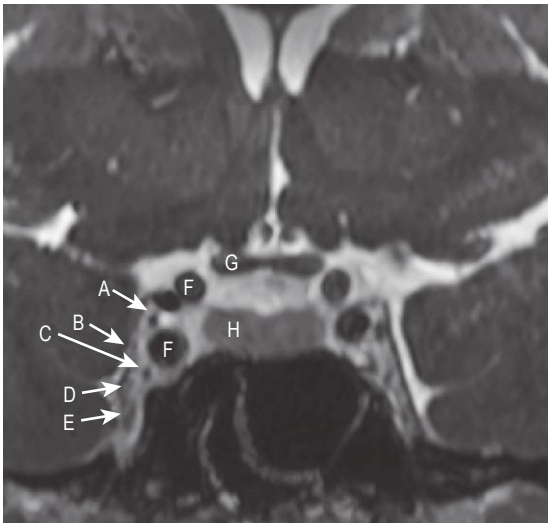
a. C1 (Cervical)
b. C2 (Petrous)
c. C3 (Lacerum)
d. C4 (Cavernous)
e. C5 (Clinoid)
f. C6 (ophthalmic/supraclinoid)
g. C7 (communicating)

QUESTIONS 18–25

Additional questions 18–25 available on ExpertConsult.com

EXTENDED MATCHING ITEM (EMI) QUESTIONS

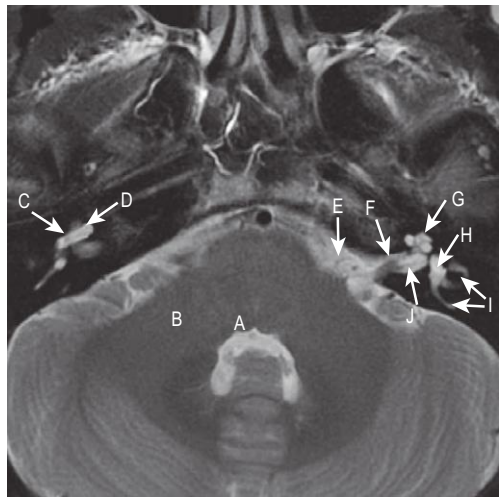
26. **Cavernous sinus imaging:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Right optic nerve
2. Oculomotor nerve
3. Abducens nerve

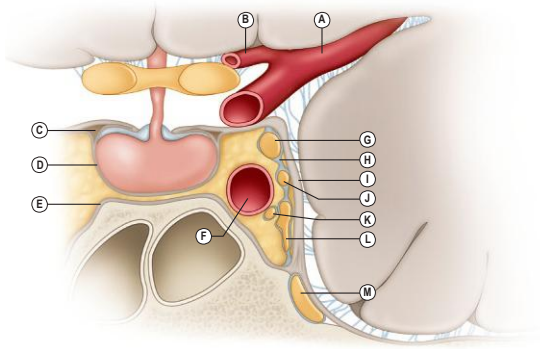
27. **Internal auditory canal:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. AICA
2. Basal turn of cochlea
3. Cochlear nerve

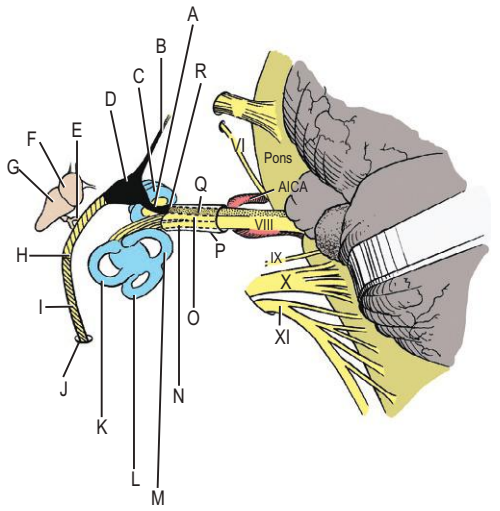
28. **Cavernous sinus anatomy:**



For each of the following descriptions, select the most appropriate answers from the diagram above. Each answer may be used once, more than once or not at all.

