

The Nervous System: C. Motor and Integrative Neurophysiology

- A 76-year-old man has a stroke that severely impairs his speech. Which area of his brain is most likely damaged?
 - Primary motor cortex
 - Premotor area
 - Broca's area
 - Cerebellum
- A 17-year-old boy sustains serious head and neck trauma during a football game. Physical examination shows a positive Babinski sign. What part of the brain has most likely been damaged in this boy?
 - Anterior motor neurons
 - Cerebellum
 - Corticospinal tract
 - Premotor cortex
- Which statement best describes a functional role for the lateral hemispheres of the cerebellum?
 - Control and coordinate movements of the axial muscles, as well as the shoulder and hip
 - Control movements that involve distal limb musculature
 - Function with the cerebral cortex to plan movements
 - Stimulate motor neurons through their connections to the spinal cord
- In which type of neuron does the axon form synaptic junctions with the skeletal muscle cells (extrafusal fibers) that comprise the major part of a muscle?
 - Alpha motor neuron
 - Pyramidal neuron
 - Gamma motor neuron
 - Granule cell
 - Purkinje cell
- Which of the following would produce an increase in cerebral blood flow?
 - Increase in carbon dioxide concentration
 - Increase in oxygen concentration
 - Decrease in the activity of cerebral cortex neurons
 - Decrease in carbon dioxide concentration
 - Decrease in arterial blood pressure from 120 mm Hg to 90 mm Hg
- As the axons of motor neurons leave the spinal cord and course peripherally to skeletal muscle, they must pass through which structure?
 - Posterior column
 - Posterior root
 - Ventral white commissure
 - Posterior horn
 - Anterior root
- Which spinal cord level contains the entire population of preganglionic sympathetic neurons?
 - C5-T1
 - C3-C5
 - S2-S4
 - T1-L2
 - T6-L1

Questions 8 and 9

A left-side subdural hematoma develops in a 23-year-old man after an automobile accident. Physical examination shows papilledema 3 days after the accident. Use this information to answer Questions 8 and 9.

- Which of the following is most likely to be increased in this patient?
 - Cerebral blood flow
 - Cerebrospinal fluid production
 - Cerebrospinal fluid volume
 - Intracranial pressure
 - Intracranial venous volume
- Collapse of which of the following structures is most likely to lead to a decrease in brain oxygenation in this patient?
 - Arteries
 - Capillaries
 - Lateral ventricles
 - Subarachnoid space
 - Veins
- Preganglionic sympathetic axons pass through which of the following structures?
 - Dorsal root
 - Dorsal primary rami
 - White rami
 - Gray rami
 - Ventral primary rami

11. Which statement best describes a functional role for the intermediate zone of the cerebellum?

- A) Controls and coordinates movements of the axial muscles, as well as the shoulder and hip
- B) Controls movements that involve distal limb musculature
- C) Functions with the cerebral cortex to plan movements
- D) Stimulates motor neurons through its connections to the spinal cord

12. Which body part is represented most laterally and inferiorly within the primary motor cortex?

- A) Face
- B) Hand
- C) Neck
- D) Abdomen
- E) Lower limb

13. The gigantocellular neurons of the reticular formation release which neurotransmitter?

- A) Norepinephrine
- B) Serotonin
- C) Dopamine
- D) Acetylcholine
- E) Glutamate

14. Astrocytes participating in the metabolic control of cerebral blood flow have the following three events associated with the process: (1) prostaglandin release, (2) a calcium wave, and (3) glutamate spillover. Which sequence best describes the correct temporal order of these three events?

- A) 2, 1, 3
- B) 1, 2, 3
- C) 3, 1, 2
- D) 1, 3, 2
- E) 3, 2, 1
- F) 2, 3, 1

15. A 15-year-old girl is taken to see a physician because of a sore throat. An antibiotic is prescribed that can enter most tissues of the body but cannot penetrate the blood-brain barrier. The blood-brain barrier can be attributed primarily to which cell type?

- A) Astrocyte
- B) Endothelial cell
- C) Glial cell
- D) Macrophage
- E) Pericyte
- F) Smooth muscle cell

16. In which type of neuron does the axon form synaptic junctions with skeletal muscle cells (intrafusal fibers) within the muscle spindles?

- A) Alpha motor neuron
- B) Pyramidal neuron
- C) Gamma motor neuron
- D) Granule cell
- E) Purkinje cell

17. Which statement best describes a functional role for the cerebellar vermis?

- A) Controls and coordinates movements of the axial muscles, as well as the shoulder and hip
- B) Controls movements that involve distal limb musculature
- C) Functions with the cerebral cortex to plan movements
- D) Stimulates motor neurons through its connections to the spinal cord

18. Which projection system is contained in the superior cerebellar peduncle?

- A) Pontocerebellar
- B) Cerebellothalamic
- C) Posterior spinocerebellar
- D) Corticospinal

Questions 19 and 20

A 29-year-old man steps on a broken bottle with his bare right foot. His right leg immediately lifts while his left leg extends before he can consciously react to the pain. Use this information to answer Questions 19 and 20.

19. This action is attributable to which reflex?

- A) Walking reflex
- B) Stretch reflex
- C) Patellar tendon reflex
- D) Golgi tendon reflex
- E) Flexor withdrawal reflex

20. Which of the following best describes the type of reflex arc and sensory receptor for this reflex?

	Reflex Arc	Sensory Receptor
A)	Disynaptic	Pacian corpuscle
B)	Disynaptic	Nociceptor
C)	Monosynaptic	Pacian corpuscle
D)	Monosynaptic	Golgi tendon organ
E)	Polysynaptic	Nociceptor
F)	Polysynaptic	Muscle spindle

21. Which brain structure serves as the major controller of the limbic system?

- A) Hypothalamus
- B) Hippocampus
- C) Amygdala
- D) Mammillary body
- E) Fornix

22. A large portion of the cerebral cortex does not fit into the conventional definition of motor or sensory cortex. Which term refers to the type of cortex that receives input primarily from several other regions of the cerebral cortex?

- A) Cortex that is agranular
- B) Secondary somatosensory cortex
- C) Association cortex
- D) Supplementary motor cortex
- E) Secondary visual cortex

23. The two hemispheres of the brain are connected by which nerve fibers or pathways?
- Lateral lemniscus
 - Corticofugal fibers
 - Corpus callosum
 - Arcuate fasciculus
 - Medial longitudinal fasciculus
24. The fibers of the corticospinal tract pass through which structure?
- Medial lemniscus
 - Medullary pyramid
 - Posterior funiculus
 - Medial longitudinal fasciculus
 - Anterior roots
25. The condition of prosopagnosia usually results from dysfunction or damage to which area of the cerebral cortex?
- Prefrontal area
 - Junction of the parietal and temporal lobe on the nondominant side of the brain
 - Frontal eye fields
 - Underside of the medial occipital and temporal lobes
 - Limbic association areas of frontal and anterior temporal lobes
26. Lesions of which area of the brain would have the most devastating effect on verbal and symbolic intelligence?
- Hippocampus
 - Amygdala
 - Wernicke's area on the nondominant side of the brain
 - Broca's area
 - Wernicke's area on the dominant side of the brain
27. Which term applies to the combination of a motor neuron and all the skeletal muscle fibers contacted by that motor neuron?
- Golgi tendon organ
 - Motor unit
 - Propriospinal neurons
 - Skeletal muscle fibers
28. Which maneuver will attenuate the stretch reflex in skeletal muscle?
- Sectioning the dorsal root of a spinal nerve
 - Disruption of the spinocerebellar tract
 - Disruption of the corticospinal tract
 - Sectioning the medial lemniscus on the contralateral side of the skeletal muscle in question
 - Creating a lesion in the contralateral globus pallidus
29. A stroke involving the middle cerebral artery on the left side is likely to cause which symptom?
- Paralysis of the left side of the face and left upper extremity
 - Paralysis of left lower extremity
 - Complete loss of vision in both eyes
 - Loss of ability to comprehend speech
 - Loss of vision in the left half of both eyes
30. The creation of memory can be interrupted by which activity?
- Phosphorylation of a potassium channel to block activity
 - Activation of adenylate cyclase
 - Unnatural loss of consciousness
 - Increase in protein synthesis
 - Activation of cyclic guanosine monophosphate (cGMP) phosphodiesterase
31. Which structure serves to connect Wernicke's area to Broca's area in the cerebral cortex?
- Arcuate fasciculus
 - Lateral lemniscus
 - Medial longitudinal fasciculus
 - Anterior commissure
 - Internal capsule
32. Broca's area is a specialized portion of motor cortex. Which condition best describes the deficit resulting from damage to Broca's area?
- Spastic paralysis of the contralateral hand
 - Paralysis of the muscles of the larynx and pharynx
 - Inability to use two hands to grasp an object
 - Inability to direct the two eyes to the contralateral side
 - Inability to speak whole words correctly
33. Which projection system is contained in the inferior cerebellar peduncle?
- Pontocerebellar
 - Cerebellothalamic
 - Posterior spinocerebellar
 - Corticospinal
 - Dorsospinocerebellar
34. Signals from motor areas of the cortex reach the contralateral cerebellum after first passing through which structure?
- Thalamus
 - Caudate nucleus
 - Red nucleus
 - Basilar pontine nuclei
 - Dorsal column nuclei
35. Cerebrospinal fluid (CSF) provides a cushioning effect both inside and outside the brain. Which space that lies outside the brain or spinal cord contains CSF?
- Lateral ventricle
 - Third ventricle
 - Cisterna magna
 - Epidural space
 - Aqueduct of Sylvius

