EANS/UEMS European examination in neurosurgery

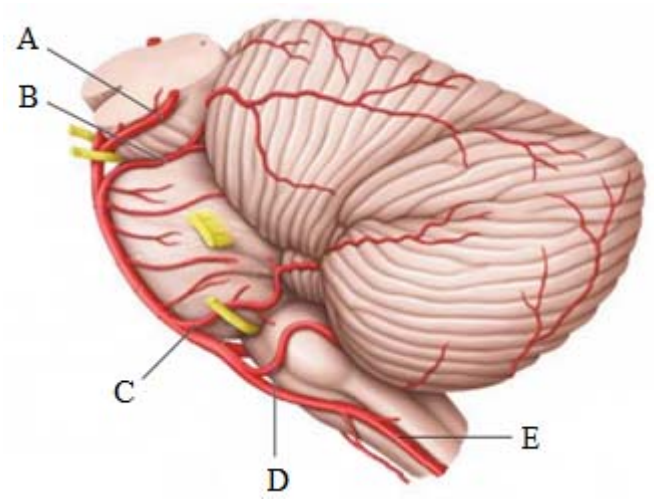
Part I (written)

Variants of questions with answers (compilation - Vyacheslav S. Botev, Department of Neurosurgery, M.Gorky Donetsk National Medical University)

Neuroanatomy

Q 1 – 7

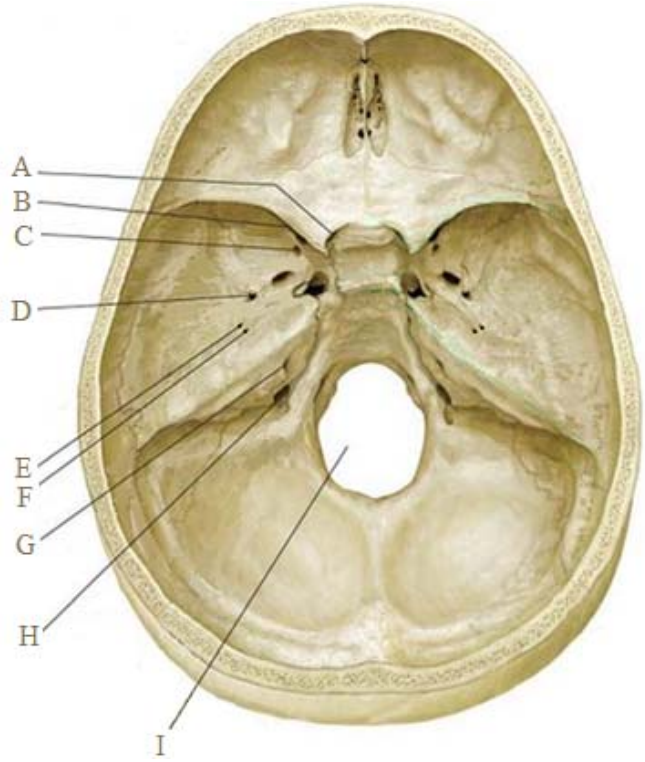
Directions: For each numbered item, select one letter heading from figure below with which it is most closely associated. Each lettered heading may be used once, more than once, or not at all.



1. Occlusion of this vessel is the most common cause of lateral medullary (Wallenberg) syndrome.
2. Supplies the pyramis, tuber, flocculus, and caudal parts of pontine tegmentum.
3. Occlusion can produce contralateral hearing impairment.
4. Vessel commonly associated with trigeminal neuralgia.
5. Vessel at most risk of injury during Chiari decompression.
6. The dentate nucleus is mainly supplied by this vessel.
7. Supplies the middle cerebellar peduncle.