1. ACA
2. Maxillary division of CN V (V2)
3. Oculomotor nerve (III)

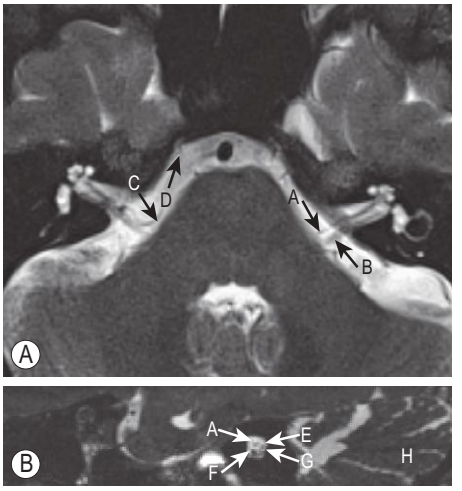
29. **Internal auditory canal:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

- 1. Facial nerve
- 2. Superior vestibular nerve
- 3. Greater superficial petrosal nerve
- 4. Posterior semicircular canal

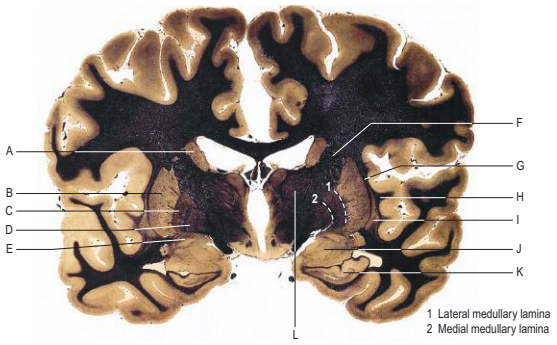
30. **Internal auditory canal:**



For each of the following descriptions, select the most appropriate answers from the images above. Each answer may be used once, more than once or not at all.

- 1. Anterior inferior cerebellar artery
- 2. Vestibulocochlear nerve
- 3. Facial nerve

31. **Basal Ganglia:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

- 1. Caudate nucleus
- 2. Claustrum
- 3. Globus pallidus interna
- 4. Internal capsule
- 5. Putamen

32. **Projection and association tracts:**

a. Central tegmental tract
b. Lamina terminalis
c. Median forebrain bundle
d. Stria medullaris
e. Stria terminalis
f. Postcommissural Fornix
g. Nucleus of the diagonal band of Broca (vertical limb)
h. Retinohypothalamic tract
i. Supraopticohypophyseal tract
j. Tuberoinfundibular (tuberohypophyseal) tract
k. Trapezoid body
l. Thalamic fasciculus (Forel's field H1)
m. Nucleus of the Diagonal band of Broca (horizontal limb)
n. Mammillothalamic tract
o. Tapetum

For each of the following descriptions, select the most appropriate tracts from the list above. Each answer may be used once, more than once or not at all.

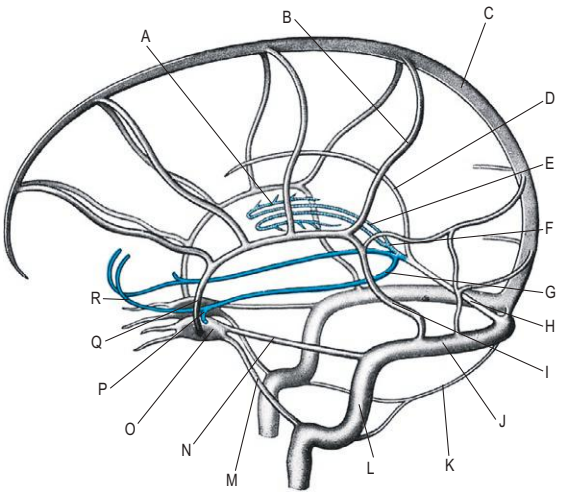
- 1. Conducts fibers to the posterior pituitary gland
- 2. Arcuate nucleus to hypophyseal portal system of infundibulum
- 3. Septal nuclei to hippocampus
- 4. Connects sepal area, hypothalamus, basal olfactory areas, hippocampus/subiculum to midbrain, pons and medulla
- 5. Hippocampus to cingulate gyrus

33. **Vascular territories:**
    a. Middle cerebral artery
    b. Basilar artery
    c. Perforators from internal carotid artery
    d. Ophthalmic artery
    e. P2 portion of posterior cerebral artery
    f. Vertebral artery
    g. Superior cerebellar artery
    h. Posterior inferior cerebellar artery
    i. Anterior inferior cerebellar artery
    j. Posterior communicating artery
    k. A2 portion of anterior cerebral artery
    l. P3 portion of posterior cerebral artery
    m. Recurrent artery of Heubner

For each of the following descriptions, select the most appropriate answers from the list above. Each answer may be used once, more than once or not at all.

