Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 1: Which is NOT a feature of the medial corticospinal projection?

a) Controls axial musculature

b) Controls trunk musculature

c) Originates largely from Brodmann's area 4

d) Decussates at the decussation of the pyramids

e) Terminates bilaterally in the spinal cord

HINT:

The medial corticospinal projection terminates bilaterally

EXPLANATION:

The corticospinal tract divides at the decussation of the pyramids, where the lateral corticospinal axons cross to become ipsilateral to the lower motor neurons they control, which are found mainly in the lateral motor pools of the spinal cord ventral horn. The medial corticospinal tract remains uncrossed, it does not decussate. The medial corticospinal tract terminates bilaterally mainly in the medial motor pools of the spinal cord ventral horns.

ANSWER: ['Decussates at the decussation of the pyramids']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 2: What is the primary stabilizing function of the medial vestibulospinal tract?

a) Contralateral control of the legs

b) Bilateral control of the legs

c) Ipsilateral control of the legs

d) Ipsilateral control of the head

e) Bilateral control of the head

HINT:

Contrast the medial and lateral vestibulospinal tracts

EXPLANATION:

There are two main vestibulospinal tracts, the bilateral medial vestibulospinal tract and the ipsilateral lateral vestibulospinal tract. The medial vestibulospinal tract projects mainly to the cervical spinal cord, where it exerts bilateral control of the head, especially in response to unexpected head motion that excites the vestibular system. Neck muscles have complex actions benefitting from bilateral control. The medial vestibulospinal tract is also called the descending medial longitudinal fasciculus. The lateral vestibulospinal tract projects mainly to the lumbosacral spinal cord, where it controls the legs to keep the body upright and balanced, by extending the ipsilateral leg when that side of the vestibular system is excited.

ANSWER: ['Bilateral control of the head']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 3: What is the distinguishing feature of responses of melanopsin-containing retinal ganglion cells?

a) They are exclusively OFF type responses (decreased activity to light)

b) They are sent to the superior colliculus and lateral geniculate nucleus

c) They persist for hours instead of adapting

d) They sense visual stimuli exclusively at the fovea

e) They are sent to the inferior colliculus and medial geniculate nucleus

HINT:

The pupillary constriction and circadian systems receive their input from the melanopsin-containing retinal ganglion cells

EXPLANATION:

The pupillary constriction and circadian systems of the brain receive their input from a special class of retinal ganglion cells that are light sensitive. These melanopsin-containing retinal ganglion cells do not require rod or cone signals to respond to light. Unlike other retinal ganglion cells, the melanopsin-containing cells fire tonically. They maintain their responsiveness as long as light is present. Other retinal ganglion cells adapt and quit responding after seconds to minutes. Melanopsin-containing retinal ganglion cells project to two visual pathways, the circadian pathway, and the pupillary constriction pathway. The destination of tonic retinal signals for the circadian system is the suprachiasmatic nucleus of the hypothalamus, the master biological clock. Tonic retinal signals for the pupillary pathway project to the pretectal olivary nucleus, or olivary pretectal nucleus, or pretectal area, which projects to the Edinger-Westphal preganglionic parasympathetic autonomic nucleus.

ANSWER: ['They persist for hours instead of adapting']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 4: Which is NOT a visual projection of axons from the retina?

a) Inferior colliculus

b) Suprachiasmatic nucleus

c) Lateral geniculate nucleus (LGN)

d) Accessory optic nuclei

e) Olivary pretectal nucleus

HINT:

Determine what sense is represented in each area

EXPLANATION:

The inferior colliculus is a relay of the auditory system. It receives input from the superior olivary nuclei and projects to the medial geniculate nucleus. The five main visual projections are the lateral geniculate nucleus, the superior colliculus, the olivary pretectal nucleus, the suprachiasmatic nucleus of the hypothalamus, and the accessory optic nuclei.

