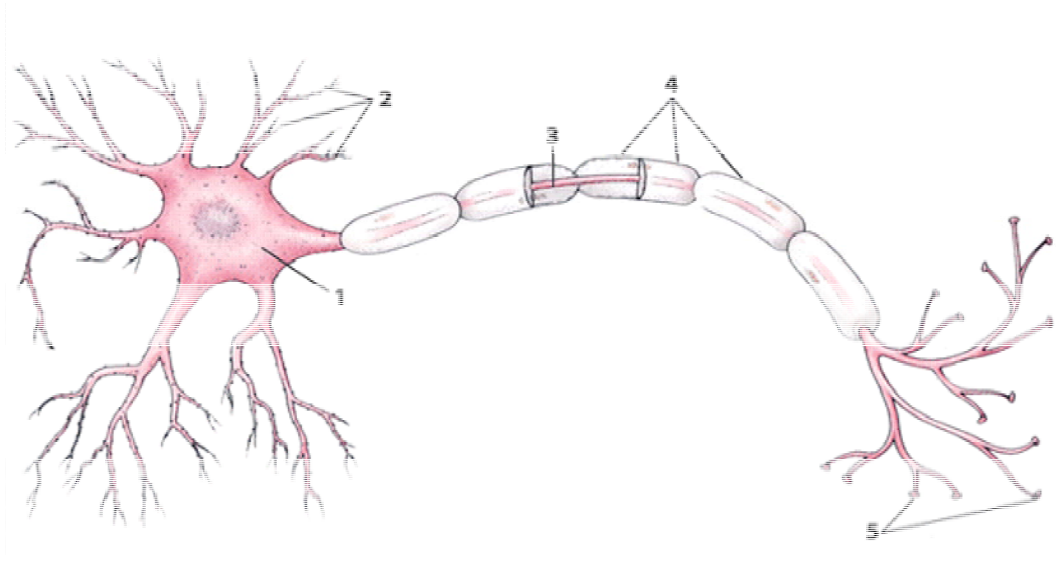


Version A

AP* Biology: Nervous System

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

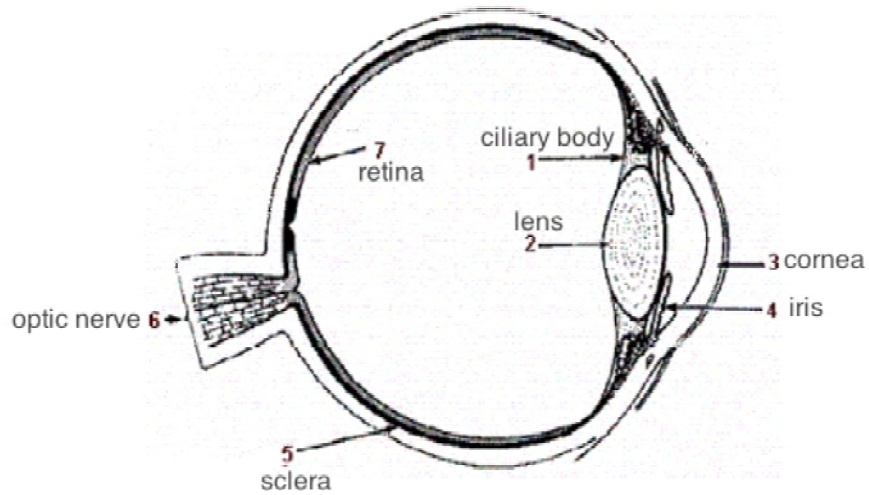
Questions 1 and 2



1. Transmission through a neuron occurs in a predictable order. Which of the following sequences represents the conduction pathway through the motor neuron shown in the diagram above?
 - A) 1—3—4—5
 - B) 2—1—4—5
 - C) 5—3—1—2
 - D) 2—1—3—5

2. The neuron is the basic structure of the nervous system. Which structure is responsible for the detection of signal information?
 - A) 1
 - B) 2
 - C) 4
 - D) 5

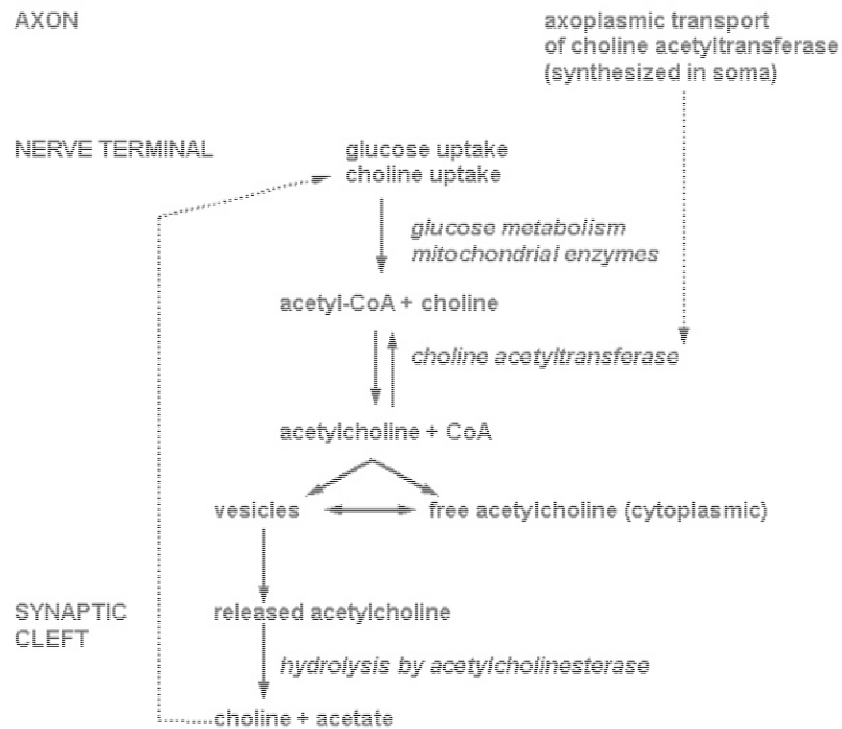
3.



Which components of the eye are areas where an action potential can be generated and conducted?

- A) 2 and 4
 B) 4 and 5
 C) 6 and 7
 D) 1 and 3
4. Given the steps shown below, which of the following is the correct transmission sequence at a chemical synapse?
1. Neurotransmitter binds with receptor
 2. Sodium ions rush into neuron's cytoplasm
 3. Action potential depolarizes the presynaptic membrane
 4. Ion channel opens to allow particular ion to enter cell
 5. Synaptic vesicles release neurotransmitter into the synaptic cleft
- A) 4-3-1-2-5
 B) 2-3-5-4-1
 C) 1-2-3-4-5
 D) 3-2-5-1-4

Synthesis and Release of Acetylcholine



5. Acetylcholine, a common neurotransmitter, is synthesized in the pre-synaptic end of a neuron and released into the synaptic cleft as shown in the illustration above. What would be a likely result of an increase in the amount of acetylcholinesterase present in the synaptic cleft?
- More sodium would enter the sodium/potassium ion channels of the postsynaptic dendrite
 - More potassium would enter sodium/potassium ion channels of the postsynaptic dendrite
 - Fewer sodium/potassium ion channels would be opened in the postsynaptic dendrite
 - Fewer vesicles in the pre-synaptic axon terminal would contain acetylcholine

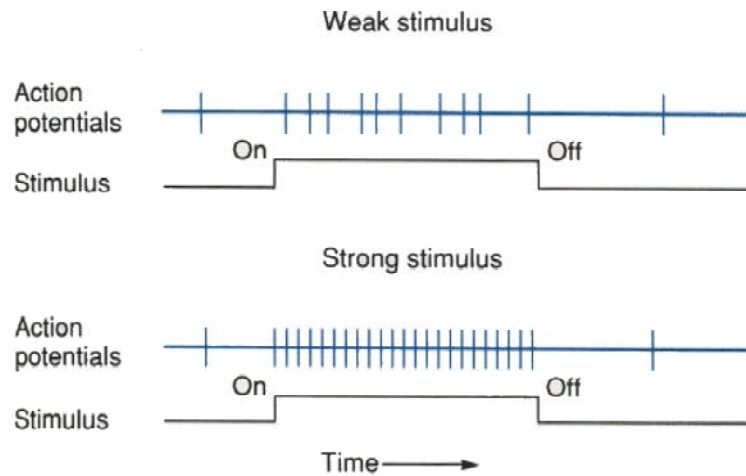
6. Which of the following best describes the function of acetylcholinesterase in neurotransmission?
- It decomposes, providing a source of choline for muscle contraction.
 - It binds acetylcholine to receptors on the postsynaptic membrane.
 - It blocks acetylcholine reception on the post-synaptic membrane.
 - It breaks down acetylcholine, preventing neurotransmission.
7. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- frequency of the impulse production to increase
 - strength of the neuronal impulse to increase
 - impulse to move faster
 - neuron membrane to become more negatively polarized
8. Schwann cells are a type of glial cells that produce myelin. In a controlled experiment, rat Schwann cells were exposed to various nonlethal levels of ethanol. The results of the experiment are shown below.

Schwann Cell Concentration <i>in situ</i> Sample				
Age of Culture (days)	Culture 1	Culture 2	Culture 3	Culture 4
	0 mM ethanol	48 mM ethanol	86 mM ethanol	172 mM ethanol
1	1.0×10^5	1.0×10^5	1.0×10^5	1.0×10^5
6	2.6×10^5	2.1×10^5	2.0×10^5	1.9×10^5
11	4.5×10^6	1.3×10^6	7.8×10^5	3.5×10^5
16	2.4×10^7	0.1×10^7	8.0×10^6	7.0×10^5

Based on this information, which of the following best represents the predicted rank order of the cultures arranged from highest to lowest levels of myelin present on day 16?

- Culture 4—Culture 3—Culture 2—Culture 1
 - Culture 3—Culture 4—Culture 1—Culture 2
 - Culture 2—Culture 1—Culture 4—Culture 3
 - Culture 1—Culture 2—Culture 3—Culture 4
9. Which of the following best explains the basic function of a motor neuron?
- The neuron receives input from thousands of transmitting neurons and responds by either transmitting or not transmitting an action potential.
 - The neuron receives inputs from one transmitting neuron and can generate thousands of different types of responses.
 - The neuron receives input from one transmitting neuron and responds by either transmitting or not transmitting an action potential.
 - The neuron receives input from thousands of transmitting neurons and can generate thousands of different types of responses.

10.



Based on the information depicted above, which of the following best explains the relationship between the action potential and the strength of the stimulus?

- A) A strong stimulus increases the length of time an action potential lasts.
 - B) A weak stimulus creates a stronger action potential.
 - C) A strong stimulus increases the frequency of the action potentials.
 - D) A weak stimulus increases the duration and frequency of the action potential.
11. Lidocaine is a local anesthetic that works as a temporary pain reliever. Lidocaine works by binding to voltage sensitive Na^+ gates on pain receptors and prevents the gates from opening. Which of the following best describes why Lidocaine is an effective anesthetic?
- A) Lidocaine limits sodium influx, which increases the production of presynaptic vesicles.
 - B) Lidocaine increases sodium influx, which stimulates the propagation of the action potential.
 - C) Lidocaine decreases sodium influx, which decreases the propagation of the action potential.
 - D) Lidocaine increases sodium influx, which decreases the release of neurotransmitters.

12.

Neurological Condition	Cells Affected	Impact of disease
Bell's Palsy	Facial Nerve inflammation	Inability to control facial muscles
Multiple Sclerosis	Brain and spinal neurons	Decreased myelination of neurons
Spinal Muscular Atrophy	Motor neurons	Decreased production of SMN, a protein needed for motor neuron survival
Tourette Syndrome	Basal ganglion of brain	Involuntary movement of face, arms, limbs, or trunk

Which of the neurological conditions would be most improved by stimulating Schwann cells to work more efficiently?

