# Chapter 7--The Peripheral Nervous System: Efferent Division

1. The autonomic nervous system is

   A. part of the somatic nervous system
   B. the involuntary branch of the peripheral nervous system's efferent division
   C. part of the central nervous system
   D. the involuntary branch of the peripheral nervous system's efferent division and part of the somatic nervous system
   E. all of these

2. The overall functioning of the ANS contributes to

   A. conservation of energy resources when stress levels are low
   B. mobilization of energy reserves when stress levels are high
   C. suppression of non-vital activities when stress levels are high
   D. homeostasis
   E. all of these

3. Which one of the following involves a response of a skeletal muscle through an efferent output?

   A. augmented breathing from the diaphragm
   B. delayed emptying of the stomach
   C. increased pumping of blood
   D. increased secretion of insulin
   E. initiation of sweating

4. Which is not characteristic of sympathetic pathways?

   A. Fibers originate from the thoracic and lumbar levels.
   B. Preganglionic fibers release norepinephrine.
   C. Some postganglionic fibers release ACh.
   D. Short preganglionic fibers.
   E. Most preganglionic fibers synapse in the chain ganglia.

5. What system would suppress the digestive organs during times of greater physical activity?

   A. sympathetic
   B. parasympathetic
   C. enteric nervous system
   D. somatic nervous system
   E. none of these

6. Postganglionic autonomic fibers

A. end in a single synaptic knob that releases the neurotransmitter
B. have numerous varicosities that simultaneously release neurotransmitter over a large area of the innervated organ rather than on single cells
C. innervate skeletal, smooth, and cardiac muscle
D. end in a single synaptic knob that releases the neurotransmitter and innervate skeletal, smooth, and cardiac muscle
E. have numerous varicosities that simultaneously release neurotransmitter over a large area of the innervated organ rather than on single cells and innervate skeletal, smooth, and cardiac muscle

7. Parasympathetic postganglionic fibers

A. arise from the ganglion chain located along either side of the spinal cord
B. are cholinergic
C. secrete a chemical messenger that binds to muscarinic receptors
D. arise from the ganglion chain located along either side of the spinal cord and are cholinergic
E. are cholinergic and secrete a chemical messenger that binds to muscarinic receptors

8. The parasympathetic nervous system

A. has long preganglionic fibers that end on terminal ganglia, which lie in or near the effector organ
B. dominates in quiet, relaxed situations
C. releases a postganglionic neurotransmitter that binds with muscarinic receptors
D. has neurons that display nicotinic receptors
E. all of these

9. The sympathetic nervous system

A. is part of the somatic nervous system
B. has some cholinergic postganglionic fibers
C. has preganglionic neurons that originate in the thoracic and lumbar regions of the spinal cord
D. none of these
E. has some cholinergic postganglionic fibers and has preganglionic neurons that originate in the thoracic and lumbar regions of the spinal cord

10. Which of the following does not characterize the sympathetic nervous system?

A. It promotes responses that prepare the body for strenuous physical activity.
B. It has some afferent fibers.
C. Most of its postganglionic neurons are adrenergic.
D. Its effects may be excitatory or inhibitory.
E. It has some afferent fibers and most of its postganglionic neurons are adrenergic.

11. Select the incorrect statement about the parasympathetic nervous system.

    A. It inhibits all cardiac muscle and smooth muscle.
    B. Neurotransmitter from all its postganglionic fibers bind to muscarinic receptors.
    C. Neurotransmitter from all its preganglionic fibers bind to nicotinic receptors.
    D. Part of it originates in the brain and part of it originates in the sacral region of the spinal cord.
    E. It inhibits all cardiac muscle and smooth muscle, and neurotransmitter from all its postganglionic fibers bind to muscarinic receptors.

12. Which statement is correct?

    A. Long parasympathetic preganglionic fibers end on the terminal ganglia, which lie in or near the effector organ.
    B. Terminal ganglia give rise to sympathetic postganglionic fibers.
    C. Terminal ganglia are the final common pathway for the autonomic nervous system.
    D. Terminal ganglia contain muscarinic receptors.
    E. Terminal ganglia lie in a chain located along either side of the spinal cord.

13. The sympathetic nervous system

    A. is always excitatory for smooth muscle
    B. innervates only tissues concerned with protecting the body against challenges from the outside environment
    C. dominates in rest-and-digest situations
    D. contains cholinergic and adrenergic fibers
    E. contains cholinergic and adrenergic fibers and is always excitatory for smooth muscle

14. Sympathetic stimulation ____ heart rate and ____ the motility in the digestive tract.

    A. does not affect; decreases
    B. decreases; decreases
    C. decreases; increases
    D. increases; decreases
    E. increases; increases

15. Parasympathetic stimulation ____ heart rate and ____ the motility in the digestive tract.

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    B. decreases; decreases
    C. decreases; increases
    D. increases; decreases
    E. increases; increases

16. The motor end plate

A. contains receptor sites that are capable of binding curare
B. contains acetylcholinesterase
C. experiences an increase in permeability to cations when combined with acetylcholine
D. contains nicotinic receptors
E. all of these

17. Nicotinic receptors

A. bind with acetylcholine released from parasympathetic postganglionic fibers
B. respond to acetylcholine released from sympathetic and parasympathetic preganglionic fibers
C. are found primarily in the heart
D. bind with norepinephrine released from sympathetic postganglionic fibers
E. none of these

18. Atropine ____ the effect of acetylcholine at ____ receptors and ____ ____ receptors.

A. blocks; muscarinic; does not affect; nicotinic
B. enhances; muscarinic; does not affect; nicotinic
C. blocks; nicotinic; does not affect; muscarinic
D. enhances; nicotinic; does not affect; muscarinic
E. blocks; muscarinic; enhances; nicotinic

19. The neurotransmitter at the neuromuscular junction is

A. acetylcholine
B. the same as the transmitter substance at parasympathetic postganglionic nerve endings
C. the same as that released by all preganglionic fibers
D. acetylcholine and the same as the transmitter substance at parasympathetic postganglionic nerve endings
E. all of these

20. The sympathetic nervous system causes

A. blood vessels with alpha receptors to dilate
B. bronchioles to constrict
C. pupils of the eye to dilate
D. sweat glands to be inhibited
E. the urinary bladder to contract and eliminate urine

21. Acetylcholinesterase

A. has enhanced activity from organophosphates
B. inactivates a neurotransmitter.
C. is a neurotransmitter
D. stimulates an EPSP
E. triggers the release of sodium from postsynaptic cells

22. Which organ is not innervated by the parasympathetic division?

A. blood vessels
B. intestines
C. eye
D. liver
E. erectile tissues

23. The neuromuscular junction

A. is the junction between a motor neuron and a skeletal muscle fiber
B. transmits an action potential between the nerve cell and muscle cell on a one-to-one basis
C. may produce either an EPSP or an IPSP on the motor end plate
D. is the junction between a motor neuron and a skeletal muscle fiber, and transmits an action potential between the nerve cell and muscle cell on a one-to-one basis
E. all of these

24. Acetylcholine

A. opens voltage-gated $Na^+$ channels in skeletal muscle fibers, which causes depolarization of the muscle fibers
B. may decrease the permeability of the motor end plate to $Na^+$ and $K^+$ when combined with the receptor sites on the motor end plate
C. always depolarizes skeletal muscle fibers and postganglionic neurons
D. opens voltage-gated $Na^+$ channels in skeletal muscle fibers, which causes depolarization of the muscle fibers, and always depolarizes skeletal muscle fibers and postganglionic neurons
E. all of these

25. Which type of receptor binds norepinephrine on cardiac muscle, thus increasing cardiac activity?

A. cholinergic
B. nicotinic
C. alpha
D. beta-1
E. beta-2

26. Acetylcholine

A. binds to cholinergic receptors on preganglionic neurons
B. destroys acetylcholinesterase
C. binds to muscarinic receptors
D. is released from all postganglionic neurons
E. all of these, except destroys acetylcholinesterase

27. Which of the following is the final signaling step following impulse conduction along the axon terminal?

A. ACh binds with receptors on the muscle cell membrane, opening sodium channels.
B. ACh diffuses across the cleft of the junction.
C. ACh is released by exocytosis.
D. Calcium diffuses into the terminal button.
E. Voltage-gated channels for calcium are opened.

28. What is the fate of ACh following binding to receptors?

A. It remains bound, causing continued excitement.
B. It is removed by acetylcholinesterase.
C. It is actively reabsorbed by the axon terminal.
D. It is passively reabsorbed by the muscle cell.
E. None of these.

29. What would occur if ACh was not removed from the nicotinic receptors on skeletal muscle cells?

A. The cell would relax.
B. The cell would repolarize with the opening of chloride channels.
C. The cell would remain contracted until fatigued.
D. Sodium would continue to move into the cell, causing excitation.
E. The cell would remain contracted until fatigued, and sodium would continue to move into the cell causing excitation.

30. An EPP

A. occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber
B. is usually smaller in magnitude than an EPSP
C. is terminated when $Ca^{2+}$ inactivates acetylcholine
D. occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber and is usually smaller in magnitude than an EPSP
E. occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber and is terminated when $Ca^{2+}$ inactivates acetylcholine

31. Efferent neurons

A. have cell bodies in ganglia
B. are part of a two-neuron chain in the autonomic nervous system
C. arise peripherally at a receptor
D. send information toward the CNS
E. signal only skeletal muscles

32. Select the CNS structure(s) that can influence autonomic activity.

A. medulla
B. hypothalamus
C. spinal cord
D. all of these
E. medulla and hypothalamus

33. Botulism is caused by a toxin from bacteria in the species

A. *Clostridium*
B. *Escherichia*
C. *Salmonella*
D. *Staphylococcus*
E. *Streptococcus*

34. Which of the following chemicals paralyzes skeletal muscle by binding to the acetylcholine receptor sites?

A. black widow spider venom
B. curare
C. organophosphates
D. insecticide
E. local anesthetics

35. Curare

A. strongly binds to acetylcholine receptor sites
B. inhibits acetylcholinesterase
C. is found in pesticides and military nerve gases
D. strongly binds to acetylcholine receptor sites and is found in pesticides and military nerve gases
E. all of these

36. Select the correct statement about the neuromuscular junction.

A. AChE activity is absent here.
B. It involves presynaptic neurons of the autonomic nervous system.
C. It is a junction between two neurons.
D. It is always excitatory.
E. The axon terminals do not store neurotransmitters.

