[lecture01]

label = "#01 Neurons, Glia, Meninges, Brain"

[[lecture01.questions]]

question = "What do axon terminals and dendritic spines have in common?"

rightanswer = ["They form parts of synapses"]

wronganswer = ["They are found within the perikaryon of the neuron", "They are parts of glial cells, not neurons", "They are typically uniform in diameter along their length", "They contain the nucleus"]

hint = "Both are slender processes that extend from the neuron cell body"

explanation = """

An axon originates at the neuron cell body axon hillock and extends to other neurons. An axon terminates in branches that have presynaptic specializations which release neurotransmitter when an action potential is conducted to them. Often, many dendrites extend from the neuron cell body and branch widely to receive axon terminal neurotransmitter at their postsynaptic specializations, which contain receptors and channels that respond to the neurotransmitter release by an axon terminal.

"""

questionid = "0101"

[[lecture01.questions]]

question = "Which -polar classification best fits the sensory receptive neurons of the dorsal root ganglia?"

rightanswer = ["Pseudounipolar"]

wronganswer = ["Bipolar depression", "Multipolar", "Stellate-polar", "Pyramidal-polar"]

hint = "Dorsal root ganglion neurons have a central and peripheral process extending from a common brnch point"

explanation = """

A short, single axonal process extends from the dorsal root ganglion neuron, but it soon splits into two bipolar branches, one of which travels to the periphery to receive input, and the other of which travels centrally to carry action potential signals into the central nervous system.

"""

questionid = "0102"

[[lecture01.questions]]

question = "Which is most likely to be a projection neuron?"

rightanswer = ["A pyramidal neuron of cerebral cortex layer 5"]

wronganswer = ["A stellate neuron of cerebral cortex layer 4", "A neuron that releases the neurotransmitter GABA", "An astrocyte", "An oligodendrocyte"]

hint = "Projection neurons have long axons and predominate in certain cortical layers"

explanation = """

Long axon projection neurons in the cerebral neocortex are found mainly in layers 2, 3, 5, and 6. Short axon local neurons are found mainly in layers 2 and 4, though they occur in layers 2-6.

"""

questionid = "0103"

[[lecture01.questions]]

question = "Which glial cell type is most important for isolating neurons from blood-borne toxins?"

rightanswer = ["Astrocyte"]

wronganswer = ["Oligodendrocyte", "Schwann cell", "Microglial cell", "Pyramidal cell"]

hint = "Blood-brain isolation is one of several functions of this most populous glial cell type"

explanation = """

Astrocyte end feet surround blood vessels and contribute to the blood-brain barrier that is primarily made by the capillary endothelial cells. Astrocytes also participate in the glutamate shuttle neurotransmitter recycling system and have immune, structural, and other functions.

"""

questionid = "0104"

[[lecture01.questions]]

question = "Which meningeal tissue provides the toughest physical barrier to protect the brain?"

rightanswer = ["Dura Mater"]

wronganswer = ["Pia mater", "Astrocyte", "Arachnoid", "Area Postrema"]

hint = "The outer meningeal layer is the toughest"

explanation = """

The dura mater or hard mother meningeal layer is a thick, leathery bi-layer. The dura has periosteal and meningeal subdivisions. The dura provides the primary physical barrier for the brain.

"""

questionid = "0106"

[[lecture01.questions]]

question = "At which location is the blood brain barrier most easily penetrated?"

rightanswer = ["Area Postrema"]

wronganswer = ["Pia mater", "Astrocyte", "Dura Mater", "Arachnoid"]

hint = "A major function of leaky blood-brain barriers is to allow neurons to sense toxins in the blood"

explanation = """

The area postrema is one of the major circumventricular organs. It detects blood toxins such as excessive alcohol and initiates the emetic (vomiting) reflex via axonal projections to the dorsal motor nucleus of the vagus nerve.

"""

questionid = "0107"

[[lecture01.questions]]

question = "The coordinate direction anterior is the same as which other coordinate directions?"

rightanswer = ["Rostral in the cerebrum, ventral in the spinal cord"]

wronganswer = ["Posterior in the cerebrum, dorsal in the spinal cord", "Posterior in the cerebrum, ventral in the spinal cord", "Dorsal in the cerebrum, ventral in the spinal cord", "Caudal in the cerebrum, dorsal in the spinal cord"]

hint = "The dorsal-ventral coordinates bend along with the axis of the brain as it ascends from spinal cord to cerebrum"

explanation = """

In the cerebrum rostral=anterior, caudal=posterior, dorsal=superior, ventral=inferior. In the spinal cord rostral=superior, caudal=inferior, dorsal=posterior, ventral=anterior.

"""

questionid = "0108"

[[lecture01.questions]]

question = "Which glial cell type participates in the glutamate-glutamine cycle (or shuttle)?"

rightanswer = ["Astrocyte"]

wronganswer = ["Oligodendrocyte", "Schwann cell", "Microglial cell", "Satellite cell"]

hint = "The glial cell that takes part in the glutamine shuttle is a very populous one that has many functions"

explanation = """

Astrocytes participate in neurotransmitter recycling as well as blood-brain isolation, immune responses, structural integrity, and developmental migration.

"""

questionid = "0109"

[[lecture01.questions]]

question = "Which is most likely to be a local interneuron?"

rightanswer = ["A granule neuron of cerebral cortex layer 4"]

wronganswer = ["A pyramidal neuron of cerebral cortex layer 5", "A neuron that releases the neurotransmitter acetylcholine onto a muscle fiber", "An astrocyte", "An oligodendrocyte"]

hint = "Local interneurons are smaller neurons that have short axonal processes"

explanation = """

Local interneurons or Golgi type II neurons are ubiquitous. In the neocortex they are found mainly in layers 2 and 4 and are generally stellate or granular in morphology. They contrast with projection neurons that are larger, have long axons, and are found largely in layers 3, 5, and 6.

"""

questionid = "0110"

[[lecture01.questions]]

question = "Where are the axons of Brodmann's area 4 giant Betz cells going?"

rightanswer = ["To the ventral horn of the spinal cord"]

wronganswer = ["To the lateral horn of the spinal cord", "To cranial nerve nuclei III through VI", "To the cerebral cortex", "To the hippocampus"]

hint = "Brodmann's area 4 is found just anterior to the central sulcus on the precentral gyrus"

explanation = """

Brodmann's are 4 is the primary motor cortex of the precentral gyrus of the frontal lobe. Its very thick layer 5 contains the upper motor neurons that project axons contralaterally to the lower motor neurons of the spinal cord ventral (anterior) horn. The largest of the upper motor neurons are the giant Betz cells, which can have cell bodies over 50 microns in diameter. They control mainly the contralateral leg.

"""

questionid = "0111"

[[lecture01.questions]]

question = "Which glial cell type is most important for myelinating central nervous system axons?"

rightanswer = ["Oligodendrocyte"]

wronganswer = ["Astrocyte", "Schwann cell", "Microglial cell", "Satellite cell"]

hint = "Different glial cell types myelinate central versus peripheral axons"

explanation = """

Oligodendrocytes are the glial cells that myelinate central axons. Each oligodendrocyte can myelinate segments of many axons, unlike the peripheral Schwann cells, each of which myelinates only one axonal segment.

"""

questionid = "0112"

[[lecture01.questions]]

question = "Which is most likely to send an axon to subcortical brain locations?"

rightanswer = ["A pyramidal neuron of cerebral cortex layer 5"]

wronganswer = ["A granule neuron of cerebral cortex layer 4", "A neuron that releases the neurotransmitter acetylcholine onto a muscle fiber", "An astrocyte", "An oligodendrocyte"]

hint = "Projection neurons are found in distinct neocortical layers"

explanation = """

Layer 5 can be called the major neocortical output layer. Many layer 5 neurons project to distant areas, including the superior colliculus, ventral pons, basal ganglia, limbic system, spinal cord, and other parts of the central nervous system.

"""

questionid = "0113"

[[lecture01.questions]]

question = "Where are the axons in the middle cerebellar peduncle going?"

rightanswer = ["To the cerebellum"]

wronganswer = ["To the lateral horn of the spinal cord", "To cranial nerve nuclei III through VI", "To the cerebral cortex", "To the internal capsule"]

hint = "The axons of the middle cerebellar peduncle are the transverse, crossing fibers of the ventral pons"

explanation = """

The middle cerebellar peduncle is the largest input to the cortico-cerebellum or cerebellar hemispheres. The middle cerebellar peduncle is axons of pontine nuclei neurons that relay information from layer 5 of neocortex and is one of the largest pathways in the brain, consisting of perhaps 20 million axons.

"""

questionid = "0114"

[[lecture01.questions]]

question = "Disynaptic pathways?"

rightanswer = ["Have only a single set of interneurons between sensory and motor neurons"]

wronganswer = ["Would involve only sensory neurons and motor neurons, but do not exist in mammals", "Use only the neurotransmitter GABA", "Include the motor cortex and frontal and temporal language areas", "Were first shown by the demonstration of active brain areas by fMRI"]

hint = "Disynaptic pathways are the next step in complexity after the monosynaptic stretch reflex"

explanation = """

Only the stretch reflex, also called the knee-jerk reflex, myotatic reflex, deep tendon reflex, and monosynaptic reflex, has no necessary intervening neurons between sensory and motor neurons. Other reflexes such as the vestibulo-ocular and vestibulo-spinal reflexes may have only a single necessary interneuron between sensory and motor neuron, and these are called disynaptic reflexes.

"""

questionid = "0116"

[[lecture01.questions]]

question = "The thalamus has which major function?"

rightanswer = ["It relays inputs from many parts of the brain to the cerebral cortex"]

wronganswer = ["It inhibits the brain via the neurotransmitter GABA", "It is the primary output from the cerebral cortex", "It is the primary input to the cerebellum", "It is the primary input to the basal ganglia"]

hint = "The thalamus is the largest structure in the diencephalon, lying between the brainstem and cerebrum"

explanation = """

Almost all information that is sent to the cerebral neocortex must pass through a thalamic relay. Specific nuclei within the thalamus relay information from specific systems, for example the ventral posterior thalamic nuclei relay somatic sensations and the lateral and medial geniculate nuclei relay vision and hearing, respectively.

"""

questionid = "0117"

[[lecture01.questions]]

question = "Looping brain pathways likely serve what purpose(s)?"

rightanswer = ["Extension of motor commands and formation of memories"]

wronganswer = ["Prevention of negative and positive feedback", "Relaying to the cerebral cortex and bypassing the thalamus", "Interconnecting the basal ganglia and the cerebellum", "Monosynaptic reflexes"]

hint = "Major brain loops include the corticopontocerebellar, cortico-basal ganglia, and corticolimbic."

explanation = """

Each major brain loop consists of many parallel interconnected loops that run parallel to each other. Information may reverberate in a loop and move to different parallel pathways within it as motor commands play out or other prolonged or elaborate brain functions take place.

"""

questionid = "0118"

[[lecture01.questions]]

question = "Which glial cell type is most important for myelinating peripheral nervous system axons?"

rightanswer = ["Schwann cell"]

wronganswer = ["Astrocyte", "Oligodendrocyte", "Microglial cell", "Satellite cell"]

hint = "Different glial cell types myelinate central versus peripheral axons"

explanation = """

Schwann cells are the most prominent of the peripheral glial cells. Each Schwann cell wraps many times around a single peripheral axon segment, insulating the axons so that action potentials are conducted roughly six times faster and at much lower metabolic cost. Demyelinating diseases are a major pathology of the nervous system, both peripherally and centrally.

"""

questionid = "0119"

[[lecture01.questions]]

question = "The vertebral arteries send blood directly into which artery or arteries?"

rightanswer = ["Basilar"]

wronganswer = ["Posterior cerebral", "Middle cerebral", "Anterior cerebral", "Carotid(s)"]

hint = "The vertebral arteries are the origin of the posterior cerebral circulation"

explanation = """

The posterior cerebral circulation begins with the two vertebral arteries ascending and joining to form the basilar artery at the base of the ventral surface of the pons.

"""

questionid = "0121"

[[lecture01.questions]]

question = "The carotid arteries send blood directly into which artery or arteries?"

rightanswer = ["Middle cerebral"]

wronganswer = ["Posterior cerebral", "Anterior communicating", "Basilar", "Carotid(s)"]

hint = "The carotid arteries are the origin of the anterior cerebral circulation"

explanation = """

The two internal carotid arteries are the origin of the anterior cerebral circulation. They ascend and branch at the circle of Willis at the base of the brain. Their largest extensions are the middle cerebral arteries, and they branch forward as the anterior cerebral arteries, which connect at the midline anterior communicating artery to complete the circle of Willis.

"""

questionid = "0122"

[[lecture01.questions]]

question = "What is the special role of capillary endothelial cells in the brain?"

rightanswer = ["Blood-brain barrier"]

wronganswer = ["Absence of blood-brain barrier", "Release of neuromodulators", "Location lateral to the sulcus limitans", "Retention of synaptic vesicles"]

hint = "Endothelial cells surround the capillaries"

explanation = """

Capillary endothelial cells over the body in general have fenestrae, pinocytosis, and loose junctions that allow substances to escape. In the brain, capillary endothelial cells have tight junctions and very limited transport of substances. This is the major blood-brain barrier. Astrocytes also contribute to the blood-brain barrier.

"""

questionid = "0124"

[[lecture01.questions]]

question = "What is stained by the Golgi stain?"

rightanswer = ["a small percentage of neurons in their entirety"]

wronganswer = ["unmyelinated axons but not myelinated axons", "gray matter but not cell bodies or neuropil", "cell bodies of cells with unmyelinated but not myelinated axons", "both cell bodies and myelin"]

hint = "The Golgi stain was the main tool used by Cajal to trace the neurons and wiring of the brain"

explanation = """

By mechanisms still unclear, the Golgi silver stain darkens a select small percentage of neurons in their entirety, revealing the extent of all their processes so that their morphology and connections can be traced. If all neurons were stained, the tissue would be too completely dark to explore.

"""

questionid = "0125"

[[lecture01.questions]]

question = "Into which structure(s) does the metencephalon develop?"

rightanswer = ["Pons and cerebellum"]

wronganswer = ["Medulla", "midbrain", "Thalamus and hypothalamus", "Rhombencephalon"]

hint = "The metencephalon lies between myelencephalon and the mesencephalon during development"

explanation = """

Early in nervous system development, the prosencephalon, mesencephalon, and rhombencephalon subdivide, with the rhombencephalon becoming the myelencephalon and metencephalon, which in turn develop respectively into the medulla and into the pons and cerebellum.

"""

questionid = "0126"

[lecture02]

label = "#02 Nerves and Spinal Cord"

[[lecture02.questions]]

question = "Which results from damage to the spinal cord ventral (anterior) commissure at lamina X?"

rightanswer = ["Bilateral loss of pain and temperature sense"]

wronganswer = ["Ipsilateral loss of touch, pressure, vibration, and proprioception", "Contralateral loss of touch, pressure, vibration, and proprioception", "Ipsilateral loss of pain and temperature sense", "Contralateral loss of pain and temperature sense"]

hint = "Second order axons of small fiber somatic sensations cross at lamina X"

explanation = """

Large axon touch, pressure, vibration, and position sense primary afferents ascend ipsilaterally to the medulla. Small axon pain and temperature sense primary afferents synapse in the ipsilateral dorsal horn and the secondary neuron axons then cross in lamina X. Lamina X contains both left and right side afferents, so pain and temperature deficits from lamina X damage are bilateral.

"""

questionid = "0201"

[[lecture02.questions]]

question = "What is a spinal segment?"

rightanswer = ["A part of the spinal cord associated with a sensory and motor pair of nerves and related to a dermatome and myotome"]

wronganswer = ["The rostro caudal extension of gray matter tracts from coccygeal through cervical levels", "The nerve fiber link between the primary sensory or motor neuron in the ventral or dorsal horn and the secondary neuron of the same pathway", "A length of a dorsal root", "A length of a ventral root"]

hint = "Each rostro-caudal part of the spinal cord, coccygeal, sacral, lumbar, thoracic, cervical, has several segments"

explanation = """

There are 31 spinal segments, each relating to a single sensory dermatome and motor myotome, 1 coccygeal, 5 sacral, 5 lumbar, 12 thoracic, and 8 cervical.

"""

questionid = "0202"

[[lecture02.questions]]

question = "A knife wound to the back has caused the loss of sensation in the right leg. Where did the knife most likely enter?"

rightanswer = ["The right lumbar spine"]

wronganswer = ["The left cervical spine", "The right cervical spine", "The left lumbar spine", "Into a ventral root"]

hint = "Identify the spinal levels that relate most closely to the legs, not the arms"

explanation = """

Spinal loss of sensation is mostly ipsilateral, because sensory information has not crossed yet, except when second order pain and temperature afferents are involved. Cervical levels serve the arms, lumbar levels serve the legs.

"""

questionid = "0203"

[[lecture02.questions]]

question = "How do the smallest spinal axons differ from large ones?"

rightanswer = ["They are unmyelinated"]

wronganswer = ["They conduct more rapidly", "They leave the spinal cord via the ventral roots", "They enter the spinal cord more medially than large axons", "They carry transient signals rather than tonic ones"]

hint = "The smallest fibers are the type C fibers"

explanation = """

Only the smallest spinal axons are unmyelinated. They conduct much more slowly than larger axons. The very smallest are the unmyelinated C fibers, which are sensory axons that carry distressing pain signals. Slightly larger A delta myelinated axons carry sharper but more manageable pain sensations. The larger A beta fibers carry touch, pressure, vibration, and position sense and ascend ipsilaterally.

"""

questionid = "0204"

[[lecture02.questions]]

question = "Which is a characteristic of the entry of large sensory axons into the spinal cord?"

rightanswer = ["They enter the cord relatively dorsomedially and remain on the ipsilateral side"]

wronganswer = ["They enter the cord ventrally and cross to the contralateral side", "They enter the cord relatively dorsomedially and cross to the contralateral side", "They enter the cord relatively dorsolaterally and cross to the contralateral side", "They enter the cord relatively dorsolaterally and remain on the ipsilateral side"]

hint = "The large axons enter closest to the fiber bundles in which they travel up the neuraxis"

explanation = """

There is a medial to lateral organization of large to small sensory fibers at the entry into the dorsal spinal cord. The largest axons enter nearest to the dorsal columns, in which they travel ipsilaterally up to synapse in the dorsal column nuclei of the medulla, the gracile and cuneate nuclei.

"""

questionid = "0205"

[[lecture02.questions]]

question = "How does a spinal segment C7 compare to segment T5?"

rightanswer = ["C7 has large ventral horns, T5 has small ventral horns"]

wronganswer = ["C7 is nearer the caudal extreme of the spinal cord, T5 near the rostral junction with the medulla", "C7 lies in the cauda equina, T5 does not", "C7 innervates the leg, T5 the arm", "C7 has Clarke's Nucleus (Nucleus Dorsalis), T5 has an enlarged substantia gelatinosa"]

hint = "Cervical segments serve the upper body"

explanation = """

The cervical enlargement of the ventral horns is prominent at C7, where lower motor neurons that control the hand are located. The segmental groups from caudal lower body to rostral upper body are 1 coccygeal segment, 5 sacral, 5 lumbar, 12 thoracic, and 8 cervical segments.

"""

questionid = "0209"

[[lecture02.questions]]

question = "Where is the propriospinal tract?"

rightanswer = ["in the spinal cord next to the gray matter"]

wronganswer = ["in the telencephalon beneath the cortex", "in the cerebellum", "in the spinal white matter running from the spinal cord to the cerebellum", "in a muscle nerve or mixed peripheral nerve"]

hint = "The propriospinal tract is conveniently located for coordinating diverse spinal segments"

explanation = """

Reflexes often involve coordination across many body parts and spinal segments. This is done by the propriospinal tract, which lies against the spinal gray matter and interconnects widespread spinal segments.

"""

questionid = "0210"

[[lecture02.questions]]

question = "A syringomyelia, or central cord syndrome, presents which clinical picture?"

rightanswer = ["Bilateral loss of pain and temperature sense in a patch corresponding to the segments of the lesion"]

wronganswer = ["Unilateral, ipsilateral loss of proprioception, mechanoreception, and pain and temperature sense on the body corresponding to and below the segment of the lesion; flaccid paralysis over approximately the same extent", "Contralateral flaccid paralysis at and below the segment of the lesion", "Ipsilateral loss of proprioception and mechanoreception on the body corresponding to and below the segment of the lesion and less extensive contralateral loss of pain and temperature sense below the lesion", "Obstruction of CSF flow within the lateral ventricles"]

hint = "The initial effects of a syrinx are due to compression of axons near its location"

explanation = """

A syrinx is a swelling of the central canal of the spinal cord, often at cervical levels. It initially compresses axons in lamina X, the ventral or anterior commissure. Small axon pain and temperature sense primary afferents synapse in the ipsilateral dorsal horn and the secondary neuron axons then cross in lamina X. Lamina X contains both left and right side afferents, so pain and temperature deficits from lamina X damage are bilateral. A syrinx initially affects only the spinal segments near the level of the swelling, but it can expand to compress the ventral horns and ultimately axons passing in descending tracts.

"""

questionid = "0212"

[[lecture02.questions]]

question = "Which is a characteristic of sensory axons of the dorsal column system?"

rightanswer = ["They are divided into medial (gracile) axons that represent the ipsilateral lower limb and lateral (cuneate) axons that represent the ipsilateral upper limb"]

wronganswer = ["They enter the cord ventrally and cross to the contralateral side", "They enter the cord relatively dorsolaterally and cross to the contralateral side", "They are divided into lateral (propriospinal) axons that represent the ipsilateral lower limb and medial (gelatinosa) axons that represent the contralateral upper limb", "They are among the smallest axons of the spinal cord"]

hint = "The dorsal column system is the large fiber somatic sensory system"

explanation = """

The large axons of the dorsal column system carry touch, pressure, vibration, and position sensations.

they enter the spinal cord dorsomedially and ascend ipsilaterally in the nearby dorsal column. They ascend ipsilaterally up to synapse in the dorsal column nuclei of the medulla, the gracile and cuneate nuclei, where the second order neurons are located.

"""

questionid = "0213"

[[lecture02.questions]]

question = "How do the functions or content of the spinal cord anterior commissure and spinal cord ventral commissure differ?"

rightanswer = ["They are the same commissure, which carries pain and temperature information"]

wronganswer = ["The anterior commissure contains sensory fibers; the ventral commissure contains motor fibers", "The anterior commissure contains motor fibers; the ventral commissure contains sensory fibers", "The anterior commissure contains proprioceptive and touch fibers; the ventral commissure contains motor fibers", "The anterior commissure contains proprioceptive and touch fibers; the ventral commissure contains pain and temperature fibers"]

hint = "The anterior commissure is Rexed lamina X"

explanation = """

Ventral and anterior are the same direction in the spinal cord, so the ventral and anterior commissure are the same white matter, located at lamina X. Small axon pain and temperature sense primary afferents synapse in the ipsilateral dorsal horn and the secondary neuron axons head ventrally then cross in lamina X, directly anterior to the central canal. Lamina X contains both left and right side afferents, so pain and temperature deficits from lamina X damage are bilateral.

"""

questionid = "0214"

[[lecture02.questions]]

question = "Which are C fibers?"

rightanswer = ["Unmyelinated pain and temperature afferents"]

wronganswer = ["Tendon organ afferents", "Myelinated pain and temperature afferents", "Autonomic nervous system preganglionic fibers", "Autonomic nervous system preganglionic fibers"]

hint = "The sensory fiber classification system proceeds in alphabetical order from large to small axons"

explanation = """

The smallest of the spinal sensory axons are the unmyelinated C fibers. They are sensory axons that carry distressing pain signals. Slightly larger A delta myelinated axons carry sharper but more manageable pain sensations. The larger A beta fibers carry touch, pressure, vibration, and position sense and ascend ipsilaterally. Autonomic nervous system fibers include B fibers.