- A) Bell's Palsy
- B) Multiple Sclerosis
- C) Spinal Muscular Atrophy
- D) Tourette Syndrome

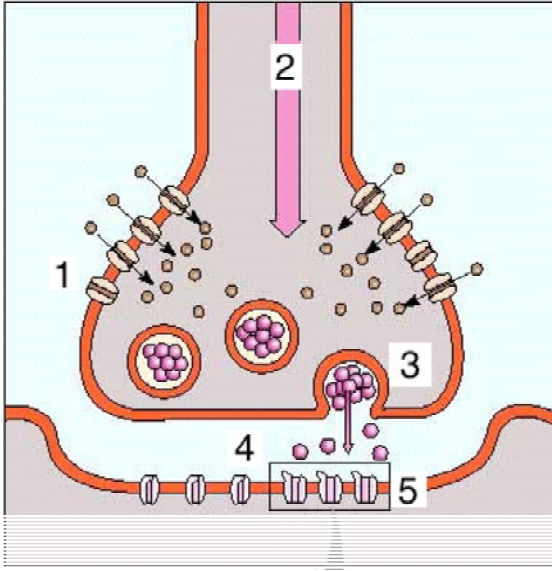
13.



The diagram above shows the typical pathway of information flow in a simple reflex arc in an organism. Which of the structures shown is located in the spinal cord?

- A) Sensory receptor
- B) Sensory neuron
- C) Interneuron
- D) Motor neuron

14.



Membrane proteins are critical components of nerve function. The diagram above depicts several events involved with impulse transmission from one neuron to the next. Which of the events shown does not require a membrane protein?

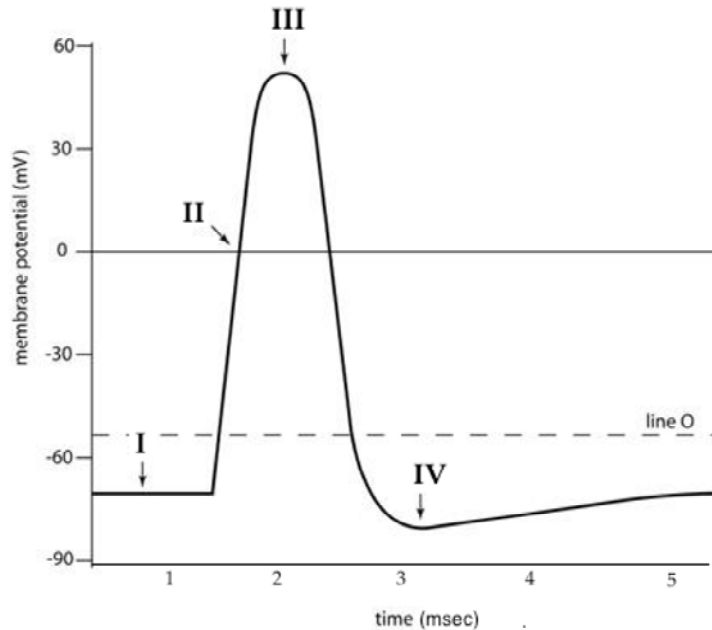
- A) Diffusion of a neurotransmitter
- B) Active transport of sodium
- C) Propagation of an action potential
- D) Binding of neurotransmitter

15. Which of the following would result if the sodium-potassium pumps of a neuron were inoperative?

- A) The movement of chloride ions would produce an action potential.
- B) An impulse would travel from the axon to the dendrites of the neuron.
- C) The rate of transmission of the impulse would greatly increase
- D) The action potential would never occur.

Questions 16 - 19

The diagram below graphs an action potential. Use the Roman Numerals to indicate your answer to the following questions.



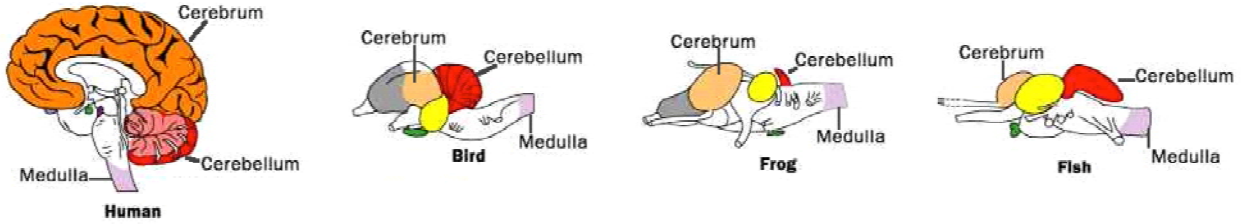
16. A neuron that is not conducting an action potential would have a membrane potential that is most like the value at
- A) I and II
 - B) I and III
 - C) I and IV
 - D) II and III
17. Which of the following best describes the line O on the graph?
- A) Line O indicates the resting potential when a neuron is not receiving information.
 - B) Line O indicates the threshold potential which when reached will result in the “all or none” response of action potential development.
 - C) Line O represents the time when the neuron is least likely to “fire” due to an influx of chlorine ions.
 - D) Line O represents the time periods when the repolarization is occurring.

18. Open sodium channels allow positively charged sodium ions to enter the neuron. Which Roman Numeral on the graph indicates the time during which the sodium channels are open?
- A) I
B) II
C) III
D) IV
19. Region IV on the graph indicates hyperpolarization which occurs when the difference in electrical potential between two sides of a cellular membrane changes significantly, resulting in a large electrical potential across the membrane. Which of the following describes the adaptive advantage of hyperpolarization?
- A) During hyperpolarization, an action potential cannot be generated which prevents the resending of same action potential.
B) During hyperpolarization, the membrane becomes impermeable to all ions and stops signal transmission.
C) During hyperpolarization, the voltage sensitive gates open, allowing sodium to rush in to establish the resting potential.
D) During hyperpolarization, the ion concentration inside and outside the neuron become equal leading to homeostasis.
20. The following data was collected during an experiment to determine the relationship between the amount a smooth muscle was stretched and the membrane potential of its neurons.

Length of strip	Membrane potential	Firing rate	Contractile force
10 mm	-50 mV	0.8 Hz	5 g
20 mm	-40 mV	1.2 Hz	10 g
30 mm	-35 mV	1.6 Hz	15 g

Which of the following statements is supported by the data shown?

- A) As the amount the muscle was stretched increases, the rate at which action potentials are generated increases.
B) A lower membrane potential generates a stronger contractile force.
C) The highest rate of action potential generation occurs when the muscle is stretched the least.
D) The firing rate increases as the contractile force decreases.



21.

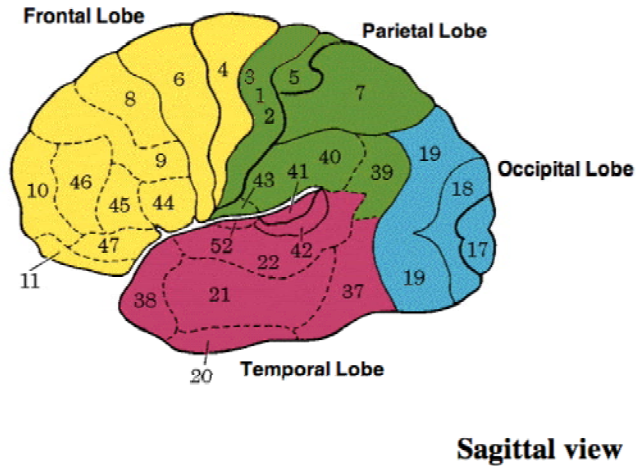
The diagram above shows the evolutionary trends in brain components of four organisms. Which of the following best describes the trends?

- A) As the brain evolved, proportional size of the medulla and cerebrum remained the same.
- B) As the brain evolved the proportional size of medulla increased.
- C) As the brain evolved the proportional size and convolutions of the cerebrum increased.
- D) As the brain evolved the proportional size of the cerebellum increased.

22.

Functional Areas of the Brain

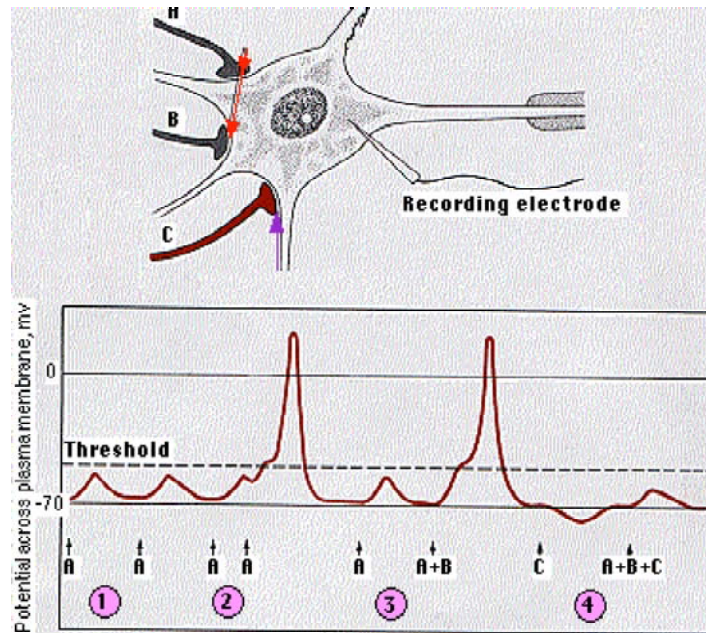
Function	Brodman Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41
secondary	22, 42
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	
	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye mov't	8
speech	44
Motor, tertiary	
	9, 10, 11, 45, 46, 47



The human forebrain consists of several regions that have different functions. Based on the data provided, what area of the brain is likely damaged in a stroke patient who symptoms include the inability to move the right arm and slurred speech?

- A) Frontal lobe
- B) Parietal lobe
- C) Occipital lobe
- D) Temporal lobe

23. The diagram shows three synapses associated with a single motor neuron. A recording electrode was inserted in the axon hillock to measure the membrane potential when synapse A, B and then C were activated.



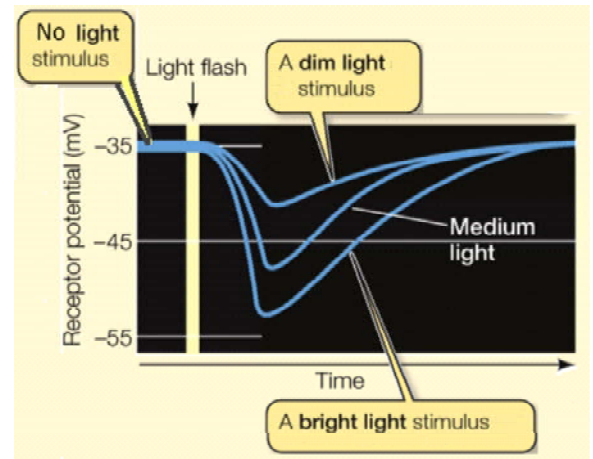
Which of the following best explains the data?

- A) Synapse A caused the generation of a membrane potential that exceeded the threshold potential at point 1.
- B) Summation of input from synapses A, B, and C exceeded the threshold potential at point 4.
- C) Synapse C is an inhibitory synapse lowering the internal charge at point 4.
- D) Synapse A is an excitatory synapse while synapse B is an inhibitory synapse.

24. The dendrites of olfactory receptor cells bind specific odor molecules present in the environment. The olfactory cells are located in the nasal cavity and have axons that connect to the olfactory bulb of the brain. Which of the following best describes the role of olfactory cells?

- A) They generate a response to the odor molecule.
- B) They convert sensory stimuli into changes in membrane potential.
- C) They integrate and interpret the sensory stimuli.
- D) They process and discriminate among odors detected in the environment.

25.

