Behavioral Neuroscience 8th edition Breedlove Test Bank

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Test Bank
to accompany
Behavioral Neuroscience, Eighth Edition
S. Marc Breedlove and Neil V. Watson

Chapter 2: Functional Neuroanatomy: The Nervous System and Behavior

TEST QUESTIONS

Essay/Discussion

Prepare a comprehensive discussion for each of the following topics:

1. What is axonal transport, and how is it important to the functioning of neurons? Describe the key components of the neuron that are involved in axonal transport, and the speeds at which they operate.

2. Summarize the neuron doctrine and the process of discovery that led up to it.

3. Give an account of the ways in which neurons may be categorized. What are the various categories, and what are some examples for each category?

4. Describe the typical synapse. What is the sequence of events at the synapse that is triggered by electrical activity in the axon?

5. What are glial cells? Name four types of glial cells, and describe three important functions that glial cells perform.

6. Summarize the ways in which one brain region may be distinguished from another. In your answer, take several perspectives, including those of gross anatomy, cellular anatomy, and functional anatomy.

7. What are the divisions of the peripheral nervous system? Briefly describe the kind of information conveyed by each division and subdivisions of the autonomic nervous system.

8. Name the 12 pairs of cranial nerves, and briefly mention the functions performed by each.

9. How does embryonic development provide a scheme for subdividing the human brain?

10. Describe four ways of visualizing the brain at a cellular level. When relevant, what molecules are involved for a given visualization technique?

11. Compare and contrast at least four different human brain imaging technologies through discussion of their technical bases and the types of information each provides.

12. Describe the arterial supply of the human brain, including both the arteries that enter the cranium and the major intracranial arteries that arise from them.

13. Describe how fMRI has been modified to look at simultaneous brain activation during social interactions. How has this technique helped our understanding of the cognitive processing that takes place in interactions between individuals?

Multiple Choice

1. Synaptic vesicles are found in the
a. cell body.
b. dendritic spines.
c. axon hillock.
d. synaptic boutons.
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

2. Which neurons can collect the most information?
a. Bipolar
b. Monopolar
c. Multipolar
d. Unipolar
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 5. Evaluating

3. The major function of Schwann cells is the
a. transmission of nutrients to neurons.
b. myelination of peripheral nerve fibers.
c. scavenging of cellular debris.
d. myelination of axons in the brain.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

4. During multiple sclerosis, myelin in the brain is lost. Which cells would be most likely to be trying to replace lost myelin in the brain?
a. Oligodendrocytes
b. Schwann cells
c. Astrocytes

d. Both a and b
Answer: a
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 4. Analyzing

5. The size range of most neuronal cell bodies is
a. 1–10 μm.
b. 1–10 mm.
c. 10–100 nm.
d. 10–100 μm.
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

6. Which histological technique is used for tract tracing?
a. Horseradish peroxidase stain
b. In situ hybridization
c. Golgi stain
d. Nissl stain
Answer: a
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

7. The human brain contains
a. 100–150 billion circuits.
b. 100–150 billion neurons.
c. 100–150 million neurons.
d. 100–150 million glial cells.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

8. The neuron doctrine
a. was confirmed using electron microscopy.
b. proposed the existence of synaptic contacts between neurons.
c. stemmed from the work of the great neuroanatomist Ramón y Cajal.
d. All of the above
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 4. Analyzing

9. The gaps between segments of myelin are known as
a. synaptic clefts.
b. nodes of Ranvier.
c. terminal boutons.
d. neuromuscular junctions.

Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

10. A collection of cell bodies in the nervous system is known as a
a. nodule.
b. nucleus.
c. fiber.
d. plexus.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

11. The range of diameters of mammalian axons is
a. 1–10 mm.
b. 0.5–20 μm.
c. 0.05–2.0 μm.
d. 100–300 μm.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

12. The width of the synaptic cleft is about
a. 200 nm.
b. 200 μm.
c. 20 μm.
d. 20 nm.
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

13. In which way(s) are dendrites and axons similar?
a. Both are characterized by branching.
b. They have similar lengths.
c. Both exhibit a tapering of diameter with increasing distance from the cell body.
d. All of the above
Answer: a
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

14. The "giant" axons of some invertebrate animals can have diameters as large as
a. 20 μm.
b. 1 mm.
c. 500 μm.
d. 20 nm.
Answer: c

Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

15. Dendrites are
a. a type of glial cell.
b. the input zone of a nerve cell.
c. the output zone of a nerve cell.
d. small cerebellar neurons.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

16. Some neurons lack which component?
a. Myelin
b. Dendrite
c. Axon
d. Nucleus
Answer: a
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

17. Which statement does *not* describe a reason that tract-tracing studies have been difficult to perform?
a. Fibers with different destinations often travel together.
b. Axons have very small diameters and therefore are hard to see.
c. Axons from different sources look alike.
d. All of the above are reasons for the difficulty.
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 3. Applying