"""

questionid = "0215"

[[lecture02.questions]]

question = "How does spinal segment T5 compare to segment L5?"

rightanswer = ["L5 has large ventral horns, T5 has small ventral horns"]

wronganswer = ["L5 is near the rostral junction with the medulla, T5 is near the caudal extreme of the spinal cord", "L5 lies below the cauda equina, T5 does not", "T5 innervates the leg, L5 the arm", "L5 has Clarke's Nucleus (Nucleus Dorsalis), T5 has an enlarged substantia gelatinosa"]

hint = "Cervical segments control the upper body, lumbar segments the legs"

explanation = """

There are two ventral horn enlargements, the cervical enlargement for control of the arms, and the lumbar (or lumbosacral) enlargement for control of the legs. All the thoracic segments below about T2 have very small ventral horns because they control little complex musculature.

"""

questionid = "0216"

[[lecture02.questions]]

question = "What is the role of the propriospinal tract?"

rightanswer = ["complex reflexes"]

wronganswer = ["the monosynaptic reflex (myotatic or deep tendon reflex)", "synapses within the dorsal root ganglia", "cerebellar efferent copy signals", "cerebellar afferent signals"]

hint = "The propriospinal tract is located adjacent to the spinal gray matter"

explanation = """

Reflexes often involve coordination across many body parts and spinal segments. This is done by the propriospinal tract, which lies against the spinal gray matter and interconnects widespread spinal segments.

"""

questionid = "0217"

[[lecture02.questions]]

question = "Which capacity is most intact in the Brown-Sequard (or cord hemi section) syndrome?"

rightanswer = ["Ipsilateral pain and temperature sense"]

wronganswer = ["Ipsilateral mechanoreception and proprioception", "Contralateral pain and temperature sense", "Ipsilateral motor function at the segment of the lesion", "Ipsilateral motor function below the segment of the lesion"]

hint = "Which sensory pathway decussates near its level of entry to the spinal cord"

explanation = """

Brown-Sequard syndrome results from transection of one side of the spinal cord. This disables the ipsilaterally descending corticospinal motor axons, the ipsilaterally ascending large primary afferent sensory axons, and the contralaterally ascending small secondary afferents that carry pain and temperature. Ipsilateral pain and temperature is intact, as are contralateral motor and large sensory axon systems.

"""

questionid = "0218"

[[lecture02.questions]]

question = "When a syringomyelia, or central cord syndrome lesion, expands beyond the ventral commissure, which function is generally lost first?"

rightanswer = ["Bilateral motor function at and below the segment of the lesion"]

wronganswer = ["Unilateral, ipsilateral proprioception and mechanoreception corresponding to and below the segment of the lesion", "Bilateral proprioception and mechanoreception corresponding to and below the segment of the lesion", "Unilateral, ipsilateral motor function at and below the segment of the lesion", "Unilateral, contralateral motor function at and below the segment of the lesion"]

hint = "A syrinx expands from the somewhat ventrally located central canal to affect the closest structures first"

explanation = """

An expanding syrinx can block blood circulation to most of the spinal cord bilaterally, except for the dorsal columns, which are supplied by the dorsally located posterior spinal arteries. The expansion first disables motor function near the level of the syrinx, then the descending axons of the corticospinal tracts in the dorsolateral white matter. The syrinx has then effectively blocked the areas served by the midline anterior spinal artery and there is a descending paralysis or severe paresis of all lower body parts.

"""

questionid = "0219"

[[lecture02.questions]]

question = "What levels of the spinal cord contain the most spinal nerve segments?"

rightanswer = ["Thoracic"]

wronganswer = ["Cervical", "Lumbar", "Sacral", "Coccygeal"]

hint = "Which levels have the largest number of the 31 spinal segments"

explanation = """

The segmental groups from caudal lower body to rostral upper body are 1 coccygeal segment, 5 sacral, 5 lumbar, 12 thoracic, and 8 cervical segments.

"""

questionid = "0220"

[[lecture02.questions]]

question = "What is (are) the most notable exception(s) to the overall laterality of the spinal cord?"

rightanswer = ["Anterolateral system"]

wronganswer = ["Dorsal columns", "Lateral corticospinal tract", "Dorsal spinocerebellar tract", "Alpha motor neurons"]

hint = "Which ascending pathway is second order neuron axons?"

explanation = """

The spinal cord has mostly ipsilateral neuronal systems. The large axons of the dorsal column system carry touch, pressure, vibration, and position sensations. They enter the spinal cord dorsomedially and ascend ipsilaterally in the nearby dorsal column. They ascend ipsilaterally up to synapse in the dorsal column nuclei of the medulla, the gracile and cuneate nuclei, where the second order neurons are located. Small axon pain and temperature sense primary afferents enter ipsilaterally more laterally and synapse in the ipsilateral dorsal horn. Their secondary neuron axons then cross in lamina X to become the main contralateral signals of the spinal cord. The descending corticospinal tracts are ipsilateral, having decussated at the spinomedullary junction.

"""

questionid = "0221"

[[lecture02.questions]]

question = "What explains the cauda equina?"

rightanswer = ["Length of the spine compared to the spinal cord"]

wronganswer = ["Trauma that affects the central spinal cord", "Unilateral spinal cord trauma", "Dorsal location of large sensory afferents vs ventral location of small afferents", "Sparse innervation of the lower body"]

hint = "The cauda equina or tail of the horse is named for its appearance in the vertebral column"

explanation = """

Spinal segments are named for the vertebra at their entry or exit, not the point of entry or exit into or from the spinal cord. The caudal end of the spinal cord is at about L2. A lumbar puncture to sample cerebrospinal fluid is safe from spinal cord injury if done at L4-L5. As one descends the spinal cord, entering and exiting nerves travel increasingly far to reach their corresponding spinal segments. Caudal to the end of the spinal cord the extended dorsal and ventral roots comprise the cauda equina.

"""

questionid = "0222"

[[lecture02.questions]]

question = "Small afferent fibers enter the cord most ----- near the -----?"

rightanswer = ["Laterally, substantia gelatinosa"]

wronganswer = ["Contralaterally, Rexed lamina IX", "Medially, spinocerebellar tracts", "Medially, Rexed lamina X", "Laterally, alpha motor neurons innervating the trunk"]

hint = "Afferents to the spinal cord enter near to their next destination"

explanation = """

There is a medial to lateral organization of large to small sensory fibers at the entry into the dorsal spinal cord. The largest axons enter nearest to the dorsal columns, in which they travel ipsilaterally up to synapse in the dorsal column nuclei of the medulla, the gracile and cuneate nuclei. The smallest axons enter near the substantia gelatinosa, in which some of them terminate or synapse with pain and temperature information.

"""

questionid = "0223"

[[lecture02.questions]]

question = "The smallest diameter axons carry which signals?"

rightanswer = ["Distressing painful sensations"]

wronganswer = ["Length of muscle spindles", "Intrafusal fiber contraction to desensitize spindles", "Proprioception", "Fast motor unit contraction"]

hint = "The C fibers are the smallest axons"

explanation = """

The smallest of the spinal sensory axons are the unmyelinated C fibers. They are sensory axons that carry distressing pain signals. Slightly larger A delta myelinated axons carry sharper but more manageable pain sensations. The larger A beta fibers carry touch, pressure, vibration, and position sense and ascend ipsilaterally. Autonomic nervous system fibers include B fibers.

"""

questionid = "0224"

[[lecture02.questions]]

question = "The A beta axons carry which signals?"

rightanswer = ["Touch, pressure, vibration"]

wronganswer = ["Distressing painful sensations", "Sharp, pricking painful sensations", "Temperature", "Proprioception"]

hint = "A beta fibers are almost the largest of the sensory axons; only the muscle spindle afferent axons are larger"

explanation = """

The smallest of the spinal sensory axons are the unmyelinated C fibers. They are sensory axons that carry distressing pain signals. Slightly larger A delta myelinated axons carry sharper but more manageable pain sensations. The larger A beta fibers carry touch, pressure, vibration, and position sense and ascend ipsilaterally. Autonomic nervous system fibers include B fibers.

"""

questionid = "0225"

[lecture03]

label = "#03 Brainstem"

[[lecture03.questions]]

question = "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?"

rightanswer = ["Paralysis of the muscles of facial expression"]

wronganswer = ["Paralysis of the sternocleidomastoid and trapezius muscles", "Loss of sensation from the face", "Paralysis of the tongue", "Difficulty with eye movements"]

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.

"""

questionid = "0301"

[[lecture03.questions]]

question = "Ipsilateral paralysis of all muscles of facial expression is a common complication of which?"

rightanswer = ["Acoustic neuroma in the cerebellopontine angle"]

wronganswer = ["Medial medullary syndrome", "Ventral syndrome of the midbrain", "Stroke in the posterior limb of the internal capsule", "Lateral medullary syndrome"]

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.

"""

questionid = "0302"

[[lecture03.questions]]

question = "A meningioma growing into and destroying the trigeminal tubercle (tuberculum cinereum) on the lateral surface of the medulla will cause loss of which?"

rightanswer = ["Pain and temperature from the ipsilateral face"]

wronganswer = ["Proprioception from the ipsilateral face", "Fine touch from the contralateral face", "Pain and temperature from the contralateral face", "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.

"""

questionid = "0303"

[[lecture03.questions]]

question = "Loss of pain and temperature from the ipsilateral side of the face can be caused by which?"

rightanswer = ["Damage to the trigeminal tubercle"]

wronganswer = ["Thalamic syndrome of Dejerine-Roussy", "Stroke in the posterior limb of the internal capsule", "Acoustic neuroma in the cerebellopontine angle", "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.

"""

questionid = "0304"

[[lecture03.questions]]

question = "A lesion of the basal portion of the pons would affect which?"

rightanswer = ["corticopontine fibers"]

wronganswer = ["reticular formation", "medial lemniscus", "trigeminothalamic tract", "spinothalamic 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.

"""

questionid = "0305"

[[lecture03.questions]]

question = "A stroke in the tegmentum of the pons would affect which?"

rightanswer = ["Medial lemniscus"]

wronganswer = ["Corticospinal tract", "Pontocerebellar fibers", "Corticopontine fibers", "Corticobulbar 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.

"""

questionid = "0306"

[[lecture03.questions]]

question = "Which of the following is in the midbrain tegmentum?"

rightanswer = ["red nucleus"]

wronganswer = ["superior colliculus", "periaqueductal gray", "substantia nigra", "corticospinal tract"]

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.

"""

questionid = "0307"

[[lecture03.questions]]

question = "Which of the following is found immediately ventral to (abutting) the midbrain tegmentum?"

rightanswer = ["Substantia nigra"]

wronganswer = ["Periaqueductal gray", "Red nucleus", "Inferior brachium", "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.

"""

questionid = "0308"

[[lecture03.questions]]

question = "The open portion of the medulla contains which?"

rightanswer = ["Caudal half of the fourth ventricle"]

wronganswer = ["Pyramidal decussation", "Superior brachium", "Inferior brachium", "Rostral half of the fourth ventricle"]

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.

"""

questionid = "0309"

[[lecture03.questions]]

question = "The closed portion of the medulla contains which?"

rightanswer = ["Continuation of the central canal"]

wronganswer = ["Superior brachium", "Inferior brachium", "Caudal half of the fourth ventricle", "Rostral half of the fourth ventricle"]

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

"""

questionid = "0310"

[[lecture03.questions]]

question = "Which is adjacent to the ventral median fissure of the medulla?"

rightanswer = ["Corticospinal tract"]

wronganswer = ["Superior brachium", "Inferior brachium", "Obex of the fourth ventricle", "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.

"""

questionid = "0311"

[[lecture03.questions]]

question = "Which interrupts the ventral median fissure at the spinomedullary junction?"

rightanswer = ["Pyramidal decussation"]

wronganswer = ["Superior brachium", "Inferior brachium", "Caudal half of the fourth ventricle", "Rostral half of the fourth ventricle"]

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.

"""

questionid = "0312"

[[lecture03.questions]]

question = "The lateral reticular area of the medulla contains neurons with which function?"

rightanswer = ["Coordination of cranial nerve reflexes"]

wronganswer = ["Production of serotonin", "Production of norepinephrine", "Generating error signals sent to the cerebellum", "Regulating burst mode of thalamocortical neurons"]

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.

"""

questionid = "0314"

[[lecture03.questions]]

question = "Which is the most complete and correct list of the longitudinal (rostrocaudal) fibers of the basal pons?"

rightanswer = ["Corticobulbar axons, corticospinal axons, corticopontine axons"]

wronganswer = ["Corticopontine axons, inferior cerebellar peduncle axons, middle cerebellar peduncle axons", "Corticomesencephalic axons, corticopontine axons, medial lemniscus axons", "Corticopontine axons, corticobulbar axons, middle cerebellar peduncle axons", "Middle cerebellar peduncle axons, corticobulbar axons, medial lemniscus 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.

"""

questionid = "0315"

[[lecture03.questions]]

question = "Which are axons of the superior brachium?"

rightanswer = ["Retinal axons projecting to the tectum"]

wronganswer = ["Lateral Geniculate Nucleus axons projecting to the tectum", "Tectal axons projecting to the Lateral Geniculate Nucleus", "Superior olivary axons projecting to the inferior colliculus", "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.

"""

questionid = "0317"

[[lecture03.questions]]

question = "Which neurons are in the mesencephalic nucleus of the trigeminal nerve?"

rightanswer = ["First order unipolar proprioceptive neurons"]

wronganswer = ["Second order pain and temperature neurons", "First order pain and temperature neurons", "Second order proprioceptive neurons", "Trigeminothalamic 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.

"""

questionid = "0318"

[[lecture03.questions]]

question = "Which axons comprise the crus cerebri?"

rightanswer = ["Corticospinal, corticobulbar, corticopontine"]

wronganswer = ["Corticospinal, frontopontine, temporopontine", "Frontopontine, temporopontine, parietopontine, occipitopontine", "Corticospinal, pyramidal, corticobulbar", "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.

"""

questionid = "0319"

[[lecture03.questions]]

question = "What is the destination of trigeminothalamic fibers?"

rightanswer = ["Ventral posteromedial nucleus"]

wronganswer = ["Ventral posterolateral nucleus", "Supraoptic nucleus", "Facial nucleus", "Chief (or main, or principal) sensory 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.

"""

questionid = "0321"

[[lecture03.questions]]

question = "Which is the path of olivocerebellar axons?"

rightanswer = ["Contralateral projection via the inferior cerebellar peduncle"]

wronganswer = ["Contralateral projection via the superior cerebellar peduncle", "Ipsilateral projection via the inferior cerebellar peduncle", "Ipsilateral projection via the superior cerebellar peduncle", "Contralateral projection via the middle 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.

"""

questionid = "0322"

[[lecture03.questions]]

question = "Which two structures are found in the lateral area of the medulla between the ventrolateral and dorsolateral sulci?"

rightanswer = ["Olive and trigeminal tubercle"]

wronganswer = ["Gracile and cuneate tubercle", "Inferior and middle cerebellar peduncle", "Left and right corticospinal tracts", "Gracile tubercle and spinal nucleus"]

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.

"""

questionid = "0323"

[[lecture03.questions]]

question = "What is the destination of trigeminal lemniscus?"

rightanswer = ["Ventral posteromedial nucleus"]

wronganswer = ["Ventral posterolateral nucleus", "Supraoptic nucleus", "Facial nucleus", "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.

"""

questionid = "0325"

[lecture04]

label = "#04 Cranial Nerves"

[[lecture04.questions]]

question = "A 65 year old man presents with a history of progressive weakness of the muscles of mastication, some difficulty in swallowing accompanied by rather raspy speech, difficulty in speaking and weakness of facial expression. What cranial nerve cell column is he suffering from lesions to?"

rightanswer = ["Pharyngeal (Branchial) motor"]

wronganswer = ["Somatic sensory", "Parasympathetic", "Somatic motor", "Special sensory"]

hint = "Distinguish the cranial nerve column related to eyes and tongue from that related to other head musculature"

explanation = """

Muscle weakness implicates either the somatic or the pharyngeal motor cranial nerve column. Cranial nerves 3, 4, 6, and 12 (oculomotor, trochlear, abducens, and hypoglossal) are the traditional somatic motor column, with nuclei located most medially. The pharyngeal motor column consists of cranial nerves 5, 7, 9, 10, and traditionally 11 (trigeminal, facial, glossopharyngeal, vagus, and spinal accessory). They control muscles of mastication, facial expression, speech, and swallowing as well as the sternocleidomastoid and trapezius neck muscles. The spinal accessory nerve, which controls those neck muscles, is now regarded as somatic. The most lateral motor column is the visceral or autonomic motor column. Cranial nerves 3, 7, 9, and 10 (oculomotor, facial, glossopharyngeal, and vagus) have autonomic motor nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0401"

[[lecture04.questions]]

question = "A 65 year old man has been experiencing progressive weakness of movements of the eyes and tongue. What cranial nerve cell column is he suffering from strokes to?"

rightanswer = ["Somatic motor"]

wronganswer = ["Pharyngeal motor", "Somatic sensory", "Parasympathetic", "Special sensory"]

hint = "Distinguish the cranial nerve column related to eyes and tongue from that related to other head musculature"

explanation = """

Muscle weakness implicates either the somatic or the pharyngeal motor cranial nerve column. Cranial nerves 3, 4, 6, and 12 (oculomotor, trochlear, abducens, and hypoglossal) are the traditional somatic motor column, with nuclei located most medially. The pharyngeal motor column consists of cranial nerves 5, 7, 9, 10, and traditionally 11 (trigeminal, facial, glossopharyngeal, vagus, and spinal accessory). They control muscles of mastication, facial expression, speech, and swallowing as well as the sternocleidomastoid and trapezius neck muscles. The spinal accessory nerve, which controls those neck muscles, is now regarded as somatic. The most lateral motor column is the visceral or autonomic motor column. Cranial nerves 3, 7, 9, and 10 (oculomotor, facial, glossopharyngeal, and vagus) have autonomic motor nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0402"

[[lecture04.questions]]

question = "An upper motor neuron (supranuclear) lesion of the facial nerve is produced by interrupting the corticobulbar fibers to the facial motor nucleus. Such a lesion on the left side of the brain will produce which?"

rightanswer = ["Only paralysis of the right lower face"]

wronganswer = ["Complete paralysis of the left side of the face", "Complete paralysis of the right side of the face", "Only paralysis of the left lower face", "No paralysis at all because the corticobulbar fibers are crossed and uncrossed"]

hint = "Distinguish bilateral vs contralateral corticobulbar projections"

explanation = """

The corticobulbar fibers controlling the upper face project bilaterally, and one side can retain control if the motor output from the other is lost. The lower face, however, has innervation from the contralateral side only, like the body below it.

"""

questionid = "0403"

[[lecture04.questions]]

question = "A stroke of the right corticobulbar tract in the genu of the internal capsule will result in which?"

rightanswer = ["Only paralysis of the left lower face"]

wronganswer = ["No paralysis because the left corticobulbar fibers end bilaterally in motor nuclei of the brainstem", "Complete paralysis of the right side of the face", "Only paralysis of the right lower face", "Complete paralysis of the right side of the face"]

hint = "Distinguish bilateral vs contralateral corticobulbar projections"

explanation = """

The corticobulbar fibers controlling the upper face project bilaterally, and one side can retain control if the motor output from the other is lost. The lower face, however, has innervation from the contralateral side only, like the body below it.

"""

questionid = "0404"

[[lecture04.questions]]

question = "A patient is diagnosed with a right medial medullary syndrome. What cranial nerve signs would you expect to see in this patient?"

rightanswer = ["Right tongue atrophy"]

wronganswer = ["Right facial paralysis", "Left tongue atrophy", "Left facial paralysis", "Left lower facial paralysis"]

hint = "Consider the cranial nerves and nuclei located at the level of the medulla"

explanation = """

A blockage of the anterior spinal artery, the vertebral artery, or the basilar artery can deprive the ventral and medial medulla of oxygen and result in medial medullary syndrome. The pyramid is affected because it is at the ventral surface, the hypoglossal nerve is affected, because this somatic motor nerve courses medially to exit ventrally, and the medial lemniscus is affected, because it lies as a dorsal to ventral ribbon adjacent to the midline of the rostral medulla. The pyramidal damage causes contralateral body paresis, the hypoglossal damage causes tongue weakness and deviation to the side of the lesion, and the medial lemniscus damage causes loss of touch, pressure, vibration, and position sense on the contralateral side of the body.

"""

questionid = "0405"

[[lecture04.questions]]

question = "A research subject is suspected of having a stroke. When he is asked to protrude his tongue, it deviates to the left. Where is the stroke?"

rightanswer = ["Left medial medullary syndrome"]

wronganswer = ["Left lateral medullary syndrome", "Right medial medullary syndrome", "Left genu of the internal capsule", "Right lateral medullary syndrome"]

hint = "Note which cranial nerve is involved and the level of the brainstem at which it and its nucleus are found."

explanation = """

A blockage of the anterior spinal artery, the vertebral artery, or the basilar artery can deprive the ventral and medial medulla of oxygen and result in medial medullary syndrome. The pyramid is affected because it is at the ventral surface, the hypoglossal nerve is affected, because this somatic motor nerve courses medially to exit ventrally, and the medial lemniscus is affected, because it lies as a dorsal to ventral ribbon adjacent to the midline of the rostral medulla. The pyramidal damage causes contralateral body paresis, the hypoglossal damage causes tongue weakness and deviation to the side of the lesion, and the medial lemniscus damage causes loss of touch, pressure, vibration, and position sense on the contralateral side of the body.

"""

questionid = "0406"

[[lecture04.questions]]

question = "To which cranial nerve component (column) do axons conveying hearing and balance belong?"

rightanswer = ["Special somatic sensory"]

wronganswer = ["Special visceral sensory", "Somatic sensory", "Visceral sensory", "Pharyngeal sensory"]

hint = "Begin by distinguishing sensory from motor cranial nerve columns"

explanation = """

The laterally located sensory cranial nerve columns are the special visceral or simply visceral or autonomic, the somatic, and the special somatic or simply special columns. Cranial nerves 7, 9, and 10 (facial, glossopharyngeal, and vagus) have visceral nuclei. Cranial nerve V, the trigeminal, has the somatic sensory nuclei (spinal, main or chief or principal, and mesencephalic). Cranial nerve 8, the vestibulocochlear nerve, has the special sensory nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0407"

[[lecture04.questions]]

question = "To which cranial nerve component (column) do axons of the trochlear nerve belong?"

rightanswer = ["Somatic motor"]

wronganswer = ["Special visceral motor", "Visceral motor", "Pharyngeal sensory", "Pharyngeal motor"]

hint = "Begin by identifying sensory vs motor"

explanation = """

The trochlear nerve is a motor nerve that controls the superior oblique eye muscle. Cranial nerves 3, 4, 6, and 12 (oculomotor, trochlear, abducens, and hypoglossal) are the traditional somatic motor column, with nuclei located most medially. The pharyngeal motor column consists of cranial nerves 5, 7, 9, 10, and traditionally 11 (trigeminal, facial, glossopharyngeal, vagus, and spinal accessory). They control muscles of mastication, facial expression, speech, and swallowing as well as the sternocleidomastoid and trapezius neck muscles. The spinal accessory nerve, which controls those neck muscles, is now regarded as somatic. The most lateral motor column is the visceral or autonomic motor column. Cranial nerves 3, 7, 9, and 10 (oculomotor, facial, glossopharyngeal, and vagus) have autonomic motor nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0408"

[[lecture04.questions]]

question = "Which is the cranial nerve component (column) of the hypoglossal nerve?"

rightanswer = ["Somatic motor"]

wronganswer = ["Special motor", "Somatic sensory", "Visceral motor", "Pharyngeal motor"]

hint = "Begin by identifying sensory vs motor"

explanation = """

The hypoglossal nerve is a motor nerve that controls the tongue. Cranial nerves 3, 4, 6, and 12 (oculomotor, trochlear, abducens, and hypoglossal) are the traditional somatic motor column, with nuclei located most medially. The pharyngeal motor column consists of cranial nerves 5, 7, 9, 10, and traditionally 11 (trigeminal, facial, glossopharyngeal, vagus, and spinal accessory). They control muscles of mastication, facial expression, speech, and swallowing as well as the sternocleidomastoid and trapezius neck muscles. The spinal accessory nerve, which controls those neck muscles, is now regarded as somatic. The most lateral motor column is the visceral or autonomic motor column. Cranial nerves 3, 7, 9, and 10 (oculomotor, facial, glossopharyngeal, and vagus) have autonomic motor nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0409"

[[lecture04.questions]]

question = "Which cranial nerves carry special visceral sensory fibers?"

rightanswer = ["Olfactory, facial, glossopharyngeal, vagus"]

wronganswer = ["Optic, vestibulocochlear", "Oculomotor, trochlear, abducens", "Glossopharyngeal, vagus, accessory, hypoglossal", "Glossopharyngeal, vagus, hypoglossal"]

hint = "Begin by identifying sensory vs motor"

explanation = """

The laterally located sensory cranial nerve columns are the special visceral or simply visceral or autonomic, the somatic, and the special somatic or simply special columns. Cranial nerves 7, 9, and 10 (facial, glossopharyngeal, and vagus) have visceral nuclei. Cranial nerve V, the trigeminal, has the somatic sensory nuclei (spinal, main or chief or principal, and mesencephalic). Cranial nerve 8, the vestibulocochlear nerve, has the special sensory nuclei. The medial to lateral ordering of the columns changes during development and is only a rough guide.