37. Atropine is an antagonist of ACh and works by

A. selectively binding to nicotinic receptors
B. selectively binding to muscarinic receptors
C. blocking the binding of ACh
D. selectively binding to nicotinic receptors and selectively binding to muscarinic receptors
E. selectively binding to muscarinic receptors and blocking the binding of ACh

38. Myasthenia gravis

A. is an autoimmune disease
B. occurs when axons are unable to release adequate amounts of acetylcholine
C. can be treated with a drug that temporarily inhibits acetylcholinesterase
D. is an autoimmune disease and can be treated with a drug that temporarily inhibits acetylcholinesterase
E. none of these

39. The sympathetic nervous system is always excitatory to the organs it innervates.

True False

40. The parasympathetic nervous system inhibits the rate of heartbeat.

True False

41. Most innervated blood vessels receive only sympathetic nerve fibers.

True False

42. Only terminals of autonomic nerve fibers and motor neurons end in a single, enlarged knoblike structure that releases neurotransmitter.

True False

43. By blocking the effect of acetylcholine at muscarinic but not nicotinic receptors, atropine is able to block parasympathetic effects while not influencing sympathetic activity at all.

True False

44. The preganglionic fibers of the autonomic nervous system are cholinergic fibers.

True False

45. The autonomic nervous system mainly controls smooth and cardiac muscles, but it can inhibit a few skeletal muscles.

True False

46. The autonomic nervous system is the part of the peripheral nervous system that regulates smooth muscle, cardiac muscle, and glands.

True False

47. The autonomic and somatic nervous systems are part of the efferent nervous system.

True False

48. Dual innervation of organs by both branches of the autonomic nervous system allows a fine degree of control over these organs.

True False

49. ACh always causes depolarization of skeletal muscles.

True False

50. Parasympathetic activation of sweat glands occurs to help reduce body temperatures.

True False

51. The parasympathetic nervous system dominates in situations when a person is afraid.

True False

52. The salivary glands and the eye are sympathetically innervated by cranial nerves.

True False

53. Sympathetic preganglionic fibers originate in the thoracic and lumbar segments of the spinal cord.

True False

54. Action potentials are transmitted on a one-to-one basis at both a neuromuscular junction and a synapse.

True False

55. Sympathetic stimulation of the urinary bladder relaxes the activity of this organ.

True False

56. Muscarinic receptors are found on the effector cells innervated by the sympathetic division.

True False

57. The sympathetic nervous system has its cells of origin in the brain stem as well as the spinal cord.

True False

58. Autonomic activity can be influenced by conscious neural activity.

True False

59. Sympathetic postganglionic fibers are longer than parasympathetic postganglionic fibers.

True False

60. Most innervated blood vessels receive sympathetic and parasympathetic fibers.

True False

61. Sympathetic and parasympathetic activity at the salivary glands is antagonistic.

True False

62. The sympathetic postganglionic fibers that innervate the sweat glands secrete acetylcholine rather than norepinephrine.

True False

63. Atropine blocks all nicotinic receptor sites.

True False

64. Nicotinic and muscarinic receptors are the two kinds of adrenergic receptors.

True False

65. It is possible through the use of drugs to activate the receptors found in bronchiolar smooth muscle without influencing the receptors in the heart.

True False

66. An EPP is similar to an EPSP, except that the magnitude of an EPSP is much larger.

True False

67. Action potentials are initiated at the motor end-plate region of skeletal muscle fibers.

True False

68. Acetylcholinesterase is stored in secretory vesicles in the motor end plate of the muscle fiber.

True False

69. Binding of ACh with receptor sites on the motor end plate opens chemical messenger-gated cation channels in the motor end plate, bringing about depolarization of the motor end plate.

True False

70. The axons controlling skeletal muscles are large and myelinated.

True False

71. Clostridium botulinum toxin inhibits acetylcholinesterase.

True False

72. An EPP is a graded potential.

    True  False

73. Binding of a neurotransmitter to a beta receptor on the urinary bladder causes the bladder to contract.

    True  False

74. **Complete each of the following statments.**

    The two divisions of the efferent division of the peripheral nervous system are the _____ nervous system, which supplies cardiac muscle, smooth muscle, and glands, and the _____ nervous system, which supplies skeletal muscle.

    _____

75. **Complete each of the following statments.**

    The two divisions of the autonomic nervous system are the _____ nervous system, which dominates in fight-or-flight situations, and the _____ nervous system, which dominates in quiet, relaxed situations.

    _____

76. **Complete each of the following statments.**

    _____ fibers of the autonomic nerve pathway are located partially in the central nervous system.

    _____

77. **Complete each of the following statments.**

    Sympathetic fibers originate from _____ and _____ spinal nerves.

    _____

78. **Complete each of the following statments.**

    Most sympathetic postganglionic fibers have cell bodies in a sympathetic ganglion _____.

    _____

79. **Complete each of the following statments.**

Most sympathetic postganglionic fibers secrete the neurotransmitter _____, whereas all parasympathetic postganglionic fibers secrete the neurotransmitter _____.

_____

80. **Complete each of the following statments.**

The _____ is a modified sympathetic ganglion that secretes hormones similar or identical to sympathetic postganglionic neurotransmitters into the blood.

_____

81. **Complete each of the following statments.**

Parasympathetic preganglionic fibers arise from the _____ and _____ areas of the CNS.

_____

82. **Complete each of the following statments.**

In the autonomic nervous system, a(n) _____ neuron sends impulses away from a ganglion.

_____

83. **Complete each of the following statments.**

_____ is the neurotransmitter that causes an EPSP on an autonomic neuron's dendrite located within a ganglion.

_____

84. **Complete each of the following statments.**

Sympathetic activity inhibits the secretion of _____ from the pancreas.

_____

85. **Complete each of the following statments.**

Sympathetic activity stimulates the secretion of _____ from the pancreas.

_____

86. **Complete each of the following statments.**

Alpha and beta are two kinds of _____ receptors.

_____

87. **Complete each of the following statments.**

Binding of _____ to nicotinic receptors is always excitatory.

_____

88. **Complete each of the following statments.**

Binding of _____ to muscarinic receptors may be initiate EPSPs or IPSPs.

_____

89. **Complete each of the following statments.**

The origin of the somatic nervous system is in the _____ horn of the spinal cord.

_____

90. **Complete each of the following statments.**

Depolarization of the motor end plate results from more _____ ions entering the cell than _____ ions leaving the cell.

_____

91. **Sequencing**

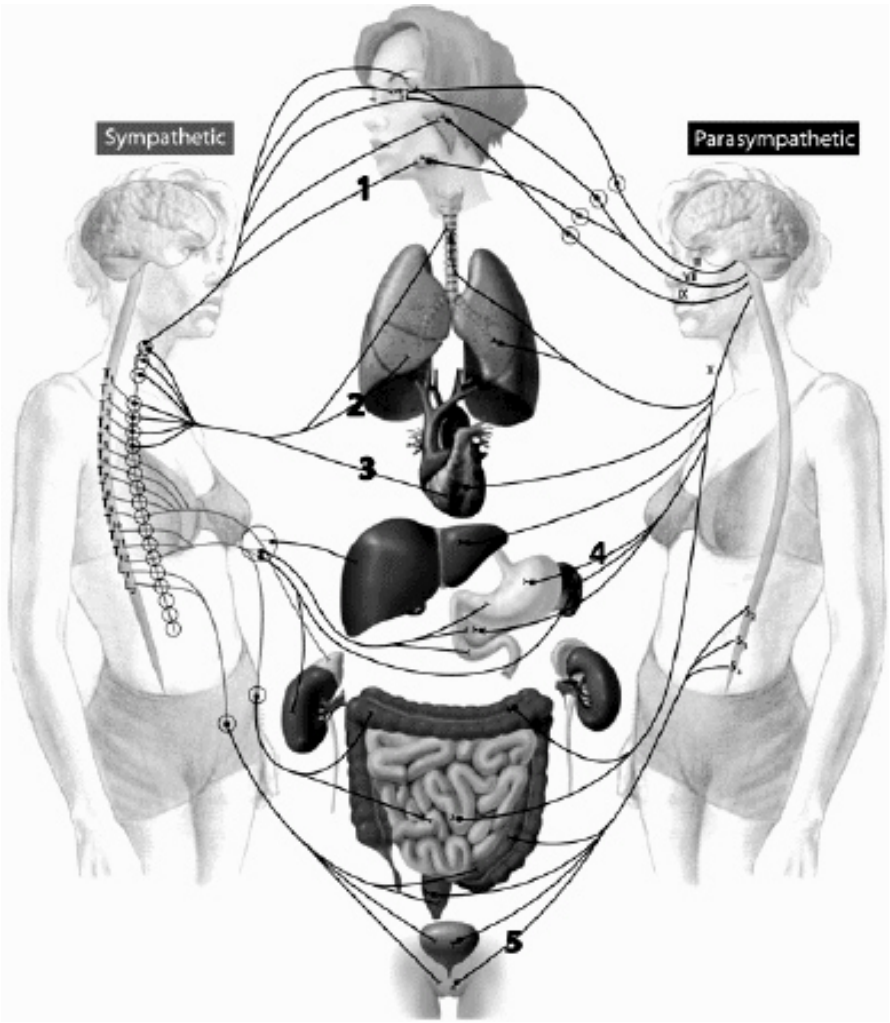
Indicate the proper sequence of events at the neuromuscular junction by filling in the blank with the appropriate number from 2 through 7. Numbers 1 and 8 are already identified.

| | |
|---|---|
| | ACh is released from the axon terminal by exocytosis. |
| | An EPP takes place, primarily as a result of $Na^+$ influx. |
| 8 | Acetylcholinesterase inactivates ACh, terminating activity at the neuromuscular junction. |
| 1 | An action potential is propagated to an axon terminal of a motor neuron. |
| | Channels that permit passage of $Na^+$ and $K^+$ are opened in the motor end plate. |
| | $Ca^{2+}$ channels are opened in the axon terminal. |
| | Local current flow between the motor end plate and adjacent muscle-cell membrane initiates an action potential that spreads throughout the muscle fiber. |
| | ACh binds with receptor sites on the motor end plate. |

92. Match the chemical with correct characteristic.

| | | |
|---|---|---|
| 1. Binds with ACH receptor sites. | curare | ____ |
| 2. Blocks release of ACh. | black widow spider venom | ____ |
| 3. Causes explosive release of ACh. | *Clostridium botulinum* toxin | ____ |
| 4. Inhibit acetylcholinesterase. | organophosphates | ____ |
| 5. Antibodies inactivate ACh receptor sites. | myasthenia gravis | ____ |

93.