Q 8 – 17

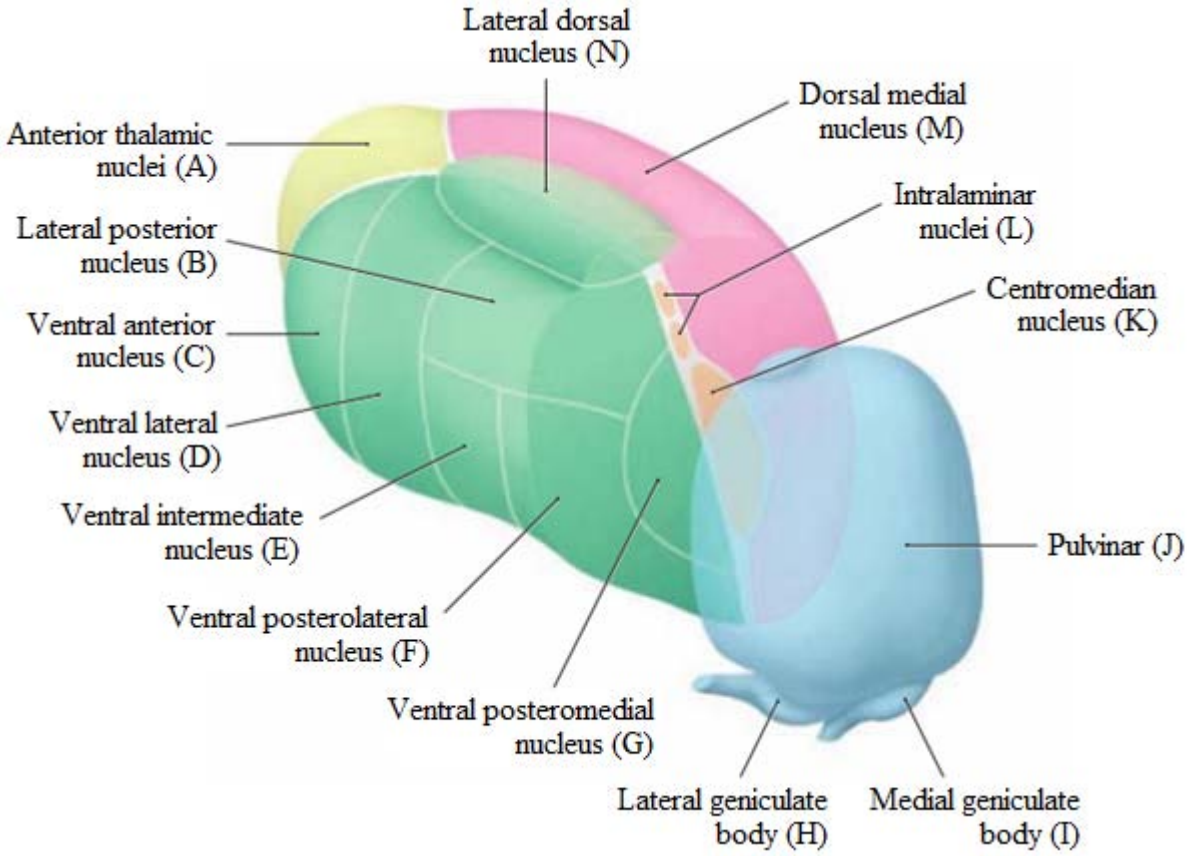
Directions: Match the appropriate cranial nerve (numbered items) with the foramina of the skull base (lettered headings in figure below) it traverses using each answer once, more than once, or not at all.



8. Injury of the cranial nerve piercing this foramen results in diplopia and weak gaze when looking down and out.
9. Nerve than traverses this foramen later joints with the deep petrosal nerve to become the nerve to the pterygoid canal.
10. Injury to a small branch of the nerve passing through this canal results in hyperacusis.
11. The nerve passing through this foramen innervates the tensor veli palatine muscle.
12. The cranial nerve passing through this foramen innervated by the superior salivatory nucleus to produce salivation.
13. The nerve passing through this foramen gives rise to general visceral efferent (GVE) fibers that supply the parotid gland.
14. The cell bodies of these afferent fibers are located in the nodosal ganglion and enter the skull through this foramen.
15. The lesser petrosal nerve traverses this foramen.
16. This foramen is traversed by a nerve that gives off the chorda tympani fibers.
17. Transmits the ophthalmic vein.