ANSWER: ['Inferior colliculus']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 5: Melanopsin-containing retinal ganglion cells project to primarily to which two areas?

a) Pretectal area and hypothalamus

b) Inferior colliculus and medial geniculate nucleus

c) Superior colliculus and lateral geniculate nucleus

d) Lateral geniculate nucleus lamina 5 and 6

e) Lateral geniculate nucleus lamina 1 and 2

HINT:

Two visual areas need tonically maintained responses to light

EXPLANATION:

The pupillary constriction and circadian systems receive their input from melanopsin-containing retinal ganglion cells. Melanopsin-containing retinal ganglion cells do not require rod or cone signals to respond to light. Unlike other retinal ganglion cells, the melanopsin-containing cells fire tonically. They maintain their responsiveness as long as light is present. Other retinal ganglion cells adapt and quit responding after seconds to minutes. Melanopsin-containing retinal ganglion cells project to two visual pathways, the circadian pathway, and the pupillary constriction pathway. The destination of tonic retinal signals for the circadian system is the suprachiasmatic nucleus of the hypothalamus, the master biological clock. Tonic retinal signals for the pupillary pathway project to the pretectal olivary nucleus, or olivary pretectal nucleus, or pretectal area, which projects to the Edinger-Westphal preganglionic parasympathetic autonomic nucleus.

ANSWER: ['Pretectal area and hypothalamus']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 6: To which does the corticotectal path contribute?

a) Recognition of faces

b) Body orientation and eye movements

c) Control of the pharynx

d) Middle cerebellar peduncle

e) Autonomic nervous system

HINT:

The tectum is in the dorsal midbrain

EXPLANATION:

The main corticotectal path connects the visual cortex of the occipital lobe to the superior colliculus in the midbrain tectum. The superior colliculus is responsible for automatic saccadic eye movements and visual orientation reflexes. There are also corticotectal projections from many other cortical areas that presumably serve other orientation reflexes.

ANSWER: ['Body orientation and eye movements']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 7: Which are the output neurons from primary motor cortex?

a) Layer V neurons that project to upper motor neurons

b) Layer V neurons that project to premotor cortex

c) Layer V neurons that project to secondary motor cortex

d) Layer V neurons that project to lower motor neurons

e) Layer IV neurons that project to secondary motor cortex

HINT:

Consider the anatomy and functions of each of the neocortical layers

EXPLANATION:

The layers of primary motor cortex are like those elsewhere in neocortex, except that the input layer 4 (IV) is very small and the long-distance output layer 5 is very large and contains very large neurons. Cortical layer 1 contains mainly axons and other processes. Layer 1 (I) functions are unknown. Layers 2 and 3 (II and III) are often combined. Layer 2-3 is the main processing layer for information within an area. Layer 4 is the thalamic input area. Thalamic input from ventral lateral thalamus is important for motor cortex, it contains information from the cerebellum and basal ganglia, but it does not occupy the large area required for primary sensory input to an area. Layer 5 (V) is the main output layer. In the primary motor cortex, it contains the very large Betz cells that have long axons which control distal extremities. Layer 6 (VI) sends axons back to the ventral thalamus.

ANSWER: ['Layer V neurons that project to lower motor neurons']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 8: The olivary pretectal nucleus receives primarily which input?

a) Medial geniculate nucleus

b) Foveal cone receptors

c) Melanopsin containing retinal ganglion cells

d) Cochlear nuclei bilaterally

e) Lateral geniculate nucleus

HINT:

Consider the pupillary constriction system of the brain from its start

EXPLANATION:

The pupillary constriction system of the brain receives its input from a special class of retinal ganglion cells that are light sensitive. These melanopsin-containing retinal ganglion cells do not require rod or cone signals to respond to light. Unlike other retinal ganglion cells, the melanopsin-containing cells fire tonically. They maintain their responsiveness as long as light is present. Other retinal ganglion cells adapt and quit responding after seconds to minutes. Melanopsin-containing retinal ganglion cells project to two visual pathways, the circadian pathway, and the pupillary constriction pathway. The destination of tonic retinal signals for the circadian system is the suprachiasmatic nucleus of the hypothalamus, the master biological clock. Tonic retinal signals for the pupillary pathway project to the pretectal olivary nucleus, or olivary pretectal nucleus, or pretectal area, which projects to the Edinger-Westphal preganglionic parasympathetic autonomic nucleus.

