**True or False Questions**

1. The central nervous system consists of the brain and spinal cord.
   T F
2. The telencephalon and diencephalon are the two main divisions of the forebrain.
   T F
3. The three main divisions of the hindbrain are the cerebellum, basal ganglia, and hypothalamus.
   T F
4. During embryogenesis, the notochord induces the formation of the neuroectoderm in the overlying ectoderm.
   T F
5. The peripheral nervous system develops from the cells of the neural tube.
   T F
6. At the equilibrium potential for a permeant ion, the flux of the ion down its concentration gradient is equal to the flux of the ion down the electrical gradient across the membrane.
   T F
7. If pNa were greater than pK, the resting membrane potential of a cell would closer to the sodium equilibrium potential than to the potassium equilibrium potential.
   T F
8. During the undershoot of the action potential, the membrane potential moves closer to the potassium equilibrium potential than at the resting potential because sodium permeability has returned to its resting level while potassium permeability remains elevated for a brief time after the action potential.
   T F
9. During the repolarizing phase of the action potential, the two mechanisms of repolarization are the closing of potassium channel n gates and the opening of the sodium channel m gates.
   T F
10. Neurotransmitter is released from a presynaptic terminal by a process of exocytosis, when synaptic vesicles fuse with the plasma membrane of the synaptic terminal in response to calcium influx.
    T F
11. A neurotransmitter that opens chloride channels in the postsynaptic cell would produce an excitatory postsynaptic potential.
    T F
12. Nociceptors respond to painful stimuli.
    T F
13. The receptive field of a secondary sensory neuron is the always the same as the receptive field of the primary sensory receptors from which the secondary neuron receives synaptic input.
    T F
14. In the somatosensory system concerned with muscle senses, the muscle spindle receptors give information about muscle length, whereas the receptors of Golgi

tendon organs give information about muscle tension.
T F

15. The main spinal cord pathway for ascending information about pain and temperature is the lateral sensory tract.

T F

16. In the retina, both the photoreceptors and the horizontal cells are depolarized in darkness and hyperpolarize in response to illumination.
T F
17. The neurons of the primary visual cortex have center-surround receptive fields.
T F
18. The first auditory relay station in the brain is the cochlear nucleus, which is organized in a spatial representation of sound frequency, called a tonotopic map.
T F
19. All hair cells of the cochlea respond best to low-frequency sounds (<1000 Hz).
T F
20. Olfactory receptor cells have axons that project directly to the brain without intervening synapses.

T F

21. G-proteins are involved in the linkage between the chemical stimulus and the change in ionic permeability in sweet and bitter taste transduction, but not in salt and sour taste transduction.
T F

**Multiple Choice Questions**

22. During development of the nervous system
    a. the neuroectoderm is induced during gastrulation in the part of the ectoderm overlying the notochord.
    b. the cells of the peripheral nervous system arise from the neural crest.
    c. the neural tube gives rise to the central nervous system.
    d. all of the above are correct.
    e. none of the above is correct.
23. Suppose that in a neuron, the sodium equilibrium potential is +58 mV, the potassium equilibrium potential is -80 mV, and the resting membrane potential of the neuron is -70 mV.
    a. In this neuron, the potassium permeability of the membrane is less than the sodium permeability.
    b. If the sodium permeability and the potassium permeability were both doubled, the resting membrane potential of the neuron would remain at -70 mV.
    c. In this neuron, the internal potassium concentration is less than the external potassium concentration.
    d. In this neuron, both sodium and potassium are at equilibrium at the resting membrane potential of the cell.

e. In this neuron, the membrane is permeable to potassium but not to sodium.

24. During an action potential
    a. the membrane potential at the peak of the action potential is close to the sodium equilibrium potential.
    b. the upstroke (depolarizing phase) of the action potential is produced by a large increase in sodium permeability as voltage-dependent sodium channels open.
    c. the refractory period corresponds to the period after an action potential when voltage-dependent potassium channels remain open, moving the membrane potential nearer to the potassium equilibrium potential.
    d. a and b, but not c.
    e. a, b, and c.
25. Regarding synaptic transmission, which of the following statements is not correct?
    a. Neurotransmitter release is triggered by calcium influx through voltage-sensitive calcium channels, which open in response to the depolarization produced by the arrival of an action potential in the synaptic terminal.
    b. Neurotransmitter is released from the synaptic terminal by exocytosis, when synaptic vesicles fuse with the plasma membrane of the terminal.
    c. An inhibitory neurotransmitter produces inhibition of a postsynaptic neuron by preventing excitatory neurotransmitters from binding to their receptors at excitatory synapses onto the postsynaptic neuron.
    d. An excitatory postsynaptic potential could be produced by a neurotransmitter that opens nonspecific cation channels that are equally permeable to sodium and potassium ions.
    e. The postsynaptic action of a neurotransmitter is mediated by neurotransmitter receptor molecules in the postsynaptic membrane, which bind the neurotransmitter and either directly or indirectly alter the ionic permeability of the postsynaptic cell.
26. In a primary sensory receptor cell:
    a. the receptor potential is the change in membrane potential produced by synaptic inputs from neighboring receptor cells.
    b. sensory transduction is required for generation of a receptor potential only in exteroceptors, and not in interoceptors.
    c. lateral inhibition refers to the fact that sensory stimuli outside the receptive field inhibit the receptor cell, whereas sensory stimuli within the receptive field excite the receptor cell.
    d. receptive fields always have a center-surround organization, with opposite responses from the center and surround.
    e. the receptive field is the region of the sensory surface where a sensory stimulus affects the membrane potential of the receptor.
27. In the somatosensory system, which of the following statements is not correct:
    a. all the axons of primary sensory receptor cells terminate locally in the spinal cord and do not send branches into the brain.
    b. the primary somatosensory cortex is located in the postcentral gyrus of the cerebral cortex.