"""

questionid = "0410"

[[lecture04.questions]]

question = "Where are the cell bodies of third order neurons of cranial nerves?"

rightanswer = ["Thalamus"]

wronganswer = ["Cranial nerve sensory nuclei", "Cranial nerve motor nuclei", "Sensory ganglia", "Infranuclear"]

hint = "Primary sensory neurons are peripheral, secondary neurons are in the brainstem cranial nerve sensory nuclei"

explanation = """

Primary sensory neurons are peripheral, secondary neurons are in the brainstem cranial nerve sensory nuclei. Secondary neurons send axons that decussate and synapse on third order neurons in the thalamus, the relay to the cerebral cortex.

"""

questionid = "0411"

[[lecture04.questions]]

question = "Which is clinically the most obvious exception to the bilateral projection of cranial nerve upper motor neurons?"

rightanswer = ["Facial nerve"]

wronganswer = ["Hypoglossal nerve", "Trigeminal nerve", "Ambiguus nerve", "Mesencephalic nerve"]

hint = "consider the paralysis produced by corticobulbar damage"

explanation = """

The corticobulbar fibers controlling the upper face project bilaterally, and one side can retain control if the motor output from the other is lost. The lower face, however, has innervation from the contralateral side only, like the body below it. The facial nerve innervates the muscles of facial expression.

"""

questionid = "0413"

[[lecture04.questions]]

question = "What does the sulcus limitans divide?"

rightanswer = ["Sensory from motor nuclei"]

wronganswer = ["Spinal cord from medulla", "Somatic from pharyngeal nuclei", "Visceral from pharyngeal nuclei", "Open from closed medulla"]

hint = "The sulcus limitans is visible on the floor of the fourth ventricle and separates groups of cranial nerve columns"

explanation = """

The sulcus limitans is visible on the floor of the fourth ventricle. It separates the medially located cranial nerve motor columns from the laterally located sensory columns.

"""

questionid = "0414"

[[lecture04.questions]]

question = "An occlusion of the posterior inferior cerebellar artery likely causes which brainstem-related deficit?"

rightanswer = ["Contralateral loss of body pain and temperature sense"]

wronganswer = ["Contralateral facial paralysis", "Contralateral Horner's syndrome with miosis and ptosis", "Contralateral facial paralysis of lower face only", "Ipsilateral body paralysis"]

hint = "The posterior inferior cerebellar artery travels along the lateral surface of the medulla"

explanation = """

The posterior inferior cerebellar artery travels along the lateral surface of the medulla. Occlusion of the posterior inferior cerebellar artery results in lateral medullary syndrome or Wallenberg's syndrome. Lateral medullary syndrome, one of the most complex syndromes, includes ipsilateral loss of face pain and temperature due to damage to the spinal nucleus of the trigeminal, contralateral loss of body pain and temperature due to damage to the spinothalamic, and dysphagia, dysarthria, and dysphonia due to damage to the nucleus ambiguus. The gag reflex is affected. There may be ipsilateral Horner's syndrome with miosis and ptosis.

"""

questionid = "0417"

[[lecture04.questions]]

question = "Taste fibers that travel in the facial, glossopharyngeal, and vagus nerves project to which brainstem area?"

rightanswer = ["Rostral solitary nucleus"]

wronganswer = ["Caudal solitary nucleus", "Chief (or main, or principal) sensory nucleus", "Olfactory tubercle", "Anterior perforated substance"]

hint = "An alternate name for the gustatory receiving area is the gustatory nucleus"

explanation = """

The nucleus of the solitary tract has caudal and rostral divisions with different functions. The rostral division of the solitary tract nucleus receives taste fibers from the facial, glossopharyngeal, and vagus nerves. It is also called the gustatory nucleus. Unlike other second order neurons, neurons in the gustatory nucleus project ipsilaterally to higher centers.

"""

questionid = "0419"

[[lecture04.questions]]

question = "Which is caused by brainstem damage due to occlusion of a branch of the posterior cerebral artery, in addition to ipsilateral oculomotor (III) nerve palsy?"

rightanswer = ["Contralateral hemiparesis"]

wronganswer = ["Ipsilateral hemiparesis", "Ipsilateral hypoglossal nerve palsy", "Contralateral Horner's syndrome with miosis and ptosis", "Contralateral sympathetic autonomic deficits"]

hint = "The oculomotor nerve is somatic and exits the brainstem ventromedially"

explanation = """

Occlusion of a branch of the posterior cerebral artery can damage the ventral midbrain, Weber's syndrome, where the oculomotor nerve exits and the crus cerebri is located. Damage to the oculomotor nerve causes ipsilateral oculomotor palsy (partial eye movement paralysis) and damage to the crus cerebri causes contralateral body and lower face paralysis or paresis.

"""

questionid = "0420"

[[lecture04.questions]]

question = "Which syndrome includes ipsilateral loss of the gag reflex?"

rightanswer = ["Lateral medullary"]

wronganswer = ["Ventral midbrain", "Dorsal midbrain", "Medial medullary", "Medial midbrain"]

hint = "The gag reflex involves cranial motor nerves of the pharyngeal column"

explanation = """

The posterior inferior cerebellar artery travels along the lateral surface of the medulla. Occlusion of the posterior inferior cerebellar artery results in lateral medullary syndrome or Wallenberg's syndrome. Lateral medullary syndrome, one of the most complex syndromes, includes ipsilateral loss of face pain and temperature due to damage to the spinal nucleus of the trigeminal, contralateral loss of body pain and temperature due to damage to the spinothalamic, and dysphagia, dysarthria, and dysphonia due to damage to the nucleus ambiguus. The gag reflex is affected. There may be ipsilateral Horner's syndrome with miosis and ptosis.

"""

questionid = "0421"

[[lecture04.questions]]

question = "Which deficits will result from a stroke in the internal capsule that spares only the anterior limb?"

rightanswer = ["Contralateral hemiparesis and contralateral lower facial paralysis"]

wronganswer = ["Ipsilateral hemiparesis without facial paralysis", "Cognitive deficits and emotional lability", "Anterograde amnesia and emotional lability", "No clinically deficits upon routine testing"]

hint = "The posterior limb and genu of the internal capsule are affected"

explanation = """

The anterior limb of the internal capsule has frontal cortex axons involved in emotion, motivation, cognition processing, and decision making. The genu of the internal capsule contains the corticobulbar axons of the upper motor neurons for the facial motor nucleus that innervates the facial muscles. The upper face has bilateral upper motor neuron projections, the lower face projection is only contralateral, as is the corticospinal projection. The posterior limb of the internal capsule contains the contralaterally projecting corticospinal upper motor neuron axons. If both the genu and posterior limb are damaged, contralateral lower face and body will be paretic.

"""

questionid = "0422"

[[lecture04.questions]]

question = "Which is a list of only parasympathetic visceral motor nuclei?"

rightanswer = ["Edinger-Westphal, inferior and superior salivatory, dorsal motor nucleus of vagus"]

wronganswer = ["Trochlear, Horner's, superior and inferior salivatory", "Trochlear, Intermediolateral cell column", "Intermediolateral cell column, Edinger-Westphal, inferior salivatory", "Intermediolateral cell column, Edinger-Westphal, superior salivatory"]

hint = "The parasympathetic visceral motor nuclei are the autonomic motor nuclei"

explanation = """

The trochlear nucleus, cranial nerve 4, is somatic motor. The intermediolateral cell column is the thoracic lateral horn of the spinal cord and contains the preganglionic sympathetic neurons. Horner's is a sympathetic autonomic syndrome affecting the eye, not a nucleus. The Edinger-Westphal nucleus is the parasympathetic preganglionic nucleus for pupil constriction and ciliary muscle focusing of the eye. The inferior (for the parotid gland) and superior (for the submandibular and sublingual glands) salivatory nuclei provide parasympathetic control of the salivary glands. The dorsal motor nucleus of the vagus provides parasympathetic control of the pharynx and the vomiting (emetic) reflex.

"""

questionid = "0423"

[[lecture04.questions]]

question = "Where are corticobulbar axons located?"

rightanswer = ["Genu of internal capsule"]

wronganswer = ["Medial corticospinal tract", "Lateral corticospinal tract", "Posterior limb of internal capsule", "Anterior limb of internal capsule"]

hint = "The main cerebral output is via the internal capsule"

explanation = """

The anterior limb of the internal capsule has frontal cortex axons involved in emotion, motivation, cognition processing, and decision making. The genu of the internal capsule contains the corticobulbar axons of the upper motor neurons for the facial motor nucleus that innervates the facial muscles. The upper face has bilateral upper motor neuron projections, the lower face projection is only contralateral, as is the corticospinal projection. The posterior limb of the internal capsule contains the contralaterally projecting corticospinal upper motor neuron axons. If both the genu and posterior limb are damaged, contralateral lower face and body will be paretic.

"""

questionid = "0424"

[[lecture04.questions]]

question = "Where are the special sensory cranial nerve nuclei located?"

rightanswer = ["Caudal pons and rostral medulla"]

wronganswer = ["Caudal diencephalon and rostral midbrain", "Midbrain tectum", "Caudal midbrain and rostral pons", "Caudal medulla and rostral spinal cord"]

hint = "These are the nerves of balance and hearing"

explanation = """

There is a single special sensory cranial nerve, the vestibulocochlear eighth nerve. It has several associated cranial nerve sensory nuclei, including four vestibular nuclei, superior, medial, lateral, and inferior, and two major auditory sensory nuclei, the dorsal and ventral cochlear nuclei. These nuclei are all located in the rostral medulla and caudal pons, mostly following the rule of fours. The rule of fours is that cranial nerves 1-4 have nuclei and exits at the midbrain and above, cranial nerves 5-8 at the level of the pons, and 9-12 at the medulla and below.

"""

questionid = "0425"

[lecture05]

label = "#05 Diencephalon"

[[lecture05.questions]]

question = "The sensory relay nuclei of the thalamus that project to primary sensory areas of the cortex are which?"

rightanswer = ["Ventral posterolateral, ventral posteromedial, medial geniculate, and lateral geniculate"]

wronganswer = ["Dorsomedial, lateral posterior, and pulvinar", "Ventral anterior and ventral lateral", "Reticular, intralaminar, and midline", "Anterior and lateral dorsal"]

hint = "Begin by distinguishing specific thalamic sensory relay nuclei from thalamic nuclei that mediate arousal or burst and tonic modes of firing"

explanation = """

The specific sensory relay nuclei of the thalamus carry somatic sense, hearing, and vision to primary cortical sensory areas. They are the ventral posterolateral for contralateral body sensations, the ventral posteromedial for contralateral face sensations, the medial geniculate for bilateral hearing, and the lateral geniculate for the contralateral hemifield of vision.

"""

questionid = "0501"

[[lecture05.questions]]

question = "The ventral posterolateral, ventral posteromedial, medial geniculate, and lateral geniculate nuclei of the thalamus are characterized by which?"

rightanswer = ["Specific inputs and projecting to sensory areas of cortex"]

wronganswer = ["Specific inputs and projecting to motor areas of cortex", "Switching thalamocortical neurons between tonic and burst modes", "Integrating different cortical areas", "Specific inputs and projecting to limbic areas of cortex"]

hint = "Begin by distinguishing specific thalamic sensory relay nuclei from thalamic nuclei that mediate arousal or burst and tonic modes of firing"

explanation = """

The specific sensory relay nuclei of the thalamus carry somatic sense, hearing, and vision to primary cortical sensory areas. They are the ventral posterolateral for contralateral body sensations, the ventral posteromedial for contralateral face sensations, the medial geniculate for bilateral hearing, and the lateral geniculate for the contralateral hemifield of vision.

"""

questionid = "0502"

[[lecture05.questions]]

question = "A lesion restricted to the ventral posterolateral (VPL) thalamic nucleus results initially in loss of sensation from which?"

rightanswer = ["Contralateral half of the body"]

wronganswer = ["Contralateral half of the head and body", "Ipsilateral half of the body", "Ipsilateral half of the head and body", "Contralateral half of the head"]

hint = "Spinal and bulbar signals project to separate subdivisions of the ventral posterior nucleus"

explanation = """

The specific sensory relay nuclei of the thalamus carry somatic sense, hearing, and vision to primary cortical sensory areas. They are the ventral posterolateral for contralateral body sensations, the ventral posteromedial for contralateral face sensations, the medial geniculate for bilateral hearing, and the lateral geniculate for the contralateral hemifield of vision

"""

questionid = "0503"

[[lecture05.questions]]

question = "The thalamic syndrome of Dejerine-Roussy (lesion destroying the Ventral Posterior Nucleus of thalamus) results initially in loss of sensation from which?"

rightanswer = ["Contralateral half of the head and body"]

wronganswer = ["Ipsilateral half of the head and body", "Contralateral half of the body only", "Ipsilateral half of the head only", "Ipsilateral half of the body only"]

hint = "Both divisions of the ventral posterior nucleus are affected"

explanation = """

The ventral posterolateral nucleus carries contralateral body sensations, the ventral posteromedial carries contralateral face (head) sensations.

"""

questionid = "0504"

[[lecture05.questions]]

question = "Which of the following describes the organization of the hypothalamus?"

rightanswer = ["It is divided from medial to lateral into periventricular, medial, and lateral zones"]

wronganswer = ["The lateral group of nuclei is divided into dorsal and ventral tiers", "It contains the subthalamic nucleus", "It consists of the habenular nuclei and pineal gland", "It is divided into lateral, medial, and anterior nuclei by the internal medullary lamina"]

hint = "The hypothalamus is divided topographically, either anterior to posterior or medial to lateral"

explanation = """

The hypothalamus is divided topographically, either anterior to posterior (rostral to caudal) or medial to lateral. The medial to lateral sequence is periventricular, medial, and lateral zones. The anterior to posterior sequence is preoptic, anterior, middle or tuberal (referring to the tuber cinereum), and posterior zones. The dorsal and ventral tiers and the internal medullary lamina are features of the thalamus.

"""

questionid = "0505"

[[lecture05.questions]]

question = "Which of the following describes a feature of the organization of the hypothalamus?"

rightanswer = ["It is divided from front to back into four regions of nuclei: preoptic, anterior, middle, and posterior"]

wronganswer = ["It contains the subthalamic nucleus", "It is divided into lateral, medial, and anterior nuclei by the internal medullary lamina", "The lateral group of nuclei is divided into dorsal and ventral tiers", "It contains the pineal gland"]

hint = "The hypothalamus is divided topographically, either anterior to posterior or medial to lateral"

explanation = """

The hypothalamus is divided topographically, either anterior to posterior (rostral to caudal) or medial to lateral. The medial to lateral sequence is periventricular, medial, and lateral zones. The anterior to posterior sequence is preoptic, anterior, middle or tuberal (referring to the tuber cinereum), and posterior or mammillary zones. The dorsal and ventral tiers and the internal medullary lamina are features of the thalamus.

"""

questionid = "0506"

[[lecture05.questions]]

question = "Which describes the ventromedial and lateral nuclei of the hypothalamus?"

rightanswer = ["Are responsible for the regulation of eating behavior"]

wronganswer = ["Control the wake-sleep cycle", "Receive their principal input from the postcommissural fibers of the fornix", "Control water balance", "Contain neurons that respond to an increase in blood temperature"]

hint = "Famous early hypothalamic lesion studies involved ventromedial nucleus lesions"

explanation = """

The lateral hypothalamus motivates appetitive behavior. Lateral hypothalamic lesions stop eating behaviors and the animal wastes away. The ventromedial hypothalamus controls satiety. In some animals, ventromedial hypothalamic lesions cause extreme obesity.

"""

questionid = "0508"

[[lecture05.questions]]

question = "Which structures comprise the epithalamus?"

rightanswer = ["Habenula, pineal gland"]

wronganswer = ["Suprachiasmatic nucleus, medial geniculate nucleus, lateral geniculate nucleus", "Suprachiasmatic nucleus, pineal gland", "Ventral posteromedial nucleus, ventral posterolateral nucleus", "Septal nuclei, stria medullaris thalami"]

hint = "The epithalamus includes a little-discussed limbic structure and a part of circadian circuitry"

explanation = """

The epithalamus includes a little-discussed limbic structure the habenula, and an important part of circadian circuitry, the melatonin-producing pineal gland. The habenula has complex inputs via the stria medullaris, including from the ventral basal ganglia and various limbic structures. The habenula has complex outputs to the brainstem tegmentum, thought to be involved in pain and other aspects of motivation. The pineal gland has input relayed from the circadian master clock in the suprachiasmatic nucleus of the hypothalamus. The output of the pineal gland is secretion of melatonin to promote sleep.

"""

questionid = "0509"

[[lecture05.questions]]

question = "Which of the thalamic nuclear groups is related to prefrontal association cortex?"

rightanswer = ["Medial"]

wronganswer = ["Anterior", "Lateral", "Preoptic", "Supraoptic"]

hint = "Eliminate the specific sensory nuclear groups"

explanation = """

The three thalamic nuclear groups are the anterior, medial, and lateral. The anterior nucleus divisions dominate the anterior group. The anterior nucleus gets limbic system input and projects to prefrontal association cortex and anterior cingulate cortex.

"""

questionid = "0511"

[[lecture05.questions]]

question = "Where is the reticular nucleus of the thalamus?"

rightanswer = ["Overlying the external medullary lamina on the lateral surface of the thalamus"]

wronganswer = ["In the brainstem tegmentum from medulla to midbrain", "Within the internal medullary lamina of the thalamus", "Spread diffusely throughout the thalamus", "In the central core region of the specific thalamic relay nuclei"]

hint = "Do not confuse the thalamic reticular nucleus with the brainstem reticular neuromodulatory areas"

explanation = """

The reticular thalamic nucleus is a thin nucleus that overlies the surface of the lateral thalamus, separated from it by the external medullary lamina. Reticular thalamic nucleus neurons project into the thalamus to regulate burst versus tonic firing of thalamic specific relay neurons.

"""

questionid = "0512"

[[lecture05.questions]]

question = "What is the function of the intralaminar thalamic nuclei?"

rightanswer = ["Increasing arousal"]

wronganswer = ["Corticolimbic relay", "Motor relay", "Association relay", "Corticothalamic relay"]

hint = "The intralaminar nuclei have a different function from the medial or lateral geniculate nucleus"

explanation = """

The intralaminar thalamic nuclei in the internal medullary lamina are neuromodulatory. They increase excitability of the thalamus and areas beyond via projections to several other parts of the brain.

"""

questionid = "0513"

[[lecture05.questions]]

question = "Which is a major nucleus of the subthalamus?"

rightanswer = ["Subthalamic nucleus"]

wronganswer = ["Tuber cinereum", "Adenohypophysis", "Pineal gland", "Suprachiasmatic nucleus"]

hint = "There is one widely recognized nucleus of the subthalamus"

explanation = """

There is one widely recognized nucleus of the subthalamus, the subthalamic nucleus, which has a major role in the basal ganglia indirect pathway that inhibits movement.

"""

questionid = "0514"

[[lecture05.questions]]

question = "The suprachiasmatic nucleus influences which diencephalic structure?"

rightanswer = ["Pineal gland"]

wronganswer = ["Habenula", "Substantia nigra pars compacta", "Dejerine-Roussy", "Lateral geniculate nucleus (LGN)"]

hint = "The suprachiasmatic nucleus is the master clock of the circadian system"

explanation = """

Circadian rhythms of sleep and wakefulness are governed by suprachiasmatic nucleus activity that follows a 24 hour cycle. Suprachiasmatic nucleus activity is cycled by its genetic expressions and influenced by light input from specialized ganglion cells of the retina. Suprachiasmatic nucleus output is relayed via the hypothalamus, intermediolateral cell column, and superior cervical ganglion to the pineal gland, which secretes melatonin to promote sleep. Damage to the suprachiasmatic nucleus disrupts sleep, resulting in very irregular sleep patterns.

"""

questionid = "0517"

[[lecture05.questions]]

question = "Where is the massa intermedia?"

rightanswer = ["Between the left and right thalamus"]

wronganswer = ["Between the diencephalon and mesencephalon", "Adjacent to the intralaminar nuclei", "Adjacent to the reticular nucleus", "Under the cerebral aqueduct"]

hint = "It is also called the interthalamic adhesion"

explanation = """

The massa intermedia or interthalamic adhesion joins the left and right thalamus at the midline, though it does not contain any major interconnections, and it is absent in some people. It is surrounded by the third ventricle.

"""

questionid = "0518"

[[lecture05.questions]]

question = "Thalamic syndrome includes emotional instability, dysesthesia, and what else?"

rightanswer = ["Intractable pain"]

wronganswer = ["Anterograde amnesia", "Retrograde amnesia", "Ipsilateral sensory loss in the body and usually the head", "Bilateral loss of pain and temperature sensitivity"]

hint = "Thalamic syndrome results from damage to the ventral posterior thalamic nucleus"

explanation = """

Thalamic syndrome initially exhibits loss of contralateral body and head sensation due to interruption of somatic sensory signals that were relayed by the ventral posterolateral and ventral posteromedial nuclei. This is eventually followed by emotional instability, dysesthesia, and intractable pain. There is no obvious explanation for these later symptoms.

"""

questionid = "0519"

[[lecture05.questions]]

question = "Extending from the ventral surface of the hypothalamus is the tuber cinereum and what?"

rightanswer = ["Neurohypophysis"]

wronganswer = ["Anterior pituitary", "Massa intermedia", "Tuberomammillary nucleus", "Reticular nucleus"]

hint = "The tuber cinereum is adjacent to the mammillary bodies"

explanation = """

The tuber cinereum lies at the base of the neurohypophysis or infundibulum, the pituitary stalk. The tuber cinereum is generally removed with the brain along with some infundibulum when the brain is removed, but its pituitary gland remains enclosed in the sella turcica in the skull.

"""

questionid = "0520"

[[lecture05.questions]]

question = "The fornix passes through the hypothalamus to synapse where?"

rightanswer = ["Mammillary body"]

wronganswer = ["Amygdala", "Cingulate gyrus", "Anterior nucleus of the thalamus", "Medial dorsal nucleus (dorsomedial nucleus) of the thalamus"]

hint = "This is part of the Papez circuit"

explanation = """

The Papez circuit is the basic limbic loop. It can be traced from cingulate cortex. Posterior cingulate cortex axons project via several steps in parahippocampal temporal cortex to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project via the mammillothalamic tract to the anterior thalamus. The anterior thalamus projects via the thalamic radiations to the cingulate cortex, completing the Papez circuit limbic loop.