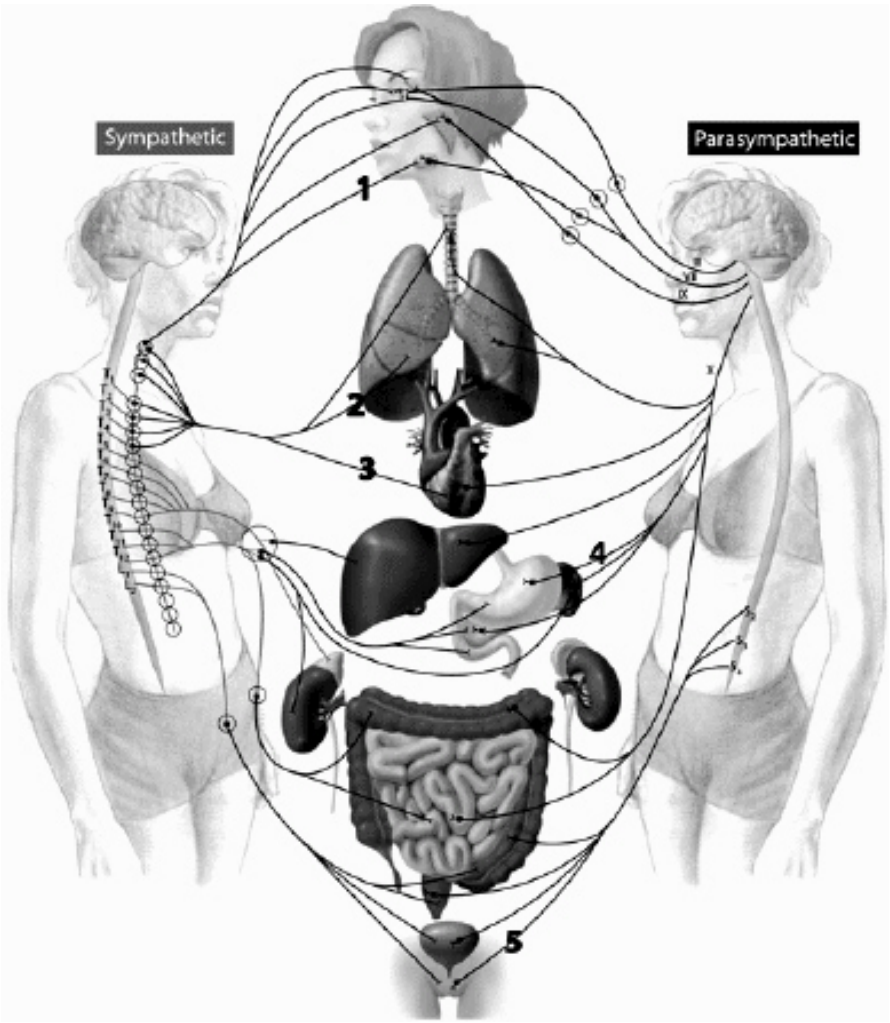



**Use this figure to answer the following questions.**

The axons labeled 1 would release ____ and have a(n) ____ effect on the effector organ.

a. ACh; inhibitory
b. ACh; excitatory
c. NE; inhibitory
d. NE; excitatory
e. NE; inhibitory and ACh; excitatory

94.

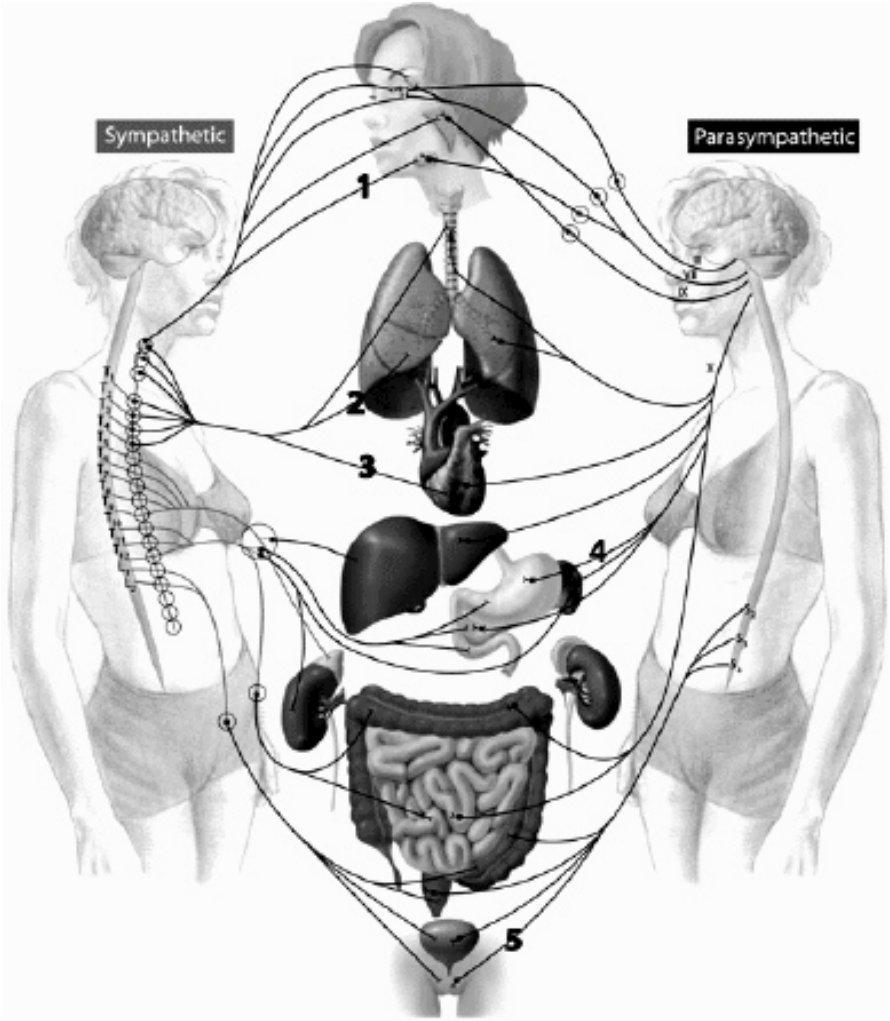



**Use this figure to answer the following questions.**

The effector for the neuron labeled 3

a. uses cholinergic receptors to respond to stimulation from 3
b. is stimulated by ACh from 3, which is a preganglionic neuron
c. uses adrenergic receptors to respond to stimulation from 3
d. is inhibited by neuron 3
e. None of these

95.

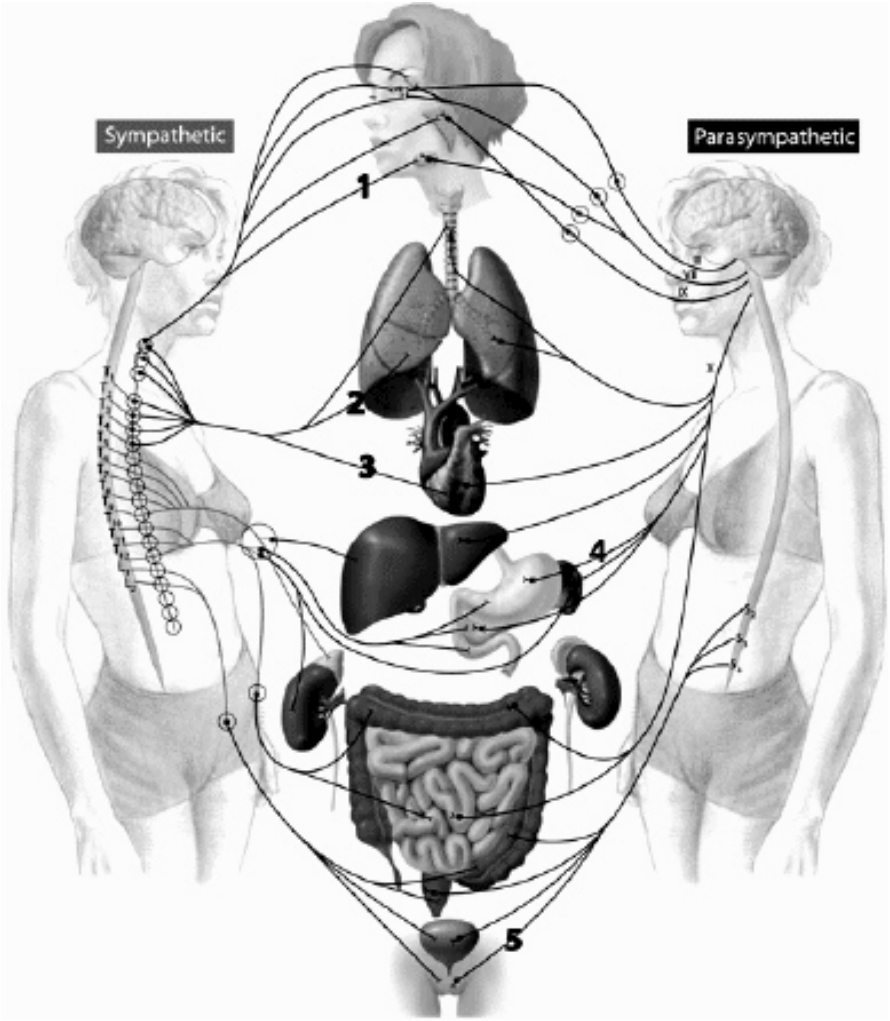



**Use this figure to answer the following questions.**

Identify the neurons that are exciting (depolarizing and/or increasing the activity of) their effectors.

a. 1, 2, and 3
b. 3 and 4
c. 4 and 5
d. 1, 4, and 5
e. 3 and 5

96.

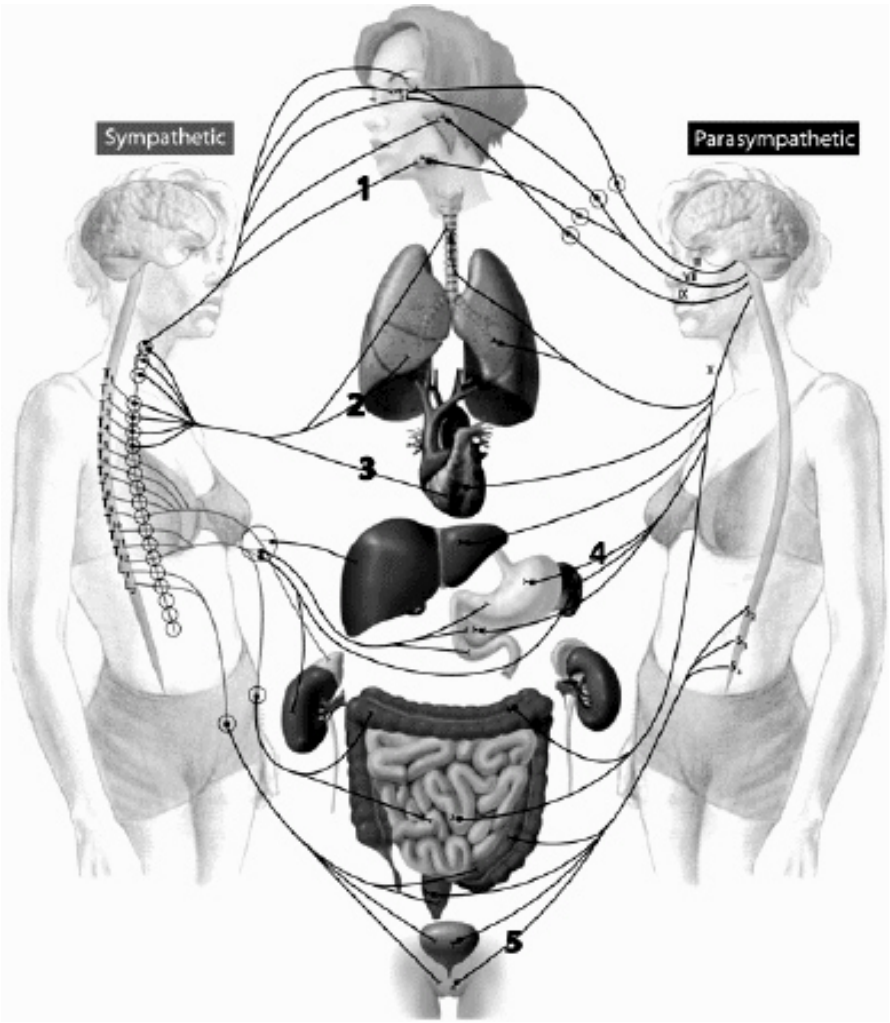



**Use this figure to answer the following questions.**

Which neuron releases a neurotransmitter that binds to $B_2$ receptors?

a. 1 and 5 only
b. 3 and 4 only
c. 3 only
d. 5 only
e. 1, 3, and 5

97.