c. the ascending axons of neurons that carry information about touch, pressure, vibration, and proprioception to the brain are found mostly in the dorsal columns of the spinal cord.
d. the ascending sensory axons of the dorsal columns leave the spinal cord and terminate in the dorsal column nuclei of the medulla, the gracile nucleus and the cuneate nucleus.
e. the three major spinal pathways for ascending sensory information are the dorsal columns, the lateral sensory tract, and the spinocerebellar tract.

28. In photoreceptors of the retina, illumination causes the cells to hyperpolarize because):
    a. rhodopsin directly binds to sodium channels in the plasma membrane and causes the channels to close.
    b. the G-protein transducin is activated when rhodopsin absorbs light, and activated transducin binds to and opens potassium channels in the plasma membrane.
    c. illumination causes the level of the second messenger, cGMP, to decline inside the cell, and cGMP directly binds to and opens nonspecific cation channels in the plasma membrane.
    d. all of the above are correct.
    e. none of the above is correct.
29. In the auditory system
    a. hair cells of the cochlea have axons that project directly to the brain in the auditory nerve.
    b. the hair cells of the cochlea make synapses onto neurons of the spiral ganglion.
    c. hair cells of the cochlea hyperpolarize in response to high-frequency sound stimuli and depolarize in response to low-frequency sound stimuli.
    d. all of the above.
    e. none of the above.
30. In the olfactory system):
    a. primary olfactory receptor neurons have axons that project directly to the brain, where they make synapses onto neurons of the olfactory bulb.
    b. olfactory stimuli depolarize primary olfactory receptor neurons by means of G-protein-coupled receptor molecules located in the cilia of the receptor neurons.
    c. each glomerulus in the olfactory bulb receives synaptic inputs from the primary olfactory receptor neurons of one particular type, among the thousand or so different types of receptor cell found in the olfactory epithelium.
    d. all of the above.
    e. none of the above.

**Answers**

1. T 2. T 3. F 4. T 5. F 6. T 7. T 8. T 9. F 10. T 11. F 12. T 13. F 14. T 15. T 16. T 17. F 18. T 19. F 20. T 21. T 22. d 23. b 24. d 25. c 26. e 27. a 28. c 29. b 30. d

**True or False Questions**

1. Contraction of a skeletal muscle fiber occurs when thick and thin filaments of a myofibril slide past each other, which is triggered when calcium ions are released from the sarcoplasmic reticulum and bind to the regulatory protein, troponin, associated with the thin filaments.
   T F
2. As tension in a muscle increases, the first motor units to be recruited at low levels of tension are the largest motor units, which have the largest number of muscle cells contacted by a single motor neuron.
   T F
3. In the myotatic reflex, the sensory neurons from the muscle spindles make direct inhibitory synapses onto the motor neurons of antagonistic muscles.
   T F
4. If the connection between the brain and spinal cord is severed, the spinal cord still retains the ability to produce locomotor movements.
   T F
5. The primary motor cortex, located in the precentral gyrus of the cerebral cortex, has a somatotopic organization, with the lower limb represented near the midline and the head represented at the lateral edge.
   T F
6. The three nuclei making up the basal ganglia are the caudate, the globus pallidus, and the substantia nigra.
   T F
7. The cell bodies of autonomic motor neurons are located in autonomic ganglia distributed throughout the body.
   T F
8. In the cardiac baroreceptor reflex, preganglionic neurons found in the intermediolateral cell column of the spinal cord are inhibited when blood pressure increases. 9. All motor neurons that control the eye muscles are located in the oculomotor nucleus (the nucleus of cranial nerve III) in the brainstem.
9. T F

   In the saccade control system of the brain, omnidirectional pause neurons stop firing during saccades of all directions, and the direction of a saccade is determined by which set or sets of excitatory burst neurons are activated by eye movement command centers
   T F

10. The limbic system refers to the part of the neocortex concerned with emotion.
    T F
11. All neurosecretory neurons of the hypothalamus release the substances they secrete directly into blood vessels from their nerve endings. 13. In almost all people, loss of the ability to speak would be caused by damage to the left cerebral

hemisphere.
T F

12. Agnosia refers to the loss of ability to identify objects based on particular sensory information, without damage to the corresponding primary sensory cortex.
13. T F
14. If the hippocampus is destroyed, short-term memory and existing long-term memory are relatively intact, but the ability to transfer new information into long-term memory is impaired.