"""

questionid = "0521"

[[lecture05.questions]]

question = "According to the review article by Janig et al. 2006, what is the proposed order of the four medial to lateral functional zones of the hypothalamus?"

rightanswer = ["Neuroendocrine, circadian, visceral motor, behavioral control"]

wronganswer = ["Appetitive, thermoregulatory, osmotic regulatory, reproductive", "Medial, intermediate, tuberomammillary, lateral", "Periventricular, intermediate, tuberomammillary, lateral", "Periventricular, medial, tuberomammillary, lateral"]

hint = "The highest functions are most lateral"

explanation = """

The four Janig hypothalamic functional zones from medial to lateral are endocrine, circadian, visceral motor, and behavioral control. One may regard these as progressing from most simple and fundamental to most complex and advanced neuronal functions.

"""

questionid = "0522"

[[lecture05.questions]]

question = "Destruction of which hypothalamic nucleus most directly disrupts sleep cycles?"

rightanswer = ["Suprachiasmatic"]

wronganswer = ["Supraoptic", "Reticular", "Tuberomammillary", "Subthalamic"]

hint = "The master biological clock controls sleep cycles"

explanation = """

Circadian rhythms of sleep and wakefulness are governed by suprachiasmatic nucleus activity that follows a 24 hour cycle. Suprachiasmatic nucleus activity is cycled by its genetic expressions and influenced by light input from specialized ganglion cells of the retina. Suprachiasmatic nucleus output is relayed via the hypothalamus, intermediolateral cell column, and superior cervical ganglion to the pineal gland, which secretes melatonin to promote sleep. Damage to the suprachiasmatic nucleus disrupts sleep, resulting in very irregular sleep patterns.

"""

questionid = "0523"

[[lecture05.questions]]

question = "Which hypothalamic structure provides a major input to the anterior thalamic nucleus?"

rightanswer = ["Mammillary body"]

wronganswer = ["Anterior", "Tuberomammillary", "Interthalamic adhesion", "Massa intermedia"]

hint = "This is part of the Papez circuit"

explanation = """

The Papez circuit is the basic limbic loop. It can be traced from cingulate cortex. Posterior cingulate cortex axons project via several steps in parahippocampal temporal cortex to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project via the mammillothalamic tract to the anterior thalamus. The anterior thalamus projects via the thalamic radiations to the cingulate cortex, completing the Papez circuit limbic loop.

"""

questionid = "0524"

[[lecture05.questions]]

question = "Which of the thalamic nuclear groups is related to cingulate cortex?"

rightanswer = ["Anterior"]

wronganswer = ["Medial", "Lateral", "Preoptic", "Supraoptic"]

hint = "This is part of the Papez circuit"

explanation = """

The Papez circuit is the basic limbic loop. It can be traced from cingulate cortex. Posterior cingulate cortex axons project via several steps in parahippocampal temporal cortex to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project via the mammillothalamic tract to the anterior thalamus. The anterior thalamus projects via the thalamic radiations to the cingulate cortex, completing the Papez circuit limbic loop.

"""

questionid = "0525"

[[lecture05.questions]]

question = "Which hypothalamic region facilitates body heat conservation?"

rightanswer = ["Posterior"]

wronganswer = ["Tuberomammillary", "Supraoptic", "Ventromedial", "Lateral"]

hint = "This is best answered in terms of the rostrocaudal hypothalamic zones"

explanation = """

Several hypothalamic nuclei, areas, or regions can be linked to specific regulatory functions. The ventromedial (or ventral medial tuberal) and lateral hypothalamus regulate satiety and hunger, respectively. The posterior hypothalamus regulates body heat conservation. The medial preoptic nucleus contains neurons that are heat sensitive and command heat loss mechanisms including sweating. Other medial preoptic neurons detect water loss and drive behaviors to restore water.

"""

questionid = "0526"

[lecture06]

label = "#06 Neuromodulatory Systems"

[[lecture06.questions]]

question = "Where is the locus coeruleus located?"

rightanswer = ["Dorsal pons"]

wronganswer = ["Dorsal medulla", "Dorsal midbrain", "Ventral medulla", "Ventral pons"]

hint = "The locus coeruleus is the primary source of norepinephrine in the brain"

explanation = """

Norepinephrine is produced by neurons of the locus coeruleus in the dorsolateral pons, which have long ascending and descending axons that provide norepinephrine throughout the brain. Norepinephrine is a major arousal neuromodulator. The locus coeruleus is an important component of the ascending reticular activating system.

"""

questionid = "0601"

[[lecture06.questions]]

question = "Which enzyme is required for production of norepinephrine but not dopamine?"

rightanswer = ["Dopamine beta hydroxylase"]

wronganswer = ["Tyrosine hydroxylase", "Dopa decarboxylase", "Tryptophan hydroxylase", "5-HTP decarboxylase"]

hint = "norepinephrine is one metabolic step beyond dopamine"

explanation = """

The amine neurotransmitters are generally made from amino acids with a hydroxylase enzyme followed by a decarboxylase enzyme, with further steps to make additional neurotransmitters. Tyrosine is converted by tyrosine hydroxylase to levodopa, l-dopa, which is converted by dopa decarboxylase to dopamine. If dopamine beta hydroxylase is present, dopamine is converted to norepinephrine. Further steps can follow for epinephrine, etc. Serotonin is made from tryptophan. Tryptophan is converted to 5-hydroxytryptophan (5 HTP) by tryptophan hydroxylase. 5-HTP is converted to serotonin (5 HT) by 5 HTP decarboxylase. Monoamine oxidases break down the amine neurotransmitters. Catechol-O-methyl transferase (COMT) breaks down the catecholamine neurotransmitters dopamine and norepinephrine.

"""

questionid = "0602"

[[lecture06.questions]]

question = "Which neuromodulator is most directly associated with reward prediction?"

rightanswer = ["Dopamine"]

wronganswer = ["Acetylcholine", "Norepinephrine", "Serotonin", "Substance P"]

hint = "The reward neurotransmitter is also vital for motor activity"

explanation = """

Dopamine is a catecholamine neurotransmitter that has major functions in motor behavior and internal reward mechanisms. Dopamine is produced mainly in the midbrain by the substantia nigra pars compacta and the ventral tegmental area, which have long ascending axons that terminate throughout the higher brain regions. Loss of dopamine with degeneration of the substantia nigra in Parkinson's disease results in reduced motor abilities. Replacement of dopamine as a therapy for Parkinson's disease can result in inappropriate reward-seeking behavior.

"""

questionid = "0603"

[[lecture06.questions]]

question = "Which neuromodulator is found in the pedunculopontine and laterodorsal tegmental nuclei of the pons?"

rightanswer = ["Acetylcholine"]

wronganswer = ["Galanin", "Muscarine", "Histamine", "Gamma Amino Butyric Acid (GABA)"]

hint = "The same neurotransmitter is found in the basal forebrain"

explanation = """

Acetylcholine acts as an arousal neuromodulatory neurotransmitter. Neuromodulatory acetylcholine is produced mainly by the neurons of the basal forebrain, in areas including the nucleus basalis of Meynert, and also in two nuclei of the pontine tegmentum, the pedunculopontine nucleus and the laterodorsal tegmental nucleus. The pontine acetylcholine neurons are involved in the wake-sleep cycle, with acetylcholine levels being high during wakefulness and rapid eye movement sleep (REM sleep) and low during slow wave sleep.

"""

questionid = "0606"

[[lecture06.questions]]

question = "Which is a prominent inhibitory peptide neuromodulator?"

rightanswer = ["Galanin"]

wronganswer = ["Acetylcholine", "Muscarine", "Histamine", "Gamma Amino Butyric Acid (GABA)"]

hint = "First identify excitatory vs inhibitory neurotransmitters"

explanation = """

Known inhibitory neuromodulator neurotransmitters are less numerous than excitatory ones. The main inhibitory neurotransmitter throughout the central nervous system is gamma amino butyric acid or GABA. Glycine is also an inhibitory amine neurotransmitter. The most prominent inhibitory peptide neurotransmitter is galanin, which is widespread in the nervous system. Galanin inhibits the excitatory neuromodulators and promotes sleep.

"""

questionid = "0607"

[[lecture06.questions]]

question = "Where are the cell bodies of noradrenergic (norepinephrinergic) neurons?"

rightanswer = ["Locus coeruleus"]

wronganswer = ["Substantia nigra (SNc)", "Tuberomammillary nucleus", "Raphe nuclei", "Basal forebrain"]

hint = "Identify the nucleus that produces norepinephrine"

explanation = """

Norepinephrine is produced by neurons of the locus coeruleus in the dorsolateral pons, which have long ascending and descending axons that provide norepinephrine throughout the brain. Norepinephrine is a major arousal neuromodulator. The locus coeruleus is an important component of the ascending reticular activating system.

"""

questionid = "0610"

[[lecture06.questions]]

question = "Where are the cell bodies of dopaminergic neurons?"

rightanswer = ["Substantia nigra (SNc)"]

wronganswer = ["Locus coeruleus", "Tuberomammillary nucleus", "Raphe nuclei", "Basal forebrain"]

hint = "Dopamine loss accompanies Parkinson's disease"

explanation = """

Dopamine is a catecholamine neurotransmitter that has major functions in motor behavior and internal reward mechanisms. Dopamine is produced mainly in the midbrain by the substantia nigra pars compacta and the ventral tegmental area, which have long ascending axons that terminate throughout the higher brain regions. Loss of dopamine with degeneration of the substantia nigra in Parkinson's disease results in reduced motor abilities. Replacement of dopamine as a therapy for Parkinson's disease can result in inappropriate reward-seeking behavior.

"""

questionid = "0611"

[[lecture06.questions]]

question = "Where are the cell bodies of cholinergic neuromodulatory neurons?"

rightanswer = ["Basal forebrain"]

wronganswer = ["Substantia nigra (SNc)", "Locus coeruleus", "Tuberomammillary nucleus", "Raphe nuclei"]

hint = "Alzheimer's disease is believed to result from loss of cholinergic neuromodulatory neurons"

explanation = """

Acetylcholine acts as an arousal neuromodulatory neurotransmitter. Neuromodulatory acetylcholine is produced mainly by the neurons of the basal forebrain, in areas including the nucleus basalis of Meynert, and also in two nuclei of the pontine tegmentum, the pedunculopontine nucleus and the laterodorsal tegmental nucleus. The pontine acetylcholine neurons are involved in the wake-sleep cycle, with acetylcholine levels being high during wakefulness and rapid eye movement sleep (REM sleep) and low during slow wave sleep.

"""

questionid = "0612"

[[lecture06.questions]]

question = "What disease is believed to result from loss of cell bodies of cholinergic neuromodulatory neurons?"

rightanswer = ["Alzheimer's"]

wronganswer = ["Parkinson's", "Huntington's", "Pick's", "Hemiballismus"]

hint = "These cell bodies lie at the base of the forebrain"

explanation = """

Alzheimer's disease is believed to result from loss of cholinergic neuromodulatory neurons, leading to depression of the cerebral cortex. There is little effective treatment for Alzheimer's disease, with most promising treatments acting on the cholinergic neuromodulatory system.

"""

questionid = "0613"

[[lecture06.questions]]

question = "What is the most universal aspect of a neuromodulator's action?"

rightanswer = ["It is G protein coupled"]

wronganswer = ["It has rapid onset", "It has rapid termination", "It has precisely placed synapses", "It originates from billions of widely dispersed cell bodies"]

hint = "Contrast neuromodulators with neurotransmitters that act directly to alter ion channels"

explanation = """

Direct ion channel neurotransmission is inherently rapid and discrete. It is delayed only by cleft transport and action upon binding at receptors, and it does not spread beyond the closely apposed pre- and post-synaptic elements. Neuromodulators may be released at axonal varicosities located at a distance from their site of action, rather than at discrete synapses. Neuromodulators are also called second messenger neurotransmitters. They act via G protein coupled mechanisms that alter enzymatic activity and thus indirectly, slowly, and profoundly alter neuronal excitability. There are many G protein coupled actions. The most common action is via adenylate cyclase and protein kinase to phosphorylate membrane proteins and thus alter membrane properties.

"""

questionid = "0614"

[[lecture06.questions]]

question = "Which correctly matches a neuromodulator with its principal nucleus of origin?"

rightanswer = ["Serotonin, Raphe nuclei"]

wronganswer = ["Acetylcholine, Hypothalamus", "Serotonin, Hypothalamus", "Histamine, Locus Coeruleus", "Dopamine, Hypothalamus"]

hint = "Consider the neurotransmitter thought to be involved in depression"

explanation = """

Serotonin is produced by the widespread raphe nuclei and sent by long ascending and descending axons throughout the central nervous system.

Acetylcholine::Basal forebrain, two pontine nuclei.

Dopamine::substantia nigra pars compacta, ventral tegmental area.

Histamine::tuberomammillary nucleus of hypothalamus.

Norepinephrine::locus coeruleus.

Serotonin::raphe nuclei of brainstem.

"""

questionid = "0615"

[[lecture06.questions]]

question = "Which is a common feature of the initial synthetic step for Dopamine and Serotonin?"

rightanswer = ["Hydroxylase enzyme"]

wronganswer = ["Tyrosine amino acid", "Tryptophan amino acid", "Monoamine oxidase", "5-HTP"]

hint = "Dopamine is synthesized from tyrosine, serotonin from tryptophan"

explanation = """

The amine neurotransmitters are generally made from amino acids with a hydroxylase enzyme followed by a decarboxylase enzyme, with further steps to make additional neurotransmitters. Tyrosine is converted by tyrosine hydroxylase to levodopa, l-dopa, which is converted by dopa decarboxylase to dopamine. If dopamine beta hydroxylase is present, dopamine is converted to norepinephrine. Further steps can follow for epinephrine, etc. Serotonin is made from tryptophan. Tryptophan is converted to 5 hydroxytryptophan (5 HTP) by tryptophan hydroxylase. 5 HTP is converted to serotonin (5HT, 5 hydroxy tryptamine) by 5 HTP decarboxylase. Monoamine oxidases break down the amine neurotransmitters. Catechol-O-methyl transferase (COMT) breaks down the catecholamine neurotransmitters dopamine and norepinephrine.

"""

questionid = "0616"

[[lecture06.questions]]

question = "Which is a feature of direct ion channel neurotransmission that is not shared by neuromodulators?"

rightanswer = ["Rapid and discrete action"]

wronganswer = ["Amplification of effects by enzymes that convert multiple molecules", "Wide variety of potential ultimate effects", "Phosphorylation of membrane proteins", "Control of overall neuronal excitability"]

hint = "Contrast neuromodulators with neurotransmitters that act directly to alter ion channels"

explanation = """

Direct ion channel neurotransmission is inherently rapid and discrete. It is delayed only by cleft transport and action upon binding at receptors, and it does not spread beyond the closely apposed pre- and post-synaptic elements. Neuromodulators may be released at axonal varicosities located at a distance from their site of action, rather than at discrete synapses. Neuromodulators are also called second messenger neurotransmitters. They act via G protein coupled mechanisms that alter enzymatic activity and thus indirectly, slowly, and profoundly alter neuronal excitability. There are many G protein coupled actions. The most common action is via adenylate cyclase and protein kinase to phosphorylate membrane proteins and thus alter membrane properties.

"""

questionid = "0617"

[[lecture06.questions]]

question = "Cocaine and amphetamines share which neuromodulatory action?"

rightanswer = ["Increase of the duration and spatial extent of dopamine action"]

wronganswer = ["Reduction of the duration and spatial extent of dopamine action", "Increasing the activity of the dopamine transporter", "Increasing the activity of the serotonin transporter", "Reduction of symptoms of schizophrenia"]

hint = "Cocaine and amphetamines act at catecholaminergic synapses"

explanation = """

Cocaine and amphetamines have multiple actions, most directly affecting dopamine and norepinephrine. They reduce reuptake of dopamine and norepinephrine by reducing activity of the dopamine transporter (DAT) and norepinephrine transporter (NET). This increases the duration and spatial extent of dopamine and norepinephrine action. Cocaine and amphetamines mimic internal reward mechanisms that act via dopamine release.

"""

questionid = "0618"

[[lecture06.questions]]

question = "Which is a second location of the cell bodies of dopaminergic neurons?"

rightanswer = ["Ventral tegmental area (VTA)"]

wronganswer = ["Substantia nigra pars reticulata (SNr)", "Striatum", "Horizontal limb of the diagonal band of Broca (HDB)", "Nucleus basalis of Meynert"]

hint = "The secondary area of dopamine cell bodies is near the primary area"

explanation = """

The ventral tegmental area (VTA) is located in the midbrain. The VTA is medial and partly ventral to the substantia nigra pars compacta. A summary of neuromodulator areas and transmitters is:

Acetylcholine::Basal forebrain, two pontine nuclei.

Dopamine::substantia nigra pars compacta, ventral tegmental area.

Histamine::tuberomammillary nucleus of hypothalamus.

Norepinephrine::locus coeruleus.

Serotonin::raphe nuclei of brainstem.

"""

questionid = "0619"

[[lecture06.questions]]

question = "What disorder results from loss of the subthalamic nucleus?"

rightanswer = ["Hemiballismus"]

wronganswer = ["Parkinson's", "Huntington's", "Alzheimer's", "Pick's"]

hint = "The subthalamic nucleus is part of the indirect pathway of the basal ganglia"

explanation = """

Important basal ganglia disease correlations are:

Parkinson's disease::substantia nigra pars compacta

Huntington's disease::D2 striatal neurons

Hemiballism::subthalamic nucleus

"""

questionid = "0620"

[[lecture06.questions]]

question = "What disease progresses from loss of the D2 striatal neurons?"

rightanswer = ["Huntington's"]

wronganswer = ["Parkinson's", "Alzheimer's", "Pick's", "Hemiballismus"]

hint = "An early part of the indirect pathway of the basal ganglia is involved"

explanation = """

Important basal ganglia disease correlations are:

Parkinson's disease::substantia nigra pars compacta

Huntington's disease::D2 striatal neurons

Hemiballism::subthalamic nucleus

"""

questionid = "0621"

[[lecture06.questions]]

question = "What disease results from loss of substantia nigra (SNc) neurons?"

rightanswer = ["Parkinson's"]

wronganswer = ["Huntington's", "Alzheimer's", "Pick's", "Hemiballismus"]

hint = "The direct and indirect pathways of the basal ganglia are both affected, but the root cause lies elsewhere"

explanation = """

The substantia nigra pars compacta has dopamine neurons that release dopamine in the striatum at D1 and D2 receptor-expressing striatal projection neurons, depressing the excitatory direct pathway and enhancing the inhibitory indirect pathway. Important basal ganglia disease correlations are:

Parkinson's disease::substantia nigra pars compacta

Huntington's disease::D2 striatal neurons

Hemiballism::subthalamic nucleus

"""

questionid = "0622"

[[lecture06.questions]]

question = "Where are the raphe nuclei located?"

rightanswer = ["Brainstem midline"]

wronganswer = ["Dorsolateral pontine tegmentum", "Midbrain (mesencephalon)", "Basal forebrain", "Hypothalamus"]

hint = "The serotonergic nuclei are among the most widespread of neuromodulator nuclei"

explanation = """

Raphe refers to the midline seam of the brainstem. Serotonergic raphe nuclei are narrow structures found from medulla through midbrain along the raphe. The raphe nuclei appear very big from a lateral view, but small and thin when looking up or down the brainstem.

"""

questionid = "0623"

[[lecture06.questions]]

question = "What is the effect of blocking DAT or NET (SLC6A2)?"

rightanswer = ["Increased catecholamine levels"]

wronganswer = ["Decreased catecholamine levels", "Decreased arousal", "Increased acetylcholine levels", "Decreased acetylcholine levels"]

hint = "Some drugs act primarily in this manner"

explanation = """

Cocaine and amphetamines have multiple actions, most directly affecting dopamine and norepinephrine. They reduce reuptake of dopamine and norepinephrine by reducing activity of the dopamine transporter (DAT) and norepinephrine transporter (NET). This increases the duration and spatial extent of dopamine and norepinephrine action. Cocaine and amphetamines mimic internal reward mechanisms that act via dopamine release.

"""

questionid = "0624"

[[lecture06.questions]]

question = "Which neuromodulator is released by stimuli that predict reward?"

rightanswer = ["Dopamine"]

wronganswer = ["Acetylcholine", "Histamine", "Norepinephrine", "Serotonin"]

hint = "Reward prediction involves the same neuromodulator as internal reward itself"

explanation = """

Reward prediction involves the same neuromodulator as internal reward itself. Dopamine is a catecholamine neurotransmitter that has major functions in motor behavior and internal reward mechanisms. Dopamine is produced mainly in the midbrain by the substantia nigra pars compacta and the ventral tegmental area, which have long ascending axons that terminate throughout the higher brain regions. Loss of dopamine with degeneration of the substantia nigra in Parkinson's disease results in reduced motor abilities. Replacement of dopamine as a therapy for Parkinson's disease can result in inappropriate reward-seeking behavior.

"""

questionid = "0625"

[[lecture06.questions]]

question = "5-hydroxytryptamine (5HT) is which neuromodulator?"

rightanswer = ["Serotonin"]

wronganswer = ["Acetylcholine", "Dopamine", "Histamine", "Norepinephrine"]

hint = "Consider alternate names for amine neuromodulators"

explanation = """

Serotonin is made from tryptophan. Tryptophan is converted to 5 hydroxytryptophan (5 HTP) by tryptophan hydroxylase. 5 HTP is converted to serotonin (5HT, 5 hydroxy tryptamine) by 5 HTP decarboxylase. Monoamine oxidases break down the amine neurotransmitters.

"""

questionid = "0626"

[lecture07]

label = "#07 Cerebral Cortex Organization"

[[lecture07.questions]]

question = "Which two cortical layers, respectively, receive input from and project output back to the diencephalon?"

rightanswer = ["4 and 6"]

wronganswer = ["1 and 2", "2 and 5", "5 and 6", "3 and 6"]

hint = "The projections are to and from the thalamus"

explanation = """

The cerebral neocortex receives most of its input via thalamic projections into layer 4, the input layer of cortex. This input is topographically organized, with specific thalamic nuclei projecting to specific cortical area. Neurons of cortical layer 6, in turn, project back to the same parts of thalamus that provide input to an area.

"""

questionid = "0701"

[[lecture07.questions]]

question = "Why are cortical layers 2 and 3 often described as a single layer 2-3?"

rightanswer = ["Both are involved in cortico-cortical processing"]

wronganswer = ["Both project long axons to subcortical structures", "Both have granular cells", "Both have stellate cells", "Brodmann was unable to distinguish one from the other"]

hint = "Layers 2 and 3 contain the neurons that form the corpus callosum and other types of cortico-cortical neurons"

explanation = """

Layer 4 is the input layer of neocortex, receiving a heavy, topographically organized projection of axons from the thalamus. Almost all input to the cortex must be relayed via the thalamus. Layers 5 and 6 are the main output layers of neocortex. Layer 5 contains the largest neurons with long axons that project to other parts of the brain below cortex. Most layer 6 neurons project back to the thalamic area that provides input to layer 4. Layer 1 has almost no neurons and has an unknown function. Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0702"

[[lecture07.questions]]

question = "Which cortical layer receives major thalamic input?"

rightanswer = ["4"]

wronganswer = ["2", "3", "5", "6"]

hint = "It is called the input layer; most cortical inputs arrive here via a relay"

explanation = """

Layer 4 is the input layer of neocortex, receiving a heavy, topographically organized projection of axons from the thalamus. Almost all input to the cortex must be relayed via the thalamus. Layers 5 and 6 are the main output layers of neocortex. Layer 5 contains the largest neurons with long axons that project to other parts of the brain below cortex. Most layer 6 neurons project back to the thalamic area that provides input to layer 4. Layer 1 has almost no neurons and has an unknown function. Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0703"

[[lecture07.questions]]

question = "What does the frontal lobe do?"

rightanswer = ["Control movement and executive functions"]

wronganswer = ["Perform arithmetic calculations", "Identify meaningful objects by name", "Recognize faces", "Respond to visual objects in the contralateral lower visual hemifield"]

hint = "The frontal lobe is often considered the highest part of the brain"

explanation = """

The occipital lobe is visual. It receives input relayed from the retina by the lateral geniculate nucleus of the thalamus. The temporal lobe also has visual functions, related to higher level processing, for example face recognition by the ventral occipito-temporal cortex or fusiform gyrus. The temporal lobe also has the primary auditory cortex and higher auditory areas. Wernicke’s language area on the left hemisphere is mainly in the temporal lobe. Much of temporal lobe information is directed to the hippocampus and amygdala of the limbic system. The parietal lobe also has some of Wernicke’s area. The parietal lobe is mostly concerned with multi-modal sensory integration, attention, and spatial aspects of motor control. The frontal lobe has primary motor cortex and premotor areas. More anterior, dorsolateral, and ventral on the frontal lobe are areas that serve the highest executive functions, decision-making, and short term memory.