18. Synaptic boutons are
a. found within synaptic vesicles.
b. protrusions occurring along the length of dendrites.
c. swellings found at axon terminals.
d. specialized synapses occurring on muscles.
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

19. Which type of cell gives rise to brain tumors?
a. Pyramidal cells
b. Multipolar cells
c. Glial cells
d. Granule cells
Answer: c

Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

20. The "slow" rate of axonal transport is
a. 400 mm/day.
b. 1 m/day.
c. less than 8 mm/day.
d. 40 mm/day.
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

21. Which statement about dendritic spines is true?
a. Alzheimer's disease is associated with a pathological change in dendritic spines.
b. Dendritic spines are outgrowths on the surface of dendrites that are modified by experience.
c. Dendritic spines are neuronal structures found along the axon..
d. Only the structure of dendritic spines can be altered by experience.
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

22. Which glial cells have sucker-like extensions that contact blood vessels?
a. Oligodendrocytes
b. Astrocytes
c. Microglial cells
d. Stellate cells
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

23. Most neurons
a. receive input related to changes in the environment.
b. are classified as motoneurons.
c. are classified as sensory neurons.
d. are classified as interneurons.
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

24. The electrical impulse that stimulates neurotransmitter release, thereby transmitting information to other neurons, arises in the
a. dendrites.
b. axon hillock.
c. axon.
d. dendritic spine.

Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

25. Which statement about dendrites is *false*?
a. A single cell's dendrites form a dendritic tree.
b. The diversity of neuronal shapes is caused primarily by variation in the form and shape of dendrites.
c. Dendrites may be several meters in length in giraffes.
d. Dendritic spines appear to be subject to modification as a result of experience.
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 3. Applying

26. Which three cranial nerves are involved in the control of eye movements?
a. Oculomotor, trochlear, vagus
b. Oculomotor, trochlear, abducens
c. Trochlear, abducens, vagus
d. Abducens, oculomotor, vagus
Answer: b
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

27. The pons is part of the
a. diencephalon.
b. mesencephalon.
c. metencephalon.
d. myelencephalon.
Answer: c
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 2. Understanding

28. How many pairs of spinal nerves do humans have?
a. It varies, depending on an individual's age and height.
b. 5
c. 12
d. 31
Answer: d
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

29. The left and right portions of the body are divided by the _____ plane.
a. sagittal
b. frontal
c. coronal
d. horizontal

Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

30. Which cranial nerve carries both motor and sensory information?
a. Facial
b. Olfactory
c. Optic
d. Hypoglossal
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

31. The four major lobes of the cerebral cortex are named for
a. the skull bones lying over them.
b. their anatomical positions relative to one another.
c. their major functions.
d. their gross appearance.
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

32. In which plane of section would it be easiest to see the corpus callosum?
a. Sagittal cut directly down the midline
b. Horizontal cut at the level of the brainstem
c. Coronal cut at the level of the cerebellum
d. Sagittal cut at the level of the temporal lobe
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

33. The brainstem contains which structure?
a. Medulla
b. Inferior colliculus
c. Corpus callosum
d. Central sulcus
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

34. The preganglionic neurons of the sympathetic nervous system are found in the
a. basal ganglia.
b. sympathetic chain.
c. spinal cord.
d. muscles.
Answer: c

Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 2. Understanding

35. Which response is a consequence of sympathetic activation?
a. Increased salivation
b. Increased heart rate
c. Decreased blood pressure
d. Increased digestion
Answer: b
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

36. The ridges of tissue on the convoluted surface of the cortex are called
a. gyri.
b. sulci.
c. nuclei.
d. ganglia.
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

37. How much of the surface of the cortex is hidden within the convolutions of the brain?
a. 2%
b. 25%
c. 33%
d. 66%
Answer: d
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

38. Which region of the cortex is crucial for motor control?
a. Postcentral gyrus
b. Parietal lobe
c. Precentral gyrus
d. Prefrontal cortex
Answer: c
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

39. How many distinct layers are observed in the human neocortex?
a. Three
b. One
c. About one million
d. Six
Answer: d
Textbook Reference: The Brain Shows Regional Specialization of Functions

Bloom's Level: 1. Remembering

40. Parallel fibers are a feature of the
a. basal ganglia.
b. superior colliculus.
c. corpus callosum.
d. cerebellum.
Answer: d
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

41. The structures of the limbic system are particularly implicated in
a. emotion and learning.
b. sensation.
c. motor control.
d. sympathetic nervous system control.
Answer: a
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

42. Which statement about allocortex is true?
a. It has six cell layers.
b. It is found in the frontal lobe.
c. It can have an unlayered organization.
d. It is organized into columns.
Answer: c
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

43. Which structure contains the reticular formation?
a. Diencephalon
b. Cerebellum
c. Metencephalon
d. Telencephalon
Answer: c
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 4. Analyzing