T F

15. Blocking protein synthesis would prevent long-term sensitization but would have no effect on short-term sensitization in the Aplysia withdrawal reflex.

T F

16. The extracellular matrix in all parts of the body has the same molecular composition, and all neurons in the nervous system express the same types of adhesion molecules that interact with the extracellular matrix.
T F
17. Immature muscle cells insert acetylcholine molecules at high density at a single site that will become the neuromuscular junction, and growth cones of motor neurons are then attracted to this site during embryonic development.
T F
18. A transgenic organism is one in which non-native DNA has been incorporated into the genome of the organism.
T F
19. Heterologous expression refers to the artificial synthesis of a protein, which is then injected into a cell that does not normally express that protein.
T F

**Multiple Choice**

21. The nervous system controls the strength of contraction of a skeletal muscle by
    a. varying the total number of motor neurons activated, thus changing the total number of motor units contracting.
    b. varying the frequency of action potentials in the motor neuron of a single motor unit.
    c. varying the number of muscle cells that contract within a single motor unit.
    d. a and b, but not c
    e. a, b, and c.
22. The functional roles of the myotatic and inverse myotatic reflexes are
    a. the myotatic reflex maintains constant muscle tension, and the inverse myotatic reflex maintains constant muscle length.

b. the myotatic reflex controls the length of extensor muscles, and the inverse myotatic reflex controls the length of flexor muscles.
c. the myotatic reflex stimulates muscles that withdraw the ipsilateral limb and extend the contralateral limb, and the inverse myotatic reflex stimulates muscles that withdraw the contralateral limb and extend the ipsilateral limb.
d. the myotatic reflex maintains constant muscle length, and the inverse myotatic reflex maintains constant muscle tension.
e. none of the above.

23. The corticospinal tract
    a. is involved in gross motor control such as locomotion, rather than fine motor control such as manipulation of objects with the fingers.
    b. consists of axons that project from the motor cortex to the brainstem, where they synapse on interneurons that relay the motor commands to the spinal cord.
    c. originates from pyramidal neurons found in layer V of the motor cortex.
    d. all of the above.
    e. none of the above.
24. Acetylcholine is the neurotransmitter used by
    a. somatic motor neurons
    b. parasympathetic motor neurons
    c. parasympathetic preganglionic neurons
    d. sympathetic preganglionic neurons
    e. all of the above
25. In the vestibulo-ocular reflex
    a. sensory neurons in the vestibular ganglion of the semicircular canals make direct synaptic connections with motor neurons of the ocular muscles.
    b. motor neurons of the eye muscles are located in three different nuclei in the brainstem: the oculomotor nucleus, the trochlear nucleus, and the abducens nucleus.
    c. neurons of the vestibular nuclei in the brainstem receive sensory inputs only from the vestibular apparatus.
    d. horizontal motion of the head to the left causes the eyes to move to the left in the horizontal plane.
    e. the amount of movement of the eye is controlled by feedback from muscle stretch receptors of the ocular muscles to ensure that rotation of the eyes matches rotation of the head.
26. In the hypothalamus
    a. both the lateral hypothalamic area and the ventromedial nucleus are involved in feeding.
    b. hormones of the anterior pituitary are secreted directly into the bloodstream by hypothalamic neurosecretory neurons.
    c. the anterior nuclei of the hypothalamus are specialized for control of body temperature, and the posterior nuclei of the hypothalamus are specialized for control of water intake.
    d. all of the above.

e. none of the above.

27. In aphasia
    a. damage to Wernicke's area would most likely be associated with expressive aphasia.
    b. damage to Broca's area would most likely be associated with receptive aphasia.
    c. damage to the left temporal lobe would likely produce receptive aphasia in a right-handed person.
    d. all of the above.
    e. none of the above.
28. Long-term potentiation in the hippocampus requires
    a. postsynaptic depolarization
    b. presynaptic action potential activity
    c. influx of calcium into the postsynaptic cell
    d. all of the above
    e. none of the above
29. The extracellular matrix can include the following molecular components:
    a. collagen
    b. glycosaminoglycans
    c. glycoproteins
    d. laminina
    e. all of the above.
30. The functional role of a protein in the nervous system could be established by
    a. constructing a transgenic animal in which the gene encoding the protein is removed.
    b. identifying the gene for the protein and determining the DNA sequence of the gene.
    c. determining which neurons in the nervous system express mRNA encoding the protein.
    d. identifying the chromosome carrying the gene encoding the protein.
    e. all of the above.