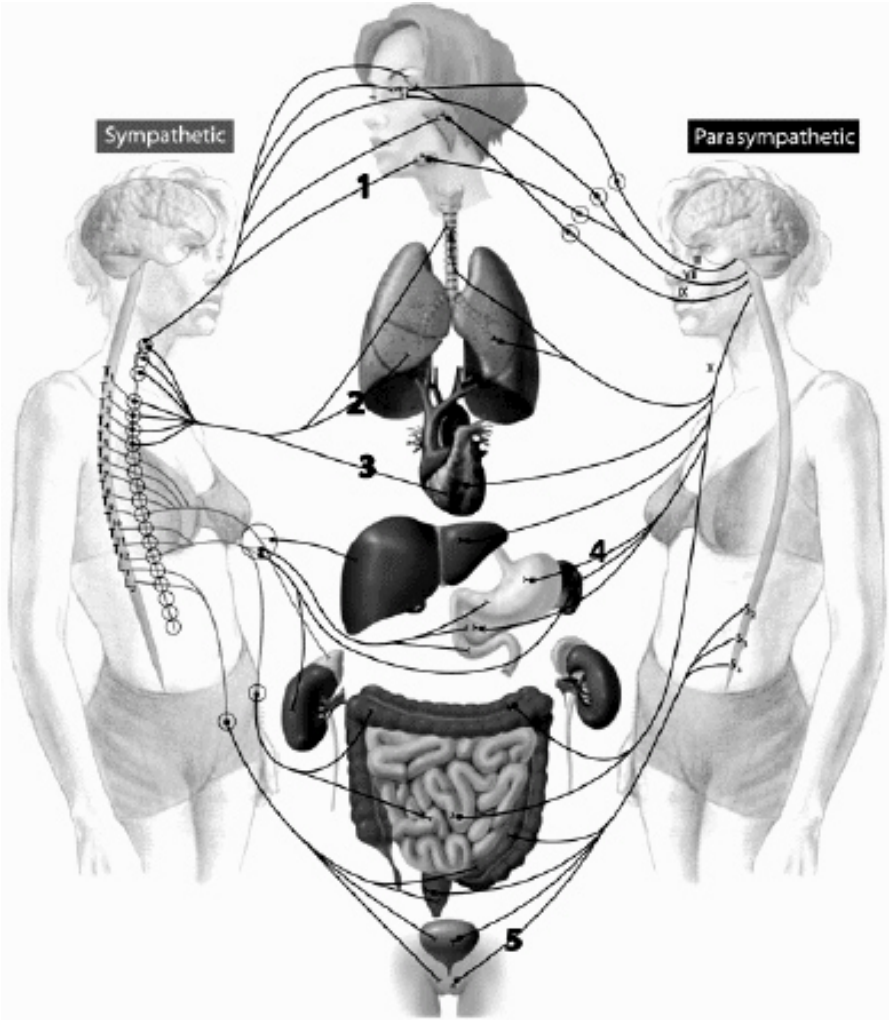



**Use this figure to answer the following questions.**

Neuron 3

a. releases a chemical that binds to muscarinic receptors
b. is stimulated by NE released from a preganglionic neuron
c. excites its effector
d. all of these
e. is stimulated by NE released from a preganglionic neuron and excites its effector

98.

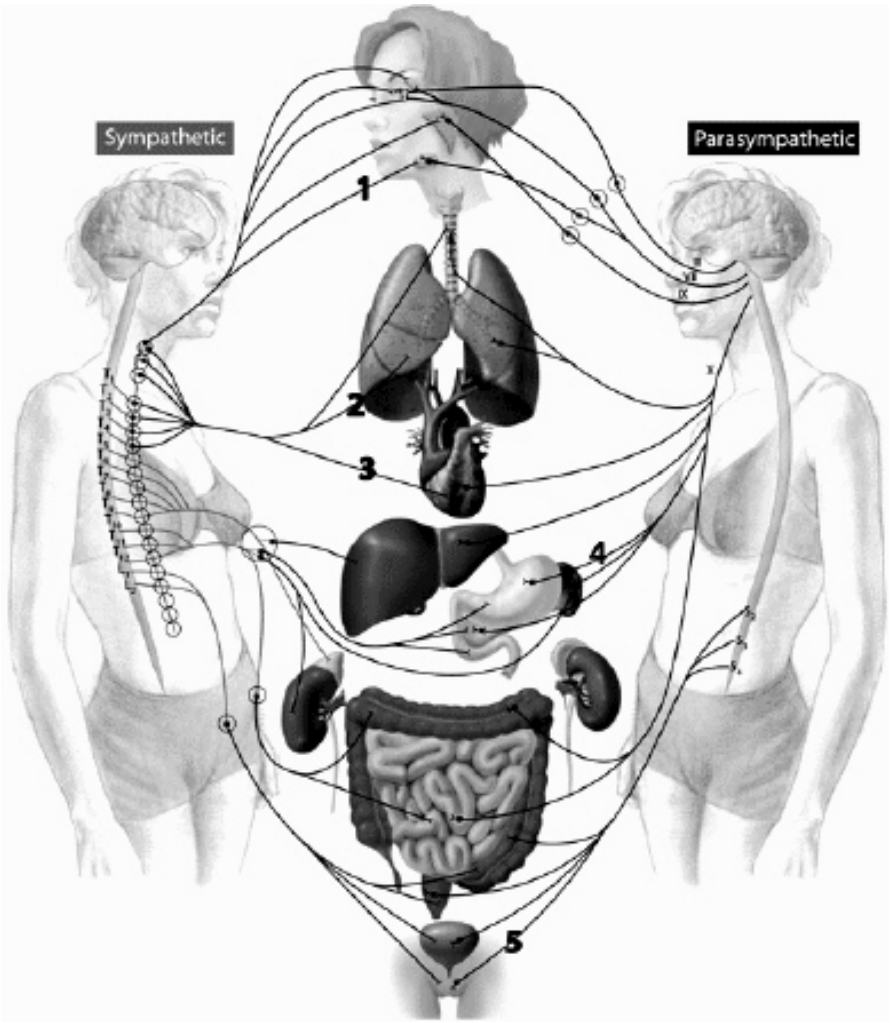



**Use this figure to answer the following questions.**

Neuron 2

a. uses adrenergic receptors to respond to stimulation by a preganglionic neuron
b. releases NE onto a very short postganglionic neuron
c. releases a chemical that binds to adrenergic receptors on a postganglionic neuron
d. all of these
e. none of these

99.




**Use this figure to answer the following questions.**

Identify the correct statement(s):

a. Neuron 5 causes contraction of its effector.
b. Neuron 6 is stimulated by ACh released from a preganglionic neuron.
c. Neuron 1 causes constriction of bronchioles
d. Neuron 2 releases a chemical that binds to nicotinic receptors on a postganglionic neuron.
e. Two of the above.

100. Compare and contrast the divisions of the autonomic nervous system with reference to the following: (1) the alternate names for each divisions; (2) where their neurons exit the CNS; (3) anatomical differences between their pre- and post-ganglionic neurons; and (4) the specific neurotransmitters released from the neurons in part 3.

101. Compare and contrast the autonomic and somatic nervous systems with reference to the following: (1) the types of effectors stimulated; (2) number of neurons involved; and (3) the specific neurotransmitters released onto effectors.

102. Describe the events that occur at a skeletal neuromuscular junction. Include the following in your answer: action potential (on axon and muscle fiber), end-plate potential, terminal button, ACh, $Ca^{+2}$ channels, motor end plate, depolarization, and $Na^{+}$ channels.

103. What are the various ways in which toxins can interfere with normal neuron functioning?

104. Compare and contrast the various types of autonomic receptors.

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Key

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   A. part of the somatic nervous system
   **B.** the involuntary branch of the peripheral nervous system's efferent division
   C. part of the central nervous system
   D. the involuntary branch of the peripheral nervous system's efferent division and part of the somatic nervous system
   E. all of these

2. The overall functioning of the ANS contributes to

   A. conservation of energy resources when stress levels are low
   B. mobilization of energy reserves when stress levels are high
   C. suppression of non-vital activities when stress levels are high
   D. homeostasis
   **E.** all of these

3. Which one of the following involves a response of a skeletal muscle through an efferent output?

   **A.** augmented breathing from the diaphragm
   B. delayed emptying of the stomach
   C. increased pumping of blood
   D. increased secretion of insulin
   E. initiation of sweating

4. Which is not characteristic of sympathetic pathways?

   A. Fibers originate from the thoracic and lumbar levels.
   **B.** Preganglionic fibers release norepinephrine.
   C. Some postganglionic fibers release ACh.
   D. Short preganglionic fibers.
   E. Most preganglionic fibers synapse in the chain ganglia.

5. What system would suppress the digestive organs during times of greater physical activity?

   **A.** sympathetic
   B. parasympathetic
   C. enteric nervous system
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   E. none of these

6. Postganglionic autonomic fibers

A. end in a single synaptic knob that releases the neurotransmitter
**B.** have numerous varicosities that simultaneously release neurotransmitter over a large area of the innervated organ rather than on single cells
C. innervate skeletal, smooth, and cardiac muscle
D. end in a single synaptic knob that releases the neurotransmitter and innervate skeletal, smooth, and cardiac muscle
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7. Parasympathetic postganglionic fibers

A. arise from the ganglion chain located along either side of the spinal cord
B. are cholinergic
C. secrete a chemical messenger that binds to muscarinic receptors
D. arise from the ganglion chain located along either side of the spinal cord and are cholinergic
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8. The parasympathetic nervous system

A. has long preganglionic fibers that end on terminal ganglia, which lie in or near the effector organ
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10. Which of the following does not characterize the sympathetic nervous system?

