Lecture #03 Brainstem

Question 1: Which of the following is found immediately ventral to (abutting) the midbrain tegmentum?

a) Periaqueductal gray

b) Substantia nigra

c) Inferior brachium

d) Red nucleus

e) Medial lemniscus

HINT:

It is involved in Parkinson's disease

EXPLANATION:

The red nucleus in the midbrain tegmentum is the origin of the rubrospinal tract, the other component of the lateral descending motor system, less important than the corticospinal tract. Its name comes from its distinctive pink hue in unfixed tissue. It is involved in overall control of the hand, while the corticospinal tract controls the individual fingers. The substantia nigra is immediately ventral to the midbrain tegmentum and the corticospinal tract is more ventral still, part of the crus cerebri at the ventral surface. The periaqueductal gray is in the midbrain tectum like the superior colliculus or is considered separately. The inferior brachium or brachium of the inferior colliculus can be considered part of the tectum or as a separate entity.

ANSWER: ['Substantia nigra']

Lecture #03 Brainstem

Question 2: Which interrupts the ventral median fissure at the spinomedullary junction?

a) Rostral half of the fourth ventricle

b) Superior brachium

c) Pyramidal decussation

d) Caudal half of the fourth ventricle

e) Inferior brachium

HINT:

This is the ventral landmark for transition from medulla to spinal cord

EXPLANATION:

The corticospinal tracts carry contralateral motor command signals. They cross at the pyramidal decussation to become the ipsilateral lateral corticospinal tracts of the spinal cord. The spinal ventral horns are their destination, and ventral horns are ipsilateral to the muscles they control.

ANSWER: ['Pyramidal decussation']

Lecture #03 Brainstem

Question 3: The lateral reticular area of the medulla contains neurons with which function?

a) Regulating burst mode of thalamocortical neurons

b) Generating error signals sent to the cerebellum

c) Production of serotonin

d) Production of norepinephrine

e) Coordination of cranial nerve reflexes

HINT:

Do not confuse the lateral reticular area of the medulla with the thalamic reticular nucleus

EXPLANATION:

Lateral reticular neurons coordinate a variety of reflexes and behaviors that require participation of more than one cranial nerve nucleus. Serotonin is produced by raphe nuclei neurons spread along the brainstem midline. Norepinephrine is produced by locus coeruleus neurons in the pontine tegmentum. Error signals for the cerebellum are generated by neurons of the inferior olivary nuclei in the medulla, which send climbing fibers to the cerebellum. The thalamic reticular nucleus regulates thalamocortical neurons.

ANSWER: ['Coordination of cranial nerve reflexes']

Lecture #03 Brainstem

Question 4: Ipsilateral paralysis of all muscles of facial expression is a common complication of which?

a) Ventral syndrome of the midbrain

b) Medial medullary syndrome

c) Stroke in the posterior limb of the internal capsule

d) Lateral medullary syndrome

e) Acoustic neuroma in the cerebellopontine angle

HINT:

An acoustic neuroma is a Schwannoma

EXPLANATION:

The facial and vestibulocochlear nerves are in the cerebellopontine angle and quite close to each other. A Schwannoma is a relatively common tumor that can compress facial nerve motor axons and cause facial paralysis.

ANSWER: ['Acoustic neuroma in the cerebellopontine angle']

Lecture #03 Brainstem

Question 5: A patient with a Schwannoma in the cerebellopontine angle has problems with balance and hearing. What other problem is this patient most likely to have on the tumor side?

a) Paralysis of the tongue

b) Difficulty with eye movements

c) Loss of sensation from the face

d) Paralysis of the sternocleidomastoid and trapezius muscles

e) Paralysis of the muscles of facial expression

HINT:

Balance and hearing involve the eighth cranial nerve

EXPLANATION:

The abducens, facial, and vestibulocochlear nerves, six through eight, all meet the brain at the pontomedullary junction on the ventral surface of the brain, with the abducens quite medial like other somatic motor column nuclei and nerves (oculomotor, trochlear, and hypoglossal). The facial and vestibulocochlear nerves are more lateral in the cerebellopontine angle and quite close to each other. A Schwannoma can compress facial nerve motor axons and cause facial paralysis.