44. Two important motor nuclei, the substantia nigra and the _____ nucleus, are contained within the _____.
a. caudate; brainstem
b. oculomotor; diencephalon
c. raphe; telencephalon
d. red; midbrain
Answer: d
Textbook Reference: The Brain Shows Regional Specialization of Functions

Bloom's Level: 1. Remembering

45. In the cerebral cortex, layer 5 is especially noticeable because it
a. is a different color from the rest.
b. contains many large cell bodies.
c. contains many fibers.
d. is quite variable from region to region.
Answer: b
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 3. Applying

46. Which structures are part of the basal ganglia?
a. Globus pallidus, caudate nucleus, amygdala
b. Caudate nucleus, putamen, fornix
c. Putamen, amygdala, mammillary bodies
d. Globus pallidus, substantia nigra, putamen
Answer: d
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

47. Purkinje cells are located in the
a. cerebral cortex.
b. cerebellum.
c. cervical spinal cord.
d. basal ganglia.
Answer: b
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

48. A person who has suffered a stroke that affects the base of the anterior cerebral artery will likely have reduced blood flow to the
a. medial frontal and parietal lobes.
b. occipital lobe.
c. lateral temporal lobe.
d. lateral frontal and parietal lobes.
Answer: a
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 4. Analyzing

49. The specialized vascular tissue that produces the cerebrospinal fluid is called the
a. circle of Willis.
b. meninges.
c. corpus callosum.
d. choroid plexus.
Answer: d
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain

Bloom's Level: 1. Remembering

50. Which arteries provide blood to the brain?
a. Basilar artery and carotid artery
b. Carotid artery and vertebral artery
c. Basilar artery, carotid artery, and vertebral artery
d. Carotid artery, choroid plexus, and vertebral artery
Answer: c
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 3. Applying

51. The ventricular system contains
a. the circle of Willis.
b. blood.
c. cerebrospinal fluid.
d. the meninges.
Answer: c
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 1. Remembering

52. The anterior and middle cerebral arteries branch from the
a. superior vena cava.
b. internal carotid artery.
c. basilar artery.
d. vertebral artery.
Answer: b
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 2. Understanding

53. Which statement about the blood–brain barrier is true?
a. It is a part of the immune system that involves the release of antibodies to protect the brain from infectious agents.
b. It is a property of the closely packed endothelial cells of the walls of brain capillaries that prevents large molecules from entering the brain.
c. It is a property of the blood vessels of the brain that promotes the diffusion of nutrients into the tissue of the brain.
d. It is a property of neurons that prevents them from accidentally releasing their neurotransmitters into the blood circulation.
Answer: b
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 2. Understanding

54. The basilar artery of the brain is formed by the fusion of the _____ arteries.
a. carotid
b. vertebral
c. subclavian

d. femoral
Answer: b
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 1. Remembering

55. The physiological activity of the brain can be visualized using
a. PET.
b. CT.
c. DTI.
d. electron microscopy.
Answer: a
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 1. Remembering

56. Which imaging technique is *not* used for studies of the structural details of the brain?
a. CT scan
b. fMRI scan
c. MRI scan
d. All of the above are used for studies of the structural details of the brain.
Answer: b
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 3. Applying

57. Which imaging technology could provide a physician with a very high resolution image of the thalamus?
a. MRI
b. CT
c. PET
d. DTI
Answer: a
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 3. Applying

58. Which technique does *not* provide information about the activity level of brain regions?
a. PET
b. fMRI
c. CT
d. Autoradiography
Answer: c
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 3. Applying

59. Which statement is a true of conventional fMRI?
a. Subjects must fast before testing.
b. Subjects must lie completely motionless.
c. It involves the use of X-rays.
d. Subjects must perform specific cognitive tasks.
Answer: b
Textbook Reference: The Cutting Edge: Two Heads Are Better Than One
Bloom's Level: 3. Applying

60. A dyadic fMRI could be used to
a. test a person's response to two voices coming through headphones.
b. sequentially examine the brain responses of identical twins.
c. simultaneously examine how two people respond to the same stimulus.
d. stimulate movement of two people simultaneously.
Answer: c
Textbook Reference: The Cutting Edge: Two Heads Are Better Than One
Bloom's Level: 3. Applying

Fill in the Blank

1. The two major cell types that make up the nervous system are _____ cells and _____.
Answer: glial; neurons
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

2. Substances are conveyed from the cell body of the neuron to the distant reaches of the axon through the process of _____.
Answer: axonal transport
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

3. Axon terminals form the _____ side of a synapse, and dendrites form the _____ side of a synapse.
Answer: presynaptic; postsynaptic
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

4. Although nerve cells typically have only one axon, it may divide into numerous axon _____.
Answer: collaterals
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

5. Almost all incoming sensory information passes through the _____, which sends the information on to the overlying cortex.
Answer: thalamus
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