"""

questionid = "0704"

[[lecture07.questions]]

question = "Which two layers, respectively, are the main input and output layers of cerebral cortex?"

rightanswer = ["4 and 5"]

wronganswer = ["6 and 5", "5 and 6", "1 and 6", "6 and 1"]

hint = "Input is from the thalamus, output is via long axons to lower brain centers"

explanation = """

Layer 4 is the input layer of neocortex, receiving a heavy, topographically organized projection of axons from the thalamus. Almost all input to the cortex must be relayed via the thalamus. Layers 5 and 6 are the main output layers of neocortex. Layer 5 contains the largest neurons with long axons that project to other parts of the brain below cortex. Most layer 6 neurons project back to the thalamic area that provides input to layer 4. Layer 1 has almost no neurons and has an unknown function. Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0706"

[[lecture07.questions]]

question = "How are cortical layers 4 and 6 alike?"

rightanswer = ["Both have connections with the thalamus"]

wronganswer = ["Both project long axons to subcortical structures", "Both are mainly involved in cortico-cortical processing", "Both are mainly pyramidal cells", "Brodmann was unable to distinguish one form the other"]

hint = "Consider both input and output"

explanation = """

Layer 4 is the input layer of neocortex, receiving a heavy, topographically organized projection of axons from the thalamus. Almost all input to the cortex must be relayed via the thalamus. Most layer 6 neurons project back to the thalamic area that provides input to layer 4.

"""

questionid = "0707"

[[lecture07.questions]]

question = "Which two cortical layers are believed to be most involved in intrinsic cortical processing, the so called thinking layers?"

rightanswer = ["2 and 3"]

wronganswer = ["4 and 5", "1 and 6", "4 and 6", "5 and 6"]

hint = "These are neither major input nor major subcortical output layers"

explanation = """

Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0708"

[[lecture07.questions]]

question = "What does the temporal lobe do (not counting Heschl's gyrus auditory cortex)?"

rightanswer = ["Recognize objects and faces"]

wronganswer = ["Direct attention", "Process spatial relations", "Discriminate musical tone pitch", "Respond to visual objects in the lower visual field"]

hint = "Recall the location of the fusiform cortex"

explanation = """

The occipital lobe is visual. It receives input relayed from the retina by the lateral geniculate nucleus of the thalamus. The temporal lobe also has visual functions, related to higher level processing, for example face recognition by the ventral occipito-temporal cortex or fusiform gyrus. The temporal lobe also has the primary auditory cortex and higher auditory areas. Wernicke’s language area on the left hemisphere is mainly in the temporal lobe. Much of temporal lobe information is directed to the hippocampus and amygdala of the limbic system. The parietal lobe also has some of Wernicke’s area. The parietal lobe is mostly concerned with multi-modal sensory integration, attention, and spatial aspects of motor control. The frontal lobe has primary motor cortex and premotor areas. More anterior, dorsolateral, and ventral on the frontal lobe are areas that serve the highest executive functions, decision-making, and short term memory.

"""

questionid = "0709"

[[lecture07.questions]]

question = "Which best describes the laminar organization of the cerebral cortex?"

rightanswer = ["The neocortex has 6 laminae, with main input to layer IV and outputs from II, III, V, and VI"]

wronganswer = ["The neocortex has 3 laminae: stellate, pyramidal, and white matter", "The allocortex has 6 laminae, with pyramidal cells primarily in layer IV", "The neocortex has 6 laminae of white matter, though layer IV may be nearly absent in agranular cortex areas", "Dendritic spines provide output from stellate neurons to pyramidal neurons in a pial-to- white matter lamination"]

hint = "Contrast neocortex with archicortex and paleocortex"

explanation = """

Allocortex, including paleocortex and archicortex, has roughly 3 layers (or 4), with variable appearance. Neocortex has a strikingly uniform 6 layer structure with well-defined functions for layers 2 through 6. Thalamic input is to layer 4, layers 2 and 3 are cortico-cortical processing layers, layer 5 is the long axon output layer, and layer 6 projects back to thalamus.

"""

questionid = "0710"

[[lecture07.questions]]

question = "Which is characteristic of local interneurons of neocortex?"

rightanswer = ["Local interneurons are often stellate in shape"]

wronganswer = ["Local interneurons are most prevalent in layer V", "Local interneurons are often pyramidal in shape", "Local interneurons receive their input from the dendritic spines of layer IV neurons", "Local interneurons are usually excitatory and use the neurotransmitter glycine"]

hint = "Local interneurons are also called Golgi type II neurons"

explanation = """

The most general, but not encompassing, subdivision of cortical neuron morphology is into stellate or granular Golgi type II local interneurons and pyramidal Golgi type I long axon projection neurons.

"""

questionid = "0711"

[[lecture07.questions]]

question = "Which is characteristic of layer VI of neocortex?"

rightanswer = ["Layer VI sends the main cortical output of axons to the thalamus"]

wronganswer = ["Local interneurons are most prevalent in layer VI", "Layer VI neurons are most often stellate in shape", "Layer VI has the fewest projection neurons of any layer", "Layer VI receives the main input of axons from the thalamus"]

hint = "Layer 6 gets input from layer 4 and contains neurons that project out of the cortex"

explanation = """

The cerebral neocortex receives most of its input via thalamic projections into layer 4, the input layer of cortex. This input is topographically organized, with specific thalamic nuclei projecting to specific cortical area. Neurons of cortical layer 6, in turn, project back to the same parts of thalamus that provide input to an area. This is the main role of layer 6.

"""

questionid = "0712"

[[lecture07.questions]]

question = "Which is characteristic of layer II of neocortex?"

rightanswer = ["Layer II neurons develop later than neurons in layers III-VI"]

wronganswer = ["Layer II neurons are called callosal neurons because many their axons have interhemispheric terminations via the corpus callosum", "Layer II is the layer most purely comprised of stellate neurons", "Layer II is the site of the fusiform neurons", "Layer II is the thalamic input layer"]

hint = "Use a process of elimination to find the answer"

explanation = """

Migration of projection neurons to their respective layers in the cortex follows an inside-out pattern, with later maturing neurons migrating through earlier maturing neurons to reside in more superficial, lower number, layers. Thus, layer 2 neurons are the latest developing neurons, with layer 3 neurons maturing just before them. (Layer 1 is ignored; it has very few neurons with unknown functions.) Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas. Layer 3 has larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0713"

[[lecture07.questions]]

question = "Damage to which specific part of the brain was most likely responsible for personality changes observed in the famous patient Phineas Gage?"

rightanswer = ["Ventromedial prefrontal cortex"]

wronganswer = ["Inferotemporal cortex", "Temporal pole", "Dorsolateral frontal cortex", "Right parietal cortex"]

hint = "Personality is considered a higher order executive function"

explanation = """

The higher function areas of prefrontal cortex are divided into dorsolateral and ventromedial. Dorsolateral prefrontal cortex is required for working memory, short term memory, for example temporary memory of an address or phone number. Ventromedial prefrontal cortex is considered the highest cortical region, serving abstract functions including emotional responses through its connections with the limbic system, long term goals, and personality.

"""

questionid = "0714"

[[lecture07.questions]]

question = "Which neurons contribute most to cortico-cortical connections?"

rightanswer = ["Pyramidal neurons of layers 2 and 3"]

wronganswer = ["Modified pyramidal cells of layer 6", "Layer 1 neurons", "Chandelier cells", "Corticostriate neurons of layer 5 and 6"]

hint = "The neurons most closely associated with cortical processing contribute most to cortico-cortical connections"

explanation = """

Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons, mainly in layer 3, that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum.

"""

questionid = "0716"

[[lecture07.questions]]

question = "What lies at a depth between the corona radiata and superior longitudinal fasciculus?"

rightanswer = ["Short association fibers"]

wronganswer = ["Inferior longitudinal fasciculus", "Arcuate fasciculus", "Uncinate fasciculus", "Tapetum"]

hint = "The superior longitudinal fasciculus contains long association fibers"

explanation = """

The corona radiata is the incoming and outgoing axons that end or arise in the cortical cellular layers. Beneath the corona radiata lie the short cortico-cortical association axons mainly from layer 2 (and 3). Beneath the short association fibers are found the long association fibers, including the superior and inferior longitudinal fasciculi and the arcuate fasciculus.

"""

questionid = "0717"

[[lecture07.questions]]

question = "What type of cortex makes up the largest proportion of the cerebrum?"

rightanswer = ["Neocortex"]

wronganswer = ["Heterogenetic cortex", "Limbic cortex", "Paleocortex", "Archicortex"]

hint = "Most of the cerebral cortex has 6 layers"

explanation = """

In humans, 90% or more of the cortex is neocortex that includes over 50 cytoarchitonically and functionally defined areas. Non-neocortical areas include the hippocampus in the temporal lobe, which is archicortex, and much of olfactory cortex in orbital frontal cortex, which is paleocortex.

"""

questionid = "0718"

[[lecture07.questions]]

question = "Damage to which area would most likely lead to the inability to remember a phone number for long enough to dial it?"

rightanswer = ["Prefrontal association cortex"]

wronganswer = ["Parietal association cortex", "Temporal association cortex", "Occipital association cortex", "Limbic efferents"]

hint = "The same region in non-human primates is responsible for successful delayed responses to obtain hidden rewards"

explanation = """

The higher function areas of prefrontal cortex are divided into dorsolateral and ventromedial. Dorsolateral prefrontal cortex is required for working memory, short term memory, for example temporary memory of an address or phone number. Ventromedial prefrontal cortex is considered the highest cortical region, serving abstract functions including emotional responses through its connections with the limbic system, long term goals, and personality.

"""

questionid = "0719"

[[lecture07.questions]]

question = "What is best developed in macro-osmic cortex?"

rightanswer = ["Paleocortex"]

wronganswer = ["Archicortex", "Homogenetic cortex", "Neocortex", "Pallium"]

hint = "homogenetic and isogenetic are names for 6 layered cortex"

explanation = """

Humans are said to have micro-osmotic cortex, with little olfactory tissue. Dogs, in contrast, are said to have macro-osmotic cortex, including a larger proportion of paleocortex olfactory cortex than found in humans. In humans, 90% or more of the cortex is neocortex that includes over 50 cytoarchitonically and functionally defined areas. Non-neocortical areas include the hippocampus in the temporal lobe, which is archicortex, and much of olfactory cortex in orbital frontal cortex, which is paleocortex.

"""

questionid = "0721"

[[lecture07.questions]]

question = "What cortical layer has the least neurons?"

rightanswer = ["1"]

wronganswer = ["2", "3", "5", "6"]

hint = "There is one neocortical layer with unknown function"

explanation = """

Layer 1 has almost no neurons and has an unknown function. Layer 4 is the input layer of neocortex, receiving a heavy, topographically organized projection of axons from the thalamus. Almost all input to the cortex must be relayed via the thalamus. Layers 5 and 6 are the main output layers of neocortex. Layer 5 contains the largest neurons with long axons that project to other parts of the brain below cortex. Most layer 6 neurons project back to the thalamic area that provides input to layer 4. Layers 2 and 3 are the cortico-cortical processing layers. Layers 2 and 3 contain small pyramidal neurons that project locally and to other nearby cortical areas, as well as larger pyramidal neurons that send an axon to the corresponding area of the contralateral hemisphere via the corpus callosum

"""

questionid = "0722"

[[lecture07.questions]]

question = "Which are the largest cortical neurons?"

rightanswer = ["Betz cells of motor cortex"]

wronganswer = ["Layer 4 cells of calcarine sulcus cortex", "Layer 6 cells of fusiform gyrus cortex", "Stellate cells calcarine sulcus cortex", "Stellate cells of fusiform gyrus cortex"]

hint = "The largest cortical neurons have the longest axons"

explanation = """

Layer 5 contains the largest neurons with long axons that project to other parts of the brain below cortex. The largest of these are the giant Betz cells of primary motor cortex, Brodmann’s area 4, which can approach 100 microns in cell body diameter. The Betz cells innervate distal musculature of the limbs and must maintain a long, large axon.

"""

questionid = "0724"

[[lecture07.questions]]

question = "Which sense has its primary cortical area in temporal cortex?"

rightanswer = ["Auditory"]

wronganswer = ["Olfactory", "Proprioceptive", "Somatic", "Visual"]

hint = "Use a process of elimination"

explanation = """

Primary visual cortex area V1 is in the occipital lobe, area 17, striate cortex, or calcarine cortex. Primary somatic cortex S1 (including proprioceptive inputs to area 3a) is on the postcentral gyrus, areas 3, 1, and 2 of the anterior parietal lobe. Primary olfactory cortex is in ventral frontal and temporal paleocortex. Primary auditory cortex, Heschl’s gyrus, is in the medial temporal lobe.

"""

questionid = "0725"

[lecture08]

label = "#08 Cerebral Cortex Sensory Systems"

[[lecture08.questions]]

question = "Which best distinguishes the olfactory paths from other sensory paths?"

rightanswer = ["They project to paleocortex"]

wronganswer = ["They remain ipsilateral", "They do not involve cranial nerves", "They have a thalamic relay", "They are contralateral"]

hint = "consider laterality of projections"

explanation = """

Primary olfactory cortex is in ventral frontal and temporal paleocortex. Olfaction is the only sense that requires no thalamic relay and projects to paleocortex. Primary visual cortex area V1 is in the occipital lobe, area 17, striate cortex, or calcarine cortex. Primary somatic cortex S1 (including proprioceptive inputs to area 3a) is on the postcentral gyrus, areas 3, 1, and 2 of the anterior parietal lobe. Primary auditory cortex, Heschl’s gyrus, is in the medial temporal lobe.

"""

questionid = "0801"

[[lecture08.questions]]

question = "Which best distinguishes the gustatory paths from other sensory paths?"

rightanswer = ["They remain ipsilateral"]

wronganswer = ["They do not involve cranial nerves", "They project to paleocortex", "They have a thalamic relay", "They are contralateral"]

hint = "Gustatory sense of taste should not be confused with olfactory sense of smell; flavors are a combination of olfaction and gustation"

explanation = """

The facial, glossopharyngeal, and vagus nerves carry taste sensations ipsilaterally into the rostral nucleus of the solitary tract, or gustatory nucleus. Gustatory nucleus secondary neurons project ipsilaterally to the ventral posteromedial nucleus (VPM) of the thalamus, which projects ipsilaterally to gustatory areas of cortex. This is the most directly ipsilateral of the sensory paths.

"""

questionid = "0802"

[[lecture08.questions]]

question = "Which is a feature of topographic organization of neocortex?"

rightanswer = ["Body parts with more detailed sensation or more sensory receptors are allotted a disproportionately large portion of somatic sensory cortex, distorting the maps"]

wronganswer = ["Sizes are precisely represented as equivalent sizes on topographic maps", "Cortical topographic maps usually represent the ipsilateral body half only", "The trunk and belly tend to have disproportionately large representations in somatic maps", "Frontal, temporal, and parietal lobes have topographically organized areas, but occipital lobes do not"]

hint = "This feature of topographic organization is apparent in both visual and somatic sense"

explanation = """

Topographic sensory maps are widespread across senses and animal species. The hands, face, and feet have an exceptionally large area of representation on primary somatic sensory cortex, in accordance with their dense innervation and functions. The fovea has a greatly enlarged representation on occipital cortex, facilitating acute foveal vision.

"""

questionid = "0803"

[[lecture08.questions]]

question = "Which visual deficit is most likely to follow left temporal lobe damage?"

rightanswer = ["Right upper field quadrantanopsia (pie-in-the-sky loss)"]

wronganswer = ["Left hemispatial neglect", "Right hemispatial neglect", "Left upper field quadrantanopsia (pie-in-the-sky loss)", "Blindness for lower right visual field"]

hint = "Think about pie"

explanation = """

The projection of contralateral visual hemifield to occipital cortex from the lateral geniculate nucleus (LGN) maintains a retinotopic (topographic) layout. The fovea is represented at the occipital pole, the upper visual field (lower retina) is represented on the lower bank of the calcarine sulcus, also called lingual cortex, and the lower visual field is represented on the upper bank of the calcarine sulcus, also called the cuneus. The upper field axons take Meyer’s loop through the temporal lobe. Damage to Meyer’s loop produces a contralateral upper field quadrantanopsia, or pie-in-the-sky visual field loss. The lower field axons pass directly back via the parietal lobe.

"""

questionid = "0804"

[[lecture08.questions]]

question = "Second order axons from the ventral cochlear nuclei project mainly to which structure to process lateralization (left-right azimuthal direction) of low frequency sounds?"

rightanswer = ["Medial superior olive"]

wronganswer = ["Lateral superior olive", "Superior colliculus", "Inferior colliculus", "Dorsal cochlear nuclei"]

hint = "Trace the main auditory pathway through three brainstem relays"

explanation = """

The cochlea sends primary auditory axons to the ipsilateral cochlear nuclei in the caudal pons (and rostral medulla). Second order cochlear neurons project bilaterally to superior olivary nuclei. The medial superior olive processes interaural time of sound arrival differences from the two ears to lateralize low frequency sounds. The lateral superior olive processes interaural level difference to lateralize high frequency sounds(intensity).

"""

questionid = "0805"

[[lecture08.questions]]

question = "The ascending axons from the medial and lateral superior olive directly project mainly to which structure?"

rightanswer = ["Inferior colliculus"]

wronganswer = ["Superior brachium", "Inferior brachium", "Superior colliculus", "Cochlear nuclei"]

hint = "Superior olive output goes to the midbrain"

explanation = """

The cochlea sends primary auditory axons to the ipsilateral cochlear nuclei in the caudal pons (and rostral medulla). Second order cochlear neurons project bilaterally to superior olivary nuclei. Superior olivary nuclei project to the inferior colliculus, which in turn projects to the medial geniculate nucleus of the thalamus.

"""

questionid = "0809"

[[lecture08.questions]]

question = "Where are the secondary neurons of the gustatory pathway located?"

rightanswer = ["Rostral solitary nucleus"]

wronganswer = ["Caudal solitary nucleus", "Medial superior olive", "Lateral superior olive", "Inferior olive"]

hint = "The gustatory receiving area has two names, one a functional description, the other an anatomical description"

explanation = """

The facial, glossopharyngeal, and vagus nerves carry taste sensations ipsilaterally into the rostral nucleus of the solitary tract, or gustatory nucleus. Gustatory nucleus secondary neurons project ipsilaterally to the ventral posteromedial nucleus (VPM) of the thalamus, which projects ipsilaterally to gustatory areas of cortex.

"""

questionid = "0810"

[[lecture08.questions]]

question = "Which is the gustatory nucleus?"

rightanswer = ["Rostral solitary nucleus"]

wronganswer = ["Ventral postero-lateral nucleus (VPL)", "Dorsomedial (medial dorsal) nucleus", "Dorsolateral (lateral dorsal) nucleus", "Rostral salivatory nucleus"]

hint = " The gustatory receiving area has two names, one a functional description, the other an anatomical description "

explanation = """

The gustatory receiving area has two names, one a functional description, the other an anatomical description. The facial, glossopharyngeal, and vagus nerves carry taste sensations ipsilaterally into the rostral nucleus of the solitary tract, or gustatory nucleus. Gustatory nucleus secondary neurons project ipsilaterally to the ventral posteromedial nucleus (VPM) of the thalamus, which projects ipsilaterally to gustatory areas of cortex.

"""

questionid = "0812"

[[lecture08.questions]]

question = "What is the function of the lateral superior olive?"

rightanswer = ["Processing direction of high frequency sounds"]

wronganswer = ["Projection of climbing fibers to the cerebellum", "Projection of mossy fibers to the cerebellum", "Processing sweet and bitter taste sensations", "Relaying large fiber somatic sensory information"]

hint = "The lateral superior olive has a function complementary to that of the medial superior olive"

explanation = """

The cochlea sends primary auditory axons to the ipsilateral cochlear nuclei in the caudal pons (and rostral medulla). Second order cochlear neurons project bilaterally to superior olivary nuclei. The medial superior olive processes interaural time of sound arrival differences from the two ears to lateralize low frequency sounds. The lateral superior olive processes interaural level difference to lateralize high frequency sounds (intensity).

"""

questionid = "0813"

[[lecture08.questions]]

question = "Which area(s) is (are) specialized for proprioception?"

rightanswer = ["Mesencephalic nucleus, Brodmann's area 3a"]

wronganswer = ["Lateral horn, intermediolateral cell column", "Heschl's gyrus", "Left parietal cortex", "Dorsolateral and central amygdala"]

hint = "The proprioceptive receiving area of cortex lies on the parietal bank of the central sulcus as part of primary somatic sensory cortex"

explanation = """

Two brain areas are most directly identified with proprioception. In the primary somatic sensory cortex, Brodmann’s areas 3, 1, 2, area 3a selectively receives proprioceptive input. Area 3b gets cutaneous input. Proprioceptors of the face have a separate trigeminal path. Large fiber type A-beta somatic sense axons for touch, pressure, and vibration from the face project to the main (or chief, or principal) sensory nucleus. The largest A-alpha proprioceptor axons project to the mesencephalic nucleus of the trigeminal, where their primary cell bodies lie. All the other primary pseudounipolar cell bodies lie in peripheral ganglia.

"""

questionid = "0814"

[[lecture08.questions]]

question = "How are the magnocellular and parvocellular visual paths organized in the LGN?"

rightanswer = ["Magnocellular axons project to LGN layers 1 and 2, parvocellular axons to layers 3-6"]

wronganswer = ["Magnocellular axons project to the left LGN, parvocellular axons to the right LGN", "Magnocellular axons project rostrally in the LGN, parvocellular axons caudally", "Magnocellular axons project along projection lines, parvocellular axons are off-line", "A projection line contains axons from only one or the other path, not both"]

hint = "Magnocellular and parvocellular visual pathways are separate from retina through cortex"

explanation = """

Magnocellular parasol retinal ganglion cells send axons to lateral geniculate nucleus (LGN) layers 1 and 2, the magnocellular LGN layers. Parvocellular midget retinal ganglion cells send axons to LGN layers 3-6, the parvocellular LGN layers. Magnocellular and parvocellular projections from LGN to calcarine cortex synapse in separate sub-layers in layer 4. Calcarine layer 4 magnocellular information is projected to the middle temporal area (MT), directly and via the second visual area V2. Parvocellular information from calcarine cortex is projected to the color area V4 via area V2. Ultimately, magnocellular information is sent to parietal cortex and is used to guide movement. Ultimately, parvocellular information is sent to inferotemporal and fusiform occipito-temporal cortex and is used for visual form perception. The magnocellular pathway is also called the parietal, dorsal, ‘what,’ or action visual stream. The parvocellular pathway is also called the temporal, ventral, ‘where,’ or form perception stream.