A. It promotes responses that prepare the body for strenuous physical activity.
**B.** It has some afferent fibers.
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D. Its effects may be excitatory or inhibitory.
E. It has some afferent fibers and most of its postganglionic neurons are adrenergic.

11. Select the incorrect statement about the parasympathetic nervous system.

**A.** It inhibits all cardiac muscle and smooth muscle.
B. Neurotransmitter from all its postganglionic fibers bind to muscarinic receptors.
C. Neurotransmitter from all its preganglionic fibers bind to nicotinic receptors.
D. Part of it originates in the brain and part of it originates in the sacral region of the spinal cord.
E. It inhibits all cardiac muscle and smooth muscle, and neurotransmitter from all its postganglionic fibers bind to muscarinic receptors.

12. Which statement is correct?

**A.** Long parasympathetic preganglionic fibers end on the terminal ganglia, which lie in or near the effector organ.
B. Terminal ganglia give rise to sympathetic postganglionic fibers.
C. Terminal ganglia are the final common pathway for the autonomic nervous system.
D. Terminal ganglia contain muscarinic receptors.
E. Terminal ganglia lie in a chain located along either side of the spinal cord.

13. The sympathetic nervous system

A. is always excitatory for smooth muscle
B. innervates only tissues concerned with protecting the body against challenges from the outside environment
C. dominates in rest-and-digest situations
**D.** contains cholinergic and adrenergic fibers
E. contains cholinergic and adrenergic fibers and is always excitatory for smooth muscle

14. Sympathetic stimulation ____ heart rate and ____ the motility in the digestive tract.

A. does not affect; decreases
B. decreases; decreases
C. decreases; increases
**D.** increases; decreases
E. increases; increases

15. Parasympathetic stimulation ____ heart rate and ____ the motility in the digestive tract.

A. does not affect; increases
B. decreases; decreases
**C.** decreases; increases
D. increases; decreases
E. increases; increases

16. The motor end plate

A. contains receptor sites that are capable of binding curare
B. contains acetylcholinesterase
C. experiences an increase in permeability to cations when combined with acetylcholine
D. contains nicotinic receptors
**E.** all of these

17. Nicotinic receptors

A. bind with acetylcholine released from parasympathetic postganglionic fibers
**B.** respond to acetylcholine released from sympathetic and parasympathetic preganglionic fibers
C. are found primarily in the heart
D. bind with norepinephrine released from sympathetic postganglionic fibers
E. none of these

18. Atropine ____ the effect of acetylcholine at ____ receptors and ____ ____ receptors.

**A.** blocks; muscarinic; does not affect; nicotinic
B. enhances; muscarinic; does not affect; nicotinic
C. blocks; nicotinic; does not affect; muscarinic
D. enhances; nicotinic; does not affect; muscarinic
E. blocks; muscarinic; enhances; nicotinic

19. The neurotransmitter at the neuromuscular junction is

A. acetylcholine
B. the same as the transmitter substance at parasympathetic postganglionic nerve endings
C. the same as that released by all preganglionic fibers
D. acetylcholine and the same as the transmitter substance at parasympathetic postganglionic nerve endings
**E.** all of these

20. The sympathetic nervous system causes

A. blood vessels with alpha receptors to dilate
B. bronchioles to constrict
**C.** pupils of the eye to dilate
D. sweat glands to be inhibited
E. the urinary bladder to contract and eliminate urine

21. Acetylcholinesterase

A. has enhanced activity from organophosphates
**B.** inactivates a neurotransmitter.
C. is a neurotransmitter
D. stimulates an EPSP
E. triggers the release of sodium from postsynaptic cells

22. Which organ is not innervated by the parasympathetic division?

A. blood vessels
B. intestines
C. eye
**D.** liver
E. erectile tissues

23. The neuromuscular junction

A. is the junction between a motor neuron and a skeletal muscle fiber
B. transmits an action potential between the nerve cell and muscle cell on a one-to-one basis
C. may produce either an EPSP or an IPSP on the motor end plate
**D.** is the junction between a motor neuron and a skeletal muscle fiber, and transmits an action potential between the nerve cell and muscle cell on a one-to-one basis
E. all of these

24. Acetylcholine

A. opens voltage-gated $Na^+$ channels in skeletal muscle fibers, which causes depolarization of the muscle fibers
B. may decrease the permeability of the motor end plate to $Na^+$ and $K^+$ when combined with the receptor sites on the motor end plate
**C.** always depolarizes skeletal muscle fibers and postganglionic neurons
D. opens voltage-gated $Na^+$ channels in skeletal muscle fibers, which causes depolarization of the muscle fibers, and always depolarizes skeletal muscle fibers and postganglionic neurons
E. all of these

25. Which type of receptor binds norepinephrine on cardiac muscle, thus increasing cardiac activity?

A. cholinergic
B. nicotinic
C. alpha
**D.** beta-1
E. beta-2

26. Acetylcholine

A. binds to cholinergic receptors on preganglionic neurons
B. destroys acetylcholinesterase
**C.** binds to muscarinic receptors
D. is released from all postganglionic neurons
E. all of these, except destroys acetylcholinesterase

27. Which of the following is the final signaling step following impulse conduction along the axon terminal?

**A.** ACh binds with receptors on the muscle cell membrane, opening sodium channels.
B. ACh diffuses across the cleft of the junction.
C. ACh is released by exocytosis.
D. Calcium diffuses into the terminal button.
E. Voltage-gated channels for calcium are opened.

28. What is the fate of ACh following binding to receptors?

A. It remains bound, causing continued excitement.
**B.** It is removed by acetylcholinesterase.
C. It is actively reabsorbed by the axon terminal.
D. It is passively reabsorbed by the muscle cell.
E. None of these.

29. What would occur if ACh was not removed from the nicotinic receptors on skeletal muscle cells?

A. The cell would relax.
B. The cell would repolarize with the opening of chloride channels.
C. The cell would remain contracted until fatigued.
D. Sodium would continue to move into the cell, causing excitation.
**E.** The cell would remain contracted until fatigued, and sodium would continue to move into the cell causing excitation.

30. An EPP

**A.** occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber
B. is usually smaller in magnitude than an EPSP
C. is terminated when $Ca^{2+}$ inactivates acetylcholine
D. occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber and is usually smaller in magnitude than an EPSP
E. occurs because of $Na^+$ diffusing into a muscle fiber after ACh binds with a receptor on the muscle fiber and is terminated when $Ca^{2+}$ inactivates acetylcholine

31. Efferent neurons

A. have cell bodies in ganglia
**B.** are part of a two-neuron chain in the autonomic nervous system
C. arise peripherally at a receptor
D. send information toward the CNS
E. signal only skeletal muscles

32. Select the CNS structure(s) that can influence autonomic activity.

A. medulla
B. hypothalamus
C. spinal cord
**D.** all of these
E. medulla and hypothalamus

33. Botulism is caused by a toxin from bacteria in the species

**A.** *Clostridium*
B. *Escherichia*
C. *Salmonella*
D. *Staphylococcus*
E. *Streptococcus*

34. Which of the following chemicals paralyzes skeletal muscle by binding to the acetylcholine receptor sites?

A. black widow spider venom
**B.** curare
C. organophosphates
D. insecticide
E. local anesthetics

35. Curare

**A.** strongly binds to acetylcholine receptor sites
B. inhibits acetylcholinesterase
C. is found in pesticides and military nerve gases
D. strongly binds to acetylcholine receptor sites and is found in pesticides and military nerve gases
E. all of these

36. Select the correct statement about the neuromuscular junction.

A. AChE activity is absent here.
B. It involves presynaptic neurons of the autonomic nervous system.
C. It is a junction between two neurons.
**D.** It is always excitatory.
E. The axon terminals do not store neurotransmitters.

37. Atropine is an antagonist of ACh and works by

A. selectively binding to nicotinic receptors
B. selectively binding to muscarinic receptors
C. blocking the binding of ACh
D. selectively binding to nicotinic receptors and selectively binding to muscarinic receptors
**E.** selectively binding to muscarinic receptors and blocking the binding of ACh

38. Myasthenia gravis

A. is an autoimmune disease
B. occurs when axons are unable to release adequate amounts of acetylcholine
C. can be treated with a drug that temporarily inhibits acetylcholinesterase
**D.** is an autoimmune disease and can be treated with a drug that temporarily inhibits acetylcholinesterase
E. none of these

39. The sympathetic nervous system is always excitatory to the organs it innervates.

**FALSE**

40. The parasympathetic nervous system inhibits the rate of heartbeat.

**TRUE**

41. Most innervated blood vessels receive only sympathetic nerve fibers.

**TRUE**

42. Only terminals of autonomic nerve fibers and motor neurons end in a single, enlarged knoblike structure that releases neurotransmitter.

**FALSE**

43. By blocking the effect of acetylcholine at muscarinic but not nicotinic receptors, atropine is able to block parasympathetic effects while not influencing sympathetic activity at all.

**TRUE**

44. The preganglionic fibers of the autonomic nervous system are cholinergic fibers.

**TRUE**

45. The autonomic nervous system mainly controls smooth and cardiac muscles, but it can inhibit a few skeletal muscles.

**FALSE**

46. The autonomic nervous system is the part of the peripheral nervous system that regulates smooth muscle, cardiac muscle, and glands.

**TRUE**

47. The autonomic and somatic nervous systems are part of the efferent nervous system.

**TRUE**

48. Dual innervation of organs by both branches of the autonomic nervous system allows a fine degree of control over these organs.

**TRUE**

49. ACh always causes depolarization of skeletal muscles.

**TRUE**

50. Parasympathetic activation of sweat glands occurs to help reduce body temperatures.

**FALSE**

51. The parasympathetic nervous system dominates in situations when a person is afraid.

**FALSE**

52. The salivary glands and the eye are sympathetically innervated by cranial nerves.

**FALSE**

53. Sympathetic preganglionic fibers originate in the thoracic and lumbar segments of the spinal cord.

**TRUE**

54. Action potentials are transmitted on a one-to-one basis at both a neuromuscular junction and a synapse.

**FALSE**

55. Sympathetic stimulation of the urinary bladder relaxes the activity of this organ.

**TRUE**

56. Muscarinic receptors are found on the effector cells innervated by the sympathetic division.

**FALSE**

57. The sympathetic nervous system has its cells of origin in the brain stem as well as the spinal cord.

**FALSE**

58. Autonomic activity can be influenced by conscious neural activity.

**TRUE**

59. Sympathetic postganglionic fibers are longer than parasympathetic postganglionic fibers.

**TRUE**

60. Most innervated blood vessels receive sympathetic and parasympathetic fibers.

**FALSE**

61. Sympathetic and parasympathetic activity at the salivary glands is antagonistic.

**FALSE**

62. The sympathetic postganglionic fibers that innervate the sweat glands secrete acetylcholine rather than norepinephrine.