6. Fibers that carry information away from the brain are called _____, whereas fibers that carry information toward the brain are called _____.
Answer: efferents; afferents
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

7. The major divisions of the spinal cord are _____, _____, _____, and _____.
Answer: cervical; thoracic; lumbar; sacral
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

8. The hypothalamus is located _____ to the thalamus.
Answer: ventral
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

9. The _____ sulcus divides the frontal lobe from the parietal lobe.
Answer: central
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

10. Eye muscles are controlled by cranial nerves _____, _____, and _____.
Answer: III (three, oculomotor); IV (four, trochlear); VI (six, abducens)
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 2. Understanding

11. The three main components of the peripheral nervous system are the _____ nerves, the _____ nerves, and the _____ nervous system.
Answer: cranial; spinal; autonomic
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

12. The dorsal root ganglia contain cell bodies of processes carrying _____ information.
Answer: sensory
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 3. Applying

13. The main parts of the basal ganglia are the _____, caudate, and _____.
Answer: globus pallidus; putamen

Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

14. The _____ and _____ are two parts of the limbic system that form arcs under the surface of the cerebral hemispheres.
Answer: fornix; hippocampus
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 2. Understanding

15. Almost all hormone secretion is under the control of the _____ gland, which is in turn controlled by the _____.
Answer: pituitary; hypothalamus
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

16. Within the midbrain, the _____ receive auditory (sound) information.
Answer: inferior colliculi
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

17. The most prominent type of neuron of the cerebral cortex—the pyramidal neuron—features a(n) _____ dendrite that extends toward the outer surface of the cortex, and _____ dendrites that spread out horizontally from the cell body.
Answer: apical; basilar
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

18. The major compartments of the ventricular system are the _____ ventricles, the _____ ventricle, and the _____ ventricle.
Answer: lateral; third; fourth
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 1. Remembering

19. MRI makes use of _____ waves and _____ fields to form images of the living brain.
Answer: radio; magnetic
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 1. Remembering

20. In _____ fMRI, the brains of two interacting individuals are simultaneously imaged.
Answer: dyadic
Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 1. Remembering

Matching

Match each of the following lettered items with an item from the numbered list below.
_____ a. Golgi stain
_____ b. In situ hybridization
_____ c. Nissl stain
_____ d. Immunohistochemistry
_____ e. Cranial nerves
_____ f. Thalamus
_____ g. Medulla
_____ h. Limbic system
_____ i. Hypothalamus
_____ j. Cerebellum
1. Intracellular proteins
2. Cell bodies
3. Entire neuron, including cell processes
Label neurons with active gene of interest
5. Sensory information
6. Cardiac control
7. Motor coordination
8. Hunger control
9. Emotion
10. Sensory/motor systems of head
Answer: a. 3; b. 4; c. 2; d. 1; e. 10; f. 5; g. 6; h. 9; i. 8; j. 7

Define/Describe/Identify

Give a definition or functional description for each of the following terms or concepts:

acetylcholine (ACh)
allocortex
amygdala
angiography
anterior cerebral arteries
apical dendrite
arachnoid
arborization
astrocyte
autonomic ganglia
autonomic nervous system
autoradiography
axon
axon collateral

axon hillock
axon terminal
axonal transport
basal dendrite
basal ganglia
basilar artery
bipolar neuron
blood-brain barrier
brainstem
c-fos
carotid arteries
caudate nucleus
cell body
cell nucleus
central nervous system (CNS)
central sulcus
cerebellum
cerebral cortex
cerebral hemispheres
cerebrospinal fluid (CSF)
cervical
choroid plexus
cingulate gyrus
circle of Willis
coccygeal
computerized axial tomography (CAT or CT)
conduction zone
corpus callosum
cortical column
cranial nerve
dendrite
diencephalon
diffusion tensor imaging (DTI)
dorsal root
dura mater
dyadic functional MRI (dfMRI)
edema
enteric nervous system
forebrain
fornix
fourth ventricle
frontal lobe
functional MRI (fMRI)
glial cells
globus pallidus
granule cell

gray matter
gross neuroanatomy
gyrus (pl. gyri)
hindbrain
hippocampus (pl. hippocampi)
hypothalamus
immediate early genes (IEGs)
immunocytochemistry (ICC)
in situ hybridization
inferior colliculi (sing. colliculus)
innervate
input zone
integration zone
interneuron
lateral ventricle
lesions
limbic system
lumbar
magnetic resonance imaging (MRI)
magnetoencephalography (MEG)
medulla
meninges
meningiomas
meningitis
metencephalon
microglial cells
midbrain
middle cerebral arteries
mitochondrion (pl. mitochondria)
motoneuron
motor nerve
multiple sclerosis
multipolar neuron
myelin
myelination
nerve
neural plasticity
neural tube
neuron
neuron doctrine
neurotransmitter
Nissl stain
node of Ranvier
norepinephrine (NE)
nucleus (pl. nuclei)
occipital lobes