ANSWER: ['Melanopsin containing retinal ganglion cells']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 9: Which is responsible for your eyes automatically tracking the outside scene when you are in a traveling vehicle?

a) Olivary pretectal areas

b) Suprachiasmatic nucleus

c) Medial superior olive

d) Lateral superior olive

e) Accessory optic nuclei

HINT:

Name all the visual paths and functions, up to five

EXPLANATION:

The optokinetic reflex is the automatic tracking of a moving visual scene, as when you are in a traveling vehicle. The optokinetic reflex is mediated by the accessory optic system and its many nuclei.

ANSWER: ['Accessory optic nuclei']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 10: What do the lateral descending pathways most directly control?

a) Axial musculature

b) The limbs

c) The four spinocerebellar tracts

d) The trunk

e) Locomotion

HINT:

The corticospinal and rubrospinal tracts are the main components of the lateral descending system

EXPLANATION:

The brain’s motor output is divided into medial and lateral descending systems that control automatic and voluntary movements respectively. The medial descending system arises from brainstem nuclei that include most importantly reticular nuclei and vestibular nuclei. Much of its output controls the trunk musculature. The lateral descending system arises mainly from motor cortex, but also from the red nucleus in the midbrain tegmentum. The lateral system pathways are the corticospinal tract (pyramidal tract) and the rubrospinal tract. Much of the lateral system output controls the extremities, limbs and especially the fingers.

ANSWER: ['The limbs']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 11: What is the corticobulbar path?

a) Axons from motor cortical areas that project to the basal pontine nuclei bulb

b) Axons from sensory cortical areas that project to the limbic bulb

c) Axons from motor cortical areas that project reciprocally to sensory cortical areas

d) Axons from motor cortical areas that project to premotor and motor brainstem nuclei

e) Axons from sensory cortical areas that project to the olfactory bulb

HINT:

Bulbar and myelo both refer to the general area of the medulla and vicinity

EXPLANATION:

The corticobulbar path is the companion to the corticospinal path. The corticospinal path carries motor commands for muscles on the contralateral side of the body below the face. The corticobulbar path carries bilateral motor commands for the muscles of the face. The corticospinal and corticobulbar paths are adjacent in the internal capsule, crus cerebri of the midbrain, and the pons. In the crus cerebri, the corticospinal tract is in the posterior limb and the corticobulbar tract is in the genu. The corticobulbar tract terminates in the pons and medulla while the corticospinal tract continues to spinal levels.

ANSWER: ['Axons from motor cortical areas that project to premotor and motor brainstem nuclei']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 12: Optic (visual) ataxia is best described as which?

a) An inability to orient held objects to match the orientation of a seen object

b) Postural instability with eyes open, but stable posture with eyes closed

c) Postural instability seen in the Romberg test, a positive Romberg sign

d) Postural instability with eyes closed, but stable posture with eyes open

e) Postural instability due to ocular instability (involuntary eye movements)

HINT:

Optic ataxia is a form of apraxia

EXPLANATION:

Optic ataxia is a form of apraxia caused by damage to the parietal (dorsal or action) visual stream. It is the inability to orient a held object to fit into a slot, even though the slot orientation can be perceived and described. Optic ataxia contrasts with visual agnosia. Visual agnosia is perceptual loss caused by damage to the temporal (ventral or perception) visual stream. Visual agnosia can be as simple as the inability to describe or match the orientation of a seen object, even though the ability to orient a held object to fit a slot may be retained. Prosopagnosia, the inability to recognize familiar faces, is a form of visual agnosia. Prosopagnosia is caused by damage to the occipitotemporal fusiform gyrus, the face area, which is part of the ventral visual stream.