ANSWER: ['Paralysis of the muscles of facial expression']

Lecture #03 Brainstem

Question 6: Which axons comprise the crus cerebri?

a) Corticospinal, pyramidal, corticobulbar

b) Frontopontine, temporopontine, parietopontine, occipitopontine

c) Corticospinal, frontopontine, temporopontine

d) Corticospinal, corticobulbar, corticopontine

e) Corticospinal, pontocerebellar

HINT:

The crus cerebri has axons destined for widespread locations down the neuraxis

EXPLANATION:

The three main components of the crus cerebri are corticospinal neurons destined for the spinal cord, corticobulbar neurons destined for cranial nerve motor nuclei, and corticopontine neurons comprising part of the corticopontocerebellar loop pathway. Corticopontine neurons are at the most medial and lateral parts of the crus cerebri, with corticobulbar and corticospinal axons in the middle.

ANSWER: ['Corticospinal, corticobulbar, corticopontine']

Lecture #03 Brainstem

Question 7: The open portion of the medulla contains which?

a) Rostral half of the fourth ventricle

b) Inferior brachium

c) Superior brachium

d) Caudal half of the fourth ventricle

e) Pyramidal decussation

HINT:

The medulla has open and closed portions, rostral to caudal

EXPLANATION:

The rostral part of the fourth ventricle is between the dorsal surface of the pons and the ventral surface of the cerebellum. The caudal part of the fourth ventricle is between the dorsal surface of the open medulla and the ventral surface of the cerebellum. The medulla closes at the obex and the fourth ventricular space contracts into the small central canal, with cerebrospinal fluid exiting the fourth ventricle either medially at the foramen of Magendie or laterally at the foramina of Luschka.

ANSWER: ['Caudal half of the fourth ventricle']

Lecture #03 Brainstem

Question 8: What is the destination of trigeminothalamic fibers?

a) Chief (or main, or principal) sensory nucleus

b) Supraoptic nucleus

c) Ventral posteromedial nucleus

d) Ventral posterolateral nucleus

e) Facial nucleus

HINT:

Thalamic sensory nuclei are segregated by body vs face

EXPLANATION:

The ventral posterolateral nucleus carries body sense, both large and small fiber types, while the ventromedial nucleus carries facial sense.

ANSWER: ['Ventral posteromedial nucleus']

Lecture #03 Brainstem

Question 9: A meningioma growing into and destroying the trigeminal tubercle (tuberculum cinereum) on the lateral surface of the medulla will cause loss of which?

a) Pain and temperature from the contralateral face

b) Fine touch from the contralateral face

c) Pain and temperature from the ipsilateral face

d) Proprioception from the ipsilateral face

e) Fine touch from the ipsilateral face

HINT:

The affected axons are destined for the spinal nucleus of the trigeminal nerve

EXPLANATION:

The small A delta and C fibers that carry pain and temperature sensations from the ipsilateral face descend along the trigeminal tubercle to synapse in the underlying spinal nucleus of the trigeminal nerve, where the secondary sensory neurons are found. The secondary neuron axons cross and carry the pain and temperature signals of the trigeminothalamic tract that projects to the ventral posteromedial nucleus of the thalamus.

ANSWER: ['Pain and temperature from the ipsilateral face']

Lecture #03 Brainstem

Question 10: Which of the following is in the midbrain tegmentum?

a) substantia nigra

b) periaqueductal gray

c) superior colliculus

d) corticospinal tract

e) red nucleus

HINT:

There is one upper motor structure that dominates the midbrain tegmentum

EXPLANATION:

The red nucleus in the midbrain tegmentum is the origin of the rubrospinal tract, the other component of the lateral descending motor system, less important than the corticospinal tract. Its name comes from its distinctive pink hue in unfixed tissue. It is involved in overall control of the hand, while the corticospinal tract controls the individual fingers. The substantia nigra is immediately ventral to the midbrain tegmentum and the corticospinal tract is more ventral still, part of the crus cerebri at the ventral surface. The periaqueductal gray is in the midbrain tectum like the superior colliculus or is considered separately.

ANSWER: ['red nucleus']

Lecture #03 Brainstem

Question 11: Which are axons of the superior brachium?

a) Tectal axons projecting to the Lateral Geniculate Nucleus

b) Superior olivary axons projecting to the inferior colliculus

c) Retinal axons projecting to the tectum

d) Lateral Geniculate Nucleus axons projecting to the tectum

e) Olivocerebellar axons

HINT:

The inferior brachium is also called the brachium of the inferior colliculus

EXPLANATION:

The superior brachium is also called the brachium of the superior colliculus. Unlike the inferior brachium, which contains axons leaving the inferior colliculus, the superior brachium contains largely axons projecting toward the superior colliculus from the retina, having bypassed the lateral geniculate nucleus.