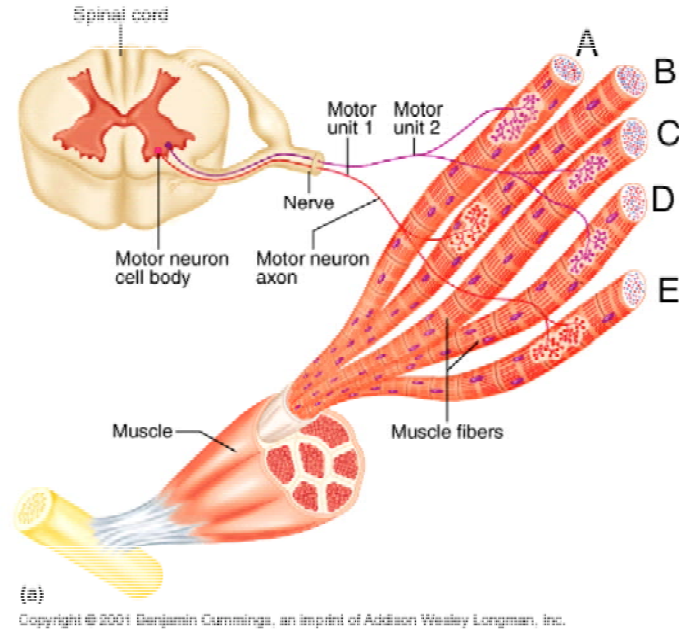


The diagram above shows the effect of dim, medium and low light on the membrane potential of receptor cells called rods. Rods are the primary source of human visual information in the dark. Based on the data, which of the following best describes the functioning of rods.

- A) Rod cells are hyperpolarized in the light and depolarized in the dark.
- B) Rod cells are hyperpolarized in the light and in the dark.
- C) Rod cells are depolarized in the light and hyperpolarized in the light.
- D) Rod cells are depolarized in the dark and in the light.

26. Maintenance of the ion concentration inside the neuron requires the action of sodium-potassium pumps. Which of the following best describes the action of the sodium- potassium pumps in the membrane of a motor neuron?
- A) Sodium is pumped out and chlorine is pumped into the neuron using energy supplied by ATP.
 - B) Sodium is pumped in and potassium is pumped into the neuron using energy supplied by a concentration gradient.
 - C) Sodium is pumped out and potassium is pumped into the neuron using energy supplied by ATP.
 - D) Sodium is pumped out while both potassium and chlorine are pumped into the neuron using energy supplied by a concentration gradient.
27. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- A) frequency of impulse production to increase
 - B) strength of the neuronal impulse to increase
 - C) impulse to move faster
 - D) neuron membrane to become less permeable to sodium

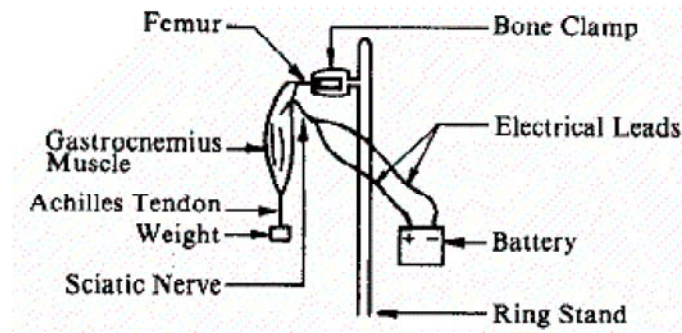
28.



Based on the information shown in the diagram above, which muscle fibers will most likely contract with the same strength and length of time?

- A) Muscle fiber A and muscle fiber B
- B) Muscle fiber B and muscle fiber C
- C) Muscle fiber C and muscle fiber D
- D) Muscle fiber D and muscle fiber E

Questions 29-32 refer to the following experiment, which is designed to test the effects of several chemicals on the contractility of skeletal muscle.



A frog femur with the gastrocnemius muscle attached is installed in a bone clamp as indicated in the accompanying figure. The sciatic nerve leading to the muscle is attached to a battery via electrical leads. A small weight is suspended from the free end of the Achilles tendon.

The entire preparation is rinsed in one of the five different solutions listed below. A brief stimulus is then applied to the sciatic nerve by closing the circuit to the battery. Three muscle responses are possible, depending on the solution with which the preparation has been rinsed: (1) the muscle will twitch once normally; (2) the muscle will go on sustained contraction until it is completely fatigued; and (3) the muscle will remain flaccid and not twitch at all.

Substance Added to Ringers' Rinsing Solution	Mechanism of Action
None	Provide an isotonic saline environment for the muscle
EDTA	Binds for free calcium ions
Botulin	Blocks the release of acetylcholine from pre-synaptic junctions
Malathion	Inhibits the enzyme acetylcholinesterase
Curare	Binds to the acetylcholine receptor site in the synapse or myoneural junction

29. Which substance allows a single muscle twitch after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
 - B) EDTA
 - C) Botulin
 - D) Malathion

30. Competitors of acetylcholine include which of the following?

- I. Botulin
- II. EDTA
- III. Curare

- A) I only
- B) II only
- C) III only
- D) I, II, and III

31. Which substance produces a sustained contraction (tetany) after a brief electrical stimulation of the sciatic nerve?

- A) Ringer's solution
- B) EDTA
- C) Botulin
- D) Malathion

32. Which of the following substances allows action potentials to reach the sarcoplasmic membrane and the transverse tubule system but prevents muscle contraction?

- A) Ringer's solution
- B) EDTA
- C) Botulin
- D) Malathion

Questions 1 and 2

A study was conducted to determine the effect of a nutritional supplement containing the inhibitory neurotransmitter, GABA. A control group was given only water to drink while the experimental group was given a drink containing 500 mg of the nutritional supplement GABA. An assessment was administered to both groups. The scores are shown below.

Control Group	GABA Treatment
1587	1600
1591	1550
1600	1576
1576	1680
1593	1590

- Calculate the mean for the scores of the individuals receiving the GABA nutritional supplement. Give your answer to the nearest whole number.

⊖	⊙	⊙	⊙	⊙	⊙
		⊙	⊙	⊙	⊙
	①	①	①	①	①
	②	②	②	②	②
	③	③	③	③	③
	④	④	④	④	④
	⑤	⑤	⑤	⑤	⑤
	⑥	⑥	⑥	⑥	⑥
	⑦	⑦	⑦	⑦	⑦
	⑧	⑧	⑧	⑧	⑧
	⑨	⑨	⑨	⑨	⑨

- Calculate the standard deviation for the control group scores. Give your answer to the nearest hundredth.

⊖	⊙	⊙	⊙	⊙	⊙
		⊙	⊙	⊙	⊙
	①	①	①	①	①
	②	②	②	②	②
	③	③	③	③	③
	④	④	④	④	④
	⑤	⑤	⑤	⑤	⑤
	⑥	⑥	⑥	⑥	⑥
	⑦	⑦	⑦	⑦	⑦
	⑧	⑧	⑧	⑧	⑧
	⑨	⑨	⑨	⑨	⑨

3. Serotonin interacts with at least 15 different receptors in the body. Serotonin receptors in the human brain begin to decline after age 25. A reduction in the serotonin receptor known as 5-HT2A has been linked to depression in middle aged humans. Data from a study comparing the number of 5-HT2A receptors found in patients cells over a 10 year period are shown below.

Year of Study	5-HT2A Binding Sites per cell
Initial Year	220
Year 2	213
Year 4	207
Year 6	201
Year 8	195
Year 10	190

Use the data above to calculate the rate of decline in 5-HT2A receptors for the 10 years of this study. Give your answer to the nearest whole number.

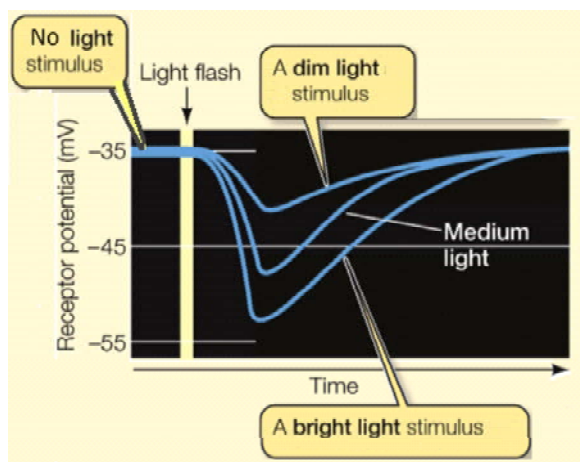
		⊘	⊘	⊘	
⊖	●	●	●	●	●
		0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Version B

AP* Biology: Nervous System

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1.



The diagram above shows the effect of dim, medium and low light on the membrane potential of receptor cells called rods. Rods are the primary source of human visual information in the dark. Based on the data, which of the following best describes the functioning of rods.

- A) Rod cells are hyperpolarized in the light and depolarized in the dark.
- B) Rod cells are hyperpolarized in the light and in the dark.
- C) Rod cells are depolarized in the light and hyperpolarized in the light.
- D) Rod cells are depolarized in the dark and in the light.

2. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the

- A) frequency of the impulse production to increase
- B) strength of the neuronal impulse to increase
- C) impulse to move faster
- D) neuron membrane to become more negatively polarized

3. Given the steps shown below, which of the following is the correct transmission sequence at a chemical synapse?

1. Neurotransmitter binds with receptor
2. Sodium ions rush into neuron's cytoplasm
3. Action potential depolarizes the presynaptic membrane
4. Ion channel opens to allow particular ion to enter cell
5. Synaptic vesicles release neurotransmitter into the synaptic cleft

- A) 4-3-1-2-5
- B) 2-3-5-4-1
- C) 1-2-3-4-5
- D) 3-2-5-1-4

4.

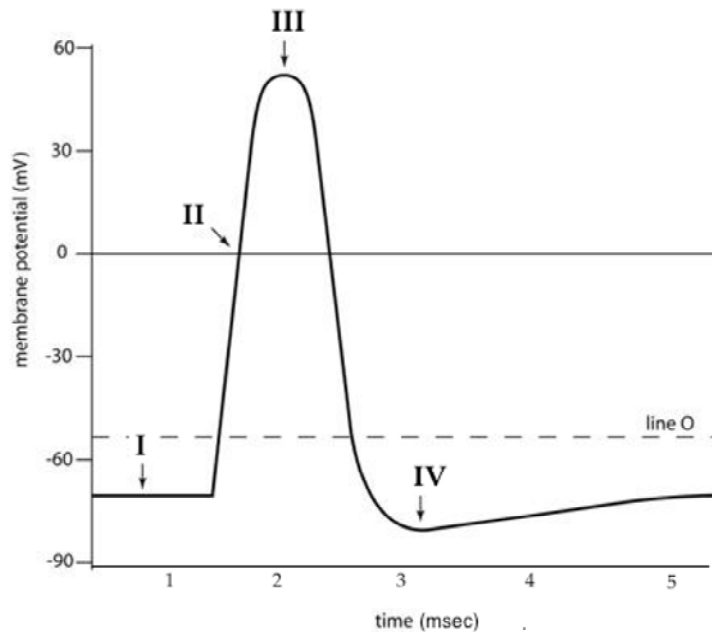


The diagram above shows the typical pathway of information flow in a simple reflex arc in an organism. Which of the structures shown is located in the spinal cord?

- A) Sensory receptor
- B) Sensory neuron
- C) Interneuron
- D) Motor neuron

Questions 5-8

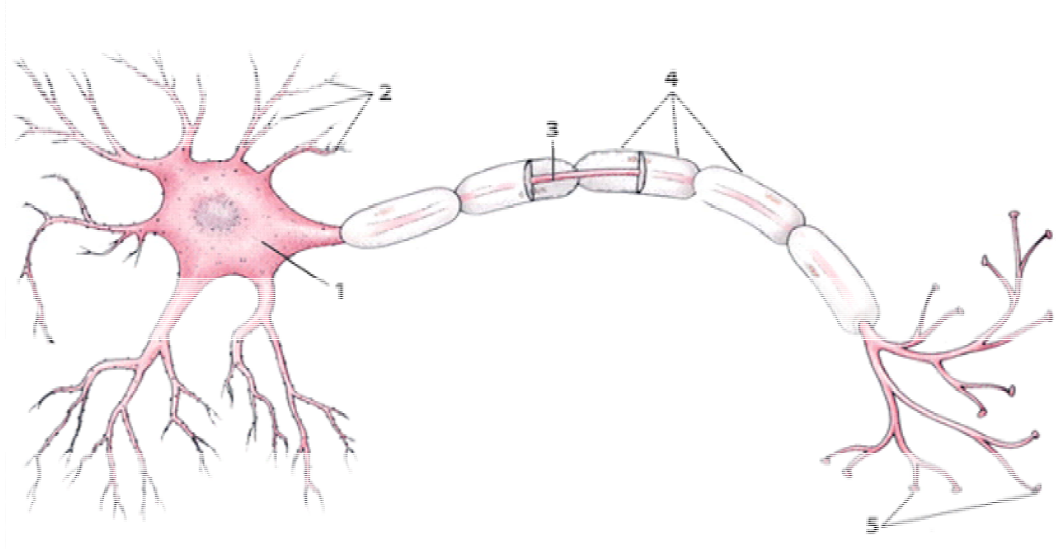
The diagram below graphs an action potential. Use the Roman Numerals to indicate your answer to the following questions.