1. Posterior limb of the internal capsule
2. Medial and lateral geniculate nuclei
3. Anterior limb of internal capsule and head of caudate
4. Posterior pituitary gland
5. Splenium of corpus callosum

34. **Cerebral veins:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Inferior anastamotic vein of Labbé
2. Superficial middle cerebral vein of Silvius
3. Superior anastamotic vein of Trolard
4. Basal vein of Rosenthal
5. Vein of Galen

35. **Offending Artery:**
    a. A1 portion of anterior cerebral artery
    b. Anterior choroid artery
    c. Anterior communicating artery
    d. Anterior inferior cerebellar artery
    e. Basilar arteries
    f. Facial artery
    g. Internal carotid artery
    h. M3 portion of middle cerebral artery
    i. Ophthalmic artery
    j. Posterior cerebral artery
    k. Posterior communicating artery
    l. Posterior inferior cerebellar artery
    m. Superior cerebellar artery
    n. Vertebral artery

For each of the following descriptions, select the most appropriate answers from the list above. Each answer may be used once, more than once or not at all.

1. Glossopharyngeal neuralgia
2. Trigeminal neuralgia
3. Hemifacial spasm
4. Horner's syndrome
5. CN III palsy

36. **Autonomic nervous system:**
    a. Erdinger-Westphal nucleus
    b. Superior salivatory nucleus
    c. Inferior salivatory nucleus
    d. Dorsal nucleus
    e. Ciliary ganglion
    f. Pterygopalatine ganglion
    g. Otic ganglion
    h. Submandibular ganglion
    i. CNII
    j. CNV
    k. Chorda tympani
    l. Vidian nerve
    m. Superior cervical ganglion
    n. Greater petrosal nerve
    o. Lesser superficial petrosal nerve
    p. Auriculotemporal nerve

For each of the following descriptions, select the most appropriate answers from the list above. Each answer may be used once, more than once or not at all.

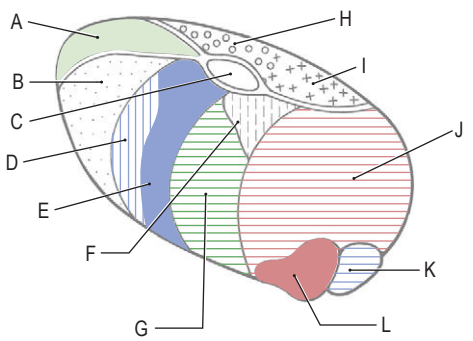
1. Mediates bronchoconstriction
2. Receives preganglionic parasympathetic fibers via CNIII
3. Postganglionic parasympathetic fibers to parotid gland
4. Preganglionic parasympathetic fibers to the submandibular ganglion
5. Origin of preganglionic parasympathetic fibers transmitted in GSPN IX

37. **Projection and association tracts:**
   a. Ansa lenticularis
   b. Fasciculus retroflexus
   c. Lenticular fasciculus (Forel's field H2)
   d. Postcommissural fornix
   e. Precommissural fornix
   f. Thalamic fasciculus (Forel's field H1)
   g. Nucleus of the diagonal band of Broca
   h. Mammillothalamic tract
   i. Tapetum
   j. Uncinate fasciculus
   k. Commissure of Probst
   l. Central tegmental tract
   m. Lamina terminalis
   n. Median forebrain bundle
   o. Stria medullaris

For each of the following descriptions, select the most appropriate option from the list above. Each answer may be used once, more than once or not at all.

1. Globus pallidus interna to thalamus through internal capsule
2. Globus pallidus interna to thalamus around internal capsule
3. Septal nuclei to amygdala
4. Temporal lobe to occipital lobe
5. Connection between nuclei of lateral lemniscus

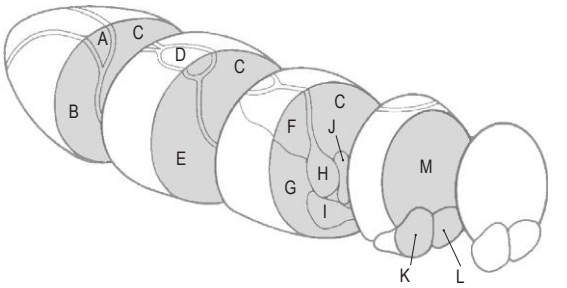
38. **Thalamus:**



For each of the following descriptions, select the most appropriate part of the thalamus from the image above. Each answer may be used once, more than once or not at all.