ANSWER: ['Retinal axons projecting to the tectum']

Lecture #03 Brainstem

Question 12: Which is the path of olivocerebellar axons?

a) Ipsilateral projection via the inferior cerebellar peduncle

b) Contralateral projection via the superior cerebellar peduncle

c) Ipsilateral projection via the superior cerebellar peduncle

d) Contralateral projection via the middle cerebellar peduncle

e) Contralateral projection via the inferior cerebellar peduncle

HINT:

Pontocerebellar axons comprise the middle cerebellar peduncle

EXPLANATION:

The inferior olive, like most of the brain beyond primary sensory neurons, carries contralateral body information. The cerebellum, however, has ipsilateral information. Olivary fibers must cross and project contralaterally to accommodate cerebellar organization. The middle cerebellar peduncle is entirely pontocerebellar axons. The superior cerebellar peduncle carries the output from the cerebellum and also the ventral spinocerebellar tract. The rest of sensory input and the inferior olivary input enter the cerebellum via the inferior cerebellar peduncle.

ANSWER: ['Contralateral projection via the inferior cerebellar peduncle']

Lecture #03 Brainstem

Question 13: Which two structures are found in the lateral area of the medulla between the ventrolateral and dorsolateral sulci?

a) Inferior and middle cerebellar peduncle

b) Gracile and cuneate tubercle

c) Gracile tubercle and spinal nucleus

d) Olive and trigeminal tubercle

e) Left and right corticospinal tracts

HINT:

These are neither the most dorsal nor the most ventral structures

EXPLANATION:

The dorsolateral sulcus divides the most dorsomedially located gracile and cuneate dorsal column nuclei from the trigeminal tubercle. The ventrolateral sulcus divides the most ventromedially located corticospinal tracts from the inferior olive. The olive and tubercle lie between the two sulci.

ANSWER: ['Olive and trigeminal tubercle']

Lecture #03 Brainstem

Question 14: Which is the most complete and correct list of the longitudinal (rostrocaudal) fibers of the basal pons?

a) Corticomesencephalic axons, corticopontine axons, medial lemniscus axons

b) Corticopontine axons, inferior cerebellar peduncle axons, middle cerebellar peduncle axons

c) Corticopontine axons, corticobulbar axons, middle cerebellar peduncle axons

d) Middle cerebellar peduncle axons, corticobulbar axons, medial lemniscus axons

e) Corticobulbar axons, corticospinal axons, corticopontine axons

HINT:

Recall the locations of the corticospinal/bulbar and medial lemniscus fibers in the pons

EXPLANATION:

Corticopontine and pontocerebellar fibers are the main components of the basal or ventral pons, with the pontocerebellar fibers oriented medio-laterally rather than longitudinally. The corticopontine fibers come from cerebral layer 5 neurons and travel longitudinally to reach the neurons of the pontine nuclei that give rise to the pontocerebellar fibers. In addition, corticospinal and corticobulbar axons pass through the basal pontine nuclei longitudinally, rather than lying at the ventral surface where they are located in the midbrain and medulla.

ANSWER: ['Corticobulbar axons, corticospinal axons, corticopontine axons']

Lecture #03 Brainstem

Question 15: A lesion of the basal portion of the pons would affect which?

a) corticopontine fibers

b) reticular formation

c) spinothalamic tract

d) medial lemniscus

e) trigeminothalamic tract

HINT:

The basal pons is the same as the ventral pontine nuclei

EXPLANATION:

The corticopontocerebellar path is part of one of the great cerebral pathway loops, along with the basal ganglia and limbic loops. Layer 5 cerebral neurons project to basal pontine nuclei, from which decussating axons project to cerebellar cortex as mossy fibers. The output of the cerebellum projects back to the cerebral cortex via the ventral lateral thalamus to complete the loop.

ANSWER: ['corticopontine fibers']

Lecture #03 Brainstem

Question 16: Which neurons are in the mesencephalic nucleus of the trigeminal nerve?

a) Second order pain and temperature neurons

b) Second order proprioceptive neurons

c) First order pain and temperature neurons

d) Trigeminothalamic neurons

e) First order unipolar proprioceptive neurons

HINT:

The spinal, principal or chief or main, and mesencephalic are the sensory nuclei of the trigeminal nerve

EXPLANATION:

The mesencephalic nucleus of the trigeminal nerve is unique in containing primary, not secondary, sensory neurons. Its neurons carry proprioceptive signals from the jaw and face. They are pseudounipolar like other somatic primary sensory neurons.