olfactory bulb
oligodendrocyte
optical imaging
output zone
parallel fiber
parasympathetic nervous system
parietal lobes
peripheral nervous system
pia mater
pons
positron emission tomography (PET)
postcentral gyrus
posterior cerebral arteries
postganglionic
postsynaptic
postsynaptic membrane
precentral gyrus
preganglionic
presynaptic
presynaptic membrane
Purkinje cell
putamen
pyramidal cell
receptor
red nucleus
reticular formation
ribosomes
sacral
Schwann cell
sensory nerve
sensory neuron
spinal nerve
stroke
substantia nigra
sulcus (pl. sulci)
superior colliculi (sing. colliculus)
Sylvian fissure
sympathetic chain
sympathetic nervous system
synapse
synaptic cleft
synaptic vesicle
tectum
telencephalon
temporal lobes
thalamus (pl. thalami)

third ventricle
thoracic
tract
transcranial magnetic stimulation (TMS)
unipolar neuron
ventral root
ventricular system
vertebral arteries
white matter

Paragraph Development

Write a coherent and informative paragraph incorporating each of the following terms or concepts:

1. Axon; Schwann cells; oligodendrocytes; nodes of Ranvier; medical problems
2. Dendrite; dendritic spines; cell body; axon; axon hillock
3. Cerebral cortex; lobes; layers; columns; corpus callosum
4. Precentral gyrus; basal ganglia; cerebellum; motoneurons; ventral roots
5. PET scan; MRI scan; CT scan; MEG scan; fMRI; optical imaging; angiography

COMPANION WEBSITE QUESTIONS

Multiple Choice

1. The neuron doctrine states that neurons
a. depend on one another for their metabolic needs.
b. are continuous with one another through a system of tubes.
c. are contiguous with one another.
d. along with glial cells form functional units.
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

2. Which neuroanatomical method provides an outline of entire neurons, including all of the cell's processes (axons and dendrites)?
a. Nissl stain
b. Radioactive glucose stain
c. Golgi stain
d. Axonal degeneration procedure
Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

3. The most common type of neuron in vertebrates is the _____ neuron.
a. unipolar
b. multipolar
c. bipolar
d. semipolar
Answer: b
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

4. Which of the following is *not* a type of glial cell?
a. Astrocyte
b. Oligodendrocyte
c. Schwann cell
d. Stellate cell
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 2. Understanding

5. Which statement about glia is *false*?
a. They regulate the chemical content of the extracellular space surrounding neurons.
b. Some types of glia are responsible for myelinating axons.
c. There are fewer glia than neurons in the CNS.
d. They are important for providing structural support for neurons.

Answer: c
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 4. Analyzing

6. Which type of cell is responsible for myelination within the central nervous system?
a. Schwann cells
b. Astrocytes
c. Microglial cells
d. Oligodendrocytes
Answer: d
Textbook Reference: Specialized Cells Make Up the Nervous System
Bloom's Level: 1. Remembering

7. The ventral roots of the spinal cord carry
a. motor information to muscles.
b. sensory information from muscles and skin.
c. both motor and sensory information.
d. pain information.
Answer: a
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 2. Understanding. Understanding

8. The two cerebral hemispheres are connected by
a. the meninges.
b. tendons.
c. the corpus callosum.
d. the reticular formation.
Answer: c
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

9. The temporal lobe is separated from the frontal and parietal lobes by the _____.
a. central sulcus
b. Sylvian fissure
c. precentral fissure
d. precunean sulcus
Answer: b
Textbook Reference: The Nervous System Consists of Central and Peripheral Divisions
Bloom's Level: 1. Remembering

10. The basal ganglia are particularly implicated in
a. emotion.
b. learning and memory.
c. motor control.
d. sympathetic nervous system control.
Answer: c

Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 2. Understanding

11. Which structure is *not* part of the limbic system?
a. Hippocampus
b. Fornix
c. Putamen
d. Mammillary body
Answer: c
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 2. Understanding

12. Which structure(s) is(are) specialized for motor control?
a. Caudate nucleus
b. Hippocampus
c. Septal nuclei
d. All of the above
Answer: a
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 3. Applying

13. The superior colliculus is located within the
a. hindbrain.
b. midbrain.
c. telencephalon.
d. diencephalon.
Answer: b
Textbook Reference: The Brain Shows Regional Specialization of Functions
Bloom's Level: 1. Remembering

14. The brain and spinal cord are wrapped in protective membranes known collectively as the
a. dura mater.
b. pia mater.
c. myelin.
d. meninges.
Answer: d
Textbook Reference: Specialized Support Systems Protect and Nourish the Brain
Bloom's Level: 1. Remembering

15. Which technique could be used to influence behavior?
a. CT
b. TMS
c. dfMRI
d. MEG
Answer: b

Textbook Reference: Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain
Bloom's Level: 3. Applying

Essay

1. Summarize the historical and current understanding of the basic cellular structure of the neuron.

2. Detail the components of a synapse, and describe the sequence of events at a synapse when information is transmitted.

3. Discuss the forms and functions of glial cells.

4. Identify the components and general layout of the peripheral nervous system. Include the three divisions and subdivisions of the autonomic nervous system.