"""

questionid = "0815"

[[lecture08.questions]]

question = "Which is the next step on the dorsal visual stream beyond the first or second visual area?"

rightanswer = ["Middle temporal area (MT)"]

wronganswer = ["Color area (V4)", "Hippocampus (CA1-CA3)", "Amygdala", "Cingulate cortex (areas 17 and 18)"]

hint = "Its name suggests a ventral stream destination"

explanation = """

Calcarine layer 4 magnocellular information is projected to the middle temporal area (MT), directly and via the second visual area V2. Parvocellular information from calcarine cortex is projected to the color area V4 via area V2. Ultimately, magnocellular information is sent to parietal cortex and is used to guide movement. Ultimately, parvocellular information is sent to inferotemporal and fusiform occipito-temporal cortex and is used for visual form perception. The magnocellular pathway is also called the parietal, dorsal, ‘what,’ or action visual stream. The parvocellular pathway is also called the temporal, ventral, ‘where,’ or form perception stream.

"""

questionid = "0816"

[[lecture08.questions]]

question = "Which is the next step on the ventral visual stream beyond the first or second visual area?"

rightanswer = ["Color area (V4)"]

wronganswer = ["Middle temporal area (MT)", "Hippocampus (CA1-CA3)", "Amygdala", "Cingulate cortex (areas 17 and 18)"]

hint = "It is named for a quality important to perception"

explanation = """

Parvocellular information from calcarine cortex is projected to the color area V4 via area V2. Ultimately, magnocellular information is sent to parietal cortex and is used to guide movement. Ultimately, parvocellular information is sent to inferotemporal and fusiform occipito-temporal cortex and is used for visual form perception. The magnocellular pathway is also called the parietal, dorsal, ‘what,’ or action visual stream. The parvocellular pathway is also called the temporal, ventral, ‘where,’ or form perception stream.

"""

questionid = "0817"

[[lecture08.questions]]

question = "Which area is known for having visual feature detectors?"

rightanswer = ["Inferotemporal cortex"]

wronganswer = ["Prefrontal cortex", "Calcarine cortex", "Middle temporal area (MT)", "Meyer's loop"]

hint = "Feature detectors include monkey hand detectors and other simple meaningful object shape detectors"

explanation = """

parvocellular information is sent to inferotemporal and fusiform occipito-temporal cortex and is used for visual form perception. Inferotemporal cortex neurons include ‘feature detectors’ for meaningful shapes. Fusiform cortex neurons include ‘face detectors’ for recognition of familiar faces. The parvocellular pathway is also called the temporal, ventral, ‘where,’ or form perception stream.

"""

questionid = "0818"

[[lecture08.questions]]

question = "What is Meyer's loop?"

rightanswer = ["The temporal course of upper visual hemifield optic radiations destined for the lower bank of the calcarine sulcus"]

wronganswer = ["The limbic pathway that originates in cerebral cortex and passes through a series of limbic structures to return to cerebral cortex", "The re-decussation of the ventral spinocerebellar tract so that it ends ipsilaterally in the cerebellum despite having a mainly contralateral course", "The re-decussation of the dorsal spinocerebellar tract so that it ends ipsilaterally in the cerebellum despite having a mainly contralateral course", "The axons responsible for hole-in-the-pole or hole in the donut blindness for objects straight ahead with intact peripheral vision"]

hint = "Meyer’s loop damage is often accompanied by ventral visual stream loss"

explanation = """

The optic radiations from the LGN split into a temporally directed upper visual quadrant component that follows “Meyer’s loop” through the temporal lobe to reach the lower bank of the calcarine sulcus, and a parietally directed lower visual quadrant component that takes a more medial direct path to reach the upper bank of the calcarine sulcus.

"""

questionid = "0819"

[[lecture08.questions]]

question = "What does the medial superior olive help discriminate?"

rightanswer = ["direction of sounds"]

wronganswer = ["pitch of sounds", "meaning of speech sounds", "sequence of musical notes", "potentially toxic odors"]

hint = "The medial and lateral superior olive process different pitch ranges"

explanation = """

Second order cochlear nucleus auditory neurons project bilaterally to superior olivary nuclei. The medial superior olive processes interaural time of sound arrival differences from the two ears to lateralize low frequency sounds, determining their horizontal (azimuthal) direction. The lateral superior olive processes interaural level (loudness or intensity) difference to lateralize high frequency sounds.

"""

questionid = "0820"

[[lecture08.questions]]

question = "Damage to which structure(s) results in ipsilateral hearing loss?"

rightanswer = ["Cochlear nuclei"]

wronganswer = ["Heschl's gyrus (or gyri)", "Medial geniculate nucleus", "Superior colliculus", "Inferior colliculus"]

hint = "Only one relay along the auditory path has information from a single ear"

explanation = """

The cochlea sends primary auditory axons to the ipsilateral cochlear nuclei in the caudal pons (and rostral medulla). The cochlear nuclei are the only auditory relay nuclei that are monoaural and ipsilateral. All further relays are binaural, bilateral. Second order cochlear neurons project bilaterally to superior olivary nuclei. The medial superior olive processes interaural time of sound arrival differences from the two ears to lateralize low frequency sounds. The lateral superior olive processes interaural level difference to lateralize high frequency sounds (intensity). Superior olivary nuclei project to the inferior colliculi. The commissure of the inferior colliculus interconnects the two colliculi for more binocular processing. The inferior colliculi project to the medial geniculate nuclei, which project to primary auditory cortex of Heschl’s gyrus. The corpus callosum interconnects the two Heschl’s gyri.

"""

questionid = "0821"

[[lecture08.questions]]

question = "Damage to which structure(s) results in loss of pitch sequence discrimination (cannot name that tune)?"

rightanswer = ["Heschl's gyrus (or gyri)"]

wronganswer = ["Medial geniculate nucleus", "Superior colliculus", "Inferior colliculus", "Cochlear nuclei"]

hint = "Pitch sequence discrimination is a cortical function"

explanation = """

Brainstem auditory centers are sufficient for simple pitch discrimination, discriminating different pitches from each other. However, the auditory cortex of Heschl’s gyrus and beyond is required for discrimination of pitch sequences and more complex auditory discriminations such as voice and language recognition.

"""

questionid = "0822"

[[lecture08.questions]]

question = "What body part occupies the largest part of rodent somatic sensory cortex?"

rightanswer = ["Whiskers (vibrissae)"]

wronganswer = ["Hands (forepaws)", "Feet (hindpaws)", "Mouth", "Sex organs"]

hint = "Rodents rely less on sight and sound than humans do"

explanation = """

More densely innervated and more important parts of sensory inputs have an expanded representation on sensory cortex. The fovea is only a tiny portion of our visual field of view, yet much of calcarine primary visual cortex is devoted to the fovea. Similarly, the homunculus on human somatic sensory cortex has a greatly enlarged representation of the face, especially the mouth, and of the hands, with very little area devoted to the trunk. Rodents rely on their vibrissae, facial whiskers, for much of their exploration of the environment. The vibrissae representation is much of rodent somatic sensory cortex. Each vibrissa has a devoted barrel area of cortical neurons that process information from that one whisker. The barrel fields are the distinctive feature of rodent somatic sensory cortex.

"""

questionid = "0823"

[[lecture08.questions]]

question = "What body part is represented most laterally in human somatic sensory cortex?"

rightanswer = ["Mouth"]

wronganswer = ["Hands", "Feet", "Trunk", "Sex organs"]

hint = "Bilateral damage to the medial walls of the postcentral gyri affect lower limb sensations"

explanation = """

The human somatic sensory cortex area 3,1,2 has a clearly defined homunculus, a topographic map that represents the contralateral half of the body. Beginning in the interhemispheric fissure, the feet and legs are represented on the medial wall and dorsomedial surface of the postcentral gyrus, then the trunk has a small representation, then the arm, followed laterally by a very large hand and fingers representation. The face is most lateral, with an enlarged representation of the lower face, and especially the mouth, most laterally and ventrally located on the postcentral gyrus.

"""

questionid = "0824"

[[lecture08.questions]]

question = "Where is the fovea represented in calcarine (occipital) cortex?"

rightanswer = ["Posterior"]

wronganswer = ["Upper bank", "Lower bank", "Anterior", "Along the fundus"]

hint = "Upper, lower, and posterior retina are mapped to upper, lower, and posterior calcarine cortex"

explanation = """

Each calcarine cortex maps the contralateral visual hemifield. Damage to the calcarine map produces permanent blind regions of the visual field. Upper, lower, and posterior retina are mapped to upper, lower, and posterior calcarine cortex. The cuneus maps the lower visual field (upper retina). The lingual cortex maps the upper visual field (lower retina). The fovea is represented over a very large area around the occipital pole of the brain, with the map proceeding peripherally in the anterior direction forward from the pole. The far visual periphery is represented most anteriorly. The horizontal meridian (horizon) lies along the fundus (bottom) of the calcarine fissure. The vertical meridian (vertical midline) is the dividing line between the two visual hemifields and the two cortical hemispheres. The two calcarine cortices are joined at the vertical meridian by axons that pass through the splenium of the corpus callosum. Damage to all of one calcarine cortex produces a blindness of the contralateral visual hemifield. Damage to the occipital pole can cause foveal blindness and loss of acuity, though there may be retained vision called macular sparing. Damage to the cuneus causes a contralateral lower field quadrantanopia (quadrantanopsia). Damage to the lingual cortex causes a contralateral upper field quadrantanopia. Damage to the temporal Meyer’s loop geniculocortical axons that project to the lingual cortex can produce a similar pie-in-the-sky blind region. Blind areas are also called scotomas (scotomata) or field cuts.

"""

questionid = "0825"

[[lecture08.questions]]

question = "Damage to the cuneus of the occipital lobe causes which deficit?"

rightanswer = ["Permanent scotoma in contralateral lower visual field quadrant"]

wronganswer = ["Temporary scotoma in contralateral lower visual field quadrant", "Temporary scotoma in contralateral upper visual field quadrant", "Permanent scotoma in contralateral upper visual field quadrant", "A specific blindness from which there is only partial recovery"]

hint = " Upper, lower, and posterior retina are mapped to upper, lower, and posterior calcarine cortex "

explanation = """

Damage to the calcarine map produces permanent blind regions of the visual field. Damage to all of one calcarine cortex produces a blindness of the contralateral visual hemifield. Damage to the occipital pole can cause foveal blindness and loss of acuity, though there may be retained vision called macular sparing. Damage to the cuneus causes a contralateral lower field quadrantanopia (quadrantanopsia). Damage to the lingual cortex causes a contralateral upper field quadrantanopia. Damage to the temporal Meyer’s loop geniculocortical axons that project to the lingual cortex can produce a similar pie-in-the-sky blind region. Blind areas are also called scotomas (scotomata) or field cuts.

"""

questionid = "0826"

[lecture09]

label = "#09 Cerebral Cortex Vision, Motor Systems"

[[lecture09.questions]]

question = "Which is NOT a major neocortical efferent pathway?"

rightanswer = ["Corticonigral"]

wronganswer = ["Corticostriate", "Corticopontine", "Corticospinal", "Corticothalamic"]

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.

"""

questionid = "0901"

[[lecture09.questions]]

question = "Which is NOT a feature of the medial corticospinal projection?"

rightanswer = ["Decussates at the decussation of the pyramids"]

wronganswer = ["Originates largely from Brodmann's area 4", "Terminates bilaterally in the spinal cord", "Controls axial musculature", "Controls trunk musculature"]

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.

"""

questionid = "0902"

[[lecture09.questions]]

question = "What do the lateral descending pathways most directly control?"

rightanswer = ["The limbs"]

wronganswer = ["Locomotion", "Axial musculature", "The trunk", "The four spinocerebellar tracts"]

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.

"""

questionid = "0903"

[[lecture09.questions]]

question = "What do the medial descending pathways control?"

rightanswer = ["The trunk"]

wronganswer = ["The upper limbs", "The lower limbs", "The dorsal and cuneo spinocerebellar tracts", "Skilled hand movements"]

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.

"""

questionid = "0904"

[[lecture09.questions]]

question = "Which is NOT a visual projection of axons from the retina?"

rightanswer = ["Inferior colliculus"]

wronganswer = ["Lateral geniculate nucleus (LGN)", "Olivary pretectal nucleus", "Suprachiasmatic nucleus", "Accessory optic nuclei"]

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.

"""

questionid = "0905"

[[lecture09.questions]]

question = "Melanopsin-containing retinal ganglion cells project to primarily to which two areas?"

rightanswer = ["Pretectal area and hypothalamus"]

wronganswer = ["Superior colliculus and lateral geniculate nucleus", "Inferior colliculus and medial geniculate nucleus", "Lateral geniculate nucleus lamina 1 and 2", "Lateral geniculate nucleus lamina 5 and 6"]

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.

"""

questionid = "0906"

[[lecture09.questions]]

question = "What is the distinguishing feature of responses of melanopsin-containing retinal ganglion cells?"

rightanswer = ["They persist for hours instead of adapting"]

wronganswer = ["They are sent to the superior colliculus and lateral geniculate nucleus", "They are sent to the inferior colliculus and medial geniculate nucleus", "They are exclusively OFF type responses (decreased activity to light)", "They sense visual stimuli exclusively at the fovea"]

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.

"""

questionid = "0907"

[[lecture09.questions]]

question = "Optic (visual) ataxia is best described as which?"

rightanswer = ["An inability to orient held objects to match the orientation of a seen object"]

wronganswer = ["Postural instability with eyes closed, but stable posture with eyes open", "Postural instability with eyes open, but stable posture with eyes closed", "Postural instability due to ocular instability (involuntary eye movements)", "Postural instability seen in the Romberg test, a positive Romberg sign"]

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.

"""

questionid = "0908"

[[lecture09.questions]]

question = "What is the corticobulbar path?"

rightanswer = ["Axons from motor cortical areas that project to premotor and motor brainstem nuclei"]

wronganswer = ["Axons from motor cortical areas that project reciprocally to sensory cortical areas", "Axons from motor cortical areas that project to the basal pontine nuclei bulb", "Axons from sensory cortical areas that project to the olfactory bulb", "Axons from sensory cortical areas that project to the limbic 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.

"""

questionid = "0909"

[[lecture09.questions]]

question = "What is the primary origin of the medial descending system?"

rightanswer = ["Brainstem"]

wronganswer = ["Cerebellum", "Basal ganglia", "Limbic system", "Motor cortex"]

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.

"""

questionid = "0910"

[[lecture09.questions]]

question = "What is the function of the hypothalamospinal tract?"

rightanswer = ["Autonomic control"]

wronganswer = ["Limb control", "Axial control", "Control of the emetic reflex", "Control of distal musculature during locomotion"]

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).

"""

questionid = "0911"

[[lecture09.questions]]

question = "What is the primary stabilizing function of the medial vestibulospinal tract?"

rightanswer = ["Bilateral control of the head"]

wronganswer = ["Bilateral control of the legs", "Ipsilateral control of the legs", "Contralateral control of the legs", "Ipsilateral 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.

"""

questionid = "0912"

[[lecture09.questions]]

question = "Which are the output neurons from primary motor cortex?"

rightanswer = ["Layer V neurons that project to lower motor neurons"]

wronganswer = ["Layer V neurons that project to secondary motor cortex", "Layer V neurons that project to premotor cortex", "Layer V neurons that project to upper motor neurons", "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.

"""

questionid = "0914"

[[lecture09.questions]]

question = "Which structure(s) is (are) believed to mediate optokinetic reflexes?"

rightanswer = ["Accessory optic nuclei"]

wronganswer = ["Suprachiasmatic nucleus", "Olivary pretectal areas", "Medial superior olive", "Lateral superior olive"]

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.

"""

questionid = "0915"

[[lecture09.questions]]

question = "Which is the destination of axons from the pretectal area?"

rightanswer = ["Edinger-Westphal preganglionic parasympathetic nucleus"]

wronganswer = ["Retina", "Tectum", "Lateral horn of spinal cord", "Intermediolateral cell column"]

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.

"""

questionid = "0917"

[[lecture09.questions]]

question = "Which is responsible for your eyes automatically tracking the outside scene when you are in a traveling vehicle?"

rightanswer = ["Accessory optic nuclei"]

wronganswer = ["Suprachiasmatic nucleus", "Olivary pretectal areas", "Medial superior olive", "Lateral superior olive"]

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.

"""

questionid = "0918"

[[lecture09.questions]]

question = "Which cerebral lobe, if any, does not have association areas?"

rightanswer = ["None of the listed lobes lack association areas; all have association areas"]

wronganswer = ["Frontal", "Parietal", "Occipital", "Temporal"]

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.

"""

questionid = "0919"

[[lecture09.questions]]

question = "The olivary pretectal nucleus receives primarily which input?"

rightanswer = ["Melanopsin containing retinal ganglion cells"]

wronganswer = ["Medial geniculate nucleus", "Lateral geniculate nucleus", "Foveal cone receptors", "Cochlear nuclei bilaterally"]

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.

"""

questionid = "0921"

[[lecture09.questions]]

question = "The suprachiasmatic nucleus receives primarily which input?"

rightanswer = ["Melanopsin containing retinal ganglion cells"]

wronganswer = ["Medial geniculate nucleus", "Lateral geniculate nucleus", "Foveal cone receptors", "Cochlear nuclei bilaterally"]

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.

"""

questionid = "0922"

[[lecture09.questions]]

question = "Parietal lobe lesions often result in which deficit?"

rightanswer = ["Apraxia"]

wronganswer = ["Ataxia of the trunk", "Tremor", "Akinesia or bradykinesia", "Prosopagnosia"]

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.

"""

questionid = "0923"

[[lecture09.questions]]

question = "To which does the corticotectal path contribute?"

rightanswer = ["Body orientation and eye movements"]

wronganswer = ["Autonomic nervous system", "Control of the pharynx", "Middle cerebellar peduncle", "Recognition of faces"]

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.

"""

questionid = "0925"

[[lecture09.questions]]

question = "Cortical reflexes such as foot placement are mediated by which pathway?"

rightanswer = ["Areas 3,1,2 to area 4"]

wronganswer = ["Area 17 to area 18", "Area 17 to the dorsal stream", "Area 17 to the ventral stream", "Area 18 to V4a"]

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.

"""

questionid = "0926"

[lecture10]

label = "#10 Cerebellum"

[[lecture10.questions]]

question = "Which lists the major mossy fiber pathway through the cerebellum via the correct structures in the correct order?"

rightanswer = ["mossy fiber>granule cell>parallel fiber>Purkinje cell>deep nuclear neuron"]

wronganswer = ["mossy fiber>deep nuclear neuron>granule cell>Purkinje cell", "mossy fiber>deep nuclear neuron>parallel fiber>granule cell>Purkinje cell", "Purkinje cell>granule cell>parallel fiber>Golgi cell>deep nuclear neuron", "Purkinje cell>parallel fiber>granule cell>Golgi cell>deep nuclear neuron"]

hint = "Consider the initial synaptic site for mossy fibers in the cerebellum"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Mossy fibers arise from many areas of the central nervous system and make excitatory synapses in the granule cell layer of cerebellar cortex within glomeruli. Mossy fiber glomeruli consist of incoming mossy fiber axon terminals, granule cell dendrites, and inhibitory axon terminals of Golgi cells of cerebellar cortex. Granule cell axons rise and bifurcate to become parallel fibers in the cerebellar molecular layer. Parallel fibers synapse at the planar Purkinje cell dendritic trees. Climbing fibers arise exclusively from the inferior olive in the medulla. Each climbing fiber branches to excite a few Purkinje cells with extensive axonal arborizations all over the dendritic tree. Each Purkinje cell receives only one climbing fiber input. Purkinje cell axons project to deep cerebellar nuclei. The axons of deep nuclear cells project out of the cerebellum to the ventral lateral thalamus. In addition to mossy and climbing fiber inputs, there are neuromodulatory inputs to the cerebellum.

"""

questionid = "1001"

[[lecture10.questions]]

question = "The cerebellar deep nuclei are which?"

rightanswer = ["The major output destination of cerebellar cortex Purkinje cell axons"]

wronganswer = ["The vermis, intermediate zone, and hemispheres", "The major input projection to cerebellar cortex Purkinje cell dendrites", "Numbered from I to X, medial to lateral", "Excited by Purkinje cell axons"]

hint = "The deep nuclei lie within the cerebellar white matter and are the output from the cerebellum"

explanation = """

The output neurons of cerebellar cortex, the Purkinje cells, project GABA-ergic axons to the cerebellar deep nuclei. The deep nuclei lie within the cerebellar white matter. Deep nuclear cell axons are the output from the cerebellum, projected mainly to the ventral lateral thalamus to be relayed to motor areas of cortex. The deep nuclei from medial to lateral are the fastigial nucleus, the interposed nuclei (or globose and emboliform nucleus), and the very large dentate nucleus.

"""

questionid = "1002"

[[lecture10.questions]]

question = "Which neurological problem would be LEAST suggestive of damage to the vermis?"

rightanswer = ["Reduced hand coordination"]

wronganswer = ["Loss of balance", "Blurred vision due to poor oculomotor control of saccades", "Drunken gait", "Reduced tone of postural muscles"]

hint = "More lateral in the cerebellum corresponds to more lateral or more complex higher motor functions"

explanation = """

The flocculonodular lobe (vestibulocerebellum) and the vermis, medial cerebellum, are most closely associated with trunk coordination, postural tone, trunk ataxia, and loss of balance. The vermis has a region devoted to control of saccadic eye movements. The intermediate zone between the vermis and hemispheres is most related to limb function and limb ataxia, abnormal gait, or limb coordination. The lateral cerebellum (hemisphere) is most related to multi-joint movements, finger control, and to motor planning and motor learning.

"""

questionid = "1003"

[[lecture10.questions]]

question = "Which neurological problem would NOT suggest damage to the flocculus?"

rightanswer = ["Inability to suppress saccades"]

wronganswer = ["Loss of the ability to smoothly track a moving visual target", "Loss of visual pursuit", "Loss of the ability to alter the vestibulo-ocular reflex to adjust when new glasses are fitted", "A vestibulo-ocular reflex that is too large"]

hint = "The flocculus is responsible for a type of eye movement exclusively found in primates"

explanation = """

The nodulus and flocculus comprise the vestibulocerebellum or flocculonodular lobe. The flocculus is required for adaptive adjustment of the vestibulo-ocular reflex and for visual pursuit, the ability to smoothly follow a moving visual target. Only primates have visual pursuit. Non-primates follow moving targets with a series of saccades. Suppression of saccades and other saccade planning is primarily a function of the frontal cortex eye field area. The short latency, automatic generation of saccades is dependent on the superior colliculus.

"""

questionid = "1004"

[[lecture10.questions]]

question = "Which two tracts convey mainly lower body information to the cerebellum?"

rightanswer = ["Dorsal and ventral spinocerebellar tracts"]

wronganswer = ["Dorsal and cuneo cerebellar tracts", "Ventral and caudal spinocerebellar tracts", "Ventral and anterior spinocerebellar tracts", "Propriospinal tracts"]

hint = "Both spinocerebellar tracts that serve the lower body are named for coordinate directions, and so is one of the two that serve the upper body"

explanation = """

There are four spinocerebellar tracts, two for the lower body and two for the upper body. The dorsal and ventral spinocerebellar tracts convey information from the lower body. Information in the dorsal spinocerebellar tract is somatic sense. Dorsal spinocerebellar tract signals are lost when sensory nerves are cut. Information in the ventral spinocerebellar tract remains when sensory nerves are cut, showing that it is motor command-related signals rather than sensory signals. Similarly, for the upper body, the cuneocerebellar tract carries sensory signals, and the rostral spinocerebellar tract is believed to carry motor command information.