Questions 36 and 37

A 40-year-old woman visits the physician because of uncontrolled movements of her arms, legs, head, face, and upper body. These symptoms have increased progressively during the past 12 months. She is also depressed and irritable, and she repeats the same question six times during the 30-minute office visit. Gene analyses show expansion of a CAG triplet repeat on chromosome 4. Use this information to answer Questions 36 and 37.

36. Which diagnosis is most likely?
- Alzheimer's disease
 - Bipolar disorder
 - Brain tumor
 - Huntington's disease
 - Parkinson's disease
37. Which of the following is most likely to be decreased in this woman?
- Acetylcholine neurons in the magnocellular fore-brain nucleus
 - Dopamine neurons in the substantia nigra
 - γ -Aminobutyric acid (GABA) neurons in the caudate nucleus and putamen
 - Serotonin neurons in the raphe nuclei
38. Which projection system is contained in the middle cerebellar peduncle?
- Pontocerebellar
 - Cerebellothalamic
 - Posterior spinocerebellar
 - Corticospinal
 - Ventrospinocerebellar
39. The peripheral sensory input that activates the ascending excitatory elements of the reticular formation comes mainly from which of the following?
- Pain signals
 - Proprioceptive sensory information
 - Corticospinal system
 - Medial lemniscus
 - Input from Pacinian corpuscles
40. Cells of the adrenal medulla receive synaptic input from which type of neuron?
- Preganglionic sympathetic
 - Postganglionic sympathetic
 - Preganglionic parasympathetic
 - Postsynaptic parasympathetic
 - Presynaptic parasympathetic
41. Which activity will increase the sensitivity of the stretch reflex?
- Cutting the dorsal root fibers associated with the muscle in which the stretch reflex is being examined
 - Increasing the activity of the medullary reticular nuclei
 - Bending the head forward
 - Enhanced activity in the fusimotor (gamma motor neuron) system
 - Stimulating the lateral hemispheres of the cerebellum
42. Neurological disease associated with the cerebellum produces which type of symptoms?
- Resting tremor
 - Athetosis
 - Rigidity
 - Ataxia
 - Akinesia
43. Preganglionic parasympathetic neurons that contribute to the innervation of the descending colon and rectum are found in which structure?
- Superior cervical ganglion
 - Dorsal motor nucleus of the vagus
 - Superior mesenteric ganglion
 - Ciliary ganglion
 - Spinal cord levels S2 and S3
44. A complex spike pattern in the Purkinje cells of the cerebellum can be initiated by stimulation of which brain area?
- Inferior olivary complex
 - Brain stem reticular nuclei
 - Neurons in red nucleus
 - Superior olivary complex
 - Dorsal vestibular nucleus
45. In a muscle spindle receptor, which type of muscle fiber is responsible for the dynamic response?
- Extrafusal muscle fiber
 - Static nuclear bag fiber
 - Nuclear chain fiber
 - Dynamic nuclear bag fiber
 - Smooth muscle fiber
46. Which structure serves as an "alternative pathway" for signals from the motor cortex to the spinal cord?
- Red nucleus
 - Basilar pontine nuclei
 - Caudate nucleus
 - Thalamus
 - Dorsal column nuclei
47. The phenomenon of decerebrate rigidity can be explained, at least in part, by which of the following?
- Stimulation of type 1b sensory neurons
 - Loss of cerebellar inputs to the red nucleus
 - Overactivity of the medullary reticular nuclei involved in motor control
 - Unopposed activity of the pontine reticular nuclei
 - Degeneration of the nigrostriatal pathway

48. Like the primary visual cortex, the primary motor cortex is organized into vertical columns composed of cells linked together throughout the six layers of the cortex. The cells that contribute axons to the corticospinal tract are concentrated in which cortical layer?

- A) Layer I
- B) Layer II
- C) Layer III
- D) Layer IV
- E) Layer V

Questions 49 and 50

A 60-year-old man is taken to the physician because of a tremor in his hands, trouble sleeping, constipation, and dizziness. Physical examination shows a resting tremor, rigidity, and bradykinesia. The man is alert, engaging, and optimistic. He speaks in a low, soft voice. Use this information to answer Questions 49 and 50.

49. Which diagnosis is most likely?

- A) Alzheimer's disease
- B) Bipolar disorder
- C) Brain tumor
- D) Huntington's disease
- E) Parkinson's disease

50. Which of the following is most likely to be decreased in this man?

- A) Serotonin neurons in the raphe nuclei
- B) GABA neurons in the caudate nucleus and putamen
- C) Dopamine neurons in the substantia nigra
- D) Acetylcholine neurons in the magnocellular fore-brain nucleus

51. Motor cortex neurons receive feedback from muscles activated by the corticospinal system. This feedback arises from which of the following structures?

- A) Red nucleus
- B) Spinocerebellar tracts
- C) Skin surface of fingers used to grasp an object
- D) Muscle spindles in muscles antagonistic to those used to make the movement
- E) Vestibular nuclei

52. The sweat glands and piloerector muscles of hairy skin are innervated by which type of fibers?

- A) Cholinergic postganglionic parasympathetic
- B) Cholinergic postganglionic sympathetic
- C) Adrenergic preganglionic parasympathetic
- D) Adrenergic postganglionic sympathetic
- E) Adrenergic preganglionic sympathetic

53. In a neurophysiology experiment conducted with monkeys, the amygdalae are surgically ablated bilaterally. Which of the following is most likely to be increased 6 months after ablation of the amygdala?

- A) Despondence
- B) Memory
- C) Paranoia
- D) Sex drive
- E) Tremors

54. In controlling the fine muscles of the hands and fingers, corticospinal axons can synapse primarily with which of the following?

- A) Posterior horn neurons
- B) Spinal cord interneurons
- C) Spinal cord motor neurons
- D) Purkinje cells
- E) Renshaw cells

55. Which of the following foramina allows cerebrospinal fluid to pass directly from the ventricular system into the subarachnoid space?

- A) Foramen of Magendie
- B) Aqueduct of Sylvius
- C) Third ventricle
- D) Lateral ventricle
- E) Arachnoid villi

56. Which epileptic condition involves a postictal depression period lasting from several minutes to perhaps as long as several hours?

- A) Generalized tonic-clonic seizure
- B) Absence seizure
- C) Jacksonian seizure
- D) Phase-out clonic seizure
- E) Temporal lobe seizure

57. An area in the dominant hemisphere, when damaged, may leave the sense of hearing intact but not allow words to be arranged into a comprehensive thought. Which term is used to identify this portion of the cortex?

- A) Primary auditory cortex
- B) Wernicke's area
- C) Broca's area
- D) Angular gyrus
- E) Limbic association cortex

58. Afferent signals from the periphery of the body travel to the cerebellum in which nerve tract?

- A) Ventral spinocerebellar
- B) Fastigioreticular
- C) Vestibulocerebellar
- D) Reticulocerebellar
- E) Dorsal spinocerebellar

59. Which cells receive direct synaptic input from Golgi tendon organs?

- A) Type Ia inhibitory interneurons
- B) Dynamic gamma motor neurons
- C) Alpha motor neurons
- D) Type Ib inhibitory interneurons
- E) Type II excitatory interneurons

60. Which neurotransmitter is used by the axons of locus coeruleus neurons that distribute throughout much of the brain?

- A) Norepinephrine
- B) Dopamine
- C) Serotonin
- D) Acetylcholine

Questions 61 and 62

A 45-year-old man visits the physician because of difficulties performing simple tasks that involve repetitive movements. The physician asks the patient to turn one hand upward and downward at a rapid pace. The man quickly loses all perception of the instantaneous position of the hand, which results in a series of stalled attempts and jumbled movements. Use this information to answer Questions 61 and 62.