1. Pulvinar
2. Ventral anterior nucleus
3. Ventral posterolateral nucleus
4. Lateral geniculate nucleus
5. Medial geniculate nucleus

39. **Thalamus:**



For each of the following descriptions, select the most appropriate part of the thalamus from the image above. Each answer may be used once, more than once or not at all.

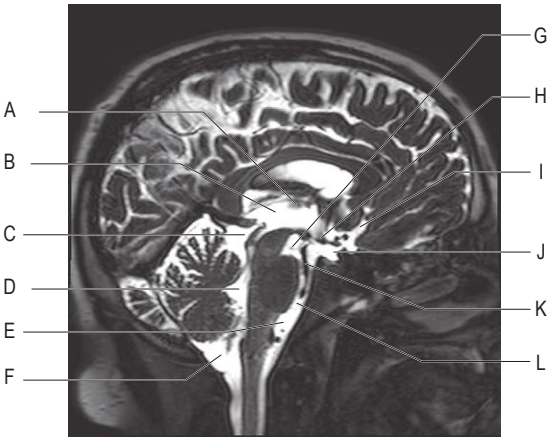
1. Receives major input from inferior colliculi
2. Major projection to the primary visual cortex
3. Receives major projections from mammillary body
4. Auditory relay nucleus
5. Contains the area of face representation

40. **Projection and association tracts:**
   a. Inferior collicular commissure
   b. Cingulate fasciculus
   c. Arcuate fasciculus
   d. Corpus callosum
   e. Posterior commissure
   f. Hypothalamospinal tract
   g. Brachium conjunctivum
   h. Brachium pontis
   i. Restiform and juxtarestiform bodies
   j. Dorsal longitudinal fasciculus
   k. Medial longitudinal fasciculus
   l. Uncinate fasciculus
   m. Lamina terminalis
   n. Commissure of Probst
   o. Stria medullaris

For each of the following descriptions, select the most appropriate X from the list above. Each answer may be used once, more than once or not at all.

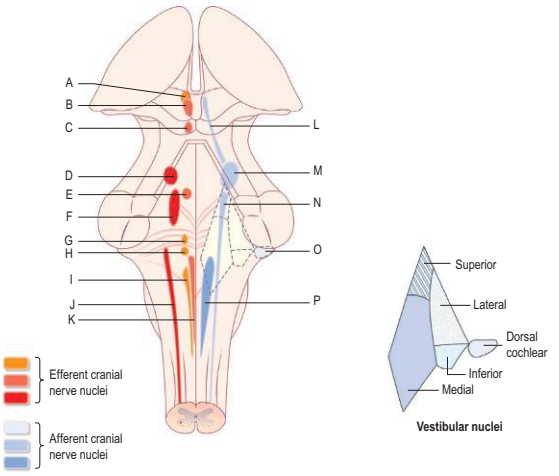
1. Periventricular hypothalamus and mammillary bodies to midbrain central gray matter
2. Covered with indusium griseum
3. Contains crossing fibers of pretectal nucleus for light reflex
4. Connects Wernicke and Broca's areas
5. Interruption can result in Horner's syndrome

41. For each of the following descriptions, select the most appropriate answers from the image below. Each answer may be used once, more than once or not at all.



1. Cisterna magna
2. Interpeduncular cistern
3. Chiasmatic cistern

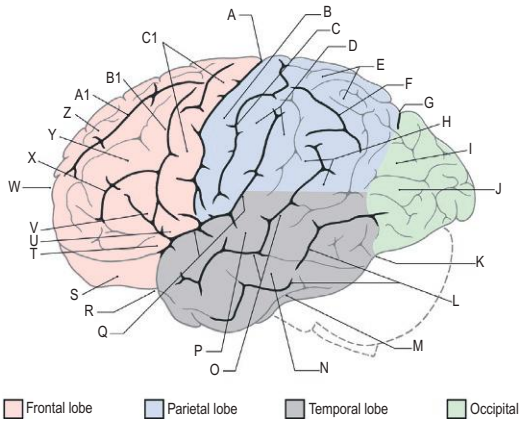
42. **Cranial Nerve Nuclei:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Abducens nerve nucleus
2. Principal sensory nucleus of trigeminal nerve
3. Solitary tract nucleus
4. Facial nerve motor nucleus
5. Nucleus ambiguus