Q 18 – 25

Directions: Match the thalamic nucleus (lettered headings in figure below) with the fibers (numbered items) it receives. Each answer may be used once, more than once, or not at all.



18. Area 5
19. Superior colliculus
20. Medial lemniscus
21. Mammilllothalamic tract; fornix
22. Inferior colliculus; lateral lemniscus
23. Optic tract
24. Trigeminothalamic tract
25. Cerebellar nuclei

Thalamus

1. Which structure lies lateral to the thalamus and medial to the thalamus?

2. What is the anatomy of the thalamus?

3. Which of the following Brodmann areas represents the primary somatosensory cortex?

A. Areas 3, 1, 2
B. Area 4
C. Area 17
D. Area 22
E. Area 40

4. Which of the following Brodmann areas represents the primary somatomotor cortex?

A. Areas 3,1,2
B. Area 4
C. Area 5
D. Area 6
E. Area 7

5. A 29-year-old man is brought to the emergency department with a severe and persistent headache. MRI shows a large tumor of the pineal gland. Based on its location, this pineal lesion would most likely impinge on which of the following structures?

A. Anterior thalamic nucleus
B. Body of the caudate nucleus
C. Globus pallidus
D. Pulvinar nucleus(i)
E. Ventral posteromedial nucleus

6. An 85-year-old woman is brought to the emergency department by her family because she suddenly became confused and lethargic. CT shows a hemorrhage into the medial and lateral geniculate bodies. Which of the following structures would also likely be involved in this lesion due to its apposition to the geniculate bodies?

A. Anterior thalamic nucleus
B. Rostral dorsomedial nucleus
C. Globus pallidus
D. Pulvinar nucleus(i)
E. Subthalamic nucleus

7. A 29-year-old woman presents with neurologic deficits that wax and wane over time suggestive of multiple sclerosis. MRI (especially T2- weighted) shows small, demyelinated areas at several locations in her brain, one of these being the mammillothalamic tract. Which of the following structures is most intimately associated with this tract?

A. Anterior thalamic nucleus
B. Centromedian nucleus
C. Dorsomedial nucleus
D. Ventral anterior thalamic nucleus
E. Ventral lateral thalamic nucleus

8. Which of the following structures is a primary target of the optic tract as it passes caudally from the optic chiasm?

A. Lateral geniculate nucleus
B. Mammillary body
C. Medial geniculate nucleus
D. Pulvinar
E. Ventral posterolateral nucleus

9. An 81-year-old man is brought to the emergency department following a fall while walking in the park. The examination reveals mild confusion and memory loss, but no obvious motor or sensory deficits. MRI shows an old infarct in the territory of the thalamus served by the thalamoperforating artery. Which of the following nuclei is most likely involved in this lesion?

A. Centromedian
B. Medial geniculate
C. Ventral anterior
D. Ventral posterolateral
E. Ventral posteromedial

10. Sensation from the face is received by which thalamic nucleus?

11. Which of the following thalamic nuclei is located within the internal medullary lamina and, therefore, is commonly referred to as one of the intralaminar nuclei?
A. Anterior
B. Dorsomedial
C. Centromedian
D. Lateral dorsal
E. Thalamic reticular

12. The MRI of a 53-year-old man reveals a lacunar infarct in the area of the thalamus that selectively projects to the cortical region indicated by the arrows in the image below. Which of the following thalamic nuclei represents the most likely location of this man's lesion?

A. Anterior
B. Centromedian
C. Dorsomedial
D. Ventral posteromedial
E. Ventral lateral

13. A 34-year-old man presents with confusion and persistent headache. MRI reveals an enlarged lateral ventricle on the left side, presumably resulting from a dime-sized tumor located in the left interventricular foramen. Based on the location of this tumor, which of the following diencephalic structures is most directly impinged upon?
A. Anterior nucleus
B. Centromedian nucleus
C. Dorsomedial nucleus
D. Ventral anterior nucleus
E. Ventral lateral nucleus

14. A 58-year-old man presents with the complaint of difficulty seeing. The history reveals that the man has hypertension and that he is largely noncompliant regarding his medications. The examination reveals that he has a right homonymous hemianopia, and an MRI shows a lesion of the primary visual cortex. Which of the following relays vital input to this damaged area of cortex?