61. Which term best describes this patient's movements?

- A) Agraphesthesia
- B) Astereognosis
- C) Dysarthria
- D) Dysdiadochokinesia
- E) Hemineglect

62. Which area of his brain is most likely to have a lesion?

- A) Cerebellum
- B) Limbic system
- C) Medulla oblongata
- D) Premotor cortex
- E) Primary motor cortex

63. The excitatory or inhibitory effect of a postganglionic sympathetic fiber is determined by which feature or structure?

- A) Function of the postsynaptic receptor to which it binds
- B) Specific organ innervated
- C) Ganglion where the postganglionic fiber originates
- D) Ganglion containing the preganglionic fiber
- E) Emotional state of the individual

64. Which of the following correctly describes the relationship of CSF pressure to the venous pressure in the superior sagittal sinus?

- A) A few millimeters higher
- B) A few millimeters lower
- C) Equal to
- D) Twice the value
- E) One-half the value

65. A vascular lesion that causes degeneration of corticospinal axons in the basilar pons will most likely lead to which condition?

- A) Paralysis primarily involving muscles around the contralateral shoulder and hip joints
- B) Paralysis of the muscles of mastication
- C) Loss of voluntary control of discrete movements of the contralateral hand and fingers
- D) Inability to speak clearly
- E) Inability to convert short-term memory to long-term memory

66. Fine motor movement of the index finger can be elicited by stimulation of which brain area?

- A) Primary motor cortex
- B) Lateral cerebellar hemisphere
- C) Premotor cortex
- D) Supplemental motor area
- E) Red nucleus

67. Which type of cholinergic receptor is found at synapses between preganglionic and postganglionic neurons of the sympathetic system?

- A) Muscarinic
- B) Nicotinic
- C) Alpha
- D) Beta-1
- E) Beta-2

68. A 23-year-old basketball player mentally rehearses free throw shots while lying in bed. Which option best describes the area of the brain that is involved in generating a motor image of this action in the absence of actual movement?

- A) Basal ganglia
- B) Cerebellum
- C) Limbic system
- D) Premotor cortex
- E) Primary motor cortex

69. The perivascular space (Virchow-Robin space) in the brain is formed between the wall of small penetrating vessels and which structure?

- A) Dura mater
- B) Arachnoid membrane
- C) Pia mater
- D) Choroid plexus
- E) Ependymal cells

70. Which type of seizure is associated with a spike and dome electroencephalogram pattern during the seizure activity?

- A) Generalized tonic-clonic
- B) Temporal lobe
- C) Jacksonian
- D) Absence
- E) Apoplectic

71. Which substance has the lowest concentration in the cerebrospinal fluid compared with the cerebral blood plasma?
- Chloride
 - Glucose
 - Potassium
 - Protein
 - Sodium
72. The formation of cerebrospinal fluid by the choroid plexus includes (1) osmosis of water, (2) active transport of sodium, and (3) passive diffusion of chloride. Which sequence best describes the correct temporal order of these processes?
- 2, 3, 1
 - 3, 2, 1
 - 1, 3, 2
 - 3, 1, 2
 - 1, 2, 3
 - 2, 1, 3
- Questions 73 and 74**
- A 10-year-old girl is taken to the physician because of difficulty walking. Physical examination shows loss of tendon reflexes in the knees and ankles and reduced two-point discrimination in the hands and feet. Repeat visits to the physician show a progressive worsening of these symptoms during the next 2 years. However, the girl is always alert and seems to have normal reasoning abilities. Her uncle had similar problems at age 12 years and later developed scoliosis followed by loss of hearing and vision. Use this information to answer Questions 73 and 74.
73. What is the most likely diagnosis?
- Friedreich's ataxia
 - Huntington's disease
 - Multiple sclerosis
 - Parkinson's disease
 - Poliomyelitis
74. What is the most likely cause of these symptoms in this girl?
- A lesion in the premotor cortex
 - A lesion in the primary motor cortex
 - Malformation of the cerebellum
 - Malformation of the frontal lobe
 - Nerve degeneration
 - Nerve proliferation
75. Which neurotransmitter is used by the axons of substantia nigra neurons that project to the caudate and putamen?
- Norepinephrine
 - Dopamine
 - Serotonin
 - Acetylcholine
 - GABA
76. Damage limited to the primary motor cortex (area 4) is thought to cause hypotonia in the affected muscles. However, most cortical lesions, particularly those caused by vascular infarcts, generally involve the primary motor cortex in addition to surrounding areas of cortex or cortical efferent axons. The latter type of cortical lesion will cause which of the following?
- Spastic muscle paralysis
 - Flaccid muscle paralysis
 - No paralysis—only jerky, fast movements
 - Complete blindness in the contralateral eye
 - Loss of sensation in the contralateral foot
77. The term *limbic cortex* includes the orbitofrontal cortex, subcallosal gyrus, cingulate gyrus, and which area?
- Supplementary motor cortex
 - Postcentral gyrus
 - Lingual gyrus
 - Parahippocampal gyrus
 - Paracentral lobule
78. Which substance activates adrenergic alpha and beta receptors equally well?
- Acetylcholine
 - Norepinephrine
 - Epinephrine
 - Serotonin
 - Dopamine
79. The posterior and lateral hypothalamus, in combination with the preoptic area, are involved in the control of which of the following functions?
- Cardiovascular functions involving blood pressure and heart rate
 - Regulation of thirst and water intake
 - Stimulation of uterine contractility and milk ejection from the breast
 - Signaling that food intake is sufficient (satiety)
 - Secretion of hormones from the anterior lobe of the pituitary gland
80. In the patellar tendon reflex, which of the following items will synapse directly on alpha motor neurons that innervate the muscle being stretched?
- Ia sensory fiber
 - Ib sensory fiber
 - Excitatory interneurons
 - Gamma motor neurons
 - Inhibitory interneurons
81. Occlusion of which structure would lead to communicating hydrocephalus?
- Aqueduct of Sylvius
 - Lateral ventricle
 - Foramen of Luschka
 - Foramen of Magendie
 - Arachnoid villi

82. Evaluation of a patient reveals the following deficits: (1) decreased aggressiveness and ambition and inappropriate social responses; (2) inability to process sequential thoughts in order to solve a problem; and (3) inability to process multiple bits of information that could then be recalled instantaneously to complete a thought or solve a problem. Damage to which brain region could be responsible for such deficits?
- Premotor cortex
 - Parieto-occipital cortex in the nondominant hemisphere
 - Broca's area
 - Limbic association cortex
 - Prefrontal association cortex
83. A lesion in Wernicke's cortical area in the dominant hemisphere is most likely to produce which symptoms?
- Impaired language skills
 - Impaired motor skills
 - Inability to form new memories
 - Inability to plan future movements
 - Reduced cerebellar activity
 - Reduced cerebral cortex activity
84. Which of the following represents the structural basis of the blood-CSF barrier?
- Tight junctions between the ependymal cells forming the ventricular walls
 - Arachnoid villi
 - Tight junctions between adjacent choroid plexus cells
 - Astrocyte foot processes
 - Tight junctions between adjacent endothelial cells of brain capillaries
85. The withdrawal reflex is initiated by stimulation delivered to which receptor?
- Muscle spindle
 - Joint capsule receptor
 - Cutaneous free nerve ending
 - Golgi tendon organ
 - Pacinian corpuscle
86. A 21-year-old woman is a right-handed musician of considerable talent. Which brain structure is most likely to have been physically larger in the dominant hemisphere compared with the nondominant hemisphere at birth?
- Anterior temporal lobe
 - Posterior temporal lobe
 - Premotor cortex
 - Primary motor cortex
 - Primary somatosensory area
 - Sensory association area
87. Nasal, lacrimal, salivary, and gastrointestinal glands are stimulated by which substance?
- Acetylcholine
 - Norepinephrine
 - Epinephrine
 - Serotonin
 - Dopamine
88. The neurons located in the locus coeruleus release which neurotransmitter at their synaptic terminals?
- Norepinephrine
 - Dopamine
 - GABA
 - Acetylcholine
 - Serotonin
89. Which of the following reflexes best describes incoming pain signals that elicit movements performed by antagonistic muscle groups on either side of the body?
- Crossed extensor reflex
 - Withdrawal reflex
 - Reciprocal inhibition
 - Autogenic inhibition
90. Which portion of the cerebellum functions in the planning of sequential movement?
- Vermis and fastigial nucleus
 - Intermediate zone and fastigial nucleus
 - Lateral hemisphere and interposed nucleus
 - Cerebrocerebellum and dentate nucleus
 - Spinocerebellum and interposed nucleus
91. Which reflex is correctly paired with the sensory structure that mediates the reflex?
- Autogenic inhibition—muscle spindle
 - Reciprocal inhibition—Golgi tendon organ
 - Reciprocal inhibition—Pacinian corpuscle
 - Stretch reflex—muscle spindle
 - Golgi tendon reflex—Meissner corpuscle
92. Damage to which brain area leads to the inability to comprehend the written or the spoken word?
- Insular cortex on the dominant side of the brain
 - Anterior occipital lobe
 - Junction of the parietal, temporal, and occipital lobes
 - Medial portion of the precentral gyrus
 - Most anterior portion of the temporal lobe
93. A computed tomography scan of a newborn boy shows agenesis of the corpus callosum. Which of the following is most likely to occur in this child during the next 5 years as he matures?
- Inability to form new memories
 - Inability to understand spoken words
 - Inability to verbally express words
 - Reduction in communication between the two hemispheres
 - Tameness and inability to recognize expressions of fear