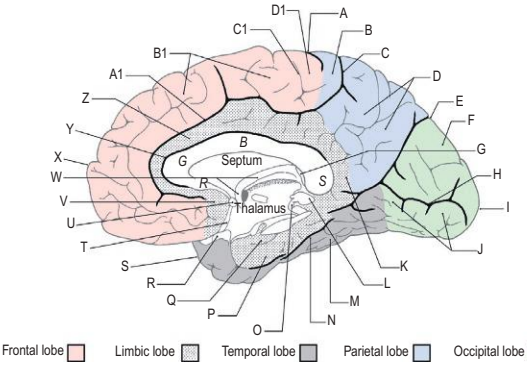
43. **Sulci and gyri:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Angular gyrus
2. Supramarginal gyrus
3. Pars opercularis of inferior frontal grus
4. Middle frontal gyrus
5. Parieto-occipital sulcus

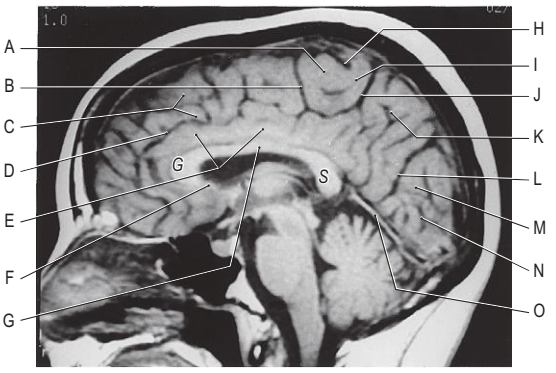
44. **Sulci and gyri:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Marginal sulcus
2. Calcarine sulcus
3. Cuneus
4. Collateral sulcus
5. Lamina terminalis

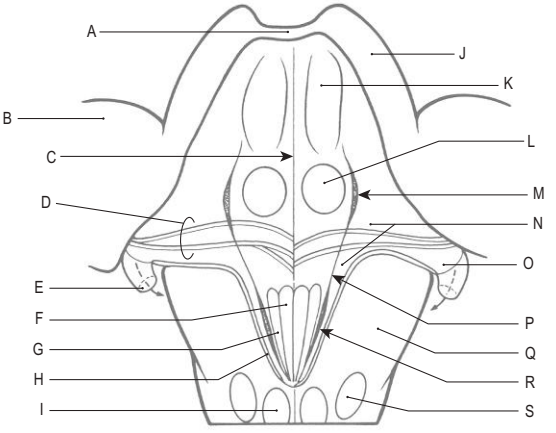
45. Sulci and gyri:



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Central sulcus
2. Paracentral sulcus
3. Calcarine sulcus
4. Marginal sulcus
5. Precuneus

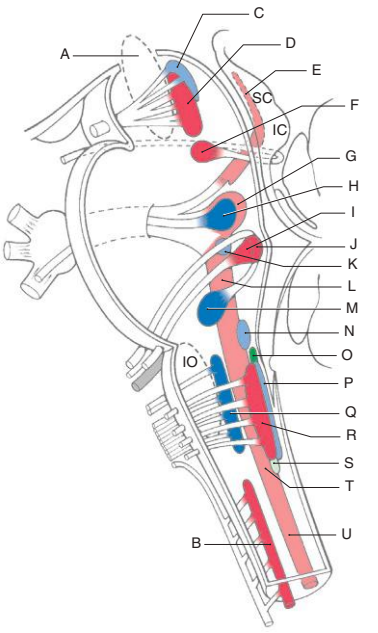
46. Fourth ventricular floor:



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Facial colliculus
2. Striae medullaris
3. Sulcus limitans
4. Median sulcus
5. Vagal trigone

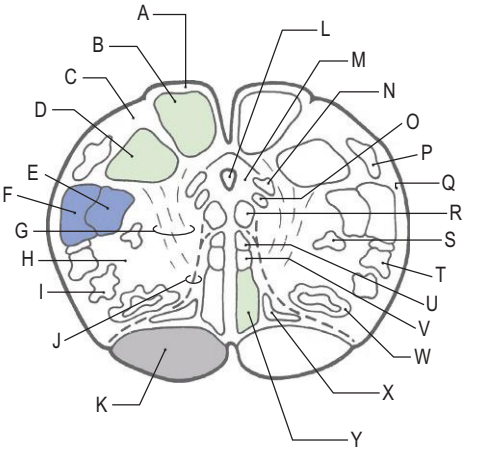
47. Cranial Nerve Nuclei:



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Red nucleus
2. Erdinger-Westphal nucleus
3. Oculomotor nucleus
4. Trochlear nucleus
5. Abducens nucleus
6. Facial nucleus
7. Nucleus ambiguus of vagus nerve

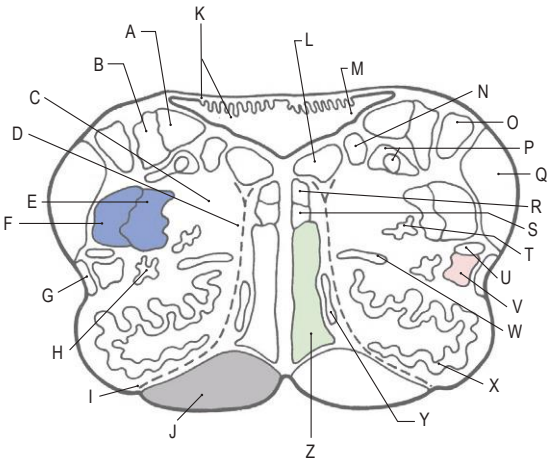
48. Medulla at sensory decussation:



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Nucleus gracilis
2. Nucleus cuneatus
3. Spinothalamic tract
4. Posterior spinocerebellar fibers

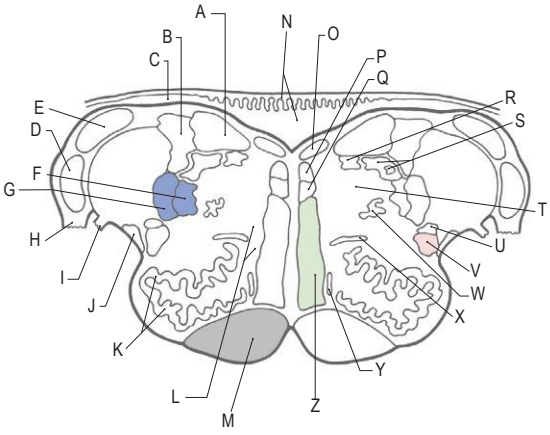
● 49. **Medulla and vagal nuclei:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Solitary nucleus and tract
2. Dorsal motor vagal nucleus
3. Reticular formation
4. Principal olivary nucleus (inferior olivary nucleus)
5. Medial lemniscus

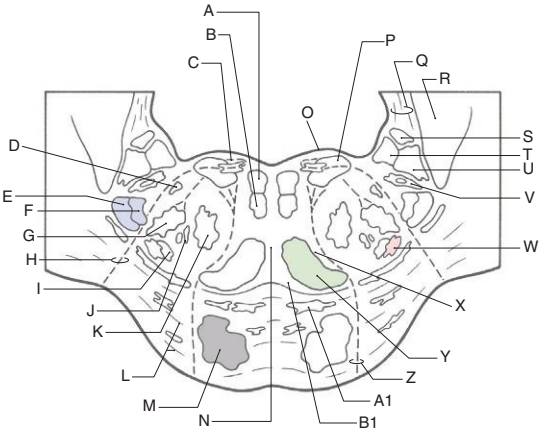
● 50. **Rostral medulla:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Posterior cochlear nucleus
2. Vestibulocochlear nerve
3. Spinal trigeminal nucleus
4. Medial longitudinal fasciculus
5. Nucleus ambiguus

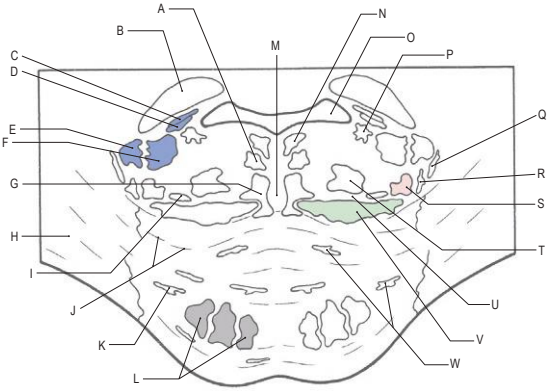
● 51. **Caudal pons:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Facial nucleus
2. Facial nerve
3. Superior olivary nucleus
4. Abducens nucleus
5. Abducens nerve