ANSWER: ['An inability to orient held objects to match the orientation of a seen object']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 13: What do the medial descending pathways control?

a) The trunk

b) The lower limbs

c) Skilled hand movements

d) The dorsal and cuneo spinocerebellar tracts

e) The upper limbs

HINT:

The reticulospinal and vestibulospinal tracts are the main components of the medial descending system

EXPLANATION:

The brain’s motor output is divided into medial and lateral descending systems that control automatic and voluntary movements respectively. The medial descending system arises from brainstem nuclei that include most importantly reticular nuclei and vestibular nuclei. Much of its output controls the trunk musculature. The lateral descending system arises mainly from motor cortex, but also from the red nucleus in the midbrain tegmentum. The lateral system pathways are the corticospinal tract (pyramidal tract) and the rubrospinal tract. Much of the lateral system output controls the extremities, especially the fingers.

ANSWER: ['The trunk']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 14: Parietal lobe lesions often result in which deficit?

a) Akinesia or bradykinesia

b) Apraxia

c) Prosopagnosia

d) Tremor

e) Ataxia of the trunk

HINT:

The parietal lobe is specialized for spatial sense, attention, and sensory-motor coordination

EXPLANATION:

The parietal lobe is specialized for spatial sense, attention, and sensory-motor coordination. The major deficit associated with the parietal lobe is hemispatial neglect of the left after right parietal lesions. Lesions that affect the parietal (dorsal) visual stream result in optic ataxia, an apraxia seen as an inability to orient objects during usage. Other apraxia can follow parietal damage, for example an inability to follow movement instructions or to perform routine repetitive movements. Apraxias are thought to be related more closely to left parietal damage, neglect to right parietal damage.

ANSWER: ['Apraxia']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 15: Which cerebral lobe, if any, does not have association areas?

a) Occipital

b) Temporal

c) None of the listed lobes lack association areas; all have association areas

d) Parietal

e) Frontal

HINT:

Identify association areas in as many lobes as you can

EXPLANATION:

The primary sensory and motor areas of the neocortex represent a small fraction of the cortex. Most of neocortex is association areas. All ventromedial and dorsolateral prefrontal cortex contains association areas. All of parietal cortex outside the postcentral gyrus primary somatic sensory cortex (areas 3,1,2) contains association areas. This includes much of the parietal (dorsal) visual stream and several multi-sensory areas. All of temporal neocortex outside the primary auditory cortex (Heschl’s gyrus) contains association areas, including the ventral visual stream and the occipito-temporal fusiform face area. Occipital cortex contains multiple secondary visual areas and beyond, as well as the calcarine primary visual cortex.

ANSWER: ['None of the listed lobes lack association areas; all have association areas']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 16: The suprachiasmatic nucleus receives primarily which input?

a) Melanopsin containing retinal ganglion cells

b) Lateral geniculate nucleus

c) Medial geniculate nucleus

d) Cochlear nuclei bilaterally

e) Foveal cone receptors

HINT:

Consider the circadian system of the brain from its start

EXPLANATION:

The circadian system of the brain receives its input from a special class of retinal ganglion cells that are light sensitive. These melanopsin-containing retinal ganglion cells do not require rod or cone signals to respond to light. Unlike other retinal ganglion cells, the melanopsin-containing cells fire tonically. They maintain their responsiveness as long as light is present. Other retinal ganglion cells adapt and quit responding after seconds to minutes. Melanopsin-containing retinal ganglion cells project to two visual pathways, the circadian pathway, and the pupillary constriction pathway. The destination of tonic retinal signals for the circadian system is the suprachiasmatic nucleus of the hypothalamus, the master biological clock. Tonic retinal signals for the pupillary pathway project to the pretectal olivary nucleus, or pretectal area, which projects to the Edinger-Westphal preganglionic parasympathetic autonomic nucleus.

ANSWER: ['Melanopsin containing retinal ganglion cells']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 17: Cortical reflexes such as foot placement are mediated by which pathway?

a) Area 17 to the dorsal stream

b) Area 17 to area 18

c) Area 17 to the ventral stream

d) Area 18 to V4a

e) Areas 3,1,2 to area 4

HINT:

Consider the most direct path from sensory to motor cortex

EXPLANATION:

Dorsal column-medial lemniscus and spinothalamic (anterolateral) somatic sense are relayed to the primary somatic sensory cortex areas 3,1,2 by the ventral posterior nucleus of the thalamus. The primary somatic sensory cortex lies on the postcentral gyrus of the rostral parietal lobe. There are direct projections from primary somatic sensory cortex to the primary motor cortex area 4. Area 4 lies on the precentral gyrus of the caudal frontal lobe. These direct connections are the basis of simple cortical somatic reflexes, including foot placement reflexes.