94. A 67-year-old man has a stroke. One week later, he experiences sudden and uncontrolled flailing, ballistic movements of his limbs. Which part of the man's brain is most likely to have been damaged by the stroke?
- Globus pallidus
 - Lateral hypothalamus
 - Red nucleus
 - Subthalamic nucleus
 - Ventrobasal complex of thalamus
95. A physiology experiment is conducted in which a test dose of norepinephrine is administered intravenously to the front limbs of rats, causing a 25 percent reduction in blood flow to the front limbs compared with basal values. Next, the stellate ganglion is removed. Three days later the same dose of norepinephrine is administered intravenously. Which option best describes the most likely change in front limb blood flow (compared with basal values) within 30 minutes after norepinephrine is administered to the ganglionectomized rats?
- 25 percent increase
 - 25 percent reduction
 - 5 percent increase
 - 5 percent reduction
 - 75 percent increase
 - 75 percent reduction
96. In an otherwise normal person, dysfunction of which brain area will lead to behavior that is not appropriate for the given social occasion?
- Ventromedial nuclei of hypothalamus
 - Amygdala
 - Corpus callosum
 - Fornix
 - Uncus
97. The function of which organ or system is dominated by the sympathetic nervous system?
- Systemic blood vessels
 - Heart
 - Gastrointestinal gland secretion
 - Salivary glands
 - Gastrointestinal motility
98. Schizophrenia is thought to be caused in part by excessive production and release of which neurotransmitter agent?
- Norepinephrine
 - Serotonin
 - Acetylcholine
 - Substance P
 - Dopamine
99. Stimulation of which subcortical area can lead to contraction of a single muscle or small groups of muscles?
- Dentate nucleus of the cerebellum
 - Ventrobasal complex of the thalamus
 - Red nucleus
 - Subthalamic nucleus
 - Nucleus accumbens
100. Bilateral lesions involving the ventromedial hypothalamus will lead to which of the following deficits?
- Decreased eating and drinking
 - Loss of sexual drive
 - Excessive eating, rage and aggression, hyperactivity
 - Uterine contractility, mammary gland enlargement
 - Obsessive compulsive disorder
101. Under awake, resting conditions, brain metabolism accounts for about 15 percent of the total metabolism of the body; this rate is among the highest metabolic rates of all tissues in the body. Which cellular population of the nervous system contributes most substantially to this high rate of metabolism?
- Astrocytes
 - Neurons
 - Ependymal cells
 - Choroid plexus cells
 - Brain endothelial cells
102. Which structure(s) in the cerebellum has/have a topographical representation of the body?
- Dentate nucleus
 - Lateral hemispheres
 - Flocculonodular lobe
 - Vermis and intermediate hemisphere
 - Cerebellar peduncle
103. Which structure is an important pathway for communication between the limbic system and the brain stem?
- Mammillothalamic tract
 - Fornix
 - Anterior commissure
 - Indusium griseum
 - Medial forebrain bundle
104. A 75-year-old woman is taken to the physician because of worsening forgetfulness. She has trouble playing cards with her friends because she cannot remember what game is being played. She recently got lost during a walk in the neighborhood she has lived in for 35 years. Which substance is most likely to be increased in the brain of this woman?
- alpha-1 antitrypsin
 - alpha-amylase
 - beta-amyloid peptide
 - beta-endorphin
 - gamma-glutamyl hydrolase
 - gamma-glutamyl transferase
105. Which of the following best describes the cerebellar deficit in which there is a failure to perform rapid alternating movements indicating a failure of "progression" from one part of the movement to the next?
- Past-pointing
 - Intention tremor
 - Dysarthria
 - Cerebellar nystagmus
 - Dysdiadochokinesia

106. Which structure in the vestibular apparatus is responsible for the detection of angular acceleration?

- A) Statoconia
- B) Macula
- C) Semicircular canals
- D) Saccule
- E) Ampullae

107. The concept of “autonomic tone” is quite advantageous because it allows the nervous system to have much finer control over the function of an organ or organ system than would otherwise be possible. This ability is exemplified in the control of systemic arterioles. Which action would lead to vasodilation of systemic arterioles?

- A) Increased activity of preganglionic parasympathetic neurons
- B) Decreased activity of postganglionic parasympathetic neurons
- C) Increased activity of postganglionic sympathetic neurons
- D) Decreased activity of postganglionic sympathetic neurons
- E) Increased activity of preganglionic sympathetic neurons

108. A person who has had a traumatic brain injury seems to be able to understand the written and spoken word but cannot create the correct sounds to be able to speak a word that is recognizable. This person most likely has damage to which area of the brain?

- A) Wernicke’s area
- B) Broca’s area
- C) Angular gyrus
- D) Dentate nucleus
- E) Prefrontal lobe

Questions 109 and 110

A 45-year-old man is taken to the psychiatrist because of delusional behavior in the workplace. The man accused a co-worker of scheming with his neighbor to transplant poison ivy in his backyard. This plot was revealed to the man by a voice in his head. Other examples of delusional thinking and voices in the man’s head are abundant. Use this information to answer Questions 109 and 110.

109. What is the most likely diagnosis?

- A) Bipolar disorder
- B) Dissociative identity disorder
- C) Multiple personality disorder
- D) Schizophrenia

110. A decrease in size of which brain structure is most likely in this man?

- A) Globus pallidus
- B) Hippocampus
- C) Lateral hypothalamus
- D) Red nucleus
- E) Subthalamic nucleus

111. Which structure is maximally sensitive to linear head movement in the vertical plane?

- A) Macula of the utricle
- B) Macula of the saccule
- C) Crista ampullaris of the anterior semicircular duct
- D) Crista ampullaris of the horizontal semicircular duct

112. Retrograde amnesia is the inability to recall long-term memories. Damage to which brain region leads to retrograde amnesia?

- A) Hippocampus
- B) Dentate gyrus
- C) Amygdaloid complex
- D) Thalamus
- E) Mammillary nuclei of hypothalamus

113. Which component of the basal ganglia plays the major role in the control of cognitive (memory-guided) motor activity?

- A) Globus pallidus
- B) Substantia nigra
- C) Caudate nucleus
- D) Putamen
- E) Subthalamic nucleus

114. A 9-month-old boy is brought to the emergency department by his grandmother because of irritability and vomiting. The parents dropped the baby off at the grandmother’s house 1 hour ago; their current whereabouts are not known. Magnetic resonance imaging shows retinal hemorrhages in both eyes, a subdural hematoma, and cerebral edema. Which of the following is most likely to be increased in this infant?

- A) Brain oxygenation
- B) Cerebral venous volume
- C) Intracranial pressure
- D) Visual acuity

115. Stimulation of the punishment center can inhibit the reward center, demonstrating that fear and punishment can take precedence over pleasure and reward. Which of the following cell groups is considered the punishment center?

- A) Lateral and ventromedial hypothalamic nuclei
- B) Periventricular hypothalamus and midbrain central gray area
- C) Supraoptic nuclei of hypothalamus
- D) Anterior hypothalamic nucleus

116. Drugs that stimulate specific adrenergic receptors are called *sympathomimetic drugs*. Which drug is a sympathomimetic drug?