5. Describe anatomical conventions regarding directions and planes.

6. Identify the components and general layout of the central nervous system.

7. Describe the components and general function of the basal ganglia, limbic system, and reticular formation.

8. Discuss the cellular structure of the cerebral cortex and the functional correlates of this structure.

9. Describe the anatomy of the membranes, fluids, and blood supply that provide support and protection for the brain.

10. Review some of the techniques that allow us to study the structure and function of the living brain, including techniques that can be used to study social neuroscience.

Instructor's Manual
to accompany
Behavioral Neuroscience, Eighth Edition
Breedlove and Watson

Chapter 2: Functional Neuroanatomy: The Nervous System and Behavior

OVERVIEW OF THIS CHAPTER

It has been said that the brain is the most complicated object in the known universe. Nevertheless, students of behavioral neuroscience must quickly develop at least an initial familiarity with this most complex of things because we can't really proceed to discussions of how the brain produces behavior without first describing what the brain is! This requires a deft touch: Too much rote memorization of the names of tracts and nuclei will have students reaching for the course calendar to see what else is available, but too little knowledge of neuroanatomy will preclude complete understanding of topics later in the course.

Chapter 2 eases the student into neuroanatomy by taking different points of view in succession to provide general background knowledge on the topic. The first section introduces the student to the basic cellular units of the nervous system: neurons and glial cells. A discussion of the techniques used to study cellular neuroanatomy is included in the first section. This is followed by an overview of the gross anatomy of the nervous system, including an introduction to the planes, directions, and orientations used to describe locations in the nervous system. Next, the specialized functions of layers, nuclei, and tracts of the brain are discussed. As for all organs, nutrients and waste products must be brought into and out of the brain respectively. A complex system of blood vessels and spaces within the brain, called ventricles, assist with this task. The ventricles, along with the brain coverings (meninges) and the skull, protect the brain. The perspective then shifts to functional neuroanatomy to provide some insight into the operations performed by the various divisions of the nervous system.

CHAPTER OUTLINE

Introduction: A Stimulating Experience

Specialized Cells Make up the Nervous System

- The neuron has four structural divisions specialized for information processing
- Neurons can be classified by shape, size, or function
- Information is received through synapses
- The axon integrates and then transmits information
- Glial cells support and enhance neural activity

BOX 2.1 Visualizing the Cells of the Brain

The Nervous System Consists of Central and Peripheral Divisions

- The peripheral nervous system has two divisions
- The central nervous system consists of the brain and spinal cord

BOX 2.2 Three Customary Orientations for Viewing the Brain and Body

The Brain Shows Regional Specialization of Functions

- The cerebral cortex performs complex cognitive processing
- Subcortical structures are involved in movement and the regulation of emotions
- The diencephalon directs sensory information and controls basic physiological functions
- The midbrain has sensory and motor components
- The cerebellum is attached to the pons and is crucial for motor coordination
- The medulla maintains vital basic body functions
- Behaviors and cognitive abilities are determined by functional connections between brain regions

Specialized Support Systems Protect and Nourish the Brain

- The cerebral ventricles are chambers filled with fluid
- The brain has an elaborate vascular system

Brain-Imaging Techniques Reveal the Structure and Function of the Living Human Brain

- Measurements of density can be used to map the structure of the brain
- Functional-imaging techniques map regional brain activity during behaviors
- Sophisticated imaging techniques are powerful tools requiring cautious interpretation

BOX 2.3 Isolating Specific Brain Activity

The Cutting Edge: Two Heads Are Better Than One

KEY CONCEPTS

1. The nervous system reaches into every part of the body and coordinates every aspect of bodily functions, from seemingly automatic processes, like heart rate, to the most sophisticated of behavioral responses and complex emotions.

2. The immense amount of information processing that the nervous system performs requires an immensely complicated "computer"—more than 80 billion neurons, with widely varying shapes and sizes, reflecting the functions they perform. Nevertheless, neurons can be categorized according to general layout, size, and function. "Typical" neurons share three main structural elements: (1) dendrites, which are the main receptive surfaces of the cell, (2) a cell body, containing the cell's DNA within the nucleus, and (3) an axon, which carries nerve impulses away from the cell body. From a functional perspective, neurons share four basic elements: (1) an input zone

(dendrites and cell body), (2) an integration zone (the axon hillock), (3) a conduction zone (the axon), and (4) an output zone (the axon terminals).