5. A neuron that is not conducting an action potential would have a membrane potential that is most like the value at
- A) I and II
 - B) I and III
 - C) I and IV
 - D) II and III
6. Open sodium channels allow positively charged sodium ions to enter the neuron. Which Roman Numeral on the graph indicates the time during which the sodium channels are open?
- A) I
 - B) II
 - C) III
 - D) IV

7. Which of the following best describes the line O on the graph?
- A) Line O indicates the resting potential when a neuron is not receiving information.
 - B) Line O indicates the threshold potential which when reached will result in the “all or none” response of action potential development.
 - C) Line O represents the time when the neuron is least likely to “fire” due to an influx of chlorine ions.
 - D) Line O represents the time periods when the repolarization is occurring.
8. Region IV on the graph indicates hyperpolarization which occurs when the difference in electrical potential between two sides of a cellular membrane changes significantly, resulting in a large electrical potential across the membrane. Which of the following describes the adaptive advantage of hyperpolarization?
- A) During hyperpolarization, an action potential cannot be generated which prevents the resending of same action potential.
 - B) During hyperpolarization, the membrane becomes impermeable to all ions and stops signal transmission.
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 - D) During hyperpolarization, the ion concentration inside and outside the neuron become equal leading to homeostasis.

Questions 9 and 10

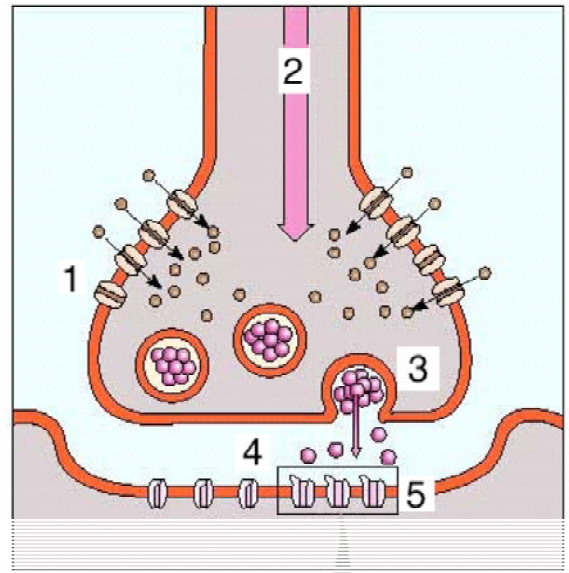


9. The neuron is the basic structure of the nervous system. Which structure is responsible for the detection of signal information?
- A) 1
 B) 2
 C) 4
 D) 5
10. Transmission through a neuron occurs in a predictable order. Which of the following sequences represents the conduction pathway through the motor neuron shown in the diagram above?
- A) 1—3—4—5
 B) 2—1—4—5
 C) 5—3—1—2
 D) 2—1—3—5

11. Which of the following best explains the basic function of a motor neuron?

- A) The neuron receives input from thousands of transmitting neurons and responds by either transmitting or not transmitting an action potential.
- B) The neuron receives inputs from one transmitting neuron and can generate thousands of different types of responses.
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12.

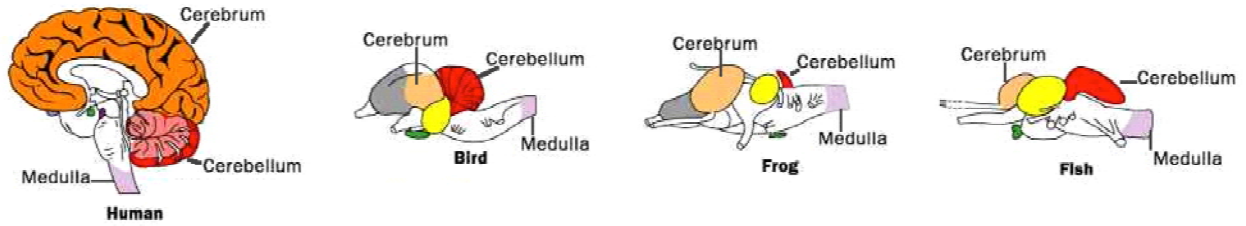


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- A) Diffusion of a neurotransmitter
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- C) Propagation of an action potential
- D) Binding of neurotransmitter

13. Which of the following best describes the function of acetylcholinesterase in neurotransmission?

- A) It decomposes, providing a source of choline for muscle contraction.
- B) It binds acetylcholine to receptors on the postsynaptic membrane.
- C) It blocks acetylcholine reception on the post-synaptic membrane.
- D) It breaks down acetylcholine, preventing neurotransmission.

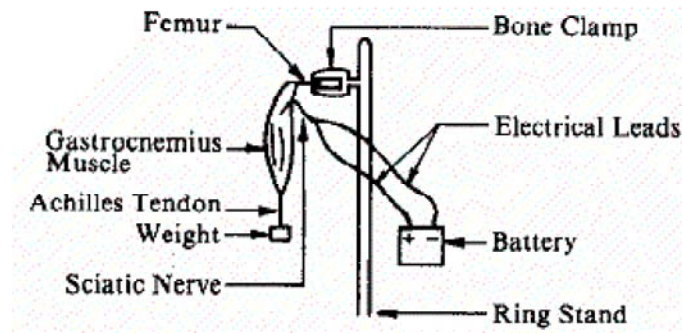


14.

The diagram above shows the evolutionary trends in brain components of four organisms. Which of the following best describes the trends?

- A) As the brain evolved, proportional size of the medulla and cerebrum remained the same.
- B) As the brain evolved the proportional size of medulla increased.
- C) As the brain evolved the proportional size and convolutions of the cerebrum increased.
- D) As the brain evolved the proportional size of the cerebellum increased.

Questions 15-18 refer to the following experiment, which is designed to test the effects of several chemicals on the contractility of skeletal muscle.



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The entire preparation is rinsed in one of the five different solutions listed below. A brief stimulus is then applied to the sciatic nerve by closing the circuit to the battery. Three muscle responses are possible, depending on the solution with which the preparation has been rinsed: (1) the muscle will twitch once normally; (2) the muscle will go on sustained contraction until it is completely fatigued; and (3) the muscle will remain flaccid and not twitch at all.

Substance Added to Ringers' Rinsing Solution	Mechanism of Action
None	Provide an isotonic saline environment for the muscle
EDTA	Binds for free calcium ions
Botulin	Blocks the release of acetylcholine from pre-synaptic junctions
Malathion	Inhibits the enzyme acetylcholinesterase
Curare	Binds to the acetylcholine receptor site in the synapse or myoneural junction

15. Competitors of acetylcholine include which of the following?

- I. Botulin
- II. EDTA
- III. Curare

- A) I only
- B) II only
- C) III only
- D) I, II, and III

16. Which of the following substances allows action potentials to reach the sarcoplasmic membrane and the transverse tubule system but prevents muscle contraction?
- A) Ringer's solution
B) EDTA
C) Botulin
D) Malathion
17. Which substance allows a single muscle twitch after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
B) EDTA
C) Botulin
D) Malathion
18. Which substance produces a sustained contraction (tetany) after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
B) EDTA
C) Botulin
D) Malathion
19. Schwann cells are a type of glial cells that produce myelin. In a controlled experiment, rat Schwann cells were exposed to various nonlethal levels of ethanol. The results of the experiment are shown below.

Schwann Cell Concentration <i>in situ</i> Sample				
Age of Culture (days)	Culture 1	Culture 2	Culture 3	Culture 4
	0 mM ethanol	48 mM ethanol	86 mM ethanol	172 mM ethanol
1	1.0×10^5	1.0×10^5	1.0×10^5	1.0×10^5
6	2.6×10^5	2.1×10^5	2.0×10^5	1.9×10^5
11	4.5×10^6	1.3×10^6	7.8×10^5	3.5×10^5
16	2.4×10^7	0.1×10^7	8.0×10^6	7.0×10^5

Based on this information, which of the following best represents the predicted rank order of the cultures arranged from highest to lowest levels of myelin present on day 16?

- A) Culture 4—Culture 3—Culture 2—Culture 1
B) Culture 3—Culture 4—Culture 1—Culture 2
C) Culture 2—Culture 1—Culture 4—Culture 3
D) Culture 1—Culture 2—Culture 3—Culture 4
20. Which of the following would result if the sodium-potassium pumps of a neuron were inoperative?
- A) The movement of chloride ions would produce an action potential.
B) An impulse would travel from the axon to the dendrites of the neuron.
C) The rate of transmission of the impulse would greatly increase
D) The action potential would never occur.

21.

Neurological Condition	Cells Affected	Impact of disease
Bell's Palsy	Facial Nerve inflammation	Inability to control facial muscles
Multiple Sclerosis	Brain and spinal neurons	Decreased myelination of neurons
Spinal Muscular Atrophy	Motor neurons	Decreased production of SMN, a protein needed for motor neuron survival
Tourette Syndrome	Basal ganglion of brain	Involuntary movement of face, arms, limbs, or trunk

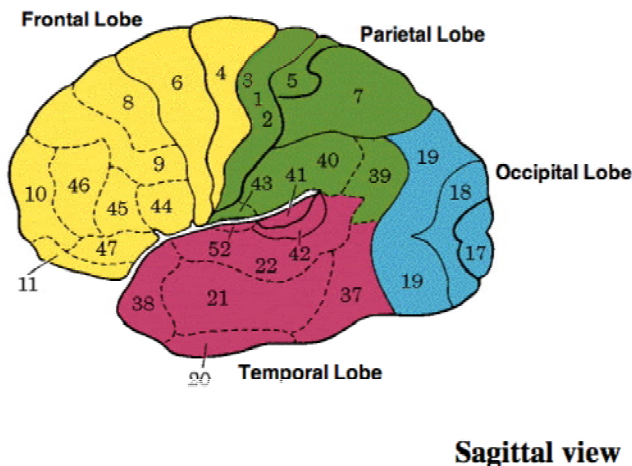
Which of the neurological conditions would be most improved by stimulating Schwann cells to work more efficiently?

- A) Bell's Palsy
 - B) Multiple Sclerosis
 - C) Spinal Muscular Atrophy
 - D) Tourette Syndrome
22. Lidocaine is a local anesthetic that works as a temporary pain reliever. Lidocaine works by binding to voltage sensitive Na^+ gates on pain receptors and prevents the gates from opening. Which of the following best describes why Lidocaine is an effective anesthetic?
- A) Lidocaine limits sodium influx, which increases the production of presynaptic vesicles.
 - B) Lidocaine increases sodium influx, which stimulates the propagation of the action potential.
 - C) Lidocaine decreases sodium influx, which decreases the propagation of the action potential.
 - D) Lidocaine increases sodium influx, which decreases the release of neurotransmitters.

23.

Functional Areas of the Brain

Function	Brodman Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41
secondary	22, 42
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	
	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye mov't	8
speech	44
Motor, tertiary	
	9, 10, 11, 45, 46, 47



The human forebrain consists of several regions that have different functions. Based on the data provided, what area of the brain is likely damaged in a stroke patient who symptoms include the inability to move the right arm and slurred speech?