**TRUE**

63. Atropine blocks all nicotinic receptor sites.

**FALSE**

64. Nicotinic and muscarinic receptors are the two kinds of adrenergic receptors.

**FALSE**

65. It is possible through the use of drugs to activate the receptors found in bronchiolar smooth muscle without influencing the receptors in the heart.

**TRUE**

66. An EPP is similar to an EPSP, except that the magnitude of an EPSP is much larger.

**FALSE**

67. Action potentials are initiated at the motor end-plate region of skeletal muscle fibers.

**FALSE**

68. Acetylcholinesterase is stored in secretory vesicles in the motor end plate of the muscle fiber.

**FALSE**

69. Binding of ACh with receptor sites on the motor end plate opens chemical messenger-gated cation channels in the motor end plate, bringing about depolarization of the motor end plate.

**TRUE**

70. The axons controlling skeletal muscles are large and myelinated.

**TRUE**

71. Clostridium botulinum toxin inhibits acetylcholinesterase.

**FALSE**

72. An EPP is a graded potential.

**TRUE**

73. Binding of a neurotransmitter to a beta receptor on the urinary bladder causes the bladder to contract.

**FALSE**

74. **Complete each of the following statments.**

The two divisions of the efferent division of the peripheral nervous system are the _____ nervous system, which supplies cardiac muscle, smooth muscle, and glands, and the _____ nervous system, which supplies skeletal muscle.

**autonomic, somatic**

75. **Complete each of the following statments.**

The two divisions of the autonomic nervous system are the _____ nervous system, which dominates in fight-or-flight situations, and the _____ nervous system, which dominates in quiet, relaxed situations.

**sympathetic, parasympathetic**

76. **Complete each of the following statments.**

_____ fibers of the autonomic nerve pathway are located partially in the central nervous system.

**Preganglionic**

77. **Complete each of the following statments.**

Sympathetic fibers originate from _____ and _____ spinal nerves.

**thoracic, lumbar**

78. **Complete each of the following statments.**

Most sympathetic postganglionic fibers have cell bodies in a sympathetic ganglion _____.

**chain**

79. **Complete each of the following statments.**

Most sympathetic postganglionic fibers secrete the neurotransmitter _____, whereas all parasympathetic postganglionic fibers secrete the neurotransmitter _____.

**norepinephrine (noradrenaline), acetylcholine**

80. **Complete each of the following statments.**

The _____ is a modified sympathetic ganglion that secretes hormones similar or identical to sympathetic postganglionic neurotransmitters into the blood.

**adrenal medulla**

81. **Complete each of the following statments.**

Parasympathetic preganglionic fibers arise from the _____ and _____ areas of the CNS.

**cranial, sacral**

82. **Complete each of the following statments.**

In the autonomic nervous system, a(n) _____ neuron sends impulses away from a ganglion.

**postganglionic**

83. **Complete each of the following statments.**

_____ is the neurotransmitter that causes an EPSP on an autonomic neuron's dendrite located within a ganglion.

**ACh (Acetylcholine)**

84. **Complete each of the following statments.**

Sympathetic activity inhibits the secretion of _____ from the pancreas.

**insulin**

85. **Complete each of the following statments.**

Sympathetic activity stimulates the secretion of _____ from the pancreas.

**glucagon**

86. **Complete each of the following statments.**

Alpha and beta are two kinds of _____ receptors.

**adrenergic**

87. **Complete each of the following statments.**

Binding of _____ to nicotinic receptors is always excitatory.

**acetylcholine**

88. **Complete each of the following statments.**

Binding of _____ to muscarinic receptors may be initiate EPSPs or IPSPs.

**acetylcholine**

89. **Complete each of the following statments.**

The origin of the somatic nervous system is in the _____ horn of the spinal cord.

**ventral**

90. **Complete each of the following statments.**

Depolarization of the motor end plate results from more _____ ions entering the cell than _____ ions leaving the cell.

**sodium, potassium**

91. **Sequencing**

Indicate the proper sequence of events at the neuromuscular junction by filling in the blank with the appropriate number from 2 through 7. Numbers 1 and 8 are already identified.

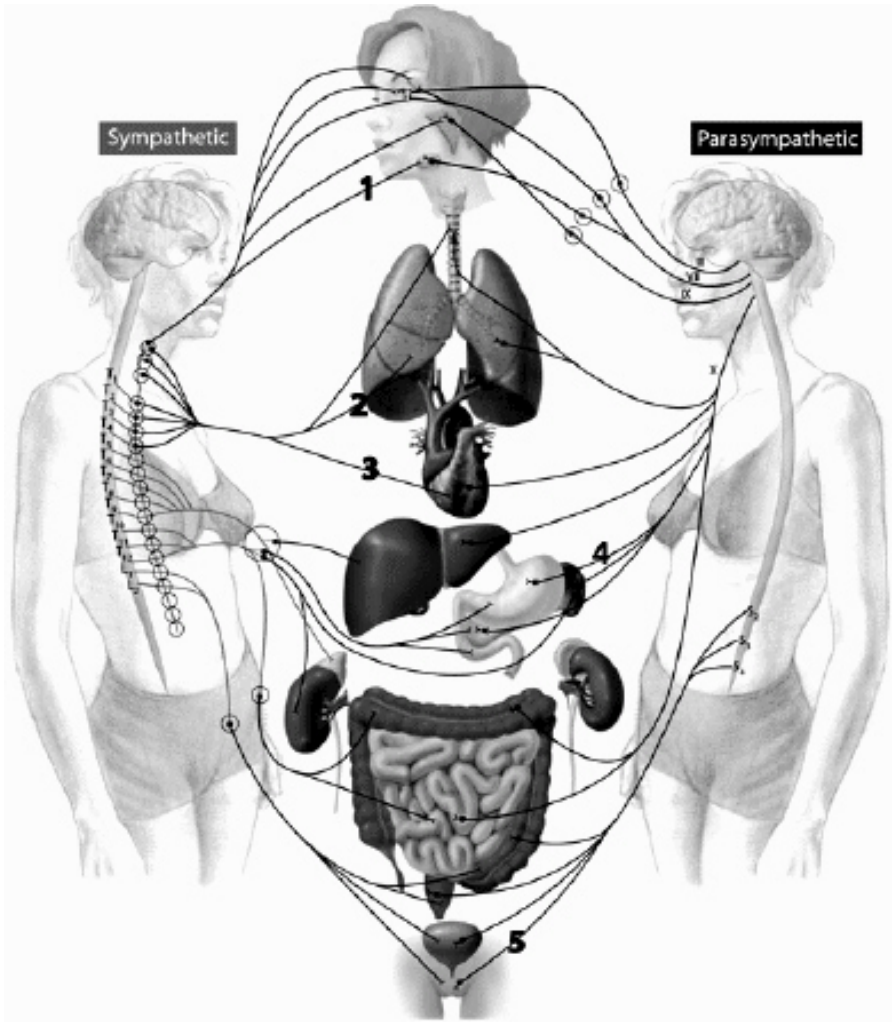
| | |
|---|---|
| | ACh is released from the axon terminal by exocytosis. |
| | An EPP takes place, primarily as a result of $Na^+$ influx. |
| 8 | Acetylcholinesterase inactivates ACh, terminating activity at the neuromuscular junction. |
| 1 | An action potential is propagated to an axon terminal of a motor neuron. |
| | Channels that permit passage of $Na^+$ and $K^+$ are opened in the motor end plate. |
| | $Ca^{2+}$ channels are opened in the axon terminal. |
| | Local current flow between the motor end plate and adjacent muscle-cell membrane initiates an action potential that spreads throughout the muscle fiber. |
| | ACh binds with receptor sites on the motor end plate. |

3, 6, 8, 1, 5, 2, 7, 4

92. Match the chemical with correct characteristic.

| | | |
|---|---|---|
| 1. Binds with ACH receptor sites. | curare | **1** |
| 2. Blocks release of ACh. | black widow spider venom | **3** |
| 3. Causes explosive release of ACh. | *Clostridium botulinum* toxin | **2** |
| 4. Inhibit acetylcholinesterase. | organophosphates | **4** |
| 5. Antibodies inactivate ACh receptor sites. | myasthenia gravis | **5** |

93.



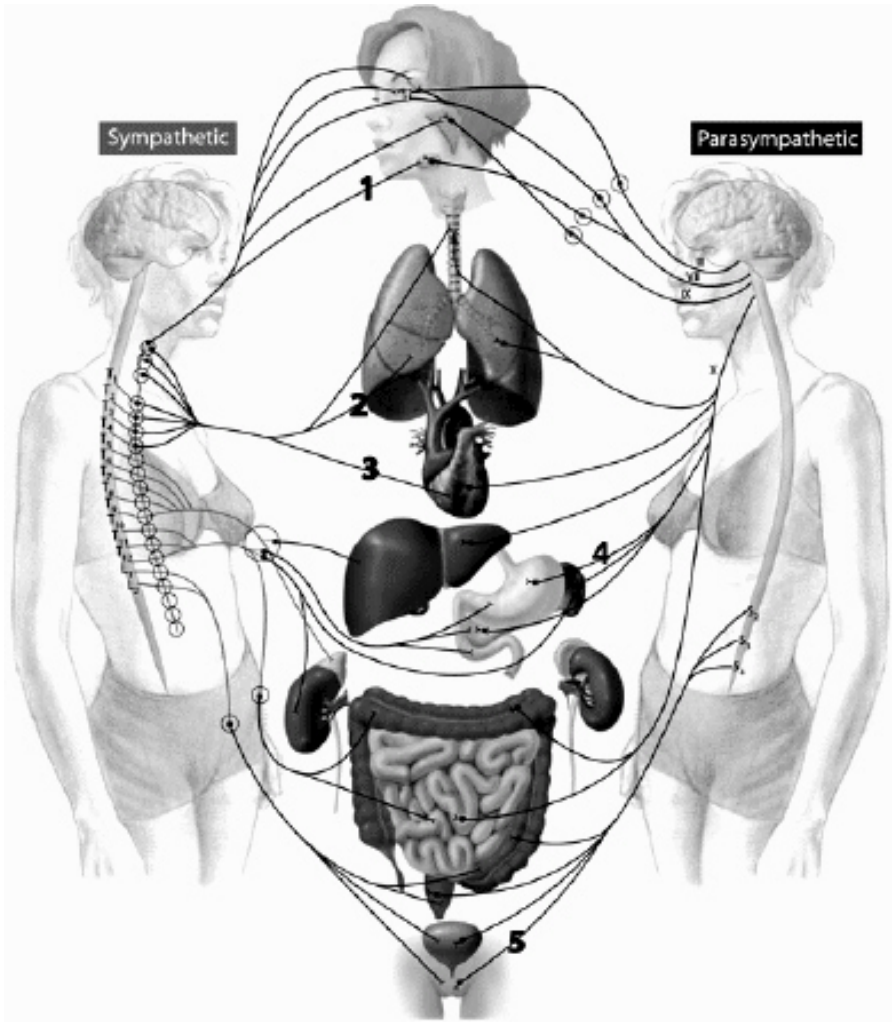

**Use this figure to answer the following questions.**

The axons labeled 1 would release ____ and have a(n) ____ effect on the effector organ.

a. ACh; inhibitory
b. ACh; excitatory
c. NE; inhibitory
d. NE; excitatory
e. NE; inhibitory and ACh; excitatory

c

94.