**Answers**

1. T 2. F 3. F 4. T 5. T 6. F 7. T 8. T 9. F 10. T 11. F 12. T 13. T 14. T 15. T 16. T 17. F 18. F 19. T 20. F 21. d 22. d 23. c 24. e 25. b 26. a 27. c 28. d 29. e 30. a

**True or False Questions**

1. The cerebrospinal fluid fills the hollow core of the central nervous system: the cerebral ventricles in the brain and the spinal canal in the spinal cord. (Chapter 1)
   T F
2. The notochord is the structure that gives rise to the spinal cord during embryonic development.
   T F

3. The Nernst equation gives the equilibrium potential for an ion: the value of membrane potential at which the electrical gradient across the membrane exactly compensates for the concentration gradient for the ion.
   T F
4. The depolarizing phase of the action potential is caused by the explosive cycle of depolarization opening voltage-dependent sodium channels, which in turn produces further depolarization.
   T F
5. An inhibitory postsynaptic potential would result from a neurotransmitter that opens nonspecific cation channels that are equally permeable to sodium and potassium ions.
   T F
6. The dorsal columns of the spinal cord consist predominantly of ascending axons of spinal neurons that receive incoming sensory information about pain and temperature.
   T F
7. Many neurons in the primary visual cortex respond best to bars or stripes of light of a particular orientation.
   T F
8. In the cochlea, hair cells at the basal end respond best to low-frequency sound, whereas hair cells at the apical end respond best to high-frequency sound.
   T F
9. In the olfactory system, each olfactory receptor neuron has an axon that projects directly to a particular glomerulus in the olfactory bulb.
   T F
10. In skeletal muscle fibers, thick filaments are made up of the protein actin, and thin filaments are made up of the protein myosin.
    T F
11. In the inverse myotatic reflex, primary sensory neurons from a particular muscle make direct excitatory synapses onto motor neurons of the same muscle.
    T F
12. The basal ganglia are the caudate, the putamen, and the globus pallidus.
    T F
13. The sympathetic and somatic divisions are the two divisions of the autonomic nervous system.
    T F
14. Motor neurons that control the eye muscles are located in three cranial nerve nuclei: the oculomotor nucleus (cranial nerve III), the trochlear nucleus (cranial nerve IV), and the abducens nucleus (cranial nerve VI).
    T F
15. The Papez circuit is another name for the limbic system.
    T F
16. Broca's area is part of the frontal lobe, and damage to Broca's area causes difficulty in speech production.
    T F

17. Destruction of the hippocampus would erase all memories.
    T F
18. Cellular adhesion molecules interact with complementary adhesion molecules on the surface of surrounding cells or in the extracellular matrix.
    T F
19. Information about the function of a gene in the nervous system can be obtained if either a naturally occurring or induced mutation in the gene can be identified.
    T F

**Multiple Choice**

21. The forebrain includes the following structures:
    a. the diencephalon
    b. the cerebral cortex
    c. the basal ganglia
    d. all of the above)
    e. none of the above
22. During development of the nervous system:
    a. the neurons of the central nervous system arise from the neural crest, and the neurons of the peripheral nervous system arise from the neural tube.
    b. the three vesicles that give rise to the brain are called the telencephalon, diencephalon, and the cerebrum.
    c. the neuroectoderm gives rise to the cells of the nervous system.
    d. all of the above
    e. none of the above
23. Suppose a neuron is permeable to sodium and potassium ions and that the intracellular and extracellular fluids have their usual compositions. If pNa were doubled, leaving pK unchanged, the membrane potential of the neuron would:

    a. become more positive (depolarize).
    b. become more negative (hyperpolarize).
    c. remain unchanged.
24. The refractory period following an action potential arises because:
    a. voltage-dependent potassium channels close slowly upon repolarization and so remain open for a period after the action potential.
    b. the inactivation gates (h-gates) of voltage-dependent sodium channels reopen slowly upon repolarization, and so the sodium channels are unable to open again upon depolarization for a period after the action potential.
    c. the activation gates (m-gates) of voltage-dependent sodium channels close slowly upon repolarization, and so the sodium channels remain open for a period after the action potential.
    d. both voltage-dependent sodium channels and voltage-dependent potassium channels are incapable of responding again to depolarization for a period after the action potential.
    e. none of the above.
25. Neurotransmitter release:

a. occurs when membrane-bound synaptic vesicles are released from the presynaptic cell and then fuse with the plasma membrane of the postsynaptic cell.
b. requires the release of calcium ions from the postsynaptic cell.
c. is required for excitatory neurotransmission but not for inhibitory neurotransmission.
d. all of the above
e. none of the above

26. The receptor potential of a primary sensory neuron:
    a. is another name for the action potential in a primary sensory neuron.
    b. is the change in membrane potential resulting from the process of sensory transduction.
    c. is stimulated by synaptic inputs from other primary sensory neurons.
    d. all of the above are correct.
    e. none of the above is correct.
27. The primary somatosensory cortex:
    a. is located in the postcentral gyrus, just behind the central sulcus of the cerebral cortex.
    b. is organized in a somatotopic map, with sensory inputs from the head represented nearest the midline and inputs from the feet at the most lateral position.
    c. receives direct synaptic input from primary sensory neurons, without any intervening synapses.
    d. on the right side of the brain receives sensory information from the right side of the body.
    e. receives sensory information only from the dorsal column pathway of the spinal cord.
28. In the retina:
    a. photoreceptors depolarize in response to illumination.
    b. light is absorbed in rod photoreceptors by the visual pigment molecule, rhodopsin.
    c. center-surround receptive fields are observed only in retinal ganglion cells.
    d. all of the above
    e. none of the above
29. The primary auditory cortex:
    a. receives direct synaptic inputs from the cochlear nucleus, without intervening synapses.
    b. is located in the frontal lobe of the cerebral cortex.
    c. is organized in a two-dimensional array of vertically oriented frequency columns and binaural columns.
    d. all of the above
    e. none of the above
30. The olfactory bulb:
    a. receives olfactory inputs from the thalamus, which in turn receives direct synaptic input from the axons of primary olfactory receptor neurons.
    b. receives synaptic inputs from the glomeruli of the olfactory paleocortex.