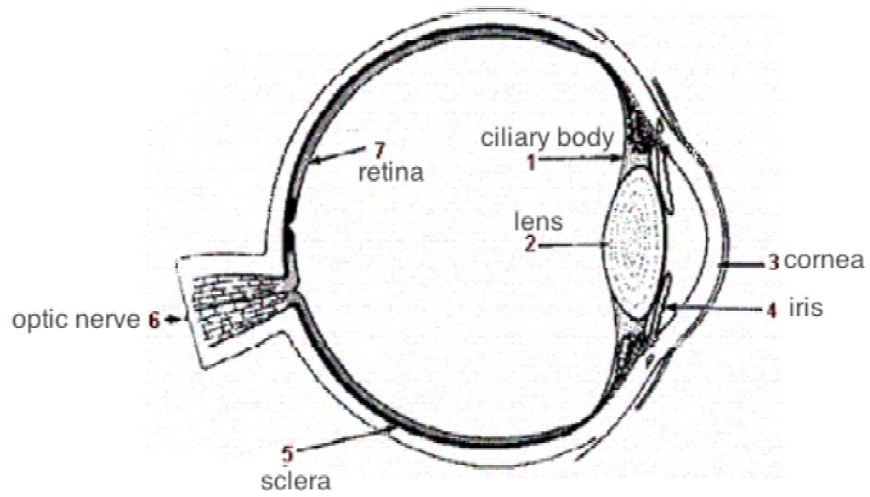
- A) Frontal lobe
 B) Parietal lobe
 C) Occipital lobe
 D) Temporal lobe
24. The following data was collected during an experiment to determine the relationship between the amount a smooth muscle was stretched and the membrane potential of its neurons.

Length of strip	Membrane potential	Firing rate	Contractile force
10 mm	-50 mV	0.8 Hz	5 g
20 mm	-40 mV	1.2 Hz	10 g
30 mm	-35 mV	1.6 Hz	15 g

Which of the following statements is supported by the data shown?

- A) As the amount the muscle was stretched increases, the rate at which action potentials are generated increases.
 B) A lower membrane potential generates a stronger contractile force.
 C) The highest rate of action potential generation occurs when the muscle is stretched the least.
 D) The firing rate increases as the contractile force decreases.

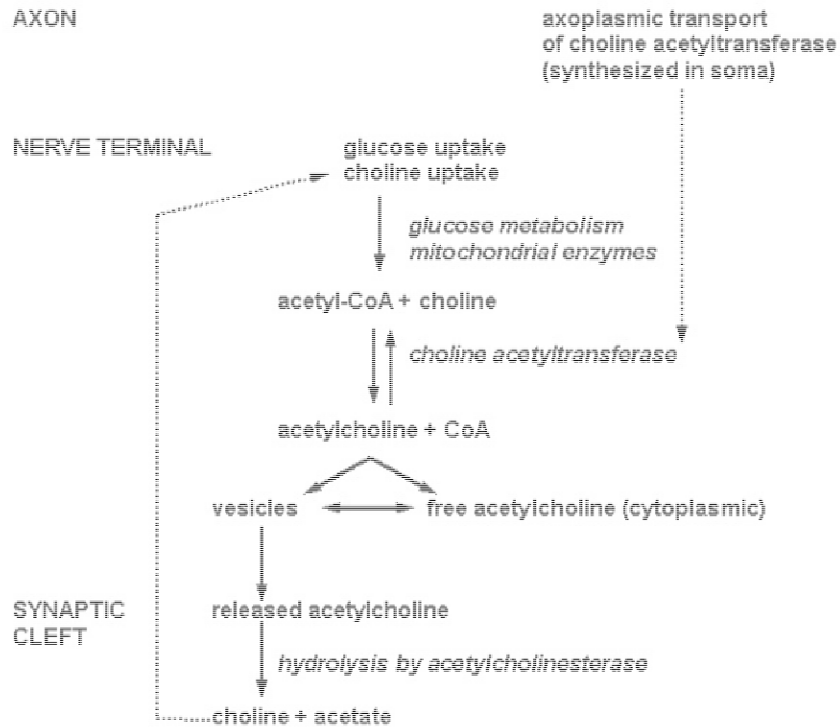
25.



Which components of the eye are areas where an action potential can be generated and conducted?

- A) 2 and 4
- B) 4 and 5
- C) 6 and 7
- D) 1 and 3

Synthesis and Release of Acetylcholine

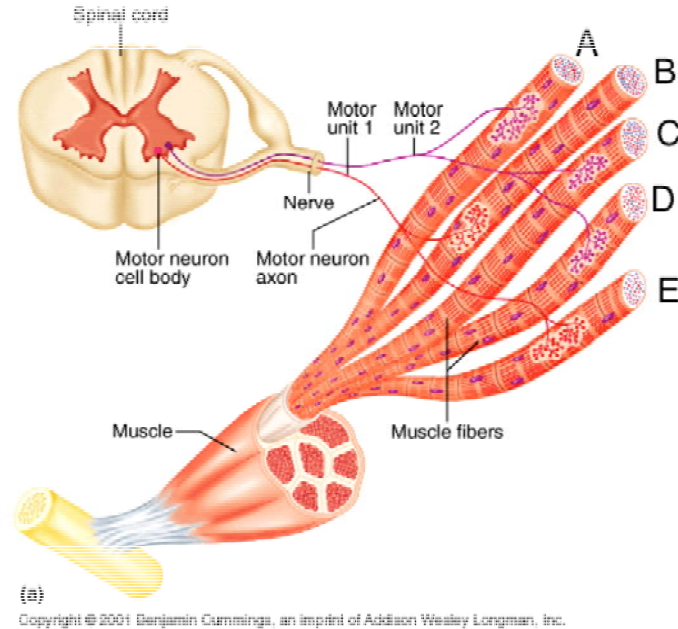


26. Acetylcholine, a common neurotransmitter, is synthesized in the pre-synaptic end of a neuron and released into the synaptic cleft as shown in the illustration above. What would be a likely result of an increase in the amount of acetylcholinesterase present in the synaptic cleft?

- A) More sodium would enter the sodium/potassium ion channels of the postsynaptic dendrite
- B) More potassium would enter sodium/potassium ion channels of the postsynaptic dendrite
- C) Fewer sodium/potassium ion channels would be opened in the postsynaptic dendrite
- D) Fewer vesicles in the pre-synaptic axon terminal would contain acetylcholine

27. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- A) frequency of impulse production to increase
 - B) strength of the neuronal impulse to increase
 - C) impulse to move faster
 - D) neuron membrane to become less permeable to sodium
28. Maintenance of the ion concentration inside the neuron requires the action of sodium-potassium pumps. Which of the following best describes the action of the sodium- potassium pumps in the membrane of a motor neuron?
- A) Sodium is pumped out and chlorine is pumped into the neuron using energy supplied by ATP.
 - B) Sodium is pumped in and potassium is pumped into the neuron using energy supplied by a concentration gradient.
 - C) Sodium is pumped out and potassium is pumped into the neuron using energy supplied by ATP.
 - D) Sodium is pumped out while both potassium and chlorine are pumped into the neuron using energy supplied by a concentration gradient.

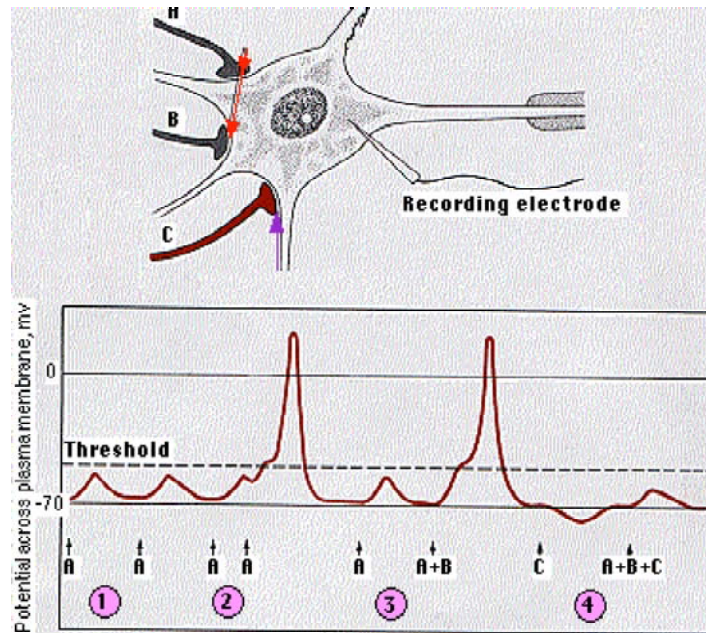
29.



Based on the information shown in the diagram above, which muscle fibers will most likely contract with the same strength and length of time?

- A) Muscle fiber A and muscle fiber B
 - B) Muscle fiber B and muscle fiber C
 - C) Muscle fiber C and muscle fiber D
 - D) Muscle fiber D and muscle fiber E
30. The dendrites of olfactory receptor cells bind specific odor molecules present in the environment. The olfactory cells are located in the nasal cavity and have axons that connect to the olfactory bulb of the brain. Which of the following best describes the role of olfactory cells?
- A) They generate a response to the odor molecule.
 - B) They convert sensory stimuli into changes in membrane potential.
 - C) They integrate and interpret the sensory stimuli.
 - D) They process and discriminate among odors detected in the environment.

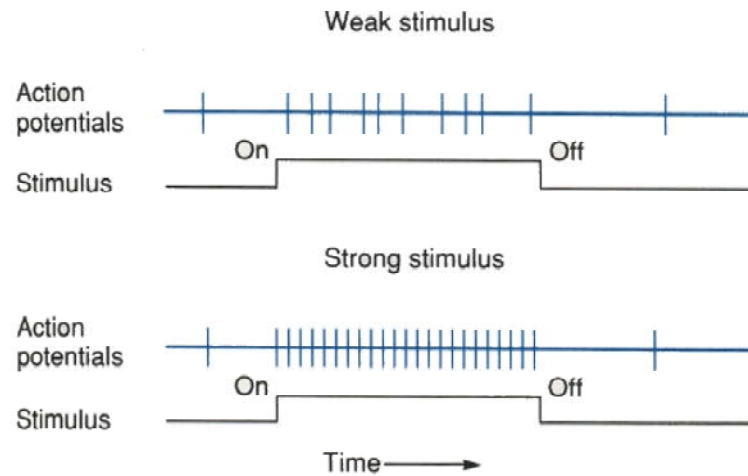
31. The diagram shows three synapses associated with a single motor neuron. A recording electrode was inserted in the axon hillock to measure the membrane potential when synapse A, B and then C were activated.



Which of the following best explains the data?

- A) Synapse A caused the generation of a membrane potential that exceeded the threshold potential at point 1.
- B) Summation of input from synapses A, B, and C exceeded the threshold potential at point 4.
- C) Synapse C is an inhibitory synapse lowering the internal charge at point 4.
- D) Synapse A is an excitatory synapse while synapse B is an inhibitory synapse.

32.



Based on the information depicted above, which of the following best explains the relationship between the action potential and the strength of the stimulus?

- A) A strong stimulus increases the length of time an action potential lasts.
- B) A weak stimulus creates a stronger action potential.
- C) A strong stimulus increases the frequency of the action potentials.
- D) A weak stimulus increases the duration and frequency of the action potential.

Questions 1 and 2

A study was conducted to determine the effect of a nutritional supplement containing the inhibitory neurotransmitter, GABA. A control group was given only water to drink while the experimental group was given a drink containing 500 mg of the nutritional supplement GABA. An assessment was administered to both groups. The scores are shown below.

Control Group	GABA Treatment
1587	1600
1591	1550
1600	1576
1576	1680
1593	1590

- Calculate the mean for the scores of the individuals receiving the GABA nutritional supplement. Give your answer to the nearest whole number.

⊖	●	⊘	⊘	⊘	●
		0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4
	5	5	5	5	5
	6	6	6	6	6
	7	7	7	7	7
	8	8	8	8	8
	9	9	9	9	9

- Calculate the standard deviation for the control group scores. Give your answer to the nearest hundredth.

⊖	●	⊘	⊘	⊘	●
		0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4
	5	5	5	5	5
	6	6	6	6	6
	7	7	7	7	7
	8	8	8	8	8
	9	9	9	9	9

3. Serotonin interacts with at least 15 different receptors in the body. Serotonin receptors in the human brain begin to decline after age 25. A reduction in the serotonin receptor known as 5-HT2A has been linked to depression in middle aged humans. Data from a study comparing the number of 5-HT2A receptors found in patients cells over a 10 year period are shown below.