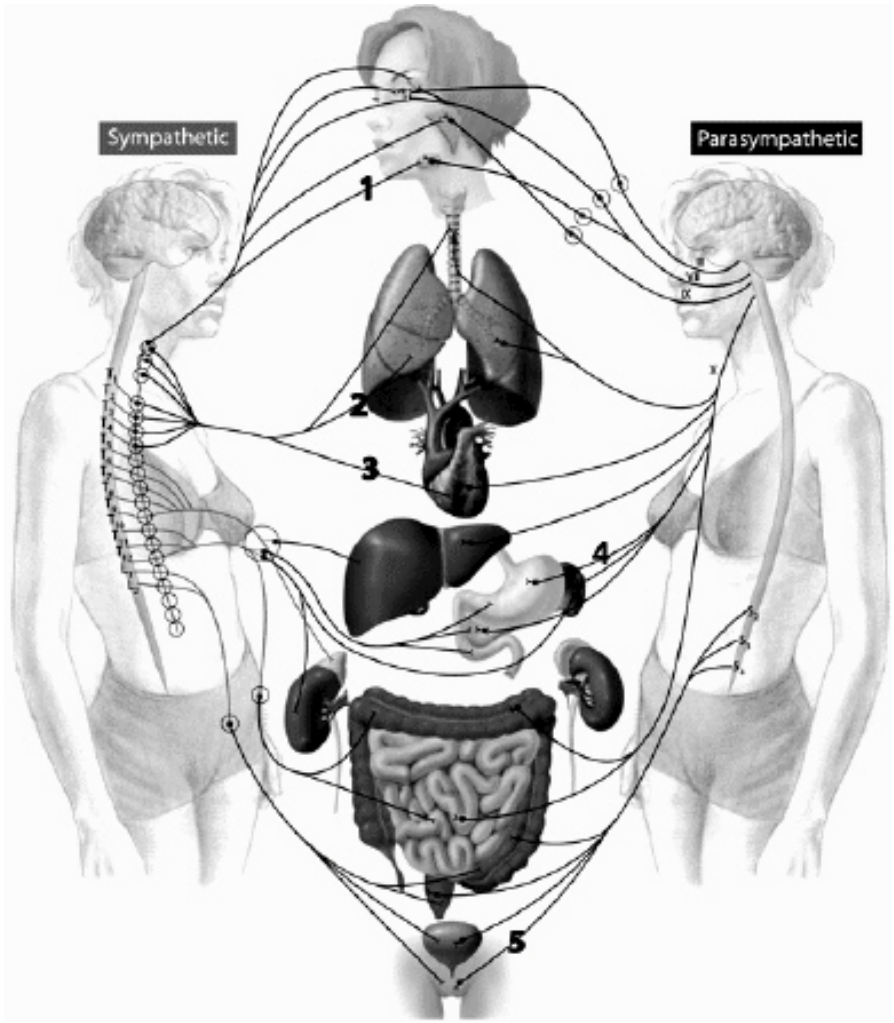

**Use this figure to answer the following questions.**

The effector for the neuron labeled 3

a. uses cholinergic receptors to respond to stimulation from 3
b. is stimulated by ACh from 3, which is a preganglionic neuron
c. uses adrenergic receptors to respond to stimulation from 3
d. is inhibited by neuron 3
e. None of these

c

95.



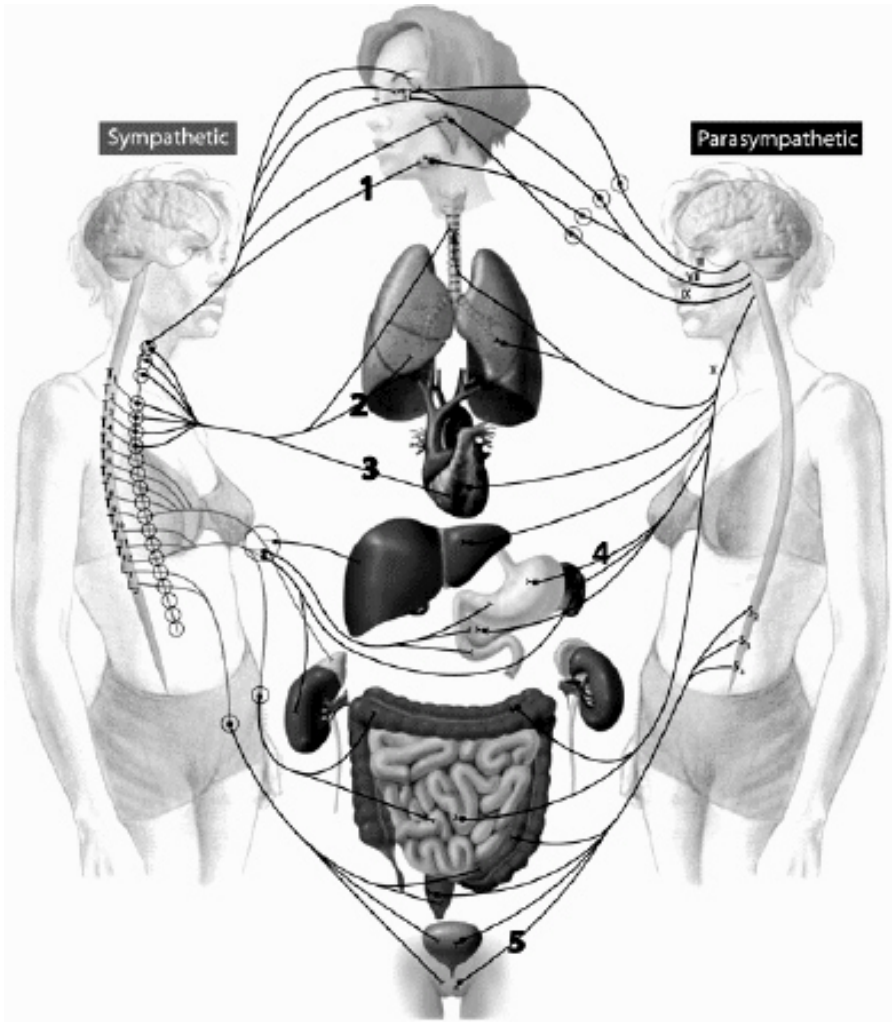

**Use this figure to answer the following questions.**

Identify the neurons that are exciting (depolarizing and/or increasing the activity of) their effectors.

a. 1, 2, and 3
b. 3 and 4
c. 4 and 5
d. 1, 4, and 5
e. 3 and 5

b

96.



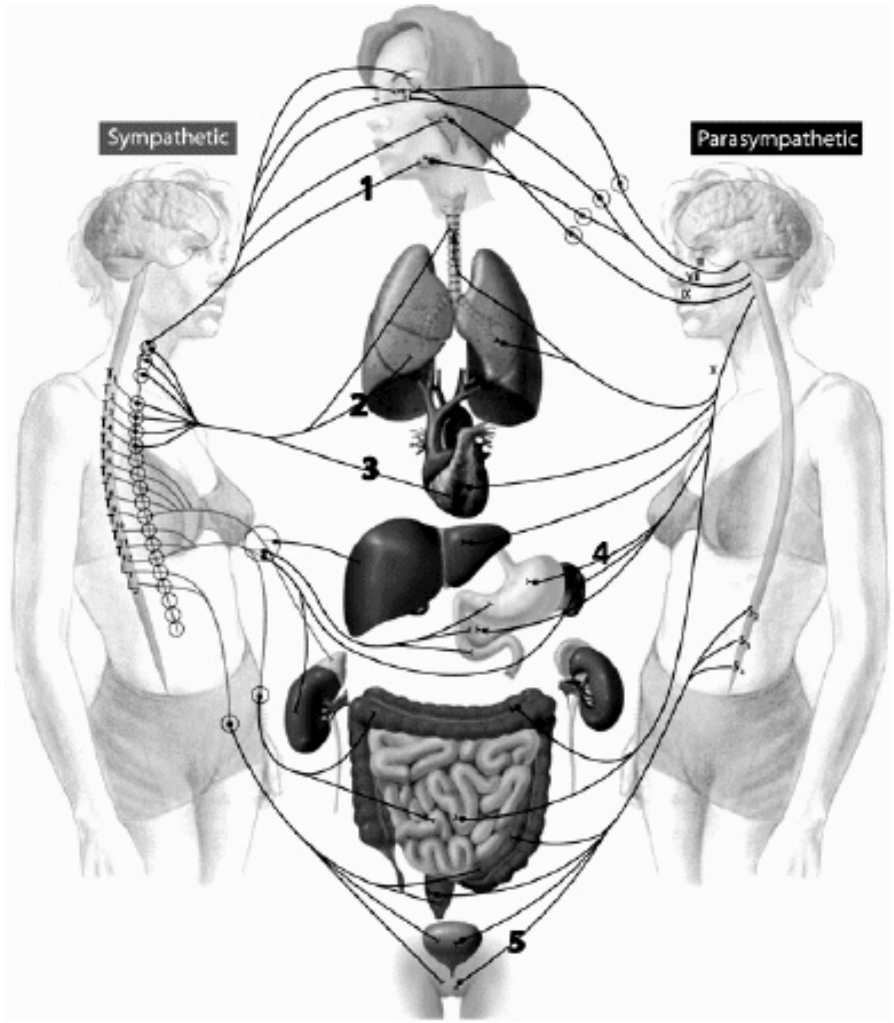

**Use this figure to answer the following questions.**

Which neuron releases a neurotransmitter that binds to $B_2$ receptors?

a. 1 and 5 only
b. 3 and 4 only
c. 3 only
d. 5 only
e. 1, 3, and 5

c

97.