c. is located within the nasal cavity and contains the olfactory epithelium.
d. all of the above
e. none of the above

31. During contraction of a skeletal muscle cell:
    a. calcium ions are released from the transverse tubules to initiate contraction.
    b. calcium ions bind to the regulatory protein tropomyosin, which is associated with the thin filaments.
    c. neither the thin filaments nor the thick filaments change in length.
    d. all of the above
    e. none of the above
32. The myotatic reflex differs from the inverse myotatic reflex in which of the following ways?
    a. the myotatic reflex produces limb flexion, whereas the inverse myotatic reflex produces limb extension.
    b. the sensory neurons of the myotatic reflex innervate muscle spindles, whereas the sensory neurons of the inverse myotatic reflex innervate Golgi tendon organs.
    c. the myotatic reflex is activated by muscle stretch, whereas the inverse myotatic reflex is activated by muscle relaxation.
    d. all of the above
    e. none of the above
33. The primary motor cortex:
    a. has output neurons whose axons form the pyramidal tract.
    b. has output neurons that make direct synaptic connections with motor neurons in the spinal cord.
    c. is located in the precentral gyrus of the cerebral cortex.
    d. all of the above
    e. none of the above
34. Neurons of the intermediolateral cell column of the spinal cord make direct synaptic connection with:
    a. paravertebral sympathetic ganglia
    b. prevertebral sympathetic ganglia
    c. sympathetic chain ganglia
    d. all of the above
    e. none of the above.
35. During a saccade:
    a. neural circuits in the superior colliculus help determine the direction of the eye movement.
    b. omnidirectional pause neurons fire a rapid burst of action potentials.
    c. excitatory burst neurons stop firing.) inhibitory burst neurons stop firing.
    d. all of the above
36. Which of the following hormones are released in the posterior lobe of the pituitary?
    a. growth hormone and thyroxin
    b. prolactin and somatotropin

c. thyrotropin and ACTH
d. the gonadotropins LH and FSH
e. vasopressin and oxytocin

37. Which of the following brain regions, lobes, and neurological syndromes are associated?
    a. Wernicke's area; frontal lobe; expressive aphasia
    b. Broca's area; temporal lobe; receptive aphasia
    c. angular gyrus; parietal lobe; agnosia
    d. Wernicke's area; frontal lobe; agnosia
    e. Broca's area; parietal lobe; receptive aphasia
38. Long-term potentiation in a hippocampal neuron:
    a. is thought to involve changes in both postsynaptic and presynaptic events at the potentiated synapse, resulting in enhanced synaptic transmission.
    b. occurs only at synapses that are silent during a period of strong activity in other synapses on the same postsynaptic neuron.
    c. produces an enhancement of the strength of synaptic transmission that lasts for a few hours.
    d. all of the above
    e. none of the above
39. The guidance of growing neurites during development of the nervous system involves:
    a. interaction of adhesion molecules on the surface of the neurite with complementary adhesion molecules in the extracellular matrix.
    b. interaction of adhesion molecules on the surface of the neurite with complementary adhesion molecules on neighboring cells.
    c. chemotropic molecules that attract or repel growth cones.
    d. all of the above
    e. a and b, but not c
40. Regarding genetic and molecular biological analysis of the nervous system:
    a. genetic analysis is possible in simple organisms such as Drosophila, but not in more complex organisms, such as mammals.
    b. in a transgenic animal, the inserted DNA inserts randomly in the genome of the host, and it is not possible to control the site of insertion.
    c. it is possible to test the function of a protein by selectively disrupting the corresponding gene by replacing it with a nonfunctional gene that does not encode a functional protein.
    d. all of the above
    e. a and b, but not c

**Answers**

1. T 2. F 3. T 4. T 5. F 6. F 7. F 8. T 9. F 10. T 11. F 12. F 13. T 14. F 15. T 16. F 17. T 18. F 19. T 20.
21. d) 22. c 23. a 24. b 25. e 26. b 27. a 28. b 29. c 30. e 31. c 32. b 33. d 34. d 35. a 36. e 37. c 38. a 39. d
40. c

**Vision, the eye**

1. Ganglion cells from the fovea

A. are not selective for colour
B. project predominantly to layers 1 and 2 of the lateral geniculate nucleus (LGN)
C. are best activated by a big light source
D. have very large receptive fields
E. non of the above

2. When rods are subjected to darkness

A. the electrical potential inside the cell decreases
B. the concentration of cyclic GMP increases
C. $Na^+$ channels close
D. more rhodopsin is broken down
E. none of the above

**Vision, the cortex**

3. Strabismus in early childhood will produce

A. a loss of orientation columns in primary visual cortex (V1).
B. a loss of cells in the blob region of V1.
C. a loss of binocularly driven cells in layer 4 of V1.
D. a loss of binocularly driven cells in layers above and below layer 4 of V1.
E. no permanent changes in visual ability.