Year of Study	5-HT2A Binding Sites per cell
Initial Year	220
Year 2	213
Year 4	207
Year 6	201
Year 8	195
Year 10	190

Use the data above to calculate the rate of decline in 5-HT2A receptors for the 10 years of this study. Give your answer to the nearest whole number.

⊖	⊙	⊙	⊙	⊙	⊙
		0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

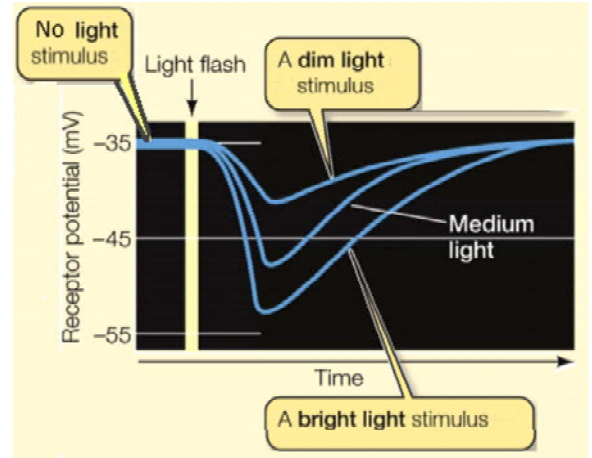
Version C

AP* Biology: Nervous System

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1. Which of the following best explains the basic function of a motor neuron?
- A) The neuron receives input from thousands of transmitting neurons and responds by either transmitting or not transmitting an action potential.
 - B) The neuron receives inputs from one transmitting neuron and can generate thousands of different types of responses.
 - C) The neuron receives input from one transmitting neuron and responds by either transmitting or not transmitting an action potential.
 - D) The neuron receives input from thousands of transmitting neurons and can generate thousands of different types of responses.

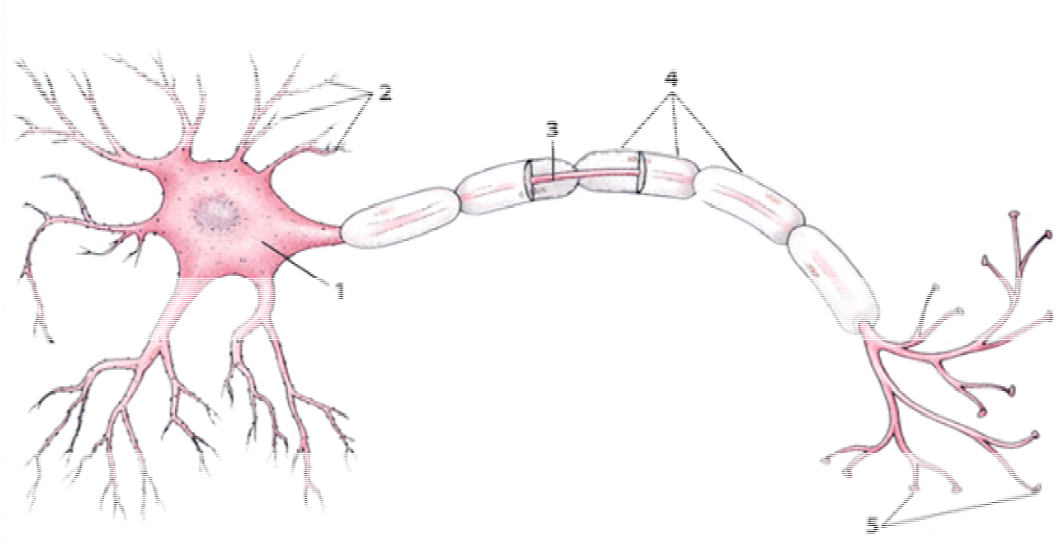
2.



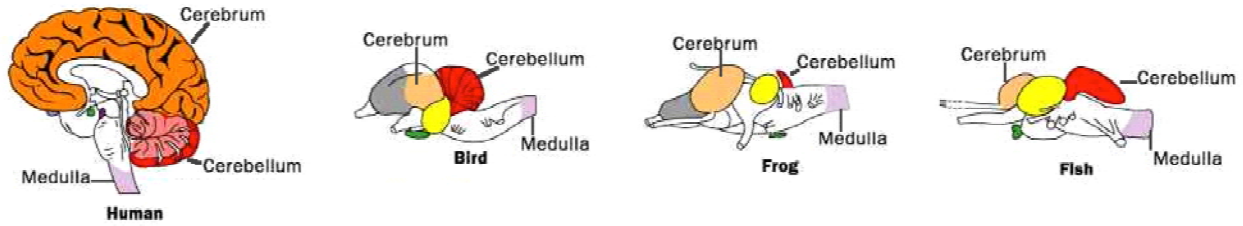
The diagram above shows the effect of dim, medium and low light on the membrane potential of receptor cells called rods. Rods are the primary source of human visual information in the dark. Based on the data, which of the following best describes the functioning of rods.

- A) Rod cells are hyperpolarized in the light and depolarized in the dark.
- B) Rod cells are hyperpolarized in the light and in the dark.
- C) Rod cells are depolarized in the light and hyperpolarized in the light.
- D) Rod cells are depolarized in the dark and in the light.

Questions 3 and 4



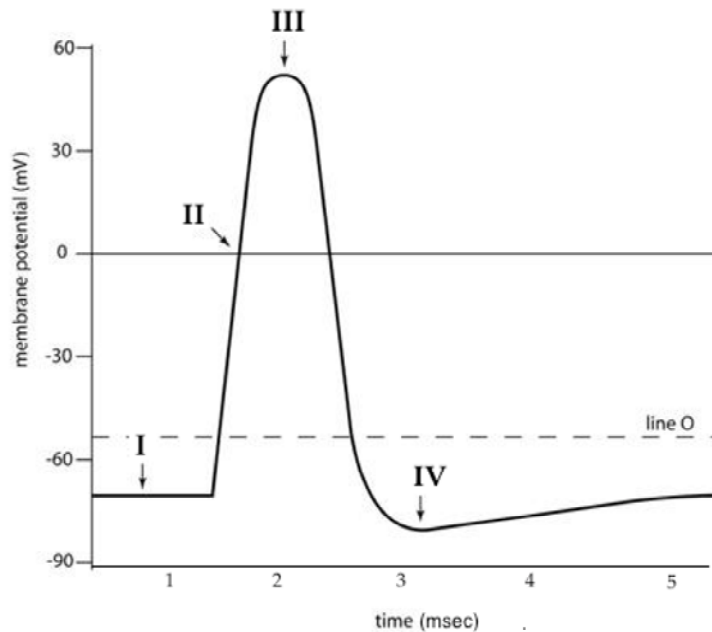
3. The neuron is the basic structure of the nervous system. Which structure is responsible for the detection of signal information?
- A) 1
B) 2
C) 4
D) 5
4. Transmission through a neuron occurs in a predictable order. Which of the following sequences represents the conduction pathway through the motor neuron shown in the diagram above?
- A) 1—3—4—5
B) 2—1—4—5
C) 5—3—1—2
D) 2—1—3—5
5. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- A) frequency of impulse production to increase
B) strength of the neuronal impulse to increase
C) impulse to move faster
D) neuron membrane to become less permeable to sodium



6. The diagram above shows the evolutionary trends in brain components of four organisms. Which of the following best describes the trends?
- As the brain evolved, proportional size of the medulla and cerebrum remained the same.
 - As the brain evolved the proportional size of medulla increased.
 - As the brain evolved the proportional size and convolutions of the cerebrum increased.
 - As the brain evolved the proportional size of the cerebellum increased.
7. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- frequency of the impulse production to increase
 - strength of the neuronal impulse to increase
 - impulse to move faster
 - neuron membrane to become more negatively polarized

Questions 8-11

The diagram below graphs an action potential. Use the Roman Numerals to indicate your answer to the following questions.



8. A neuron that is not conducting an action potential would have a membrane potential that is most like the value at
- A) I and II
 - B) I and III
 - C) I and IV
 - D) II and III
9. Which of the following best describes the line O on the graph?
- A) Line O indicates the resting potential when a neuron is not receiving information.
 - B) Line O indicates the threshold potential which when reached will result in the “all or none” response of action potential development.
 - C) Line O represents the time when the neuron is least likely to “fire” due to an influx of chlorine ions.
 - D) Line O represents the time periods when the repolarization is occurring.

10. Open sodium channels allow positively charged sodium ions to enter the neuron. Which Roman Numeral on the graph indicates the time during which the sodium channels are open?
- A) I
 - B) II
 - C) III
 - D) IV
11. Region IV on the graph indicates hyperpolarization which occurs when the difference in electrical potential between two sides of a cellular membrane changes significantly, resulting in a large electrical potential across the membrane. Which of the following describes the adaptive advantage of hyperpolarization?
- A) During hyperpolarization, an action potential cannot be generated which prevents the resending of same action potential.
 - B) During hyperpolarization, the membrane becomes impermeable to all ions and stops signal transmission.
 - C) During hyperpolarization, the voltage sensitive gates open, allowing sodium to rush in to establish the resting potential.
 - D) During hyperpolarization, the ion concentration inside and outside the neuron become equal leading to homeostasis.
12. The dendrites of olfactory receptor cells bind specific odor molecules present in the environment. The olfactory cells are located in the nasal cavity and have axons that connect to the olfactory bulb of the brain. Which of the following best describes the role of olfactory cells?
- A) They generate a response to the odor molecule.
 - B) They convert sensory stimuli into changes in membrane potential.
 - C) They integrate and interpret the sensory stimuli.
 - D) They process and discriminate among odors detected in the environment.
13. Maintenance of the ion concentration inside the neuron requires the action of sodium-potassium pumps. Which of the following best describes the action of the sodium- potassium pumps in the membrane of a motor neuron?
- A) Sodium is pumped out and chlorine is pumped into the neuron using energy supplied by ATP.
 - B) Sodium is pumped in and potassium is pumped into the neuron using energy supplied by a concentration gradient.
 - C) Sodium is pumped out and potassium is pumped into the neuron using energy supplied by ATP.
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14.

Neurological Condition	Cells Affected	Impact of disease
Bell's Palsy	Facial Nerve inflammation	Inability to control facial muscles
Multiple Sclerosis	Brain and spinal neurons	Decreased myelination of neurons
Spinal Muscular Atrophy	Motor neurons	Decreased production of SMN, a protein needed for motor neuron survival
Tourette Syndrome	Basal ganglion of brain	Involuntary movement of face, arms, limbs, or trunk

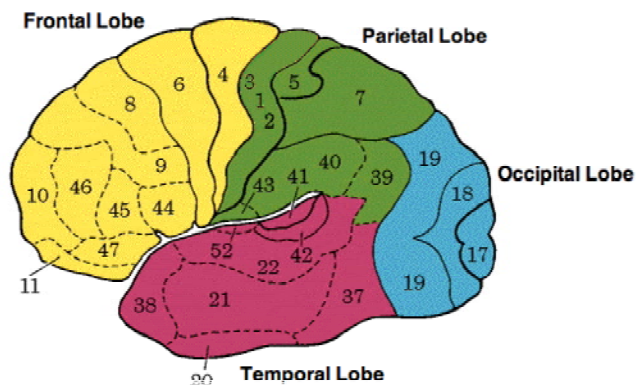
Which of the neurological conditions would be most improved by stimulating Schwann cells to work more efficiently?

- A) Bell's Palsy
- B) Multiple Sclerosis
- C) Spinal Muscular Atrophy
- D) Tourette Syndrome

15.

Functional Areas of the Brain

Function	Brodman Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41
secondary	22, 42
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	
	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye mov't	8
speech	44
Motor, tertiary	
	9, 10, 11, 45, 46, 47



Sagittal view

The human forebrain consists of several regions that have different functions. Based on the data provided, what area of the brain is likely damaged in a stroke patient who symptoms include the inability to move the right arm and slurred speech?

- A) Frontal lobe
- B) Parietal lobe
- C) Occipital lobe
- D) Temporal lobe

16.