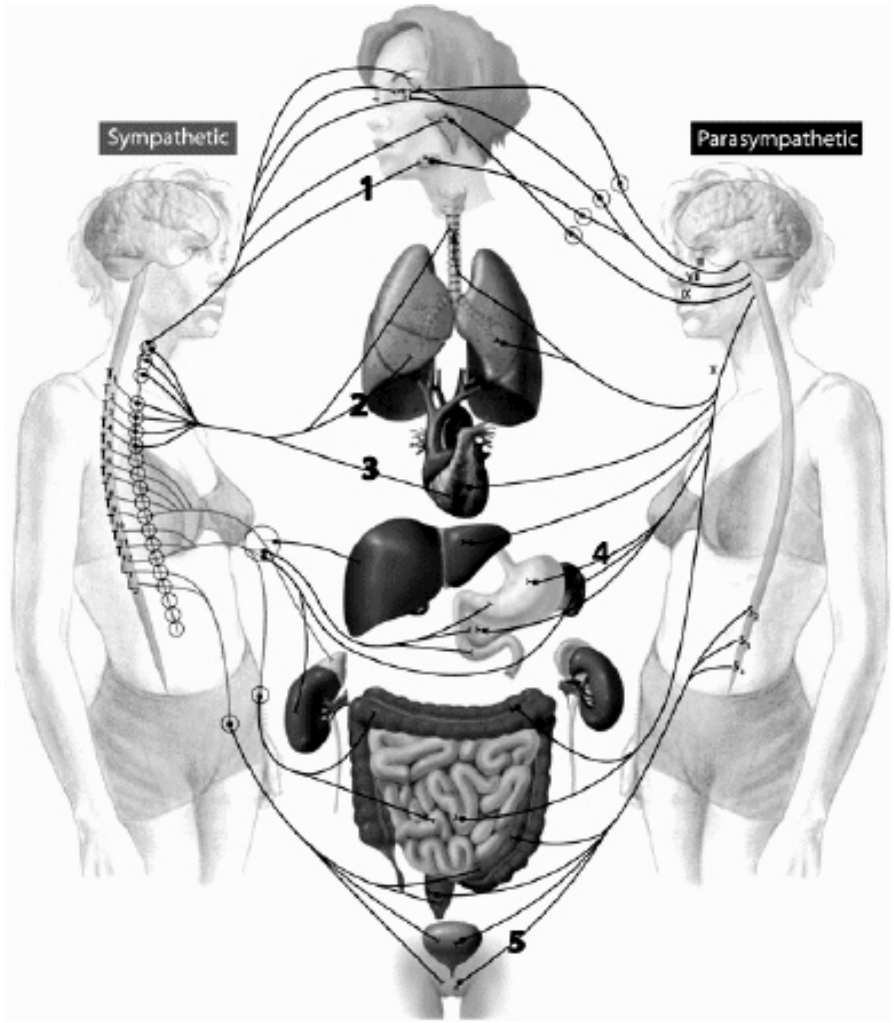

**Use this figure to answer the following questions.**

Neuron 3

a. releases a chemical that binds to muscarinic receptors
b. is stimulated by NE released from a preganglionic neuron
c. excites its effector
d. all of these
e. is stimulated by NE released from a preganglionic neuron and excites its effector

c

98.



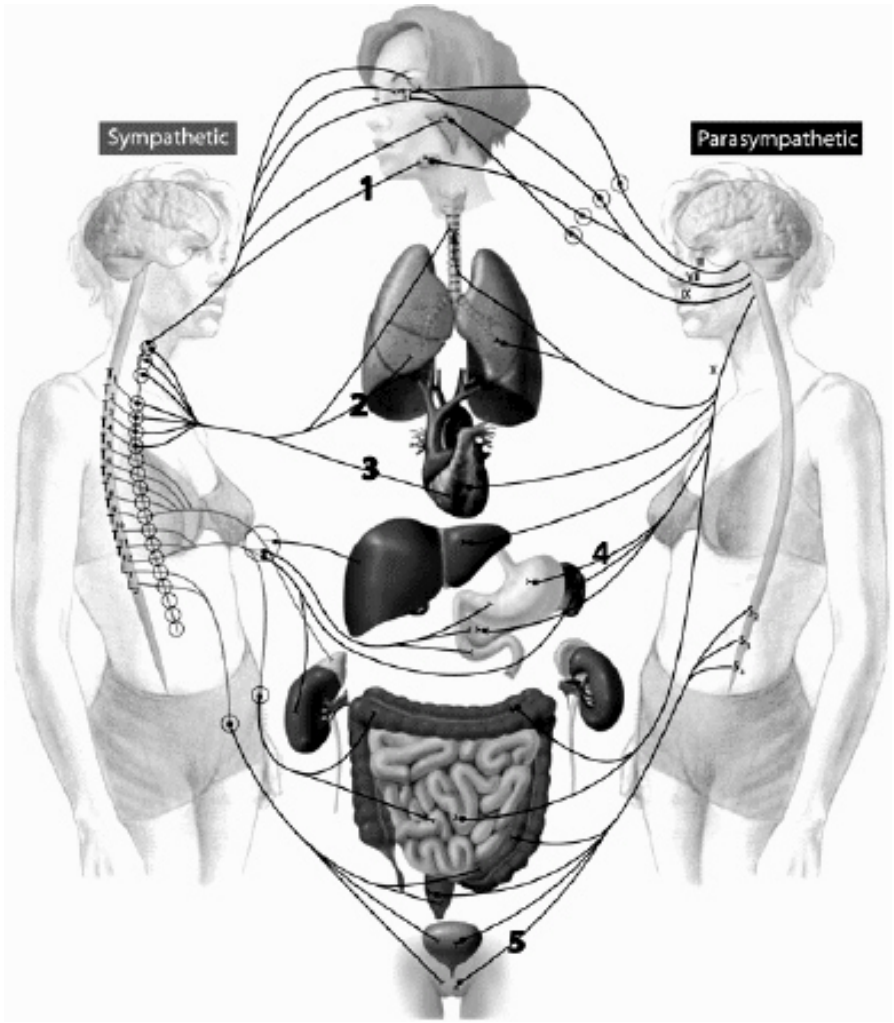

**Use this figure to answer the following questions.**

Neuron 2

a. uses adrenergic receptors to respond to stimulation by a preganglionic neuron
b. releases NE onto a very short postganglionic neuron
c. releases a chemical that binds to adrenergic receptors on a postganglionic neuron
d. all of these
e. none of these

e

99.




**Use this figure to answer the following questions.**

Identify the correct statement(s):

a. Neuron 5 causes contraction of its effector.
b. Neuron 6 is stimulated by ACh released from a preganglionic neuron.
c. Neuron 1 causes constriction of bronchioles
d. Neuron 2 releases a chemical that binds to nicotinic receptors on a postganglionic neuron.
e. Two of the above.

d

100. Compare and contrast the divisions of the autonomic nervous system with reference to the following: (1) the alternate names for each divisions; (2) where their neurons exit the CNS; (3) anatomical differences between their pre- and post-ganglionic neurons; and (4) the specific neurotransmitters released from the neurons in part 3.

*(1) The sympathetic nervous system (SNS) is also called the "fight-or-flight" division and is most active during times of stress. The parasympathetic nervous system (PNS) is called the "rest-and-digest" division because it is more active during restful periods.*
*(2) The SNS preganglionic neurons exit the CNS in the thoracic and lumbar regions of the spine, while the PNS preganglionic neurons exit the CNS in the cranial and sacral regions of the spine.*
*(3) Most SNS preganglionic fibers (axons) are short, while those in the PNS are long. Most SNS postganglionic fibers are long, while those in the PNS are short.*
*(4) All preganglionic neurons in both the SNS and PNS release ACh, while all postganglionic neurons in the PNS release ACh. Only a few postganglionic neurons in the SNS release ACh, while most release NE.*

101. Compare and contrast the autonomic and somatic nervous systems with reference to the following: (1) the types of effectors stimulated; (2) number of neurons involved; and (3) the specific neurotransmitters released onto effectors.

*(1) The autonomic nervous system (ANS) stimulates structures that are controlled involuntarily, including smooth and cardiac muscle tissue and glands. The somatic nervous system (SNS) stimulates only voluntary muscle tissue in skeletal muscles.*
*(2) In every case except one (stimulation of the adrenal gland), the ANS uses two neurons (a preganglionic and postganglionic) to conduct impulses from the CNS to the effector. The SNS always uses only one neuron.*
*(3) The ANS uses ACh to transmit impulses from preganglionic neurons to postganglionic neurons, and then may release either ACh or NE from the postganglionic neuron (depending on the specific division of the ANS). The SNS releases only ACh onto its effectors.*

102. Describe the events that occur at a skeletal neuromuscular junction. Include the following in your answer: action potential (on axon and muscle fiber), end-plate potential, terminal button, ACh, $Ca^{+2}$ channels, motor end plate, depolarization, and $Na^{+}$ channels.

*When an action potential reaches the terminal button on the axon, voltage-gated $Ca^{2+}$ channels open, allowing $Ca^{2+}$ ions to enter the button. This causes the release of ACh, which binds to $Na^{+}$ channels on the muscle cell's membrane (called the motor end plate). These channels open and allow Na+ ions to enter the muscle cell, causing depolarization; this is called the end-plate potential. This depolarization causes nearby voltage-gated $Na^{+}$ channels to open and initiate action potentials on the muscle cell.*

103. What are the various ways in which toxins can interfere with normal neuron functioning?

*Some toxins bind with receptors on terminal endings of axons, causing continual release of neurotransmitter, while some toxins may block the release of the neurotransmitter. Some toxins block the neurotransmitter's binding site at the target organ?, preventing stimulation of the organ. Other toxins may bind to the target's receptor site and cause continual stimulation. Still other toxins may allow normal release and binding of the neurotransmitter but may inhibit the enzyme that normally breaks down the neurotransmitter; the result is prolonged stimulation by the neurotransmitter.*

104. Compare and contrast the various types of autonomic receptors.

*There are two major types of autonomic receptors: (1) cholinergic receptors, to which acetylcholine (ACh) binds, and (2) adrenergic receptors, to which norepinephrine (NE) and/or epinephrine (E) bind. Cholinergic receptors include two subtypes: nicotinic, which are found on all postganglionic neurons, and muscarinic, which are found on effectors stimulated by the parasympathetic division and a few effectors stimulated by the sympathetic division. Adrenergic receptors include two major subtypes: alpha and beta. Alpha-1 receptors are found on most sympathetic targets and bind NE more readily than E, and the effect is always excitatory. Alpha-2 receptors are found on digestive system organs and binds more readily to NE than to E; the effect of binding is inhibitory. Beta-1 receptors are found on the heart's cardiac muscle and bind equally to NE and E; the effect is excitatory. Beta-2 receptors are found on smooth muscle in bronchioles and certain blood vessels; the effect is inhibitory.*