"""

questionid = "1005"

[[lecture10.questions]]

question = "Which two tracts convey mainly upper body information to the cerebellum?"

rightanswer = ["Rostral and cuneo cerebellar tracts"]

wronganswer = ["Ventral and caudal spinocerebellar tracts", "Ventral and anterior spinocerebellar tracts", "Dorsal and ventral spinocerebellar tracts", "Propriospinal tracts"]

hint = " Both spinocerebellar tracts that serve the lower body are named for coordinate directions, and so is one of the two that serve the upper body "

explanation = """

There are four spinocerebellar tracts, two for the lower body and two for the upper body. The dorsal and ventral spinocerebellar tracts convey information from the lower body. Information in the dorsal spinocerebellar tract is somatic sense. Dorsal spinocerebellar tract signals are lost when sensory nerves are cut. Information in the ventral spinocerebellar tract remains when sensory nerves are cut, showing that it is motor command-related signals rather than sensory signals. Similarly, for the upper body, the cuneocerebellar tract carries sensory signals, and the rostral spinocerebellar tract is believed to carry motor command information.

"""

questionid = "1006"

[[lecture10.questions]]

question = "The mossy fiber input to cerebellar cortex goes to which?"

rightanswer = ["Glomeruli that have granule cell dendrites"]

wronganswer = ["Purkinje cell dendrites, wrapping all around them", "Parallel fiber axons rather than dendrites", "The four spinocerebellar tracts", "GABA synapses to cause inhibition"]

hint = "Mossy fibers do not go to the cerebellar cortex layer where the climbing fibers synapse"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Mossy fibers arise from many areas of the central nervous system and make excitatory synapses in the granule cell layer of cerebellar cortex within glomeruli. Mossy fiber glomeruli consist of incoming mossy fiber axon terminals, granule cell dendrites, and inhibitory axon terminals of Golgi cells of cerebellar cortex. Climbing fibers arise exclusively from the inferior olive in the medulla and synapse on Purkinje cell dendrites in the molecular layer of cerebellar cortex.

"""

questionid = "1007"

[[lecture10.questions]]

question = "Which describes the output from cerebellar cortex?"

rightanswer = ["It is an entirely inhibitory projection of GABA-ergic neurons"]

wronganswer = ["It is comprised of axons ending primarily in motor cortex", "It uses the neurotransmitter dopamine", "It is comprised of axons that project to spinal cord motor neurons and interneurons", "It is an entirely excitatory projection of glutamatergic neurons"]

hint = "Large, flask-shaped neurons in a monolayer provide the output from cerebellar cortex"

explanation = """

Purkinje cells are the output neurons of cerebellar cortex. They are GABA-ergic neurons that project to cerebellar deep nuclear neurons. The deep nuclear neurons then project to the ventral lateral thalamus and other areas.

"""

questionid = "1008"

[[lecture10.questions]]

question = "Which two tracts convey mainly movement command feedback information to the cerebellum?"

rightanswer = ["Ventral and rostral spinocerebellar tracts"]

wronganswer = ["Rostral and cuneo cerebellar tracts", "Ventral and anterior spinocerebellar tracts", "Dorsal and ventral spinocerebellar tracts", "Propriospinal tracts"]

hint = "There are four spinocerebellar tracts, two for the lower body and two for the upper body"

explanation = """

There are four spinocerebellar tracts, two for the lower body and two for the upper body. The dorsal and ventral spinocerebellar tracts convey information from the lower body. Information in the dorsal spinocerebellar tract is somatic sense. Dorsal spinocerebellar tract signals are lost when sensory nerves are cut. Information in the ventral spinocerebellar tract remains when sensory nerves are cut, showing that it is motor command-related signals rather than sensory signals. Similarly, for the upper body, the cuneocerebellar tract carries sensory signals, and the rostral spinocerebellar tract is believed to carry motor command information.

"""

questionid = "1009"

[[lecture10.questions]]

question = "The climbing fiber input to cerebellar cortex goes to which?"

rightanswer = ["Purkinje cell dendrites, wrapping all around them"]

wronganswer = ["Glomeruli that have granule cell dendrites", "Parallel fiber axons rather than dendrites", "The four spinocerebellar tracts", "GABA synapses to cause inhibition"]

hint = "The names of the cerebellar inputs describe their terminations"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Climbing fibers arise exclusively from the inferior olive in the medulla. Each climbing fiber branches to excite a few Purkinje cells with extensive axonal arborizations all over the dendritic tree. Each Purkinje cell receives only one climbing fiber input.

"""

questionid = "1010"

[[lecture10.questions]]

question = "Which cerebellar neurons are excitatory?"

rightanswer = ["Granule cells"]

wronganswer = ["Purkinje cells", "Basket cells", "Stellate cells", "Golgi cells"]

hint = "There are three types of local inhibitory neurons within the cerebellar cortex, and one major inhibitory output neuron"

explanation = """

The very numerous granule cells are the only excitatory cells of the cerebellar cortex. The Purkinje cells that provide the output from cerebellar cortex are inhibitory to the deep nuclear cells that receive their axons. The molecular layer of the cerebellar cortex contains two types of GABA-ergic neurons that inhibit the Purkinje cells below them. Basket cells have basket shaped axonal arborizations around Purkinje cell bodies. Stellate cells are small neurons that make inhibitory synapses onto Purkinje cell dendrites. The granule cell layer of cerebellar cortex contains Golgi cells that inhibit granule cells at the mossy fiber glomeruli.

"""

questionid = "1011"

[[lecture10.questions]]

question = "Which cerebellar neurons are inhibitory to Purkinje cells?"

rightanswer = ["Stellate and basket cells"]

wronganswer = ["Granule and basket cells", "Granule and deep nuclear cells", "Granule and Golgi cells", "Basket and Golgi cells"]

hint = "the neurons that inhibit Purkinje cells are found in the outer molecular layer"

explanation = """

The molecular layer of the cerebellar cortex contains two types of GABA-ergic neurons that inhibit the Purkinje cells below them. Basket cells have basket shaped axonal arborizations around Purkinje cell bodies. Stellate cells are small neurons that make inhibitory synapses onto Purkinje cell dendrites.

"""

questionid = "1013"

[[lecture10.questions]]

question = "Where does the climbing fiber input to cerebellum originate?"

rightanswer = ["Inferior olive"]

wronganswer = ["Superior olive", "Dentate nucleus", "Dentate gyrus", "Medial superior olive"]

hint = "There is a single medullary nucleus that is the sole source of climbing fibers"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Mossy fibers arise from many areas of the central nervous system and make excitatory synapses in the granule cell layer of cerebellar cortex within glomeruli. Climbing fibers arise exclusively from the inferior olive in the medulla. Each climbing fiber branches to excite a few Purkinje cells with extensive axonal arborizations all over the dendritic tree. Each Purkinje cell receives only one climbing fiber input.

"""

questionid = "1014"

[[lecture10.questions]]

question = "Which layer of the cerebellum contains billions of parallel fibers?"

rightanswer = ["Molecular"]

wronganswer = ["Deep nuclear", "Granule cell", "Purkinje cell", "Middle cerebellar peduncle"]

hint = "There are three layers of cerebellar cortex above the cerebellar white matter and deep nuclei"

explanation = """

There are three layers of cerebellar cortex above the cerebellar white matter and deep nuclei. The most superficial layer of cerebellar cortex is the molecular layer, which contains billions of parallel fibers and the inhibitory stellate and basket cells. All synapse onto Purkinje cells. Beneath the molecular layer lies a single monolayer sheet of large, flask-shaped Purkinje cell bodies, with characteristic planar dendritic fields that extend into the molecular layer where the parallel fibers pass through the dendrites to make a few synapses on each of thousands of Purkinje cells. The deepest cerebellar cortex layer is the granule cell layer. In the granule call layer are billions of granule cells and the synaptic glomeruli at which granule cells get their input. Also in the granule cell layer are the inhibitory Golgi cells which make inhibitory synapses onto granule cell dendrites in the glomeruli. Incoming mossy fibers are the third element of the glomeruli.

"""

questionid = "1017"

[[lecture10.questions]]

question = "Which path does NOT end as mossy fibers to the cerebellum?"

rightanswer = ["Olivocerebellar"]

wronganswer = ["Pontocerebellar", "Dorsal spinocerebellar", "Ventral spinocerebellar", "Reticulocerebellar"]

hint = "The two cerebellar input types are named for the appearance of their terminations"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Mossy fibers arise from many areas of the central nervous system and make excitatory synapses in the granule cell layer of cerebellar cortex within glomeruli. Mossy fiber glomeruli consist of incoming mossy fiber axon terminals, granule cell dendrites, and inhibitory axon terminals of Golgi cells of cerebellar cortex. Climbing fibers arise exclusively from the inferior olive in the medulla. Each climbing fiber branches to excite a few Purkinje cells with extensive axonal arborizations all over the dendritic tree. Each Purkinje cell receives only one climbing fiber input. In addition to mossy and climbing fiber inputs, there are neuromodulatory inputs to the cerebellum.

"""

questionid = "1019"

[[lecture10.questions]]

question = "Damage to which part of the cerebellum is correlated to decomposition of movement?"

rightanswer = ["Hemispheres"]

wronganswer = ["Vermis", "Fastigial nucleus", "Nodulus", "Uvula"]

hint = "More lateral in the cerebellum corresponds to more lateral or more complex higher motor functions"

explanation = """

The flocculonodular lobe (vestibulocerebellum) and the vermis, medial cerebellum, are most closely associated with trunk coordination, trunk ataxia, and loss of balance. The intermediate zone between the vermis and hemispheres is most related to limb function and limb ataxia, abnormal gait, or limb coordination. The lateral cerebellum (hemisphere) is most related to multi-joint movements, finger control, and to motor planning and motor learning.

"""

questionid = "1020"

[[lecture10.questions]]

question = "A cerebellar glomerulus contains which elements?"

rightanswer = ["Granule cell dendrites, Golgi cell axon terminals, mossy fiber axon terminals"]

wronganswer = ["Granule cell dendrites, Golgi cell dendrites, mossy fiber dendrites", "Purkinje cell dendrites, granule cell axon terminals, mossy fiber axon terminals", "Purkinje cell dendrites, granule cell dendrites, mossy fiber axon terminals", "Stellate cell axon terminals, basket cell axon terminals, Golgi cell axon terminals"]

hint = "the cerebellar glomerulus is an input structure not related to the inferior olive"

explanation = """

There are two major inputs to the cerebellum, mossy fibers and climbing fibers. Mossy fibers arise from many areas of the central nervous system and make excitatory synapses in the granule cell layer of cerebellar cortex within glomeruli. Mossy fiber glomeruli consist of incoming mossy fiber axon terminals, granule cell dendrites, and inhibitory axon terminals of Golgi cells of cerebellar cortex. Climbing fibers arise exclusively from the inferior olive in the medulla. Each climbing fiber branches to excite a few Purkinje cells with extensive axonal arborizations all over the dendritic tree. Each Purkinje cell receives only one climbing fiber input. In addition to mossy and climbing fiber inputs, there are neuromodulatory inputs to the cerebellum.

"""

questionid = "1021"

[[lecture10.questions]]

question = "Limb ataxia is most closely associated with which cerebellar structure?"

rightanswer = ["Intermediate zone"]

wronganswer = ["Fastigial nucleus", "Unipolar brush cell", "Oculomotor vermis", "Lingula"]

hint = "More lateral in the cerebellum corresponds to more lateral or more complex higher motor functions"

explanation = """

The flocculonodular lobe (vestibulocerebellum) and the vermis, medial cerebellum, are most closely associated with trunk coordination, trunk ataxia, and loss of balance. The intermediate zone between the vermis and hemispheres is most related to limb function and limb ataxia, abnormal gait, or limb coordination. The lateral cerebellum (hemisphere) is most related to multi-joint movements, finger control, and to motor planning and motor learning.

"""

questionid = "1022"

[[lecture10.questions]]

question = "What are the inputs to cerebellar deep nuclei and their excitatory (+) or inhibitory (-) effects?"

rightanswer = ["Mossy fiber collaterals (+), climbing fiber collaterals (+), Purkinje cell axons (-)"]

wronganswer = ["Golgi cell axons (+), mossy fiber collaterals (+), granule cell axons (-)", "Fastigial cell axons (+), climbing fiber collaterals (+), Purkinje cell axons (+)", "Dentate cell axons (+), climbing fiber collaterals (-), Purkinje cell axons (+)", "Mossy fiber collaterals (-), dentate cell axons (-), Purkinje cell axons (-)"]

hint = "Consider where inputs to the cerebellum branch and terminate"

explanation = """

Purkinje cells are large GABA-ergic neurons that provide the output from cerebellar cortex. Most Purkinje cells project to cerebellar deep nuclei, which send axons out of the cerebellum to the thalamus and other areas. Purkinje cells are the main inhibitory input to deep nuclear cells. Mossy and climbing fiber excitatory inputs to the cerebellum branch and send a collateral axon to excite the deep nuclei.

"""

questionid = "1023"

[[lecture10.questions]]

question = "How can you best describe and contrast the motor control roles of the cerebellum vs the basal ganglia, respectively?"

rightanswer = ["Movement guidance vs movement initiation"]

wronganswer = ["Movement initiation vs resting posture", "Tremor reduction at rest vs tremor reduction near movement goal", "Movement reward vs movement punishment", "Movement punishment vs movement guidance"]

hint = "Consider the effects of cerebellar vs basal ganglia damage"

explanation = """

A primary role of the cerebellum is guidance and refinement of ongoing movement and its accurate termination. The basal ganglia are especially important for movement initiation. Cerebellar damage can result in intention tremor as a movement approaches its goal. Basal ganglia damage can result in a tremor at rest that may diminish during movement. Cerebellar damage often causes hypermetria, basal ganglia damage often causes hypometria.

"""

questionid = "1024"

[[lecture10.questions]]

question = "Which tract travels through the superior cerebellar peduncle?"

rightanswer = ["Ventral spinocerebellar"]

wronganswer = ["Cuneo spinocerebellar", "Dorsal spinocerebellar", "Olivocerebellar", "Corticospinal"]

hint = "The exception to the superior peduncle being output is exceptional in its decussations"

explanation = """

The inferior cerebellar peduncle contains almost entirely inputs. Spinocerebellar, inferior olivary olivocerebellar, vestibulocerebellar, and reticulocerebellar inputs comprise the inferior cerebellar peduncle. The large middle cerebellar peduncle is comprised of pontocerebellar inputs. The superior cerebellar peduncle contains the cerebellar deep nuclear outputs and the ventral spinocerebellar tract input. The ventral spinocerebellar tract begins with ipsilateral second order spinal sensory neurons whose axons cross to become contralateral, ascend to the superior cerebellar peduncle, then recross to return to the ipsilateral side to synapse in the cerebellar granule cell layer as mossy fibers.

"""

questionid = "1025"

[lecture11]

label = "#11 Basal Ganglia"

[[lecture11.questions]]

question = "Which lists the direct pathway through the basal ganglia via the correct structures in the correct order?"

rightanswer = ["neocortex>striatum>globus pallidus internal segment>ventral thalamus>neocortex"]

wronganswer = ["neocortex>striatum>globus pallidus external segment>ventral thalamus>neocortex", "neocortex>ventral thalamus>globus pallidus internal segment>striatum>neocortex", "neocortex>substantia nigra>ventral thalamus>neocortex", "neocortex>striatum>globus pallidus external segment>subthalamic nucleus>globus pallidus internal segment>ventral thalamus>neocortex"]

hint = "The external segment of the globus pallidus and the subthalamic nucleus are not involved"

explanation = """

There are two main pathways through the basal ganglia, the movement exciting direct path and the movement inhibiting indirect path. Both paths begin with the projection of cerebral cortex layer 5 neurons to the striatum of the basal ganglia, the caudate and putamen nuclei. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The output nuclei are inhibited by the direct pathway input, reducing their inhibition of movement. This disinhibition facilitates movement. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement. Dopamine projected to the striatum from the substantia nigra pars compacta excites D1 receptors, and thus excites the direct pathway, and it inhibits D2 receptors, and thus inhibits the indirect pathway. The two effects combine to make dopamine a powerful excitatory factor in promoting movement.

"""

questionid = "1101"

[[lecture11.questions]]

question = "Which lists the indirect pathway through the basal ganglia via the correct structures in the correct order?"

rightanswer = ["neocortex>striatum>globus pallidus external segment>subthalamic nucleus>globus pallidus internal segment>ventral thalamus>neocortex"]

wronganswer = ["neocortex>striatum>globus pallidus external segment>ventral thalamus>neocortex", "neocortex>striatum>globus pallidus internal segment>ventral thalamus>neocortex", "neocortex> ventral thalamus >globus pallidus internal segment>striatum>neocortex", "neocortex>substantia nigra >ventral thalamus>neocortex"]

hint = "Two inhibitory steps are required before the output nuclei"

explanation = """

There are two main pathways through the basal ganglia, the movement exciting direct path and the movement inhibiting indirect path. Both paths begin with the projection of cerebral cortex layer 5 neurons to the striatum of the basal ganglia, the caudate and putamen nuclei. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The output nuclei are inhibited by the direct pathway input, reducing their inhibition of movement. This disinhibition facilitates movement. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement. Dopamine projected to the striatum from the substantia nigra pars compacta excites D1 receptors, and thus excites the direct pathway, and it inhibits D2 receptors, and thus inhibits the indirect pathway. The two effects combine to make dopamine a powerful excitatory factor in promoting movement.

"""

questionid = "1102"

[[lecture11.questions]]

question = "Excitatory glutamate output projects from which basal ganglia neuron type, nuclear division, or nucleus, etc.?"

rightanswer = ["subthalamic nucleus"]

wronganswer = ["globus pallidus internal segment", "globus pallidus external segment", "D1 striatal projection neurons", "D2 striatal projection neurons"]

hint = "The excitatory step is part of the indirect pathway and hyperdirect pathway"

explanation = """

There is only one glutamatergic excitatory basal ganglia nucleus, the subthalamic nucleus. The subthalamic nucleus is part of the indirect and hyperdirect paths, receiving input from the external segment of the globus pallidus and from the cerebral cortex hyperdirect path. The output of the subthalamic nucleus excites the inhibitory output nuclei of the basal ganglia.

"""

questionid = "1103"

[[lecture11.questions]]

question = "The two main output targets of the striatum of the basal ganglia are which?"

rightanswer = ["External and internal segments of the globus pallidus (GPe and GPi)"]

wronganswer = ["Substantia nigra pars reticulata (SNr) and subthalamic nucleus (STN)", "Internal segment of the globus pallidus (GPi) and substantia nigra pars reticulata (SNr)", "Substantia nigra pars compacta (SNc) and subthalamic nucleus (STN)", "Substantia nigra pars compacta (SNc) and substantia nigra pars reticulata (SNr)"]

hint = "Both are inhibitory outputs to inhibitory neurons"

explanation = """

Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The D2 cells project the indirect path to the external segment of the globus pallidus.

"""

questionid = "1104"

[[lecture11.questions]]

question = "The two main output nuclei of the basal ganglia are which?"

rightanswer = ["Internal segment of the globus pallidus (GPi) and substantia nigra pars reticulata (SNr)"]

wronganswer = ["Substantia nigra pars reticulata (SNr) and subthalamic nucleus (STN)", "External and internal segments of the globus pallidus (GPe and GPi)", "Substantia nigra pars compacta (SNc) and subthalamic nucleus (STN)", "Substantia nigra pars compacta (SNc) and substantia nigra pars reticulata (SNr)"]

hint = "The output nuclei are the point of convergence of the direct and indirect pathways"

explanation = """

The internal segment of the globus pallidus (GPi) and substantia nigra pars reticulata (SNr) are the inhibitory output nuclei of the basal ganglia. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The output nuclei are inhibited by the direct pathway input, reducing their inhibition of movement. This disinhibition facilitates movement. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement.

"""

questionid = "1105"

[[lecture11.questions]]

question = "The output from the globus pallidus external segment (pars externa) is which?"

rightanswer = ["GABA-ergic"]

wronganswer = ["Axons that project to spinal cord motor neurons and interneurons", "Axons ending primarily in motor cortex", "Dopaminergic", "Glutamatergic"]

hint = "The subthalamic nucleus is the only glutaminergic nucleus of the basal ganglia"

explanation = """

There are two main pathways through the basal ganglia, the movement exciting direct path and the movement inhibiting indirect path. Both paths begin with the projection of cerebral cortex layer 5 neurons to the striatum of the basal ganglia, the caudate and putamen nuclei. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement.

"""

questionid = "1106"

[[lecture11.questions]]

question = "The output from the globus pallidus internal segment (pars interna) is which?"

rightanswer = ["GABA-ergic"]

wronganswer = ["Axons ending primarily in motor cortex", "Dopaminergic", "Axons that project to spinal cord motor neurons and interneurons", "Glutamatergic"]

hint = "The subthalamic nucleus is the only glutaminergic nucleus of the basal ganglia"

explanation = """

The substantia nigra pars reticulata and the internal segment of the globus pallidus are the two output nuclei of the basal ganglia. Both are GABA-ergic inhibitory nuclei that inhibit the ventral thalamus and therefore motor areas of cortex.

"""

questionid = "1108"

[[lecture11.questions]]

question = "The output from D1 receptor expressing striatal projection neurons is which?"

rightanswer = ["GABA-ergic inhibitory"]

wronganswer = ["Neuromodulatory, either excitatory of inhibitory depending on context", "Dopaminergic excitatory", "Glutamatergic excitatory", "Enkephalinergic"]

hint = "The subthalamic nucleus is the only glutaminergic nucleus of the basal ganglia"

explanation = """

Both D1 and D2 receptors are G protein coupled receptors. Adenylate cyclase activity is one of the main targets. D1 receptors increase adenylate cyclase activity, D2 receptors decrease adenylate cyclase activity. These can be regarded as excitatory and inhibitory effects, respectively.

"""

questionid = "1109"

[[lecture11.questions]]

question = "How is adenylate cyclase activity (in response to dopamine) affected in striatal projection neurons expressing D1 receptors vs those expressing D2 receptors, respectively?"

rightanswer = ["Increased vs decreased"]

wronganswer = ["Increased vs increased", "Decreased vs increased", "Decreased vs decreased", "Unaffected vs increased"]

hint = "D1=excitatory, D2=inhibitory"

explanation = """

Both D1 and D2 receptors are G protein coupled receptors. Adenylate cyclase activity is one of the main targets. D1 receptors increase adenylate cyclase activity, D2 receptors decrease adenylate cyclase activity. These can be regarded as excitatory and inhibitory effects, respectively.

"""

questionid = "1111"

[[lecture11.questions]]

question = "What is the main neurotransmitter of the substantia nigra pars reticulata neurons?"

rightanswer = ["GABA"]

wronganswer = ["Glutamate", "Dopamine", "D1", "D2"]

hint = "The substantia nigra pars reticulata is one of the output nuclei of the basal ganglia"

explanation = """

The substantia nigra pars reticulata and the internal segment of the globus pallidus are the two output nuclei of the basal ganglia. Both are GABA-ergic inhibitory nuclei that inhibit the ventral thalamus and therefore motor areas of cortex.

"""

questionid = "1112"

[[lecture11.questions]]

question = "Which is the hyperdirect pathway?"

rightanswer = ["Cerebral cortex to subthalamic nucleus"]

wronganswer = ["Cerebral cortex to substantia nigra pars compacta", "Cerebral cortex to substantia nigra pars reticulata", "Striatum to substantia nigra pars compacta", "Striatum to substantia nigra pars reticulata"]

hint = "The hyperdirect path acts like the indirect path but skips two of the inhibitory steps"

explanation = """

In addition to the direct and indirect pathways through the basal ganglia, there is a ‘hyperdirect’ pathway from cerebral cortex directly to the subthalamic nucleus, thus bypassing two inhibitory steps of the indirect pathway. The effects of the hyperdirect path are expected to be similar to those of the indirect path, inhibiting movement and sculpting the correct movement by inhibiting similar incorrect movements.