A. Lateral dorsal nucleus
B. Lateral geniculate nucleus
C. Medial geniculate nucleus
D. Pulvinar nucleus
E. Ventral lateral nucleus

15. Which of the following thalamic nuclei receives important projections from the internal segment of the globus pallidus and from the contralateral cerebellar nuclei?

A. Anterior nucleus
B. Lateral dorsal nucleus
C. Ventral lateral nucleus
D. Ventral posterolateral nucleus

Answers

1. D – Posterior inferior cerebellar artery.

Occlusion of PICA (D) or the vertebral artery (E) may produce the lateral medullary (Wallenberg) syndrome, which is characterized by ipsilateral facial numbness; contralateral trunk numbness; ipsilateral palatal, pharyngeal, and vocal cord paralysis (nucleus ambiguous); ipsilateral Horner's syndrome; vertigo; nausea; vomiting; ipsilateral cerebellar signs; and occasionally hiccups. The most common cause of Wallenberg syndrome is VA occlusion; however, it has classically been described in the literature after PICA occlusion. The PICA vessels are at risk for injury during a Chiari decompression, as they loop around the tonsils.

2. C. Anterior inferior cerebellar artery.

The characteristic picture of anterior inferior cerebellar artery (AICA) occlusion includes vertigo, nystagmus, nausea and vomiting (vestibular nuclei involvement), ipsilateral facial numbness (trigeminal spinal nucleus and tract), ipsilateral Horner's syndrome (descending sympathetic fibers), contralateral limb numbness (lateral spinothalamic tract), ipsilateral ataxia (middle cerebellar peduncle), and ipsilateral deafness and facial paralysis (lateral pontomedullary tegmentum). It supplies the middle and inferior lateral pontine regions and the anterolateral parts of the cerebellum, which includes the middle cerebellar peduncle, flocculus, pyramis, and tuber. It is the most common vessel compressing the seventh cranial nerve during hemifacial spasm, which occasionally requires surgical decompression.

3. B. Superior cerebellar artery (SCA).

Occlusion of the SCA is the least common cause of cerebellar infarction, which is characterized by nausea, vomiting, vertigo, nystagmus, ipsilateral Horner's syndrome, ataxia, ipsilateral intention tremor (superior cerebellar peduncle), contralateral limb numbness, contralateral hearing loss (crossed fibers of the lateral lemniscus), and possibly a fourth nerve palsy (pontine tectum).The SCA is the most common nerve compressing the trigeminal nerve in trigeminal neuralgia.

4. B. Superior cerebellar artery (SCA).
5. D. Posterior inferior cerebellar artery (PICA).
6. B. Superior cerebellar artery (SCA).
7. C. Anterior inferior cerebellar artery (AICA).

Comment
A. Posterior cerebral arteries.

The posterior cerebral arteries are joined by the posterior communicating arteries (PcomA) about 1 cm from the origin. The PcomA is the major origin of the PCA 15 to 20% of the time and is termed "fetal" PCA. The PCA comprises the P1 (peduncular), P2 (ambient), P3 (quadrigeminal), and P4 (distal or cortical) segments and their respective branches. Major branches of the PCA include the medial and lateral posterior choroidal arteries; anterior, middle, and posterior temporal arteries; parieto-occipital artery; calcarine artery; as well as the smaller thalamoperforating and thalamogeniculate arteries. The origin of the PcomA is the first or second most common location for aneurysm formation, along with the anterior communicating artery.

8. B. Superior orbital fissure.
The oculomotor nerve (CN III) exit the skull base through superior orbital fissure. Lesions of CN III will produce lateral strabismus ("wall eyes") with nearly complete ophthalmoplegia of the eye as well as ptosis.

9. F. Hiatus canalis n.petrosi majoris.
10. G. Internal auditory canal.
11. D. Foramen spinosum.
12. G. Internal auditory canal, n. facialis.
13. H. Jugular foramen. N. glossopharyngeus.