4. When looking forward, a visual stimulus down and to your right will activate the following region of primary visual cortex

A. above the calcarine sulcus in the left side
B. below the calcarine sulcus in the right side
C. above the calcarine sulcus in the right side
D. below the calcarine sulcus in the left side
E. on the posterior end of calcarine sulcus in the right side

**Association areas & Memory**

5. A lesion of the left parietal temporal occipital association area (PTO)

A. causes neglect of body parts on the left
B. causes neglect of objects on the left
C. affects the ability to express words
D. causes prosopagnosia
E. is less devastating than a lesion on the right

6. A patient with a bilateral lesion of the medial temporal lobe and hippocampus cannot

A. calculate the sum of three numbers
B. read books
C. recognize a new acquaintance
D. remember how to ride a bike
E. write letters

**Auditory & Vestibular Physiology**

7. The direction of a sound source is best determined by

A. the inter-aural intensity differences of low frequency sounds.
B. the inter-aural timing differences of high frequency sounds.
C. a comparison of inter-aural differences by the cochlear nucleus.
D. a comparison of inter-aural differences by the superior olivary nucleus.
E. a comparison of inter-aural differences by the superior colliculus.

8. Pitching your head, nose down

A. causes excitation in the right inferior rectus muscle
B. does not change activity in the otoliths
C. causes an increase in the activity in the right & left posterior canals
D. changes the activity of the horizontal semicircular canals
E. causes the eyes to be rotated up in the head.

**Somato Sensory Physiology**

9. In the dorsal column medial lemniscal system, <u>afferents</u> from a pressure receptor in the finger

A. must first make a synaptic connection in the spinal cord.
B. are over represented in somato sensory cortex because of low convergence in the dorsal column nuclei.
C. exhibit inhibitory surround receptive fields.
D. are gated by the cortex by post synaptic inhibition.
E. terminate, via three synaptic connections, in the ipsilateral cortex.

10. A Pacinian corpuscle afferent

A. has a small receptive field
B. responds well to steady pressure.
C. is located deep in the dermis.
D. produces a greater change in action potentials for a 100 to 101 gm change in pressure than for a 1 to 2 gm change.
E. does not show adaptation in the receptor potential.

**Muscle Receptors and Spinal Reflexes**

11. Fast contracting, fatigue prone, muscle motor units are characterized by

A. a large muscle force.
B. a red color.
C. a small innervation ratio.
D. the first to be recruited.
E. innervation from small motoneurons.

12. The stretch reflex mediated by Ia fibres

A. is dysynaptic to agonist muscles
B. is mediated by small diameter fibres
C. is primarily involved in regulating tension
D. is primarily involved in regulating length and change of length
E. mediates the flexor reflex

**Motor Cortex**

13. The supplementary motor cortex is activated when a subject

A. flexes his finger
B. performs a complex finger movement sequence or when he only thinks about the sequence
C. only thinks about a complex finger movement sequence but not when the subject actually makes the movement sequence
D. makes a complex finger movement sequence but not when he only thinks about the movement sequence
E. touches an object with his fingers

14. A large lesion of the motor cortex produces

A. muscle fiber twitches (fasciculations)
B. hypertonia in antigravity muscles
C. muscle atrophy
D. a negative Babinski sign
E. normal reflex responses to muscle stretch

**Cerebellum and Basal Ganglia**

15. In the cerebellar repair shop of the VOR (vestibular ocular reflex).

A. the VOR is modulated by excitatory input from Purkinje cells.
B. the mossy fibre input signals retinal slip.

C. the climbing fibre input from the inferior olive produces complex spikes in Purkinje cells.
D. the mossy fibre activity stops when normal VOR function is restored.
E. the adaptation occurs in the lateral cerebro cerebellum.

16. The motor deficits in cerebellar diseases include

A. rigidity.
B. movements are dysmetric.
C. a tremor which is most prominent when at rest.
D. symptoms which usually get worse.
E. the need of external sensory trigger to initiate movements.

**1. E**
**2. B**
**3. D**
**4. A**
**5. E**
**6. C**
**7. D**
**8. E**
**9. B**
**10. C**
**11. A**
**12. D**
**13. B**
**14. B**
**15. C**
**16. B**

. The lumbar and sacral roots from the spinal cord (e.g., dorsal roots) are _____ than roots from the cervical spinal cord.
a. shorter
b. wider
c. longer
d. thinner