"""

questionid = "1113"

[[lecture11.questions]]

question = "What is the most likely function of the hyperdirect pathway?"

rightanswer = ["Inhibitory sculpting of direct pathway excitation"]

wronganswer = ["Stronger excitation of movement than the direct pathway", "Shortening the latency of excitatory signals through the direct pathway", "Providing a pinpoint focus of inhibition to block a specific response commanded by the direct pathway", "Roughly equivalent in excitation of movement to direct pathway activation"]

hint = "The hyperdirect pathway projects from cerebral cortex to the subthalamic nucleus"

explanation = """

In addition to the direct and indirect pathways through the basal ganglia, there is a ‘hyperdirect’ pathway from cerebral cortex directly to the subthalamic nucleus, thus bypassing two inhibitory steps of the indirect pathway. The effects of the hyperdirect path are expected to be similar to those of the indirect path, inhibiting movement and sculpting the correct movement by inhibiting similar incorrect movements.

"""

questionid = "1114"

[[lecture11.questions]]

question = "What is the most direct early cause of the signs of Huntington's disease?"

rightanswer = ["Loss of D2 receptor expressing striatal projection neurons"]

wronganswer = ["Loss of substantia nigra pars compacta dopamine neurons", "Loss of substantia nigra pars reticulata dopamine neurons", "Loss of D1 receptor expressing striatal projection neurons", "Loss of neurons throughout cerebral cortex"]

hint = " The indirect path in basal ganglia is first damaged, with predictable motor effects "

explanation = """

Huntington’s disease first affects D2 receptor-expressing striatal projection GABA neurons of the indirect pathway. The indirect path inhibits movements, and early Huntington’s disease is characterized by the loss of inhibition causing uncontrolled dance-like movements, Huntington’s chorea.

"""

questionid = "1117"

[[lecture11.questions]]

question = "Which is the LEAST likely sign of Parkinson's disease?"

rightanswer = ["Intention tremor"]

wronganswer = ["Resting tremor", "Akinesia", "Bradykinesia", "Hypometria in gait"]

hint = "contrast Parkinson’s disease with cerebellar disease"

explanation = """

The common signs of Parkinson’s disease include bradykinesia or akinesia, hypometria, loss of balance, rigidity, mask-like face, and often a relatively rapid tremor at rest. The resting tremor contrasts with cerebellar signs, which are commonly an intention tremor at the end of movements, hypermetria, decomposition of movements into component parts, and a drunken gait. Oculomotor signs are rare in Parkinson’s disease and common in cerebellar disease.

"""

questionid = "1118"

[[lecture11.questions]]

question = "What is a (are) major direct output(s) of the substantia nigra pars reticulata and internal segment of the globus pallidus?"

rightanswer = ["Ventral thalamus"]

wronganswer = ["Substantia nigra pars compacta and external segment of the globus pallidus", "Motor cortex", "Association cortex", "Spinal cord ventral horn"]

hint = "Identify the output nuclei of the basal ganglia"

explanation = """

The output nuclei of the basal ganglia are the globus pallidus internal segment and the substantia nigra pars reticulata. They project GABA-ergic axons to the ventral thalamus, mainly to the ventral anterior nucleus. This inhibits the ventral thalamus and inhibits the motor cortical areas that the ventral thalamus excites.

"""

questionid = "1119"

[[lecture11.questions]]

question = "What neurological disorder is most closely associated with loss of the subthalamic nucleus?"

rightanswer = ["Hemiballism"]

wronganswer = ["Parkinson's disease", "Huntington's disease", "Essential tremor", "Tardive dyskinesia"]

hint = "The subthalamic nucleus excites the basal ganglia output nuclei to increase inhibition of movement"

explanation = """

A stroke or tuberculosis can damage the subthalamic nucleus on one side. This lowers excitation of the inhibitory basal ganglia output nuclei, resulting in the uncontrolled release of large flinging limb movements, hemiballism.

"""

questionid = "1120"

[[lecture11.questions]]

question = "Which neurotransmitter is supplied by structures that lie one just dorsal to the crus cerebri and the other in the midbrain tegmentum, ventrally near the midline?"

rightanswer = ["Dopamine"]

wronganswer = ["Acetylcholine", "Histamine", "Norepinephrine", "Serotonin"]

hint = "Consider the subdivisions of the midbrain seen in a cross section axial or horizontal view"

explanation = """

The two major sources of dopamine as a neuromodulator are the substantia nigra pars compacta and ventral tegmental area in the midbrain. The substantia nigra lies immediately dorsal to the most ventral crus cerebri and ventral to the midbrain tegmentum. The ventral tegmental area lies along the midline of the midbrain in a roughly defined ventral to dorsal band through the tegmentum.

"""

questionid = "1121"

[[lecture11.questions]]

question = "Which provide the main input to the external segment of the globus pallidus (GPe)?"

rightanswer = ["D2 striatal projection neurons"]

wronganswer = ["Subthalamic nucleus (STN) neurons", "Substantia nigra pars compacta (SNc) neurons", "Substantia nigra pars reticulata (SNr) neurons", "D1 striatal projection neurons"]

hint = "The indirect pathway is involved"

explanation = """

There are two main pathways through the basal ganglia, the movement exciting direct path and the movement inhibiting indirect path. Both paths begin with the projection of cerebral cortex layer 5 neurons to the striatum of the basal ganglia, the caudate and putamen nuclei. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The output nuclei are inhibited by the direct pathway input, reducing their inhibition of movement. This disinhibition facilitates movement. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement. Dopamine projected to the striatum from the substantia nigra pars compacta excites D1 receptors, and thus excites the direct pathway, and it inhibits D2 receptors, and thus inhibits the indirect pathway. The two effects combine to make dopamine a powerful excitatory factor in promoting movement.

"""

questionid = "1122"

[[lecture11.questions]]

question = "Which provide the main input to the internal segment of the globus pallidus (GPi)?"

rightanswer = ["D1 striatal projection neurons"]

wronganswer = ["Subthalamic nucleus (STN) neurons", "Substantia nigra pars compacta (SNc) neurons", "Substantia nigra pars reticulata (SNr) neurons", "D2 striatal projection neurons"]

hint = "The direct pathway is involved"

explanation = """

There are two main pathways through the basal ganglia, the movement exciting direct path and the movement inhibiting indirect path. Both paths begin with the projection of cerebral cortex layer 5 neurons to the striatum of the basal ganglia, the caudate and putamen nuclei. Corticostriate neurons synapse on GABA-ergic striatal projection neurons that express either D1 or D2 type dopamine receptors. The D1 cells project the direct path to the basal ganglia inhibitory output nuclei, the internal segment of the globus pallidus and the substantia nigra pars reticulata. The output nuclei are inhibited by the direct pathway input, reducing their inhibition of movement. This disinhibition facilitates movement. The D2 cells project the indirect path to the external segment of the globus pallidus. The indirect path continues with a projection from the external segment to the subthalamic nucleus, the only excitatory glutaminergic basal ganglia nucleus. The subthalamic nucleus projects to the basal ganglia output nuclei. The extra inhibitory step in the indirect pathway makes it inhibitory to movement. The indirect pathway excites the inhibitory basal ganglia output nuclei, discouraging movement. Dopamine projected to the striatum from the substantia nigra pars compacta excites D1 receptors, and thus excites the direct pathway, and it inhibits D2 receptors, and thus inhibits the indirect pathway. The two effects combine to make dopamine a powerful excitatory factor in promoting movement.

"""

questionid = "1123"

[[lecture11.questions]]

question = "What is the early motor sign of Huntington's disease?"

rightanswer = ["Uncontrolled movements or chorea"]

wronganswer = ["Tremor", "Bradykinesia or akinesia", "Intention tremor and/or decomposition of movement", "Oculomotor paresis and/or saccadic suppression"]

hint = "The indirect path in basal ganglia is first damaged, with predictable motor effects"

explanation = """

Huntington’s disease first affects D2 receptor-expressing striatal projection GABA neurons of the indirect pathway. The indirect path inhibits movements, and early Huntington’s disease is characterized by the loss of inhibition causing uncontrolled dance-like movements, Huntington’s chorea.

"""

questionid = "1124"

[[lecture11.questions]]

question = "What is the genetic or biochemical cause of most instances of Parkinson's disease?"

rightanswer = ["Unknown"]

wronganswer = ["Somatic mutation of the Pk1 gene", "Genetic mutation of the Pk1 gene", "Methylation of the Pk1 gene", "Intracellular damage due to low intracellular Ca++"]

hint = "Parkinson’s disease has no cure or prevention"

explanation = """

The causes of the large majority of Parkinson’s disease cases are unknown. The extent to which genetics vs environment is at fault is unknown. Dozens of genes are correlated with Parkinson’s disease, and many environmental factors are weakly correlated with Parkinson’s disease. Excess internal Ca++ has been suggested as causative, alpha-synuclein and tau protein may be causative. PINK1 gene mutations are a rare cause of Parkinson’s disease.

"""

questionid = "1125"

[lecture12]

label = "#12 Limbic System"

[[lecture12.questions]]

question = "Which neurological problem is most likely to be present after a person suffers damage to the hippocampal limbic loop?"

rightanswer = ["inability to remember driving directions to an unfamiliar location"]

wronganswer = ["flat affect with little emotional response to upsetting events", "agraphia", "psychic blindness", "inability to understand the spoken voice"]

hint = "Distinguish declarative memory from emotional memory"

explanation = """

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

"""

questionid = "1201"

[[lecture12.questions]]

question = "Which neurological problem is most likely to be present after a person suffers damage to the amygdala?"

rightanswer = ["flat affect with little emotional response to upsetting events"]

wronganswer = ["inability to remember driving directions to an unfamiliar location", "agraphia", "psychic blindness", "inability to understand the spoken voice"]

hint = "Distinguish declarative memory from emotional memory"

explanation = """

Amygdala damage impairs emotional memory. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations. S.M. appears emotionally flat. She is unable to recognize facial expressions of fear, but still able to recognize other facial expressions.

"""

questionid = "1202"

[[lecture12.questions]]

question = "Which neurological deficit is revealed in animals after lesions of the hippocampus?"

rightanswer = ["inability to learn a new spatial discrimination"]

wronganswer = ["inability to recognize a previously learned object or task", "failure to respond to social cues", "loss of sexual behaviors", "inability to detect odors"]

hint = "Distinguish the type of declarative memory that can be tested in animals"

explanation = """

Lesion studies in animals have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock.

"""

questionid = "1203"

[[lecture12.questions]]

question = "What type(s) of deficit(s) most likely result(s) from amygdala damage?"

rightanswer = ["Failure to recognize facial expressions of fear"]

wronganswer = ["Loss of Spatial memory and maze learning", "Loss of Spatial orientation and awareness of compass directions", "Failure to recognize familiar faces (prosopagnosia)", "Uncontrolled anger and loss of sexually motivated responses"]

hint = "Distinguish declarative memory from emotional memory"

explanation = """

Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock. Amygdala damage impairs emotional memory. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations. She is unable to recognize facial expressions of fear, but still able to recognize other facial expressions.

"""

questionid = "1206"

[[lecture12.questions]]

question = "Which kind of memory formation is not much affected by hippocampal damage?"

rightanswer = ["Drawing while viewing through a mirror (mirror drawing)"]

wronganswer = ["Spatial locations", "World events", "Newly met people", "Maze learning"]

hint = "Distinguish declarative memories from implicit, motor, or other types of memory "

explanation = """

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

"""

questionid = "1207"

[[lecture12.questions]]

question = "What is the ultimate destination of most entorhinal cortex projections?"

rightanswer = ["Dentate gyrus"]

wronganswer = ["Parahippocampal cortex", "Amygdala", "Fornix", "Anterior thalamus"]

hint = "Recall the initial synaptic step in the hippocampal trisynaptic ciruit"

explanation = """

The detailed trisynaptic circuit through the hippocampus begins with the perforant path from entorhinal cortex (or subiculum) crossing the hippocampal sulcus to terminate on granule cells in the dentate gyrus of the hippocampal formation. (The hippocampal formation includes the dentate gyrus and the hippocampus proper) Dentate gyrus neurons project as mossy fibers to pyramidal cells of hippocampus CA3. CA3 projects to pyramidal cells of CA1 as Schaffer collaterals. CA1 projects out of the hippocampus via the fornix and subiculum.

"""

questionid = "1210"

[[lecture12.questions]]

question = "Which was a deficit in the famous hippocampal patients H.M. and R.B.?"

rightanswer = ["Failure to recognize the scientists studying them"]

wronganswer = ["Forgotten childhood events", "Loss of social skills in conversation", "Loss of visuomotor skills", "Wernicke's aphasia"]

hint = "Distinguish declarative memories from implicit, motor, or other types of memory"

explanation = """

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

"""

questionid = "1211"

[[lecture12.questions]]

question = "Which structure has the stria terminalis (or terminal stria) as one of its prominent outputs?"

rightanswer = ["Amygdala"]

wronganswer = ["Lateral nucleus of the hypothalamus", "Orbitofrontal cortex", "Bed nucleus", "Hippocampus"]

hint = "The fornix relates more closely to memory; the nearby stria terminalis relates more closely to emotions"

explanation = """

There are three major amygdala outputs. The dorsal output, or stria terminalis, projects to the hypothalamus and septal area. The larger ventral output, or ventral amygdalofugal pathway, projects to many areas, including the hypothalamus, ventral basal ganglia (nucleus accumbens), and medial dorsal thalamus. The third amygdala output is via nearby cortical relays to other cortical areas and beyond.

"""

questionid = "1212"

[[lecture12.questions]]

question = "Which nuclei of the amygdala are regarded as its input and processing center?"

rightanswer = ["Basolateral"]

wronganswer = ["Medial", "Central", "Dentate", "Denticulate"]

hint = "The largest nuclear group of the amygdala is its input group"

explanation = """

The basolateral nuclear group of the amygdala is the largest group, subdivided in many ways. Its overall function appears to be receiving and processing inputs. Inputs to basolateral amygdala arise from hypothalamus and other autonomic centers, from prefrontal cortex, and from thalamic sensory relay nuclei for rapid fear responses. The second largest nuclear group of the amygdala is the central group, which is regarded as the output group of nuclei. The central nuclear group has widespread connections to brainstem autonomic and neuromodulatory centers, to ventral striatum, and to prefrontal cortex and anterior cingulate cortex.

"""

questionid = "1213"

[[lecture12.questions]]

question = "What is most directly a part of the ventral striatum?"

rightanswer = ["Nucleus accumbens"]

wronganswer = ["Dorsal pallidum", "Lateral dorsal (dorsolateral) nucleus", "Anterior nucleus (of thalamus)", "Dentate nucleus"]

hint = "The ventral striatum can be considered either a part of the basal ganglia or part of the limbic system"

explanation = """

The ventral striatum closely corresponds to the nucleus accumbens. (The olfactory tubercle is also ventral striatum.) Dorsal pallidum is another name for the globus pallidus. Lateral dorsal is a thalamic nucleus with projections to parietal cortex association areas. The lateral dorsal nucleus is often considered a limbic structure. The dentate nucleus is the largest deep cerebellar nucleus. The anterior nucleus of the thalamus is a step in the Papez circuit limbic loop. The anterior nucleus sends output to the cingulate cortex.

"""

questionid = "1214"

[[lecture12.questions]]

question = "Animals subjected to large, bilateral lesions of the temporal lobes exhibit which behavior (Kluver-Bucy syndrome)?"

rightanswer = ["Loss of rank in social hierarchy"]

wronganswer = ["Loss of discrimination learning", "Diminished sexual activity", "Emotional over-reaction", "Aversion to oral stimulation and eating"]

hint = "Loss of social rank may relate to loss of a limbic center for fear responses"

explanation = """

Kluver-Bucy syndrome results from widespread temporal lobe damage that affects the amygdala, hippocampus, higher visual centers, and connections with prefrontal cortex executive function areas. Kluver-Bucy syndrome includes loss of emotional responses, loss of social rank, or occasionally a rise in rank due to fearless aggression, oral examination of inappropriate objects, and indiscriminate hypersexuality.

"""

questionid = "1215"

[[lecture12.questions]]

question = "Which projection is thought to be responsible for expression of innate fears?"

rightanswer = ["Sensory thalamus to amygdala"]

wronganswer = ["Amygdala to lower motor neurons", "Amygdala to lateral geniculate nucleus", "Amygdalofugal fibers to amygdala", "Entorhinal cortex to hippocampus"]

hint = "Innate fear responses may not require the cerebral cortex"

explanation = """

The amygdala receives a very wide variety of inputs from autonomic centers, brainstem areas, cerebral cortex, and most directly from sensory thalamus. It is believed that the sensory thalamus input to the amygdala is what allows a rapid, seemingly instinctive, fear response to dangerous stimuli such as snakes.

"""

questionid = "1216"

[[lecture12.questions]]

question = "What is the main output of the dentate gyrus?"

rightanswer = ["Hippocampus proper (CA1-CA3)"]

wronganswer = ["Cerebellar cortex", "Ventral thalamus", "Mammillary bodies", "Parahippocampal cortex"]

hint = "The dentate gyrus is within the hippocampal formation"

explanation = """

The detailed trisynaptic circuit through the hippocampus begins with the perforant path from entorhinal cortex (or subiculum) crossing the hippocampal sulcus to terminate on granule cells in the dentate gyrus of the hippocampal formation. (The hippocampal formation includes the dentate gyrus and the hippocampus proper) Dentate gyrus neurons project as mossy fibers to pyramidal cells of hippocampus CA3. CA3 projects to pyramidal cells of CA1 as Schaffer collaterals. CA1 projects out of the hippocampus via the fornix and subiculum.

"""

questionid = "1217"

[[lecture12.questions]]

question = "What is the main destination of the fornix?"

rightanswer = ["Mammillary body"]

wronganswer = ["Anterior thalamus", "Parahippocampal cortex", "Entorhinal cortex", "Stria terminalis"]

hint = "The fornix is a step in the Papez circuit limbic loop "

explanation = """

The Papez circuit is the most basic limbic loop. All areas of cerebral cortex project to cingulate cortex. Cingulate cortex projects to parahippocampal cortex. Parahippocampal cortex projects via multiple steps to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project to the anterior thalamus via the mammillothalamic tract. The anterior thalamus projects to cingulate cortex, completing the loop.

"""

questionid = "1218"

[[lecture12.questions]]

question = "What is the main output of the mammillary body?"

rightanswer = ["Anterior thalamus"]

wronganswer = ["Fornix", "Parahippocampal cortex", "Entorhinal cortex", "Cingulate gyrus"]

hint = "The mammillary body output is a step in the Papez circuit limbic loop"

explanation = """

The Papez circuit is the most basic limbic loop. All areas of cerebral cortex project to cingulate cortex. Cingulate cortex projects to parahippocampal cortex. Parahippocampal cortex projects via multiple steps to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project to the anterior thalamus via the mammillothalamic tract. The anterior thalamus projects to cingulate cortex, completing the loop.

"""

questionid = "1219"

[[lecture12.questions]]

question = "What is the main output of the anterior thalamic nucleus?"

rightanswer = ["Cingulate gyrus"]

wronganswer = ["Fornix", "Mammillary body", "Parahippocampal cortex", "Entorhinal cortex"]

hint = "The anterior thalamus is a component of the limbic system"

explanation = """

The anterior thalamus is the main thalamic relay for the limbic system. The anterior thalamus projects to cingulate cortex, where posterior cingulate is most closely associated with the hippocampus and anterior cingulate associated with the amygdala. The medial dorsal nucleus of the thalamus as also considered a limbic thalamic relay, connecting limbic centers to the prefrontal cortex.

"""

questionid = "1220"

[[lecture12.questions]]

question = "Where is the subiculum interposed in the limbic circuitry?"

rightanswer = ["Between the hippocampus and fornix or cortex"]

wronganswer = ["Between the dentate gyrus and CA1-CA3", "Between the amygdala and the dorsolateral thalamus", "Between the amygdala and the anterior thalamus", "Between wide areas of cortex and the cingulate gyrus"]

hint = "The subiculum is adjacent to the limbic structures with which it has major connections"

explanation = """

The subiculum and its associated regions (pre-, post-, etc. subiculum) provide both inputs to and output destinations from the hippocampus. It can be considered to be part of parahippocampal or entorhinal cortex, though it is often omitted from descriptions of the Papez circuit as the Papez circuit passes via multiple synaptic steps from parahippocampal cortex to hippocampus.

"""

questionid = "1221"

[[lecture12.questions]]

question = "Which part of cerebral cortex outside the temporal lobe relates most closely to the hippocampus?"

rightanswer = ["Posterior cingulate cortex"]

wronganswer = ["Occipital cortex", "Parietal cortex", "Insular cortex", "Anterior cingulate cortex"]

hint = " Consider the cortical gyrus that is divided into an amygdala region and a hippocampal region "

explanation = """

The cingulate cortex is often divided into an anterior portion that relates to the amygdala and a posterior portion that relates to the hippocampus. The prefrontal cortex and anterior cingulate cortex have extensive interconnections with the amygdala, mainly relayed by the thalamus, as do parts of the temporal lobe. The temporal lobe is the main conduit into the hippocampus, which connects back to the posterior cingulate cortex via the fornix projection to the mammillary bodies, and then the mammillothalamic tract to the anterior thalamus areas that project to posterior cingulate cortex. Insular cortex also has interconnections with the limbic system and specifically the amygdala, but these are less well understood or robust than the amygdala connections with the anterior cingulate cortex.

"""

questionid = "1222"

[[lecture12.questions]]

question = "Which part of cerebral cortex outside the temporal lobe relates most closely to the amygdala?"

rightanswer = ["Anterior cingulate cortex"]

wronganswer = ["Occipital cortex", "Parietal cortex", "Insular cortex", "Posterior cingulate cortex"]

hint = "Consider the cortical gyrus that is divided into an amygdala region and a hippocampal region"

explanation = """

The cingulate cortex is often divided into an anterior portion that relates to the amygdala and a posterior portion that relates to the hippocampus. The prefrontal cortex and anterior cingulate cortex have extensive interconnections with the amygdala, mainly relayed by the thalamus, as do parts of the temporal lobe. The temporal lobe is the main conduit into the hippocampus, which connects back to the posterior cingulate cortex via the fornix projection to the mammillary bodies, and then the mammillothalamic tract to the anterior thalamus areas that project to posterior cingulate cortex. Insular cortex also has interconnections with the limbic system and specifically the amygdala, but these are less well understood or robust than the amygdala connections with the anterior cingulate cortex.

"""

questionid = "1223"

[[lecture12.questions]]

question = "Which best matches, respectively - declarative memory: emotional memory?"

rightanswer = ["Hippocampus : amygdala"]

wronganswer = ["Amygdala : amygdala", "Amygdala : hippocampus", "Hippocampus : hippocampus", "Spatial memory : fact memory"]

hint = "Distinguish the losses associated with damage to the two major limbic structures"

explanation = """

Animal studies and humans with specific neurological deficits have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock. Amygdala damage impairs emotional memory. Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations.

"""

questionid = "1224"

[[lecture12.questions]]

question = "Which best matches, respectively - spatial memory : declarative memory?"

rightanswer = ["Hippocampus : hippocampus"]

wronganswer = ["Amygdala : amygdala", "Amygdala : hippocampus", "Hippocampus : amygdala", "Event memory : specific relay thalamic nuclei"]

hint = "spatial memory can be considered a form of declarative memory"

explanation = """

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze.

"""

questionid = "1225"

[[lecture12.questions]]

question = "Fear memory is to amygdala as\_\_\_\_\_\_is to\_\_\_\_\_\_?"

rightanswer = ["Spatial memory : hippocampus"]

wronganswer = ["Spatial memory : amygdala", "Face recognition : amygdala", "Face recognition : hippocampus", "Fear memory : hippocampus"]

hint = "Animal studies have elucidated roles of the two major limbic centers"

explanation = """

Lesion studies in animals have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock.

"""

questionid = "1226"