The term general efferent fibers (GVE or visceral efferent or autonomic efferent) refers to the efferent neurons of the autonomic nervous system that provide motor innervation to smooth muscle, cardiac muscle, and glands (contrast with SVE fibers). GVE fibers may be either sympathetic or parasympathetic.The cranial nerves containing GVE fibers include the oculomotor nerve (CN III), the facial nerve (CN VII), the glossopharyngeal nerve (CN IX) and the vagus nerve (CN X).

14. H. Jugular foramen.
15. E. Hiatus canalis n.petrosi minoris.
16. G. Internal auditory canal, n. facialis.
17. A. Fissura orbitalis superior.

18. B. Area 5 - Lateral posterior nucleus
19. J. Superior colliculus - Pulvinar
20. F. Medial lemniscus – Ventral posterolateral nucleus
21. A. Mammilllothalamic tract; fornix – Anterior nuclear group
22. I. Inferior colliculus; lateral lemniscus - Medial geniculate body
23. H. Optic tract - Lateral geniculate body
24. G. Trigeminothalamic tract – Ventral posteromedial nucleus
25. E. Cerebellar nuclei - Ventral intermediate nucleus

Thalamic afferent and efferent connections

Thalamic nucleus	Afferent fibers	Efferent fibers
Anterior nuclear group	Mamillothalamic tract, fornix	Cingulate gyrus
LD, Lateral dorsal nucleus	Unclear	Cingulate gyrus
LP, Lateral posterior nucleus	Area 5	Areas 5 and 7
Pulvinar	Superior colliculus	Areas 18 and 19; parietal and temporal neocortex
MGB, Medial geniculate body	Inferior colliculus; lateral lemniscus	Areas 41 and 42
LGB, Lateral geniculate body	Optic tract	Area 17
VPM, Ventral posteromedial nucleus	Trigeminothalamic tracts; gustatory projections	Areas 3, 1 and 2
VPL, Ventral posterolateral nucleus	Medial lemniscus; spinothalamic tracts	Areas 3, 1 and 2
VL, Ventral lateral nucleus	Cerebellar nuclei; globus pallidus	Area 4; premotor cortex
VA, Ventral anterior nucleus	Substantia nigra; globus pallidus	Area 6; diffuse frontal
VI, Ventral intermediate nucleus	Cerebellar nuclei	Area 4; motor cortex

Thalamus

1. The posterior limb of the internal capsule is the lateral border of the thalamus. The third ventricle lies medial to the thalamus.

2. The intermedullary lamina divides the thalamus into anterior, medial, and lateral groups. The lateral group is further divided into ventral and dorsal tiers. Each group contains specific nuclei:

- Anterior group: Anterior nucleus
- Medial group: Dorsomedial (DM) nucleus
- Lateral group:
    - Dorsal tier
        - Lateral dorsal (LD) nucleus
        - Lateral posterior (LP) nucleus
        - Pulvinar
    - Ventral tier
        - Ventral anterior (VA) nucleus
        - VL nucleus
        - VPL nucleus
        - VPM nucleus
        - Lateral geniculate (LG)
        - Medial geniculate (MG)

Other nuclei that are often considered part of the thalamus include
(1) reticular nucleus - a small group of neurons that projects to other thalamic nuclei and may help regulate cortical activity;
(2)midline nuclei - diffuse neurons connected to the hypothalamus; and
(3) centromedian (CM) - an intralaminar nucleus that is part of the reticular formation which activates the cortex.

3. A. Areas 3, 1, 2 collectively represent the primary somatosensory cortex. Area 4 is the primary somatomotor cortex, area 17 the primary visual cortex, and area 22 the primary auditory cortex. Area 40 is in the supramarginal gyrus, a large part of which is called the Wernicke area.