- A) Reserpine
- B) Phentolamine
- C) Propranolol
- D) L-dopa
- E) Phenylephrine

117. Although the sympathetic nervous system is often activated in such a way that it leads to mass activation of sympathetic responses throughout the body, it can also be activated to produce relatively discrete responses. Which option is an example of a local or discrete sympathetic action?
- A) Heating of a patch of skin causes a relatively restricted vasodilation in the heated region
 - B) Food in the mouth causes salivation
 - C) Emptying of the bladder may cause reflexive emptying of the bowel
 - D) Dust particles in the eye cause increased tear fluid release
 - E) Bright light introduced into one eye
118. An experimental drug is administered intravenously to six healthy volunteers. A unanimous finding in all six volunteers is decreased induction of sleep. A decrease in production of which substance is most likely in these volunteers after treatment with the experimental drug?
- A) Acetylcholine
 - B) Dopamine
 - C) Glutamate
 - D) Norepinephrine
 - E) Serotonin
119. A 10-year-old boy jumps off the porch and lands on the balls of his feet. The increase in muscle tension causes a sudden, complete relaxation of the affected muscles. Which sensory receptor is most likely to mediate this relaxation of muscles when tension is increased?
- A) Free nerve ending
 - B) Golgi tendon organ
 - C) Krause corpuscle
 - D) Muscle spindle
 - E) Pacinian corpuscle
120. Which structure connects the hippocampus to the limbic system?
- A) Mammillothalamic tract
 - B) Fornix
 - C) Anterior commissure
 - D) Medial forebrain bundle
 - E) Arcuate fasciculus
121. A wide variety of neurotransmitters have been identified in the cell bodies and afferent synaptic terminals in the basal ganglia. A deficiency of which transmitter is typically associated with Parkinson's disease?
- A) Norepinephrine
 - B) Dopamine
 - C) Serotonin
 - D) GABA
 - E) Substance P
122. The condition of athetosis results when which area of the brain is dysfunctional?
- A) Globus pallidus
 - B) Substantia nigra
 - C) Ventral anterior complex of the thalamus
 - D) Putamen
 - E) Purkinje cell layer of the cerebellum

1. **C)** Broca's area is a region of the premotor area of one hemisphere (usually the left). Damage to Broca's area does not prevent a person from vocalizing but makes it impossible to speak whole words other than occasional simple words such as "yes" or "no." The primary motor cortex works with other areas of the brain to plan and execute movements. The cerebellum plays a critical role in motor control; it does not initiate movement but contributes to coordination, precision, and accurate timing of movements.
TMP13 pp. 708, 709
2. **C)** A positive Babinski sign (also called the *Babinski reflex*) occurs normally in children up to 2 years of age. The reflex occurs after the sole of the foot has been stroked with a blunt instrument; the big toe moves upward and the other toes fan out. A positive Babinski sign in adults can indicate damage to the corticospinal tract.
TMP13 pp. 705-706
3. **C)** The lateral cerebellar hemispheres function with the cerebral cortex in the planning of complex movements.
TMP13 p. 722
4. **A)** Alpha motor neurons form direct synaptic contact with skeletal extrafusal muscle fibers, whereas gamma motor neurons form synaptic junctions with intrafusal muscle fibers. Pyramidal, granule, and Purkinje neurons are located in the central nervous system and have no direct contact with skeletal muscle.
TMP13 p. 696
5. **A)** The most potent stimulator of cerebral blood flow is a local increase in carbon dioxide concentration, followed in order by a decrease in oxygen concentration and an increase in local neuronal activity.
TMP13 p. 788
6. **E)** Axons of motor neurons in the anterior horn exit the spinal cord through the anterior root. The posterior root serves as the entry point for sensory fibers coming into the posterior horn region of the spinal cord. The posterior column and ventral white commissure are fiber tracts located solely within the spinal cord.
TMP13 pp. 695-696
7. **D)** All preganglionic sympathetic neurons are located in the intermediolateral cell column (lateral horn); this cell group extends from T1 to L2.
TMP13 p. 774
8. **D)** A subdural hematoma can lead to increased intracranial pressure because it takes up space in the cranium; papilledema (optic disc swelling) suggests an increase in intracranial pressure. The increase in intracranial pressure does not affect production of CSF, but it may cause decreased CSF volume because the high pressure pushes CSF into venous blood through the arachnoidal villi and also compresses the volume of brain structures that contain CSF. Cerebral blood flow should remain normal with small increases in intracranial pressure, but larger increases can decrease cerebral blood flow.
TMP13 pp. 792-793
9. **E)** The veins have lower pressures compared with arteries and capillaries, making them easier to compress. When the veins are compressed, the capillary pressure increases, which increases the ultrafiltration of fluid from the capillaries into the interstitial spaces, thereby increasing the intracranial pressure even more. The increase in intracranial pressure can cause compression of lateral ventricles and the subarachnoid space, but this mechanism is compensatory rather than a cause for deterioration of blood flow and brain oxygenation.
TMP13 p. 793
10. **C)** Preganglionic sympathetic axons pass through the white communicating rami to enter the sympathetic trunk. Postganglionic sympathetic axons course through gray rami and might be found in dorsal and ventral primary rami.
TMP13 p. 773
11. **B)** The intermediate zone of the cerebellum influences the function of distal limb muscles.
TMP13 p. 722
12. **A)** The face region of the motor cortex is most inferior and lateral in the territory of the middle cerebral artery, whereas the lower limb is in the paracentral lobule in the territory of the anterior cerebral artery.
TMP13 p. 708
13. **D)** The gigantocellular neurons of the reticular formation reside in the pons and mesencephalon. These neurons release acetylcholine, which functions as an excitatory neurotransmitter in most brain areas.
TMP13 p. 753
14. **E)** Increased neuronal activity in the brain causes the neurotransmitter glutamate to diffuse from the site of release at the synapses into the adjacent tissues. The

glutamate triggers a calcium wave in astrocytes, which leads to astrocytic release of vasodilatory prostaglandins that cause arterioles to dilate. In this way, the local blood flow to the tissues can be matched with the metabolic activity of the neurons.

TMP13 p. 788

- 15. B)** The endothelial cells lining all blood vessels in the brain constitute the blood-brain barrier. The purpose of the blood-brain barrier is to protect the chemical environment of the brain from rapid changes in composition that occur normally in the rest of the body fluids. Brain capillary endothelial cells have special structural and biochemical attributes that impede diffusion of ions, nutrients, and fat-soluble substances; these substances can diffuse through the endothelial barrier and thereby enter into all other tissues of the body.
TMP13 p. 793
- 16. C)** Gamma motor neurons form direct synaptic contact with the skeletal muscle fibers known as *intrafusal fibers*. Extrafusal muscle fibers are innervated by alpha motor neurons, whereas Purkinje, granule, and pyramidal neurons have no synaptic contact with muscles in the periphery.
TMP13 p. 696
- 17. A)** The cerebellar vermis is involved with the control of axial muscles and proximal limb muscles in the shoulder and hip.
TMP13 p. 722
- 18. B)** Cerebellothalamic projections are contained in the superior cerebellar peduncle.
TMP13 p. 724
- 19. E)** In this example, the flexor withdrawal reflex is activated by a painful stimulus to the right foot. Flexor muscles in the right leg and extensor muscles in the left leg are simultaneously stimulated to contract, causing reflex removal of the foot from the painful stimulus while shifting body weight to the other leg. The patellar tendon reflex (also called *knee jerk*), which is activated by tapping the patellar tendon, is a type of stretch reflex. The Golgi tendon reflex provides a negative feedback mechanism that prevents the development of too much tension in a muscle.
TMP13 pp. 702-704
- 20. E)** The flexor withdrawal reflex is a polysynaptic reflex arc activated by stimulation of nociceptors in the skin. Multiple excitatory and inhibitory interneurons in the spinal cord are involved. The stretch reflex is a monosynaptic reflex arc involving two neurons. The Golgi tendon reflex is a disynaptic reflex arc because the reflex involves two synapses—an afferent and efferent neuron synapse with an inhibitory interneuron in the spinal cord.
TMP13 pp. 702-704
- 21. A)** The hypothalamus, despite its small size, is the most important control center for the limbic system. It controls most of the vegetative and endocrine functions of the body and many aspects of behavior.
TMP13 p. 755
- 22. C)** The association cortex is defined by the fact that it receives multiple inputs from a wide variety of sensory areas of cortex. It is the true multimodal cortex.
TMP13 pp. 739-740
- 23. C)** The corpus callosum is the main fiber pathway for communication between the two hemispheres of the brain.
TMP13 pp. 741-742
- 24. B)** Corticospinal fibers pass through the medullary pyramid.
TMP13 pp. 709-710
- 25. D)** Prosopagnosia is the inability to recognize faces. This inability occurs in people who have extensive damage on the medial undersides of both occipital lobes and along the medioventral surfaces of the temporal lobes.
TMP13 p. 740
- 26. E)** The somatic, visual, and auditory association areas all meet one another at the junction of the parietal, temporal, and occipital lobes. This area is known as *Wernicke's area*. This area on the dominant side of the brain plays the single greatest role for the highest comprehension levels we call intelligence.
TMP13 pp. 740-741
- 27. B)** The combination of a motor neuron and all the muscle fibers innervated by that motor neuron is called a *motor unit*.
TMP13 p. 696
- 28. E)** Broca's aphasia typically involves an inability to speak words correctly in the absence of any true paralysis of the laryngeal or pharyngeal musculature.
TMP13 pp. 708-709
- 29. D)** A stroke involving the left middle cerebral artery is likely to cause an aphasic syndrome that may involve the loss of speech comprehension and/or the loss of the ability to produce speech sounds. Any paralysis resulting from the lesion would affect the right side of the body; similarly, any visual field deficits would affect the right visual field of each eye.
TMP13 p. 741
- 30. E)** For an event or sensory experience to be remembered, it must first be consolidated. The consolidation of memory takes time. A disruption of consciousness during the process of consolidation will prevent the development of memory for the event or sensory experience.
TMP13 pp. 748-749