ANSWER: ['First order unipolar proprioceptive neurons']

Lecture #03 Brainstem

Question 17: Which is adjacent to the ventral median fissure of the medulla?

a) Corticospinal tract

b) Inferior brachium

c) Obex of the fourth ventricle

d) Superior brachium

e) Cuneate tubercle

HINT:

This structure lies on the ventral surface of the midbrain and medulla

EXPLANATION:

The superior and inferior brachium are midbrain structures. The cuneate tubercle is a dorsally located bump on the medulla made by the cuneate dorsal column nucleus. The obex is the point of closure of the medulla on its dorsal surface. The corticospinal tract lies on the ventral surface of the midbrain as part of the crus cerebri and lies on the ventral surface of the medulla.

ANSWER: ['Corticospinal tract']

Lecture #03 Brainstem

Question 18: The closed portion of the medulla contains which?

a) Caudal half of the fourth ventricle

b) Superior brachium

c) Continuation of the central canal

d) Rostral half of the fourth ventricle

e) Inferior brachium

HINT:

Closing refers to the ventricular space

EXPLANATION:

The superior and inferior brachium are midbrain structures. There is no ventricle where the medulla has closed. The rostral part of the fourth ventricle is between the dorsal surface of the pons and the ventral surface of the cerebellum. The caudal part of the fourth ventricle is between the dorsal surface of the open medulla and the ventral surface of the cerebellum. The medulla closes at the obex and the fourth ventricular space contracts into the small central canal, with cerebrospinal fluid exiting the fourth ventricle either medially at the foramen of Magendie or laterally at the foramina of Luschka

ANSWER: ['Continuation of the central canal']

Lecture #03 Brainstem

Question 19: What is the destination of trigeminal lemniscus?

a) Facial nucleus

b) Supraoptic nucleus

c) Ventral posterolateral nucleus

d) Ventral posteromedial nucleus

e) Chief (or main, or principal) sensory nucleus

HINT:

The medial lemniscus carries body sense, the trigeminal lemniscus carries face sense

EXPLANATION:

The trigeminal lemniscus is analogous to the medial lemniscus, but carries face sensations rather than body sense. Face sense is relayed from the trigeminal lemniscus to cerebral cortex by the ventral posteromedial thalamic nucleus. Body information from the medial lemniscus is relayed by the ventral posterolateral thalamic nucleus.

ANSWER: ['Ventral posteromedial nucleus']

Lecture #03 Brainstem

Question 20: Loss of pain and temperature from the ipsilateral side of the face can be caused by which?

a) Acoustic neuroma in the cerebellopontine angle

b) Stroke in the posterior limb of the internal capsule

c) Damage to the trigeminal tubercle

d) Thalamic syndrome of Dejerine-Roussy

e) Ventral syndrome of the midbrain

HINT:

Ipsilateral damage is usually close to the primary sensory afferents, here trigeminal afferents

EXPLANATION:

The small A delta and C fibers that carry pain and temperature sensations from the ipsilateral face descend along the trigeminal tubercle to synapse in the underlying spinal nucleus of the trigeminal nerve, where the secondary sensory neurons are found. The secondary neuron axons cross and carry the pain and temperature signals of the trigeminothalamic tract that projects to the ventral posteromedial nucleus of the thalamus.

ANSWER: ['Damage to the trigeminal tubercle']

Lecture #03 Brainstem

Question 21: A stroke in the tegmentum of the pons would affect which?

a) Corticobulbar tract

b) Pontocerebellar fibers

c) Medial lemniscus

d) Corticopontine fibers

e) Corticospinal tract

HINT:

Distinguish basal pontine structures from tegmental ones

EXPLANATION:

The corticospinal and corticobulbar tracts pierce the basal pons to pass to the ventral medulla. The pontocerebellar fibers are part of the corticopontocerebellar loop. They have decussating axons that run through the basal pons to the middle cerebellar peduncles. The corticopontine fibers are the input to the neurons that send the pontocerebellar axons, also within the basal pons. The medial lemniscus is spread vertically along the midline in the medulla, but it ascends, moves dorsally, and rotates to become medial-to-lateral in the pontine tegmentum, dorsal to the basal pons.

ANSWER: ['Medial lemniscus']