3. Glial cells also serve important functions in the nervous system: They myelinate axons, exchange nutrients and other substances with neurons, and remove cellular debris. More recent data have revealed that glial cells also contribute to information processing.

4. Information is transmitted from a neuron to other neurons, or to muscles or glands, across specialized contacts called synapses. In most neurons, the axon terminals contain specialized "boutons" that release molecules of neurotransmitter in response to the arrival of an impulse along the axon; the neurotransmitter crosses the synaptic cleft and alters the electrical properties of the postsynaptic cell via receptor proteins that recognize and react to a specific neurotransmitter.

5. The brain can be visualized in many ways. Static images of cells within the brain are achieved using different stains that bind to different types of molecules. Labeled antibodies can be used to bind to and visualize cells producing specific proteins. In situ hybridization allows for the visualization of cells producing specific mRNAs. White matter (axonal or dendritic tracts) can also be visualized using specific stains or labeled molecules that are injected into one region of the brain and transported by neurons.

6. Neurons can be classified according to their size and shape or by their function. Neurons that bring information into the spinal cord and brain are called sensory neurons; and motoneurons (or motor neurons) bring information to muscles. Interneurons make up most of the brain and spinal cord and are important for integrating information from other neurons.

7. The nervous system consists of the central nervous system (the brain and spinal cord) and the peripheral nervous system (the sympathetic, parasympathetic, and enteric divisions of the autonomic nervous system, the spinal nerves, and the cranial nerves). A simplified view is that the sympathetic nervous system prepares body systems for action, while the parasympathetic division has opposite effects (tending toward relaxation). The enteric system regulates functioning of the gut. The spinal nerves bring information to and from the spinal cord, and the cranial nerves carry information to and from the head and neck.

8. In order to discuss the relative position of brain structures, one must understand the terminology used for orientation. In general, positions are identified as paired opposites. Top and bottom are referred to as dorsal and ventral, respectively. Medial and lateral refer to closer to the midline or the side, respectively. Anterior, or rostral, refers to the front (or toward the nose), and posterior, or caudal, refers to the back (or toward the tail). These terms are easiest to understand in a body plan for animals that walks on all fours. When thinking about these terms in humans, think about a person

as an animal that has stood up. For example, dorsal is still toward the back, and ventral is still toward the belly.

9. The most prominent features of the brain are the two cerebral hemispheres, the surfaces of which are heavily convoluted with gyri (humps) and sulci (cracks). Each hemisphere contains the four major lobes—frontal, parietal, temporal, and occipital—made up of gray matter (cortex) overlying white matter. Underneath the cortex, integrated systems, such as the basal ganglia and limbic system, can be found in the forebrain.

10. The brain first develops as three distinct regions (1) the forebrain, or prosencephalon, (2) the midbrain, or mesencephalon, and (3) the hindbrain, or rhombencephalon. The forebrain differentiates into two regions called the telencephalon (cortex and basal ganglia are prominent) and diencephalon (thalamus and hypothalamus are prominent); the midbrain remains as one region (superior and inferior colliculi are prominent); and the hindbrain differentiates into the metencephalon (the cerebellum and pons are prominent) and the myelencephalon (the medulla is prominent). The brainstem is considered the midbrain and hindbrain together (without the cerebellum; think of the brain as a flower with the forebrain being the flower and the midbrain, pons, and medulla as the stalk.).

11. The cells of the neocortex are arranged in six distinct layers, with different layers performing different functions. Some other telencephalic structures are made up of allocortex, which have only three layers or an unlayered organization. Cytoarchitecture varies within the cortex and seems to correspond reasonably well with the functional organization of the brain. Clusters of cortical neurons are organized as functional units within “cortical columns”; thus, information is segregated horizontal to the surface in layers and perpendicular to the surface in columns.

12. The brain and spinal cord are protected by the three layers of the meninges (the dura mater, the arachnoid, and the pia mater), and are suspended in cerebrospinal fluid, which is produced in and circulates throughout the internal ventricular system of the brain.

13. The brain is richly vascular, supplied by the anterior, middle, and posterior cerebral arteries, plus numerous arterioles and a backup route called the circle of Willis. An alteration or disruption in the flow of blood in one of these arteries (i.e., a stroke) causes a lesion in the brain regions supplied by the affected artery, with concomitant deficits in cerebral function.

14. There have been significant improvements in techniques that allow functional and structural study of the living brain, such as CT, MRI, DTI, fMRI, PET, MEG, and optical imaging, along with transcranial magnetic stimulation. Using dyadic fMRI, researchers can image brains of two people simultaneously as they interact side by side.