- 31. A)** The connection between Wernicke's area and Broca's area is made by the arcuate fasciculus.
TMP13 pp. 743-744
- 32. A)** Type 1a sensory fibers that innervate the stretch receptors of the muscle spindle travel in the appropriate spinal nerve that provides both the sensory and motor innervation of the muscle. The spinal nerves carry both afferent and efferent fibers. The afferent fibers (which contain the sensory fibers innervating the muscle spindle) pass through the dorsal root. Cutting the dorsal root will remove the afferent limb of the stretch reflex arc.
TMP13 pp. 696, 698-699
- 33. C)** Posterior spinocerebellar fibers pass through the inferior cerebellar peduncle.
TMP13 p. 723
- 34. D)** The main pathway linking the cerebral cortex and the cerebellum involves cortical projections to the ipsilateral basilar pontine nuclei, the cells of which then project to the contralateral cerebellum.
TMP13 pp. 722-723
- 35. C)** The cerebrospinal fluid outside the brain and spinal cord is located within the subarachnoid space. Dilated regions of the subarachnoid space are identified as cisterns. The cisterna magna is one of the largest cisterns and is positioned at the caudal end of the fourth ventricle between the cerebellum and posterior surface of the medulla.
TMP13 p. 790
- 36. D)** This woman has Huntington's disease. This hereditary disorder results from expansion of a CAG triplet repeat in the Huntingtin gene on chromosome 4. Typical symptoms are listed in the question stem. Huntington's disease is a neurodegenerative disorder that at first causes flicking movements in individual muscles and then progresses to distortional movements of the entire body; severe dementia develops along with the motor dysfunctions.
TMP13 pp. 734-735
- 37. C)** The abnormal movements of Huntington's disease are thought to be caused by loss of GABA-secreting neurons in the caudate nucleus and putamen; acetylcholine-secreting neurons in many parts of the brain are also thought to be affected. The axon terminals of GABA-secreting neurons normally inhibit portions of the globus pallidus and substantia nigra. This loss of inhibition is thought to allow spontaneous outbursts of globus pallidus and substantia nigra activity that cause the distortional movements.
TMP13 pp. 734-735
- 38. A)** Pontocerebellar axons are contained in the middle cerebellar peduncle.
TMP13 pp. 722-723
- 39. A)** Pain signals traveling through the anterolateral system, but not any of the discriminative sensations coursing through the medial lemniscal system, provide input to the cells in the reticular formation that give rise to ascending projections to the intralaminar nuclei of the thalamus.
TMP13 pp. 751-752
- 40. A)** Preganglionic sympathetic axons synapse on cells in the adrenal medulla that function as postganglionic sympathetic neurons.
TMP13 p. 774
- 41. D)** Gamma motor neurons innervate the contractile ends of the muscle spindle receptor. Stimulation of gamma motor neurons will cause the ends of the spindle to contract, which in turn will stretch the center of the spindle receptor in the muscle in which the spindle receptor is embedded. The activity of the gamma motor neurons is influenced by the fusimotor system. Enhanced activity of this system will lead to an increase in gamma motor tone and increase the sensitivity of the muscle spindle as a stretch receptor.
TMP13 pp. 699-670
- 42. D)** The cerebellum is responsible for coordinating and timing motor activity. Disorders of the cerebellum are associated with lack of coordination of motor activity. An example of this lack of coordination is ataxia, which is an unsteady gait.
TMP13 p. 729
- 43. E)** Preganglionic parasympathetic neurons that contribute to the innervation of the descending colon and rectum are found at S2 and S3 levels of the spinal cord.
TMP13 p. 775
- 44. A)** Complex spike output from the Purkinje cells of the cerebellum is a response to activation of climbing fibers in cerebellar neural circuitry. All climbing fibers originate in the inferior olivary nucleus.
TMP13 p. 724
- 45. D)** The dynamic nuclear bag fiber responds to the rate of change of length of the muscle spindle receptor. This fiber is responsible for the dynamic response of the muscle spindle.
TMP13 p. 698
- 46. A)** Cortical projections to the red nucleus provide an alternative pathway for the cerebral cortex to control flexor muscles through the rubrospinal tract.
TMP13 pp. 710-711
- 47. D)** The pontine reticular nuclei are tonically active. These nuclei have a stimulatory effect on the anti-gravity muscles of the body. The pontine nuclei are normally opposed by the medullary reticular nuclei. The medullary nuclei are not tonically active and require stimulation from higher brain centers to counterbalance the signal from the pontine nuclei. Decerebrate rigidity

results when the stimulatory signal from higher brain areas to the medullary nuclei is absent. This absence allows an unopposed and vigorous activation of the antigravity muscles, resulting in extension of the arms and legs and contraction of the axial muscles of the spinal column.

TMP13 p. 714

48. E) Corticospinal axons originate from cell bodies (pyramidal neurons) in layer V of the motor areas of the cortex.

TMP13 pp. 709-710

49. E) This man has Parkinson's disease. No laboratory biomarkers exist for Parkinson's disease, and imaging results are unremarkable. Diagnosis requires two of three cardinal signs that include (1) resting tremor, (2) rigidity, and (3) bradykinesia (or slow movement); this man has all three signs. Parkinson's disease affects about 1 percent of persons older than 60 years. Progressive disability can be slowed but not halted by treatment.

TMP13 p. 734

50. C) This man with Parkinson's disease has a loss of pigmented dopaminergic neurons of the substantia nigra pars compacta that send dopamine-secreting nerve fibers to the caudate nucleus and putamen. The causes of the abnormal motor movements are poorly understood; however, dopamine is an inhibitory transmitter in the caudate nucleus and putamen. It is therefore possible that overactivity of the caudate nucleus and putamen could result from decreased dopamine levels in this patient with Parkinson's disease; these brain structures are largely responsible for voluntary movement.

TMP13 p. 734

51. C) The palmar (volar) surfaces of the skin contain receptors that project through the medial lemniscal system to the primary somatosensory cortex. When these fingers are flexed and grasp an object, the cutaneous receptors send signals to the primary somatosensory cortex. These cortical neurons then project to the adjacent motor cortex and the pyramidal neurons that sent the original message down the corticospinal tract to cause contraction of the finger flexors. The motor cortex neurons are then said to be "informed of the muscle contractions" that they originally specified.

TMP13 pp. 711-712

52. B) Sweat glands and the piloerector smooth muscle of hairy skin are innervated by the population of cholinergic postganglionic sympathetic neurons.

TMP13 p. 775

53. D) Bilateral ablation of the amygdala causes behavioral changes known as *Klüver-Bucy syndrome*. These changes include lack of fear, extreme curiosity, forgetfulness, oral fixation, and a strong sex drive. The sex

drive can be so strong that monkeys will attempt to copulate with immature animals, animals of the wrong sex, and even animals of the wrong species. Although similar brain lesions in humans are rare, afflicted people have similar symptoms. The amygdala is thought to make the person's behavioral response appropriate for each occasion.

TMP13 p. 760

54. C) Although the majority of corticospinal axons synapse with the pool of spinal cord interneurons, some will synapse directly with the motor neurons that innervate muscles controlling the wrist and finger flexors.

TMP13 p. 712

55. A) The foramen of Magendie and the two lateral foramina of Luschka form the communication channels between the ventricular system within the brain and the subarachnoid space that lies outside the brain and spinal cord.