The diagram above shows the typical pathway of information flow in a simple reflex arc in an organism. Which of the structures shown is located in the spinal cord?

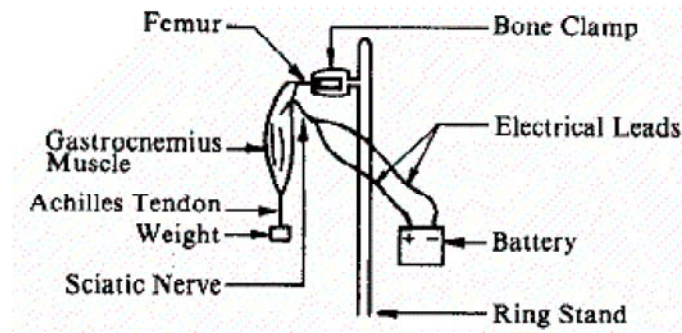
- A) Sensory receptor
 - B) Sensory neuron
 - C) Interneuron
 - D) Motor neuron
17. The following data was collected during an experiment to determine the relationship between the amount a smooth muscle was stretched and the membrane potential of its neurons.

Length of strip	Membrane potential	Firing rate	Contractile force
10 mm	-50 mV	0.8 Hz	5 g
20 mm	-40 mV	1.2 Hz	10 g
30 mm	-35 mV	1.6 Hz	15 g

Which of the following statements is supported by the data shown?

- A) As the amount the muscle was stretched increases, the rate at which action potentials are generated increases.
- B) A lower membrane potential generates a stronger contractile force.
- C) The highest rate of action potential generation occurs when the muscle is stretched the least.
- D) The firing rate increases as the contractile force decreases.

Questions 18-21 refer to the following experiment, which is designed to test the effects of several chemicals on the contractility of skeletal muscle.



A frog femur with the gastrocnemius muscle attached is installed in a bone clamp as indicated in the accompanying figure. The sciatic nerve leading to the muscle is attached to a battery via electrical leads. A small weight is suspended from the free end of the Achilles tendon.

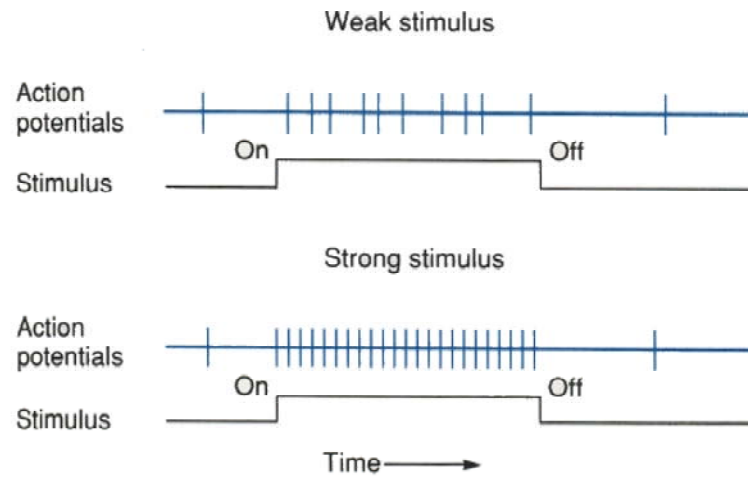
The entire preparation is rinsed in one of the five different solutions listed below. A brief stimulus is then applied to the sciatic nerve by closing the circuit to the battery. Three muscle responses are possible, depending on the solution with which the preparation has been rinsed: (1) the muscle will twitch once normally; (2) the muscle will go on sustained contraction until it is completely fatigued; and (3) the muscle will remain flaccid and not twitch at all.

Substance Added to Ringers' Rinsing Solution	Mechanism of Action
None	Provide an isotonic saline environment for the muscle
EDTA	Binds for free calcium ions
Botulin	Blocks the release of acetylcholine from pre-synaptic junctions
Malathion	Inhibits the enzyme acetylcholinesterase
Curare	Binds to the acetylcholine receptor site in the synapse or myoneural junction

18. Which of the following substances allows action potentials to reach the sarcoplasmic membrane and the transverse tubule system but prevents muscle contraction?
- A) Ringer's solution
 B) EDTA
 C) Botulin
 D) Malathion

19. Which substance allows a single muscle twitch after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
 - B) EDTA
 - C) Botulin
 - D) Malathion
20. Which substance produces a sustained contraction (tetany) after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
 - B) EDTA
 - C) Botulin
 - D) Malathion
21. Competitors of acetylcholine include which of the following?
- I. Botulin
 - II. EDTA
 - III. Curare
- A) I only
 - B) II only
 - C) III only
 - D) I, II, and III
22. Lidocaine is a local anesthetic that works as a temporary pain reliever. Lidocaine works by binding to voltage sensitive Na^+ gates on pain receptors and prevents the gates from opening. Which of the following best describes why Lidocaine is an effective anesthetic?
- A) Lidocaine limits sodium influx, which increases the production of presynaptic vesicles.
 - B) Lidocaine increases sodium influx, which stimulates the propagation of the action potential.
 - C) Lidocaine decreases sodium influx, which decreases the propagation of the action potential.
 - D) Lidocaine increases sodium influx, which decreases the release of neurotransmitters.
23. Given the steps shown below, which of the following is the correct transmission sequence at a chemical synapse?
1. Neurotransmitter binds with receptor
 2. Sodium ions rush into neuron's cytoplasm
 3. Action potential depolarizes the presynaptic membrane
 4. Ion channel opens to allow particular ion to enter cell
 5. Synaptic vesicles release neurotransmitter into the synaptic cleft
- A) 4-3-1-2-5
 - B) 2-3-5-4-1
 - C) 1-2-3-4-5
 - D) 3-2-5-1-4

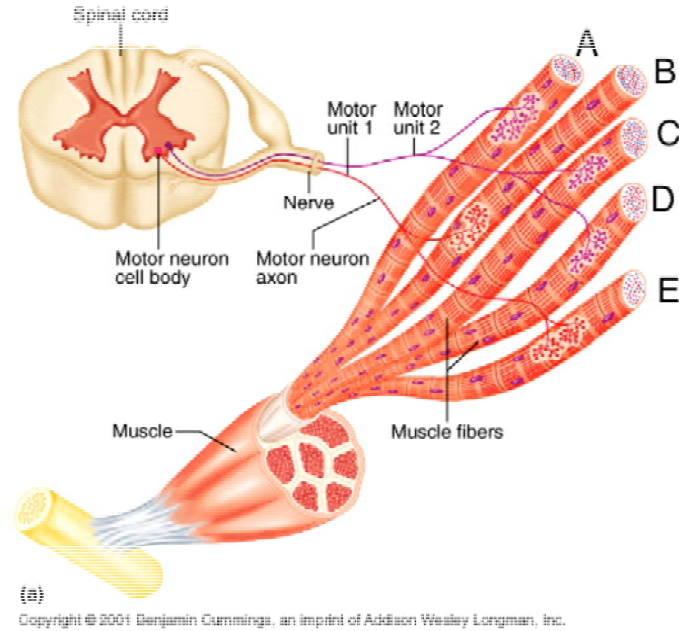
24.



Based on the information depicted above, which of the following best explains the relationship between the action potential and the strength of the stimulus?

- A) A strong stimulus increases the length of time an action potential lasts.
- B) A weak stimulus creates a stronger action potential.
- C) A strong stimulus increases the frequency of the action potentials.
- D) A weak stimulus increases the duration and frequency of the action potential.

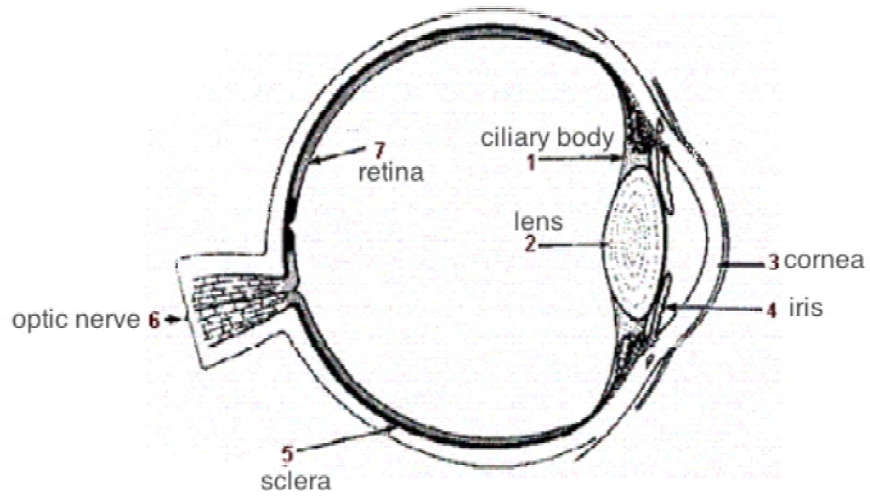
25.



Based on the information shown in the diagram above, which muscle fibers will most likely contract with the same strength and length of time?

- A) Muscle fiber A and muscle fiber B
- B) Muscle fiber B and muscle fiber C
- C) Muscle fiber C and muscle fiber D
- D) Muscle fiber D and muscle fiber E

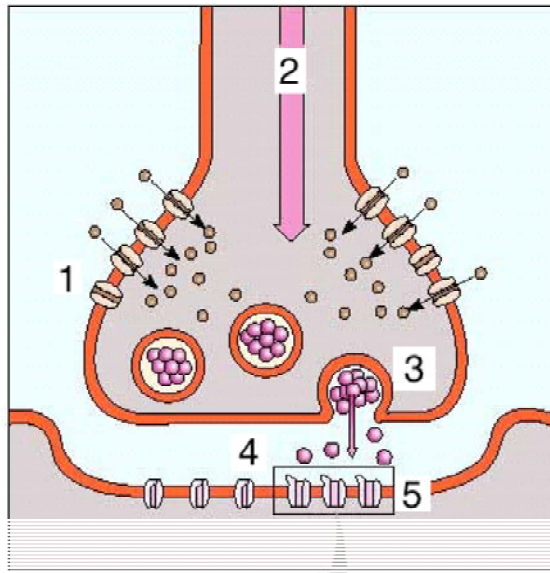
26.



Which components of the eye are areas where an action potential can be generated and conducted?

- A) 2 and 4
- B) 4 and 5
- C) 6 and 7
- D) 1 and 3

27.



Membrane proteins are critical components of nerve function. The diagram above depicts several events involved with impulse transmission from one neuron to the next. Which of the events shown does not require a membrane protein?

- A) Diffusion of a neurotransmitter
- B) Active transport of sodium
- C) Propagation of an action potential
- D) Binding of neurotransmitter

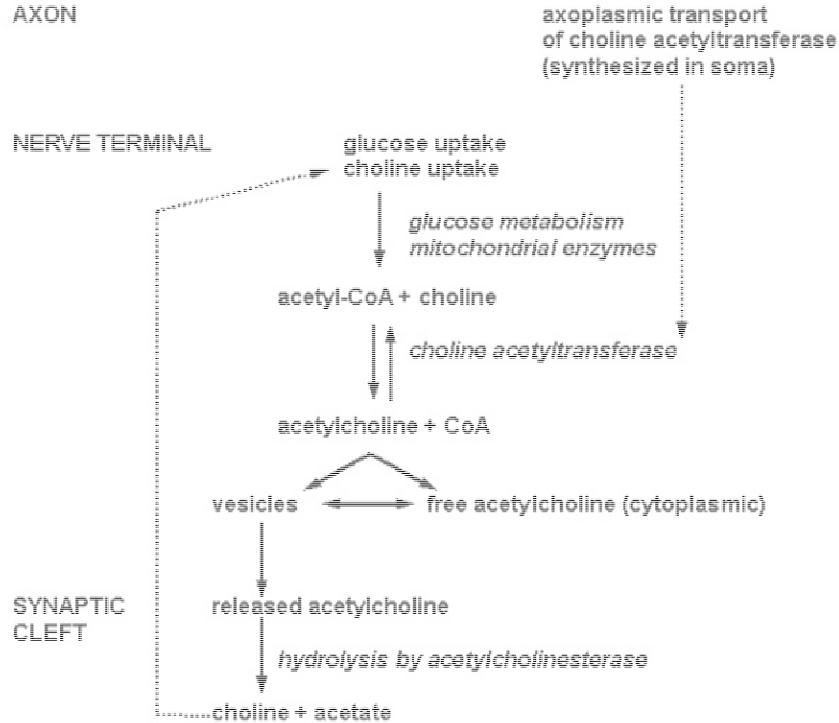
28. Schwann cells are a type of glial cells that produce myelin. In a controlled experiment, rat Schwann cells were exposed to various nonlethal levels of ethanol. The results of the experiment are shown below.