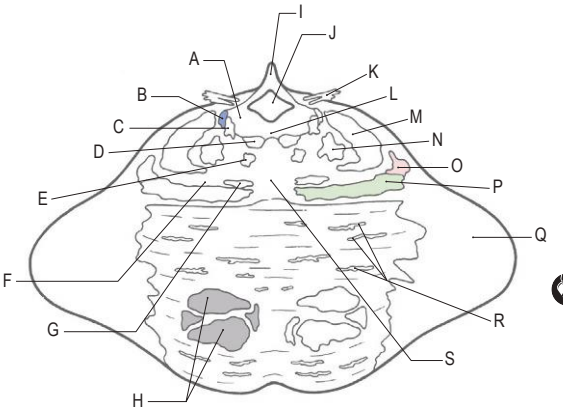
● 52. **Mid-pons:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Locus ceruleus
2. Corticospinal fibers
3. Principal trigeminal sensory nucleus
4. Fourth ventricle
5. Brachium pontis

53. **Rostral pons:**



For each of the following descriptions, select the most appropriate answers from the image above. Each answer may be used once, more than once or not at all.

1. Medial lemniscus
2. Medial longitudinal fasciculus
3. Trochlear nerve
4. Central tegmental tract
5. Tectobulbospinal tract

QUESTIONS 54–58

Additional questions 54–58 available on ExpertConsult.com

SBA ANSWERS

1. **c**—Facial artery

The external carotid artery has several branches in the neck (SALFOPSI in ascending order): superior thyroid, ascending pharyngeal, lingual, facial (aka external maxillary), occipital, posterior auricular, superficial temporal, maxillary (aka internal maxillary). It can be distinguished on angiogram (figure) from the ICA, which has no branches in the neck. During EC/IC bypass procedures for Moya Moya disease, anastomosis of the superficial temporal artery to the middle cerebral artery (or less commonly occipital artery to the posterior cerebral artery/posterior inferior cerebellar artery) may be performed.

2. **b**—Via the ventral roots and white rami communicans

3. **d**—Left subclavian artery

Each vertebral artery arises from its ipsilateral subclavian artery. The aortic arch gives off three branches in order: brachiocephalic trunk (or innominate artery), left common carotid and left subclavian arteries (A). The second commonest branching pattern (termed a "bovine arch") is where the left common carotid arises from the brachiocephalic trunk (B).

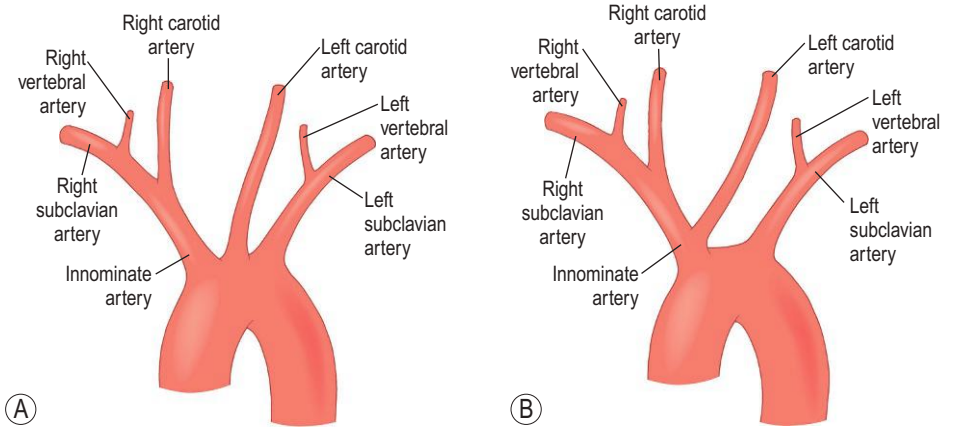


Image redrawn from Layton KF, Kallmes DF, Cloft HJ, Lindell EP, Cox VS. Bovine aortic arch variant in humans: Clarification of a common misnomer. AJNR Am J Neuroradiol 2006;27:1541-1542. In: Low M, Som PM, Naidich TP. Problem solving in neuroradiology. Elsevier.