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Online Resources

Harvard College: Anatomy of the Human Brain
http://outreach.mcb.harvard.edu/animations/brainanatomy.swf

University of Washington: Interactive Atlases: Digital Anatomist Project, John W. Sundsten
Features an interactive three-dimensional brain atlas with excellent graphics.
http://www9.biostr.washington.edu/da.html

Washington University School of Medicine: Neuroscience Tutorial, Diana Weedman Molavi
Comprehensive review of human clinical neuroanatomy, with photos.
http://www.bioon.com/bioline/neurosci/course/index.htm

Harvard University: The Whole Brain Atlas, Keith A. Johnson and J. Alex Becker,
Superb gallery of images of normal and pathological human neuroanatomy.
http://www.med.harvard.edu/AANLIB/home.html

University of Wisconsin Department of Anatomy, Medical School: Neuroscience Resource page
Large collection of microscopic and gross neuroanatomy images.
http://www.neuroanatomy.wisc.edu

UCLA School of Medicine: Multimodal Brain Atlases, Arthur W. Toga and Paul Thompson
Descriptions of multimodal brain atlases. Navigate this site to find QuickTime time-lapse videos of brain cell loss in Alzheimer's disease and other interactive media from Paul Thompson's neuroimaging laboratory.
http://users.loni.usc.edu/~thompson/projects.html
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Allen Institute for Brain Science: Allen Brain Atlas: Atlases of different mammals (adult and developing). Atlases display anatomy, gene expression, and connectivity through the brain.
http://www.brain-map.org/

Carl Schoonover: Images of neurons
http://www.carlschoonover.com/

Abrams Books: Portraits of the Mind: Visualizing the Brain from Antiquity to the 21st Century (Carl Schoonover)
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BrainMaps.org: An interactive, multiresolution next-generation brain atlas based on over 140 million megapixels of sub-micron resolution, annotated, scanned images of serial sections of both primate and non-primate brains.
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White Matter Atlas
http://www.dtiatlas.org/

Imagilys: Diffusion Tensor Imaging—Fiber Tracking: Videos
http://www.imagilys.com/diffusion-tensor-imaging-dti/

KEY TERMS

acetylcholine
allocortex
amygdala
angiography
anterior cerebral arteries
apical dendrite
arachnoid
arborization
astrocyte
autonomic ganglia
autonomic nervous system
autoradiography
axon
axon collateral

axon hillock
axon terminal
axonal transport
basal dendrite
basal ganglia
basilar artery
bipolar neuron
blood-brain barrier
brainstem
carotid arteries
caudate nucleus
cell body
cell nucleus
central nervous system (CNS)
central sulcus
cerebellum
cerebral cortex
cerebral hemispheres
cerebrospinal fluid (CSF)
cervical
choroid plexus
cingulate gyrus
circle of Willis
coccygeal
computerized axial tomography (CAT or CT)
conduction zone
corpus callosum
cortical column
cranial nerve
dendrite
diencephalon
diffusion tensor imaging (DTI)
dorsal root
DTI tractography
dura mater
dyadic functional MRI (dfMRI)
edema
enteric nervous system
forebrain
fornix
fourth ventricle
fractional anisotropy (FA)
frontal lobe
functional MRI (fMRI)
glial cells
globus pallidus

Golgi stain
granule cell
gray matter
gross neuroanatomy
gyrus
hindbrain
hippocampus
hypothalamus
immunohistochemistry (IHC)
in situ hybridization
inferior colliculi
innervate
input zone
integration zone
interneuron
lateral ventricle
lesions
limbic system
lumbar
magnetic resonance imaging (MRI)
magnetoencephalography (MEG)
mammillary body
medulla
meninges
meningiomas
meningitis
metencephalon
microglial cells
midbrain
middle cerebral arteries
mitochondrion
motor nerve
motor neuron
motor protein
multiple sclerosis
multipolar neuron
myelin
myelination
nerve
neural plasticity
neural tube
neuron
neuron doctrine
neurotransmitter
Nissl stain
node of Ranvier

norepinephrine
nucleus
occipital lobe
olfactory bulb
oligodendrocyte
optical imaging
output zone
parallel fiber
parasympathetic nervous system
parietal lobe
peripheral nervous system
pia mater
pons
positron emission tomography (PET)
postcentral gyrus
posterior cerebral arteries
postganglionic
postsynaptic
postsynaptic membrane
precentral gyrus
preganglionic
presynaptic
presynaptic membrane
Purkinje cell
putamen
pyramidal cell
receptor
red nucleus
reticular formation
ribosomes
sacral
Schwann cell
sensory nerve
sensory neuron
septal nuclei
social neuroscience
somatic nervous system
spinal nerve
stria terminalis
stroke
substantia nigra
sulcus
superior colliculi
Sylvian fissure
sympathetic chain
sympathetic nervous system

synapse
synaptic cleft
synaptic vesicle
tectum
telencephalon
temporal lobe
thalamus
third ventricle
thoracic
tract
tract tracer
transcranial magnetic stimulation (TMS)
unipolar neuron
ventral root
ventricular system
vertebral arteries
white matter