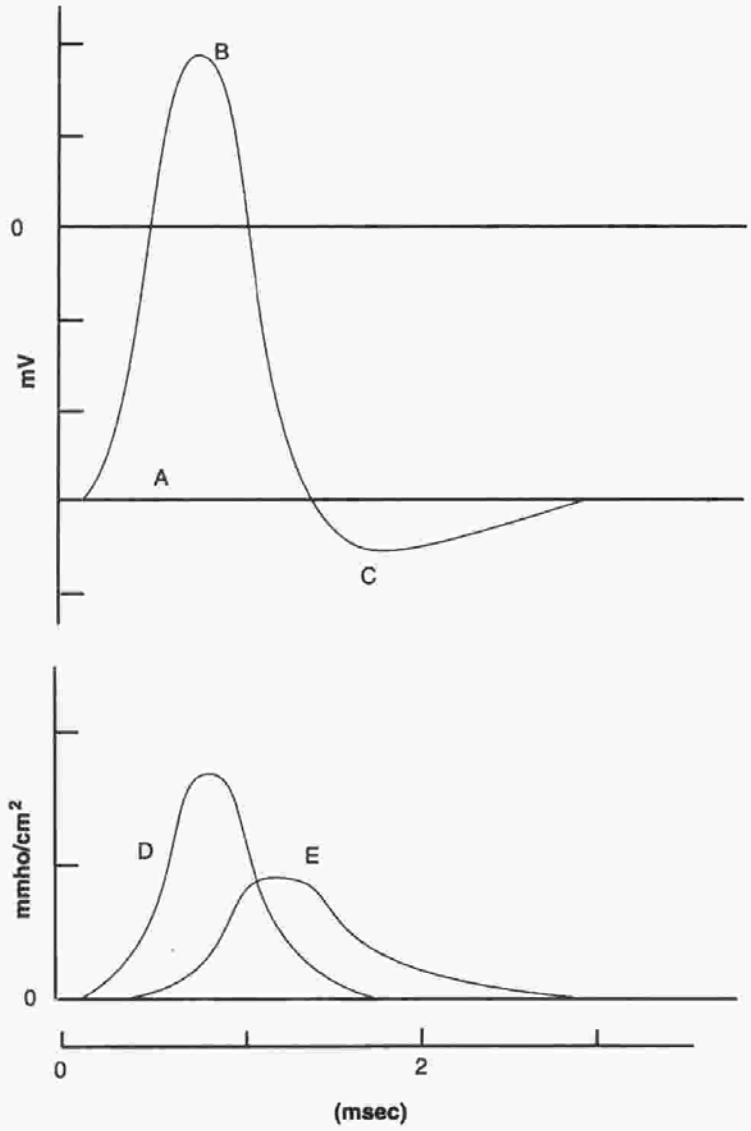
2. Which of the following is not frontal lobe cortex?
a. the precentral gyrus
b. the primary motor cortex
c. the orbital gyrus
d. none of the above (i.e., all are frontal lobe cortex)

3. Which of the following is not a component of the diencephalon?
a. hypothalamus
b. thalamus

c. epithalamus
d. metathalamus

4. Dr. Hoosier dropped his scalpel during brain surgery and damaged her patient's pyramidal tracts. In which part of the brainstem did the damage occur (i.e., where are the pyramidal tracts)?
   a. the dorsal medulla
   b. the dorsal pons
   c. the ventral medulla
   d. the tectum of the midbrain

5. The falx cerebri refers to:
   a. groups of axons
   b. groups of neuron cell bodies
   c. fused meningeal layers
   d. a network of cerebral arteries




The diagrams above depict characteristics of a mammalian spinal motoneuron measured by intracellular microelectrode.

1. From the diagrams above, choose the letter closest to the equilibrium potential for $Na^+$.
2. From the diagrams above, choose the letter that best represents $K^+$ conductance.

3. Which of the following characteristics of a neuron is not associated with increased conduction velocity?
   A. increased axon diameter
   B. myelination
   C. increased transmembrane resistance
   D. decreased fiber size

**Questions 4 and 5: Answer using the following options:**

   A. rising phase of action potential
   B. falling phase of action potential
   C. both A and B are correct
   D. resting membrane potential

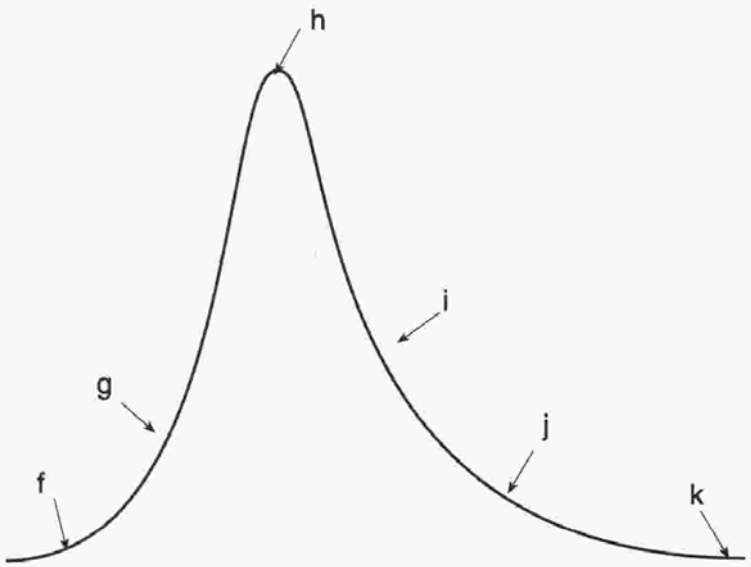
4. Is/are included in the absolute refractory period of a nerve fiber.