4. B. The primary somatomotor cortex consists of the precentral gyrus and the anterior paracentral gyrus; area 4 is found in these structures. Areas 3, 1, and 2 are the primary somatosensory cortex; areas 5 and 7 make up the superior parietal lobule and the precuneus; and area 6 is located rostral to area 4. Portions of area 6 in the caudal region of the middle frontal gyrus are the frontal eye field.

5. D. The pineal gland is located in the quadrigeminal cistern, superior to the colliculi, and between the pulvinar nuclei of the thalamus. At this location, the lesion would potentially involve the colliculi and pulvinar. The other thalamic nuclei are not adjacent to the pineal, the globus pallidus is lateral to the posterior limb of the internal capsule, and the body of the caudate is located in the lateral wall of the body of the lateral ventricle.

6. D. The geniculate bodies are tucked-up under the caudal and inferior aspect of the pulvinar. The groove between the medial geniculate body and the pulvinar contains the brachium of the superior colliculus. The geniculate bodies and the pulvinar have a common blood supply from the thalamogeniculate artery, a branch of P2. None of the other choices have a close apposition with the geniculate bodies. The anterior thalamic, rostral dorsomedial, and subthalamic nuclei do not share a common blood supply with the pulvinar.

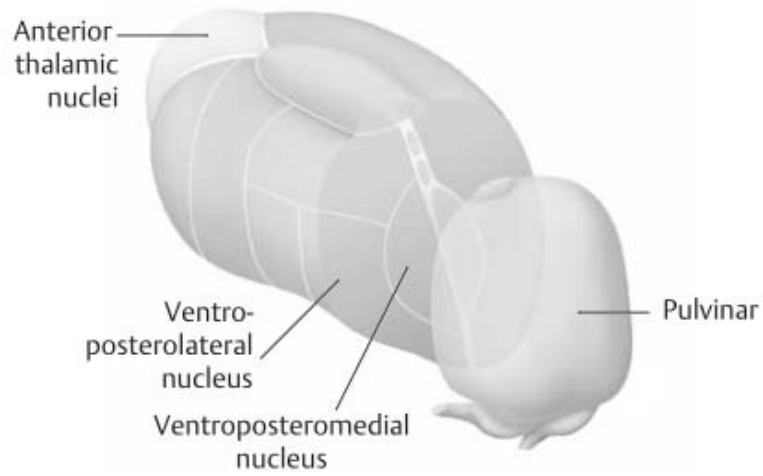
7. A. The mammillothalamic tract extends from the mammillary bodies to the anterior nucleus of the thalamus; the cells of origin are in the mammillary nuclei and the axons terminate in the anterior nucleus. This tract is frequently visible in axial T2-weighted MRI. The ventral anterior nucleus is laterally adjacent to the mammillothalamic tract, but does not receive input therefrom. The other choices are nuclei located more caudally in the diencephalon.

8. A. Many of the fibers contained in the optic tract terminate in the lateral geniculate nucleus. Some of these fibers bypass this nucleus to traverse the brachium of the superior colliculus and a few enter the suprachiasmatic nucleus. The medial

geniculate nucleus receives input via the brachium of the inferior colliculus (auditory); the pulvinar has interconnections with the visual cortex and superior colliculus; and the ventral posterolateral nucleus receives input from the anterolateral system and the medical lemniscus. The mammillary body is located rostral to the interpeduncular fossa and medial to the optic tract.

9. C. The ventral anterior nucleus is located in the rostral portions of the thalamus, is in the territory of the thalamoperforating artery, and projects to large regions of the frontal lobe. An occlusion of the vessels serving this portion of the thalamus may result in a decreased level of alertness. The other choices are in caudal regions of the thalamus, are not in the territory served by the thalamoperforating artery, and, with the exception of the centromedian nucleus, do not relate to the cortex of the frontal lobe.

10. Ventroposteromedial (VPM) nucleus. The ventroposterolateral (VPL) nucleus receives sensory input from the body.



Thalamic nuclear organization.