TMP13 pp. 790-791

56. A) A generalized tonic-clonic epileptic seizure is associated with the sudden onset of unconsciousness and an overall steady but uncoordinated contracture of many muscles of the body followed by alternating contractions of flexor and extensor muscles—that is, tonic-clonic activity. This effect is the result of widespread and uncontrolled activity in many parts of the brain. It takes the brain from a few minutes to a few hours to recover from this vigorous activity.

TMP13 pp. 769-770

57. B) Wernicke's area in the dominant hemisphere is responsible for interpreting spoken language. Damage to Wernicke's area will eliminate comprehension of spoken language.

TMP13 pp. 740-741

58. E) Afferent signals to the cerebellum travel primarily in the dorsal and ventral spinocerebellar tracts. The dorsal spinocerebellar tract carries signals from the muscle spindle receptors and Golgi tendon receptors, as well as large tactile receptors of the skin and joint proprioceptors. The ventral spinocerebellar tract carries information from the anterior portion of the spinal cord. This tract relays information regarding which motor signals from the motor areas of the brain have arrived at the level of the spinal cord.

TMP13 p. 723

59. D) Golgi tendon organs provide direct synaptic input to type Ib inhibitory interneurons. Type Ia interneurons and alpha motor neurons receive input from muscle spindle afferents, whereas dynamic gamma motor neurons and excitatory interneurons receive their input from supraspinal systems.

TMP13 p. 701

- 60. A)** Neurons in the locus coeruleus utilize the neurotransmitter norepinephrine in their widespread projections throughout the brain.
TMP13 pp. 752-753
- 61. D)** Dysdiadochokinesia is the inability to perform rapid alternating movements. Patients with hemineglect are unaware of items to one side of space. Astereognosis is the inability to recognize objects by touch. Agraphesthesia is a disorientation of the skin's sensation across its space (e.g., it is difficult to identify a number or letter traced on the hand). Dysarthria is a failure of progression in talking.
TMP13 pp. 729-730
- 62. A)** The cerebellum plays major roles in the timing of motor activities and in rapid, smooth progression from one muscle movement to the next. Lesions of the cerebellum can also cause dysmetria, ataxia, past pointing, nystagmus, dysarthria, intention tremor, and hypotonia. The premotor cortex and primary motor cortex plan and execute movements. The limbic system is involved with behavior, motivation, emotion, long-term memory, and olfaction.
TMP13 pp. 721-724
- 63. A)** The excitatory or inhibitory effect of a postganglionic sympathetic fiber is determined solely by the type of receptor to which it binds.
TMP13 p. 777
- 64. A)** CSF will flow across the valve-like arachnoid villi when the CSF pressure is only a few millimeters higher than the pressure within the superior sagittal sinus.
TMP13 p. 792
- 65. C)** The most characteristic deficit after damage to corticospinal tract neurons involves discrete voluntary movement of the contralateral hand and fingers.
TMP13 p. 713
- 66. A)** A large area of the primary motor cortex is dedicated to activating the muscles that control the movement of the fingers. Stimulation of the primary motor cortex usually results in very discrete contractions of small groups of muscles. Stimulation of the premotor cortex results in the contraction of large groups of muscles, and stimulation of the supplemental motor area results in bilateral movements.
TMP13 pp. 707-708
- 67. B)** Nicotinic cholinergic receptors are found at synapses between preganglionic and postganglionic sympathetic neurons.
TMP13 p. 777
- 68. D)** The premotor cortex generates nerve signals for complex patterns of movement rather than discrete patterns generated in the primary motor cortex. The most anterior part of the premotor area first develops a motor image of the total muscle movement that is to be performed. Next, the successive pattern of muscle activity required to achieve the image excites neurons in the posterior premotor cortex; from here, signals are sent directly to the primary motor cortex to excite specific muscles or by way of the basal ganglia and thalamus and then to the primary motor cortex.
TMP13 p. 701
- 69. C)** The perivascular space (also known as the *Virchow-Robin space*) is formed between the outer wall of small vessels penetrating into the brain and the pia mater, which lines the outer surface of the brain and is only loosely attached to the brain.
TMP13 p. 792
- 70. D)** The spike and dome pattern is characteristic of an absence seizure.
TMP13 p. 770
- 71. D)** The concentration of protein in the CSF is only 1 percent to 2 percent of that of plasma; interstitial fluid in the tissues of the brain has an equally low protein concentration. This low protein concentration of CSF can be attributed to the blood-brain barrier, which is impermeable to protein. The concentration of sodium in CSF is slightly less than that of plasma, the chloride concentration is about 15 percent greater than that of plasma, the potassium concentration is 40 percent of that of plasma, and the glucose concentration of CSF is about 30 percent of that of plasma.
TMP13 p. 791
- 72. A)** Active transport of sodium ions through the epithelial cells lining the choroid plexus is followed by passive diffusion of chloride ions to maintain electroneutrality. The osmotic gradient created by the sodium and chloride ions causes the immediate osmosis of water into the CSF. The osmolarity of CSF is identical to that of blood plasma.
TMP13 pp. 790-791
- 73. A)** This patient has Friedreich's ataxia, which is an autosomal-recessive ataxia resulting from a mutation on chromosome 9. It accounts for about 50 percent of all hereditary ataxias. Huntington's disease is a neurodegenerative disease that affects muscle coordination and causes a decline in cognitive function and psychiatric problems. Multiple sclerosis is an inflammatory disease in which the myelin covering of nerve cells in the brain and spinal cord is damaged, resulting in a wide range of symptoms that include physical, mental, and psychiatric problems.
TMP13 pp. 729-730
- 74. E)** The major pathological finding in Friedreich's ataxia is degeneration and loss of axons, especially in the spinal cord and spinal roots; this effect increases with age and duration of disease. Most major nerve tracts in the spinal cord show demyelination, and the spinal cord itself

becomes thin. There are no lesions in the premotor cortex or primary motor cortex, and the frontal lobe remains normal. The disorder does not affect cognitive functions, and unmyelinated sensory fibers are spared.

TMP13 pp. 729-730

75. **B)** Cells in the pars compacta portion of the substantia nigra use the neurotransmitter dopamine in their projections to the caudate and putamen.

TMP13 p. 733

76. **A)** Lesions that damage primary motor cortex and other surrounding motor cortical areas lead to spastic paralysis in the affected muscles.

TMP13 p. 713

77. **D)** The parahippocampal gyrus is an important component of the limbic cortex, or limbic lobe.

TMP13 pp. 754-755

78. **C)** Epinephrine activates alpha- and beta-adrenergic receptors equally well. Norepinephrine excites both types of receptors but has a markedly greater effect on alpha receptors.

TMP13 p. 777

79. **A)** The posterior and lateral hypothalamus, in combination with the preoptic hypothalamus, form an important group of cells controlling cardiovascular functions such as heart rate and blood pressure.

TMP13 pp. 755-756

80. **A)** Ia sensory fibers synapse directly with alpha motor neurons, whereas Ib sensory fibers synapse with inhibitory interneurons. Excitatory interneurons play an important role in the withdrawal reflex. Gamma motor neurons receive input primarily from supraspinal systems.

TMP13 pp. 698-700

81. **E)** Noncommunicating hydrocephalus results when a blockage of CSF flow occurs within the ventricular system or at the sites of communication between the ventricular system and the subarachnoid space. Communicating hydrocephalus occurs when a blockage occurs either within the subarachnoid space or at the arachnoid villi, thus preventing communication between the subarachnoid space and the superior sagittal sinus.

TMP13 p. 793

82. **E)** Behavioral deficits, changes in personality, and diminished problem-solving ability are all signs of damage to the prefrontal association cortex.

TMP13 pp. 741-742

83. **A)** Wernicke's cortical area is the major brain area for language comprehension. A person with a lesion in Wernicke's area may be able to understand either the spoken word or the written word but would not be able to interpret the thought that is expressed.

TMP13 pp. 739-740

84. **C)** The tight junctions formed between adjacent choroid epithelial cells represent the structural basis of the blood-CSF barrier. The blood-brain barrier is formed by the tight junctions between adjacent endothelial cells of brain capillaries.

TMP13 pp. 793-794

85. **C)** The withdrawal reflex is activated by stimuli from free nerve endings. Muscle spindles provide the afferent signals for the stretch reflex, and Golgi tendon organs are the source of stimuli for the inverse myotatic reflex.

TMP13 pp. 701-702

86. **B)** The posterior temporal lobe is larger at birth in the dominant hemisphere of the brain, which is the left hemisphere in 95 percent of people. Because of the tendency to direct one's attention to the better developed region, the rate of learning in the cerebral hemisphere that gains the first start increases rapidly, whereas learning remains slight in the opposite, less-used side. Hence, the left hemisphere normally becomes dominant over the right.