5. Period of lowest sodium conductance in a nerve fiber.

6. In excitable cells, repolarization is most closely associated with which of the following events?
   A. $Na^+$ efflux
   B. $Na^+$ influx
   C. $K^+$efflux
   D. $K^+$ influx
   E. decreased excitability

7. The molecular basis of an axonal action potential includes:
   A. increased potassium conductance followed by increased sodium conductance
   B. increased sodium conductance followed by increased potassium conductance
   C. decreased sodium conductance
   D. decreased potassium conductance
   E. decreased calcium conductance

**Questions 8–10**




8. In the action potential illustrated above:
   A. interval g–h is caused by an active transport of $Na^+$ into the cell
   B. interval g–h is caused by a diffusion of $Na^+$ into the cell
   C. interval g–h is caused by pinocytosis
   D. interval h–i is caused by active transport of $K^+$
   E. interval h–i is caused by active transport of $Na^+$

9. In the transmembrane potential illustrated above:
   A. point f represents the threshold potential or firing level for the cell
   B. the movement of the transmembrane potential from point f toward point g is called depolarization
   C. the movement of the transmembrane potential from point f toward point g is associated with a decreased excitability
   D. the cell is refractory during interval j–k
   E. all of the above statements are true

10. The above action potential is recorded from a somatic efferent neuron:
    At what interval would the $O_2$ consumption in milliliters of $O_2$ most exceed the resting level?
    A. interval f–g
    B. interval g–h
    C. interval h–i
    D. interval i–j
    E. interval j–k

# JUNCTIONAL TRANSMISSION

## Review Questions

**Directions: Select the ONE best answer.**

1. A miniature end-plate potential results from:
   A. spontaneous release of a quantal package of acetylcholine
   B. presynaptic inhibition
   C. recruitment of motor units
   D. postsynaptic atropine blockade
   E. stimulation of A-alpha fibers

2. Which of the following occurs during an inhibitory postsynaptic potential (IPSP)?
   A. decreased potassium conductance
   B. increased chloride conductance
   C. increased sodium conductance
   D. decreased calcium conductance

3. Which of the following is NOT associated with electronic neuron-to-neuron transmission?
   A. faster than chemical transmission
   B. involves direct cell-to-cell communication
   C. potentially bidirectional
   D. receptor dependent

4. The end-plate potential of skeletal muscle is best characterized as:
   A. a local reversal of charge originating at the end-plate
   B. a reversal of charge originating at the end-plate and propagated throughout the cell
   C. a decrease in the transmembrane potential that is propagated throughout the cell
   D. a local decrease in the transmembrane potential that is caused by an increased permeability to $Na^+$ and $K^+$
   E. a local decrease in the transmembrane potential that is associated with little or no increase in $Na^+$ conductance

5. The end-plate of a normally innervated skeletal muscle cell can be distinguished from the rest of the cell membrane in that **only** the end-plate:
   A. will initiate a contraction in response to the local application of acetylcholine
   B. will depolarize when exposed to an excess of extracellular $K^+$
   C. will depolarize in response to an excess of extracellular $Ca^{2+}$
   D. has all of the above characteristics
   E. has none of the above characteristics

6. The inhibitory postsynaptic potential:
   A. probably occurs only in the brain
   B. is a local depolarization caused by an increase in $Ca^{2+}$ conductance
   C. is a local hyperpolarization caused by a decrease in $Ca^{2+}$ conductance
   D. is a local depolarization caused by an increase in $C^-$ conductance
   E. is a local hyperpolarization caused by an increase in $Cl^-$ conductance

# JUNCTIONAL TRANSMISSION

## Answers

1. **Ans A** For some reason, single packets of acetylcholine are released into the synaptic cleft independent of action potentials. This causes a very small end-plate potential (referred to as miniature), too small to initiate an action potential. The mechanism is not well understood, thus the release is considered spontaneous.

2. **Ans B** The increased conductance to chloride is the only possible answer. Presumably this would produce an influx of chloride ions and hyperpolarization. Decreased conductance to potassium would depolarize because of the reduced efflux of potassium ions.

3. **Ans D** Receptors are associated with chemical transmission. Because with electronic transmission the electrical activity moves directly from cell to cell, it is faster. A direct transmission can move in either direction. Remember chemically mediated synapses are unidirectional.

4. **Ans D** An end-plate potential is a local depolarization caused by an influx of sodium ions. The channels that open to allow the passage of sodium also permit the passage of potassium. However, the main flux is the movement of sodium. The depolarization is not great enough to produce a reversal of the membrane charge.

5. **Ans A** The end-plate region of the skeletal muscle cell is the only region with receptors to acetylcholine. The end-plate potential produced in this region can lead to an action potential and muscle contraction. All regions of the muscle membrane will be depolarized by increases in extracellular potassium and neither region will be dramatically affected by calcium.

6. **Ans E** An inhibitory postsynaptic potential is a hyperpolarization making the cell less excitable. There is no closure of calcium channels involved and the only possibly listed correct choice is an increased chloride conductance.