11. C. Centromedian.
The intralaminar nuclei (these are also called the intralaminar nuclear group) consist of groups of cells insinuated within the internal medullary lamina (IML); the centromedian is the largest of these, is easily seen in brain slices and stained sections, and is sometimes discernable in MRI. The intralaminar nuclei are generally divided into a more rostral division consisting of the paracentral, central lateral, and central medial nuclei and a caudal division consisting of the centromedian, parafascicular, and subparafascicular nuclei. The anterior nuclear group actually consists of anteroventral, anterodorsal, and anteromedial nuclei but is commonly referred to as the anterior nucleus of the thalamus; this group of cells forms an important landmark: the anterior tubercle of the thalamus. The interventricular foramen (of Monro) is the space located between the anterior tubercle of the thalamus and the column of the

fornix. The dorsomedial nucleus is located medial to the IML; the lateral dorsal nucleus is lateral to the IML and is part of the lateral nuclear group, which also includes the pulvinar. The thalamic reticular nucleus is a comparatively thin layer of cells that forms a shell on the lateral and inferior aspects of the thalamus; the neuron cell bodies forming this nuclear shell intermingle with the fibers forming the external medullary lamina.

12. A. Anterior.
The anterior nucleus of the dorsal thalamus receives input from the mammillary nucleus and other areas and projects to the cingulate gyrus. These are parts of a major pathway that functions in emotions and behavior; it is a large part of the Papez circuit. The centromedian nucleus has projections to the basal nuclei, subthalamus, and substantia nigra, functioning in concert with the basal nuclei. The dorsomedial projects to wide areas of the frontal lobe including its orbital aspect. Somatosensory information from the face and oral cavity is relayed to the face area of the postcentral gyrus; the ventral lateral nucleus receives input from the cerebellum and basal nuclei and projects to the somatomotor cortex (precentral and anterior paracentral gyri).

13. A. Anterior nucleus.
The interventricular foramen, in which this tumor is located, is the space between the column of the fornix (which is rostromedial to the foramen) and the anterior nucleus of the thalamus (which is caudolateral to the foramen). Enlargement of the left lateral ventricle results from blockage of CSF flow from the left lateral ventricle into the third ventricle. The confusion experienced by this man may partially reflect the interruption of messages from this nucleus to the cingulate cortex as well as the increased intracranial pressure. The centromedian is located in the internal medullary lamina within the thalamus, and the dorsomedial nucleus is in the medial area of the thalamus bordering on the third ventricle; both project to broad areas of the cerebral cortex. The ventral anterior (VA) and ventral lateral (VL) nuclei are located in the lateral area of the thalamus adjacent to the internal capsule; the VA is a thalamic nucleus involved with the limbic system, and the VL is a relay nucleus intimately involved in motor function.

14. B. Lateral geniculate nucleus.
The primary visual cortex receives input vital to vision from the lateral geniculate body on the same side via the optic radiations. Both eyes send information to each lateral geniculate body; this is why lesions caudal to the optic chiasm result in visual loss in both visual fields. The medial geniculate nucleus relays auditory information to the temporal lobe via the auditory radiations; the ventral lateral nucleus relays information from the cerebellum and basal nuclei to the somatomotor cortex. All of

these thalamocortical systems pass through various limbs of the internal capsule. The pulvinar has connections with the visual cortex; these connections are not specifically concerned with vision, but with visual-motor function. The lateral dorsal nucleus is located in the upper portions of the thalamus and has no particular clinical importance.

15. C. Ventral lateral nucleus.

The ventral lateral (VL) nucleus, pars caudalis, receives a projection from the cerebellar nuclei (cerebellothalamic fibers) on the contralateral side, while the VL nucleus, pars oralis, receives input from the ipsilateral internal segment of the globus pallidus (pallidothalamic fibers). The VL nucleus, in turn, projects to the primary somatomotor cortex. The anterior nucleus receives input from the mammillary nuclei and projects to the cingulate gyrus; the lateral dorsal nucleus receives input from nuclei of the limbic system and also projects to the cingulate gyrus. Ventral posterolateral (VPL) and ventral posteromedial (VPM) nuclei receive sensory input from the body (to VPL) and from the head through the trigeminal nerve (to VPM) and project to their respective areas of the primary somatosensory cortex.

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