TMP13 pp. 741-742

87. **A)** The nasal, lacrimal, salivary, and gastrointestinal glands are stimulated by cholinergic postganglionic parasympathetic neurons.

TMP13 pp. 778, 780

88. **A)** The neurons located in the locus coeruleus release norepinephrine at their nerve terminals.

TMP13 pp. 752-753

89. **A)** The crossed extensor reflex depends on incoming pain signals distributed to both sides of the spinal cord via excitatory interneurons.

TMP13 p. 703

90. **D)** The cerebrotocerebellum and the dentate nucleus are involved with the thalamus and cortex in the planning of complex movements.

TMP13 p. 722

91. **D)** The stretch reflex is mediated by muscle spindles. Autogenic inhibition involves Golgi tendon organs. Reciprocal inhibition is also related to muscle spindles.

TMP13 pp. 698-699

92. **C)** The junction of the parietal, temporal, and occipital lobe is commonly referred to as *Wernicke's area*. This area of the brain is responsible for the ability to comprehend both the written and spoken word.

TMP13 p. 739

93. **D)** The corpus callosum connects the left and right cerebral hemispheres and hence facilitates communication between them. Agenesis of the corpus callosum is a rare defect in which there is a complete or partial absence of the corpus callosum.

TMP13 pp. 709-710, 742

- 94. D)** Damage to the subthalamic nucleus of the basal ganglia often leads to flailing movements of an entire limb; this condition is called *hemiballismus*. Stroke is the most common cause of hemiballismus in adults, but this condition is rare. The globus pallidus is part of the basal ganglia and is involved with movement; however, damage to the globus pallidus does not cause hemiballismus. The lateral hypothalamus is mostly concerned with hunger. The red nucleus serves as an alternative pathway for transmitting cortical signals to the spinal cord; it controls the crawling of babies and may be responsible for swinging the arms while walking. The ventrobasal complex of thalamus is a sensory relay area of the brain.
TMP13 p. 732
- 95. F)** The greater reduction in blood flow to the front limbs is caused by denervation supersensitivity of norepinephrine receptors. The mechanism of denervation supersensitivity is poorly understood, but it is most likely caused by an actual increase in the number of norepinephrine receptors on the muscle vasculature. These additional receptors greatly enhance the vasoconstrictor effects of norepinephrine.
TMP13 p. 777
- 96. B)** The amygdala seems to function in behavioral awareness at a semiconscious level. The amygdala also is thought to project into the limbic system the individual's current status with respect to his or her surroundings. Therefore, the amygdala is believed to help pattern behavior appropriate for each occasion.
TMP13 p. 760
- 97. A)** The innervation and function of systemic blood vessels is influenced primarily, if not exclusively, by the sympathetic nervous system.
TMP13 p. 780
- 98. E)** Schizophrenia is thought to be caused in part by excessive release of dopamine. Occasionally, patients with Parkinson's disease exhibit schizophrenic symptoms because of uncontrolled L-dopa therapy and the subsequent production of dopamine.
TMP13 p. 771
- 99. C)** The magnocellular portion of the red nucleus has a somatographic representation of all the muscles of the body, similar to the motor cortex. Stimulation of this area in the red nucleus results in contraction of a single muscle or small groups of muscles.
TMP13 p. 711
- 100. C)** Lesions involving the ventromedial hypothalamus lead to excessive eating (hyperphagia), excessive drinking, rage and aggression, and hyperactivity.
TMP13 p. 757
- 101. B)** The high metabolic rate in the nervous system is primarily due to the high metabolic activity in neurons, even in the resting state.
TMP13 p. 794
- 102. D)** The vermis and the intermediate zone of the cerebellar hemisphere have a distinct topographic representation of the body. These areas are responsible for coordinating the contraction of the muscles of the body for intended motion.
TMP13 p. 722
- 103. E)** The medial forebrain bundle extends from the septal and orbitofrontal regions of the cerebral cortex downward through the center of the hypothalamus to the brain stem reticular area. This structure serves as an important communication system between the limbic system and the brain stem.
TMP13 p. 755
- 104. C)** This woman has Alzheimer's disease. Increased amounts of beta-amyloid peptide is found in the brains of patients with Alzheimer's disease. The peptide accumulates in amyloid plaques with diameters up to several hundred millimeters in widespread areas of the brain, including the cerebral cortex, hippocampus, basal ganglia, thalamus, and cerebellum. A key role for excess accumulation of beta-amyloid peptide in the pathogenesis of Alzheimer's disease is suggested by multiple observations.
TMP13 pp. 771-772
- 105. E)** Dysdiadochokinesia is a cerebellar deficit that involves a failure of progression from one part of a movement to the next. Consequently, movements that include rapid alternation between flexion and extension are most severely affected.
TMP13 p. 729
- 106. C)** Linear acceleration is in a straight line; angular acceleration is that which occurs by turning about a point. The semicircular canals respond to the turning motions of the head and body.
TMP13 p. 717
- 107. D)** Decreased activity of postganglionic sympathetic neurons leads to vasodilation of systemic arterioles. In contrast, increased activity in postganglionic sympathetics results in vasoconstriction.
TMP13 p. 782
- 108. B)** Damage to Broca's area leads to motor aphasia, or the inability to form words correctly.
TMP13 p. 744
- 109. D)** This man has schizophrenia, which is characterized by a breakdown of cognitive and emotional responses. Dissociative identity disorder was formerly called *multiple personality disorder*. Bipolar disorder

is characterized by episodes of elevated mood (mania) alternating with episodes of depression.

TMP13 p. 771

110. B) A consistent finding in most schizophrenics is that the hippocampus is reduced in size. The hippocampus is part of the limbic system. Incoming sensory information activates various parts of the hippocampus that, in turn, initiate behavioral reactions for different purposes. Removal of the hippocampus makes it impossible to learn new information based on verbal symbolism; however, past memories are preserved.

TMP13 p. 771

111. B) Hair cells in the macula of the saccule are maximally sensitive to linear head movement in the vertical plane.

TMP13 p. 716

112. D) Lesions involving the thalamus lead to retrograde amnesia, because they are believed to interfere with the process of retrieving long-term memory stored in other portions of the brain.

TMP13 p. 749

113. C) The caudate nucleus is involved in the basal ganglia circuits that control memory-guided motor activity.

TMP13 pp. 732-733

114. C) This infant has shaken baby syndrome. The subdural hematoma has increased intracranial pressure, which in turn has caused cerebral edema. The venous vasculature in the brain is compressed due to the high intracranial pressure. Continued compression of brain structures can lead to worsening cerebral edema with decreased oxygenation of the brain.

TMP13 p. 793

115. B) The punishment center is primarily localized to the periventricular hypothalamus and the midbrain central gray area.

TMP13 p. 758

116. A) Athetosis is a slow and continuous writhing movement of the arm, neck, or the face. It results from damage or dysfunction of the globus pallidus.

TMP13 p. 731

117. A) An example of a relatively restricted or local sympathetic action is the vasodilation or vasoconstriction of blood vessels that occurs upon warming or cooling of a patch of skin. When a bright light is introduced to one eye, the pupils of both eyes constrict. The pupillary light reflex is a multiple-neuron event that involves the Edinger-Westphal nucleus of the brainstem; it is not a local event.

TMP13 p. 782

118. E) The most conspicuous stimulation area for causing sleep is the raphe nuclei in the lower half of the pons and in the medulla. Many nerve endings of fibers from raphe neurons secrete serotonin. When the formation of serotonin is blocked by drugs, sleep is often disrupted for hours to days. Therefore, it has been assumed that serotonin is a transmitter associated with the production of sleep.

TMP13 pp. 764-765

119. D) The Golgi tendon organ senses tension in the tendons. When tension becomes exceedingly high, an inhibitory reflex is activated that causes relaxation of the entire muscle, which serves to protect the muscle from tearing. However, the Golgi tendon organ is also thought to play a key role in maintaining equal tension in the muscle fibers of a skeletal muscle so that imbalances in tension among the different muscle fibers can be equalized.

TMP13 p. 701

120. B) The fornix connects the hippocampus to the anterior thalamus, hypothalamus, and the limbic system.

TMP13 p. 756

121. B) Degeneration of the dopaminergic cells in the pars compacta of the substantia nigra is thought to be the primary defect in Parkinson's disease.

TMP13 pp. 733-734

122. E) Phenylephrine is a sympathomimetic drug that stimulates adrenergic receptors. Reserpine, phentolamine, and propranolol are sympathetic antagonists.

TMP13 p. 758