ANSWER: ['Areas 3,1,2 to area 4']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 18: What is the function of the hypothalamospinal tract?

a) Limb control

b) Autonomic control

c) Control of distal musculature during locomotion

d) Axial control

e) Control of the emetic reflex

HINT:

Consider the overall function of the hypothalamus

EXPLANATION:

The hypothalamospinal tract is the path by which the hypothalamus controls preganglionic sympathetic neurons of the lateral horn (intermediolateral cell column). It descends ipsilaterally at an intermediate laterality and dorso-ventral location. Damage to descending sympathetics in the hypothalamospinal tract can result in Horner (or Horner’s) syndrome, which is seen as ipsilateral ptosis (drooping lid), miosis (pupil constriction), and anhidrosis (lack of facial sweating).

ANSWER: ['Autonomic control']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 19: Which is the destination of axons from the pretectal area?

a) Edinger-Westphal preganglionic parasympathetic nucleus

b) Retina

c) Intermediolateral cell column

d) Lateral horn of spinal cord

e) Tectum

HINT:

Name all the visual paths and functions, up to five

EXPLANATION:

The pupillary constriction system of the brain receives its input from a special class of retinal ganglion cells that are light sensitive. These melanopsin-containing retinal ganglion cells do not require rod or cone signals to respond to light. Unlike other retinal ganglion cells, the melanopsin-containing cells fire tonically. They maintain their responsiveness as long as light is present. Other retinal ganglion cells adapt and quit responding after seconds to minutes. Melanopsin-containing retinal ganglion cells project to two visual pathways, the circadian pathway, and the pupillary constriction pathway. Tonic retinal signals for the pupillary pathway project to the pretectal olivary nucleus, or olivary pretectal nucleus, or pretectal area, which projects to the Edinger-Westphal preganglionic parasympathetic autonomic nucleus.

ANSWER: ['Edinger-Westphal preganglionic parasympathetic nucleus']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 20: Which is NOT a major neocortical efferent pathway?

a) Corticospinal

b) Corticonigral

c) Corticothalamic

d) Corticopontine

e) Corticostriate

HINT:

Consider the main cortical loop pathways

EXPLANATION:

There are four major cortical loop pathways and a single, two-part major motor output pathway. The motor output path is the corticospinal and corticobulbar tracts. The first cortical output steps in the four major loops are the corticothalamic, corticostriate, corticopontine, and corticolimbic projections.

ANSWER: ['Corticonigral']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 21: Which structure(s) is (are) believed to mediate optokinetic reflexes?

a) Lateral superior olive

b) Medial superior olive

c) Olivary pretectal areas

d) Accessory optic nuclei

e) Suprachiasmatic nucleus

HINT:

Name all the visual paths and functions, up to five

EXPLANATION:

The optokinetic reflex is the automatic tracking of a moving visual scene, as when you are in a traveling vehicle. The optokinetic reflex is mediated by the accessory optic system and its many nuclei.

ANSWER: ['Accessory optic nuclei']

Lecture #09 Cerebral Cortex Vision, Motor Systems

Question 22: What is the primary origin of the medial descending system?

a) Cerebellum

b) Basal ganglia

c) Limbic system

d) Motor cortex

e) Brainstem

HINT:

Contrast medial and lateral descending systems

EXPLANATION:

The brain’s motor output is divided into medial and lateral descending systems that control automatic and voluntary movements respectively. The medial descending system arises from brainstem nuclei that include most importantly reticular nuclei and vestibular nuclei. Much of its output controls the trunk musculature. The lateral descending system arises mainly from motor cortex, but also from the red nucleus in the midbrain tegmentum. The lateral system pathways are the corticospinal tract (pyramidal tract) and the rubrospinal tract. Much of the lateral system output controls the extremities, especially the fingers.

ANSWER: ['Brainstem']