Schwann Cell Concentration <i>in situ</i> Sample				
Age of Culture (days)	Culture 1	Culture 2	Culture 3	Culture 4
	0 mM ethanol	48 mM ethanol	86 mM ethanol	172 mM ethanol
1	1.0×10^5	1.0×10^5	1.0×10^5	1.0×10^5
6	2.6×10^5	2.1×10^5	2.0×10^5	1.9×10^5
11	4.5×10^6	1.3×10^6	7.8×10^5	3.5×10^5
16	2.4×10^7	0.1×10^7	8.0×10^6	7.0×10^5

Based on this information, which of the following best represents the predicted rank order of the cultures arranged from highest to lowest levels of myelin present on day 16?

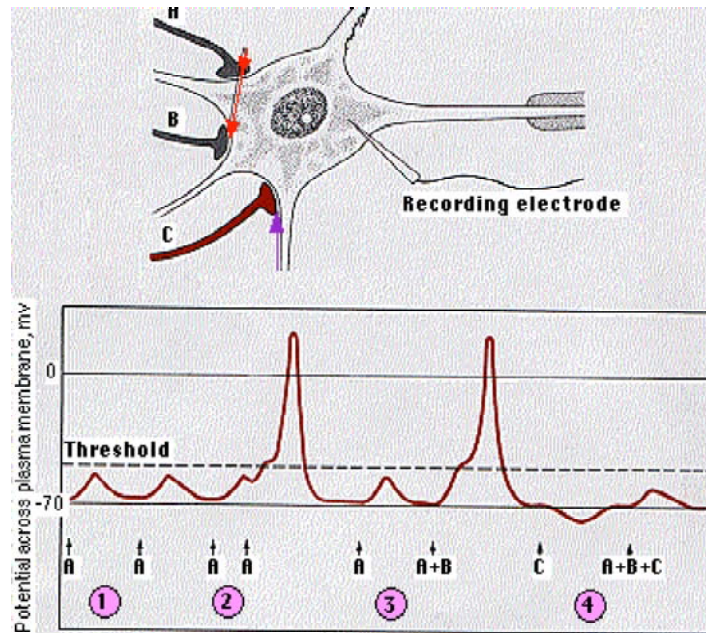
- A) Culture 4—Culture 3—Culture 2—Culture 1
 B) Culture 3—Culture 4—Culture 1—Culture 2
 C) Culture 2—Culture 1—Culture 4—Culture 3
 D) Culture 1—Culture 2—Culture 3—Culture 4
29. Which of the following would result if the sodium-potassium pumps of a neuron were inoperative?
- A) The movement of chloride ions would produce an action potential.
 B) An impulse would travel from the axon to the dendrites of the neuron.
 C) The rate of transmission of the impulse would greatly increase
 D) The action potential would never occur.

Synthesis and Release of Acetylcholine



30. Acetylcholine, a common neurotransmitter, is synthesized in the pre-synaptic end of a neuron and released into the synaptic cleft as shown in the illustration above. What would be a likely result of an increase in the amount of acetylcholinesterase present in the synaptic cleft?
- More sodium would enter the sodium/potassium ion channels of the postsynaptic dendrite
 - More potassium would enter sodium/potassium ion channels of the postsynaptic dendrite
 - Fewer sodium/potassium ion channels would be opened in the postsynaptic dendrite
 - Fewer vesicles in the pre-synaptic axon terminal would contain acetylcholine
31. Which of the following best describes the function of acetylcholinesterase in neurotransmission?
- It decomposes, providing a source of choline for muscle contraction.
 - It binds acetylcholine to receptors on the postsynaptic membrane.
 - It blocks acetylcholine reception on the post-synaptic membrane.
 - It breaks down acetylcholine, preventing neurotransmission.

32. The diagram shows three synapses associated with a single motor neuron. A recording electrode was inserted in the axon hillock to measure the membrane potential when synapse A, B and then C were activated.



Which of the following best explains the data?

- A) Synapse A caused the generation of a membrane potential that exceeded the threshold potential at point 1.
- B) Summation of input from synapses A, B, and C exceeded the threshold potential at point 4.
- C) Synapse C is an inhibitory synapse lowering the internal charge at point 4.
- D) Synapse A is an excitatory synapse while synapse B is an inhibitory synapse.

Questions 1 and 2

A study was conducted to determine the effect of a nutritional supplement containing the inhibitory neurotransmitter, GABA. A control group was given only water to drink while the experimental group was given a drink containing 500 mg of the nutritional supplement GABA. An assessment was administered to both groups. The scores are shown below.

Control Group	GABA Treatment
1587	1600
1591	1550
1600	1576
1576	1680
1593	1590

- Calculate the mean for the scores of the individuals receiving the GABA nutritional supplement. Give your answer to the nearest whole number.

⊖	⊙	⊙	⊙	⊙	⊙
		⊙	⊙	⊙	⊙
	①	①	①	①	①
	②	②	②	②	②
	③	③	③	③	③
	④	④	④	④	④
	⑤	⑤	⑤	⑤	⑤
	⑥	⑥	⑥	⑥	⑥
	⑦	⑦	⑦	⑦	⑦
	⑧	⑧	⑧	⑧	⑧
	⑨	⑨	⑨	⑨	⑨

- Calculate the standard deviation for the control group scores. Give your answer to the nearest hundredth.

⊖	⊙	⊙	⊙	⊙	⊙
		⊙	⊙	⊙	⊙
	①	①	①	①	①
	②	②	②	②	②
	③	③	③	③	③
	④	④	④	④	④
	⑤	⑤	⑤	⑤	⑤
	⑥	⑥	⑥	⑥	⑥
	⑦	⑦	⑦	⑦	⑦
	⑧	⑧	⑧	⑧	⑧
	⑨	⑨	⑨	⑨	⑨

3. Serotonin interacts with at least 15 different receptors in the body. Serotonin receptors in the human brain begin to decline after age 25. A reduction in the serotonin receptor known as 5-HT2A has been linked to depression in middle aged humans. Data from a study comparing the number of 5-HT2A receptors found in patients cells over a 10 year period are shown below.

Year of Study	5-HT2A Binding Sites per cell
Initial Year	220
Year 2	213
Year 4	207
Year 6	201
Year 8	195
Year 10	190

Use the data above to calculate the rate of decline in 5-HT2A receptors for the 10 years of this study. Give your answer to the nearest whole number.

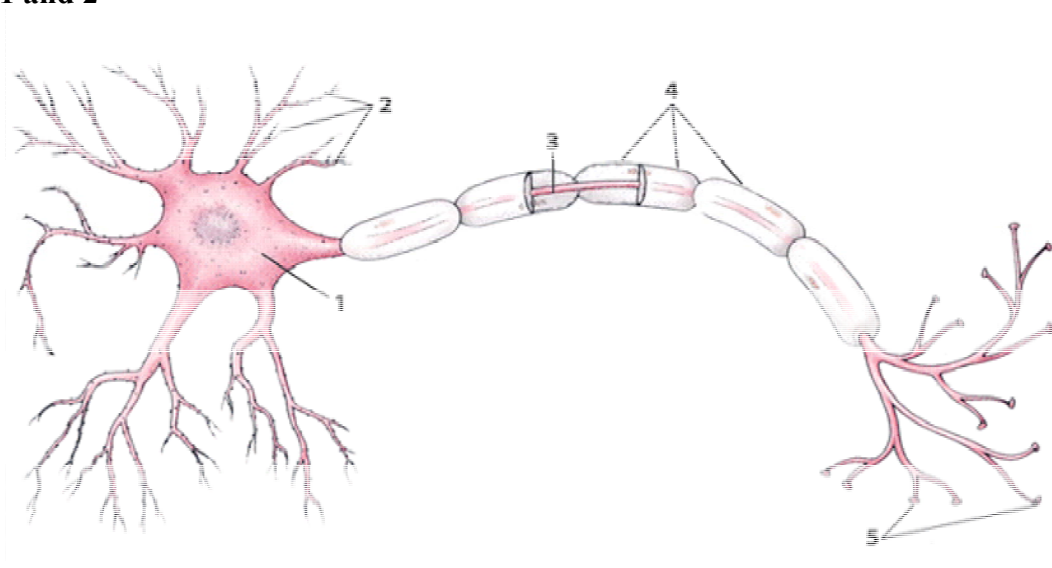
		⊘	⊘	⊘	
⊖	●	●	●	●	●
		0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Version D

AP* Biology: Nervous System

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

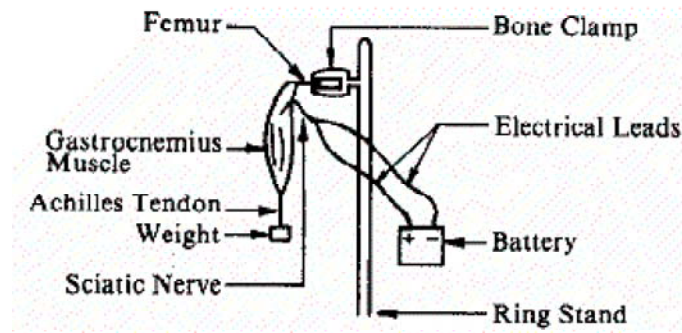
Questions 1 and 2



1. The neuron is the basic structure of the nervous system. Which structure is responsible for the detection of signal information?
 - A) 1
 - B) 2
 - C) 4
 - D) 5

2. Transmission through a neuron occurs in a predictable order. Which of the following sequences represents the conduction pathway through the motor neuron shown in the diagram above?
 - A) 1—3—4—5
 - B) 2—1—4—5
 - C) 5—3—1—2
 - D) 2—1—3—5

Questions 3-6 refer to the following experiment, which is designed to test the effects of several chemicals on the contractility of skeletal muscle.



A frog femur with the gastrocnemius muscle attached is installed in a bone clamp as indicated in the accompanying figure. The sciatic nerve leading to the muscle is attached to a battery via electrical leads. A small weight is suspended from the free end of the Achilles tendon.

The entire preparation is rinsed in one of the five different solutions listed below. A brief stimulus is then applied to the sciatic nerve by closing the circuit to the battery. Three muscle responses are possible, depending on the solution with which the preparation has been rinsed: (1) the muscle will twitch once normally; (2) the muscle will go on sustained contraction until it is completely fatigued; and (3) the muscle will remain flaccid and not twitch at all.

Substance Added to Ringers' Rinsing Solution	Mechanism of Action
None	Provide an isotonic saline environment for the muscle
EDTA	Binds for free calcium ions
Botulin	Blocks the release of acetylcholine from pre-synaptic junctions
Malathion	Inhibits the enzyme acetylcholinesterase
Curare	Binds to the acetylcholine receptor site in the synapse or myoneural junction

3. Which of the following substances allows action potentials to reach the sarcoplasmic membrane and the transverse tubule system but prevents muscle contraction?
- A) Ringer's solution
 B) EDTA
 C) Botulin
 D) Malathion

4. Competitors of acetylcholine include which of the following?
- I. Botulin
 - II. EDTA
 - III. Curare
- A) I only
 - B) II only
 - C) III only
 - D) I, II, and III
5. Which substance produces a sustained contraction (tetany) after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
 - B) EDTA
 - C) Botulin
 - D) Malathion
6. Which substance allows a single muscle twitch after a brief electrical stimulation of the sciatic nerve?
- A) Ringer's solution
 - B) EDTA
 - C) Botulin
 - D) Malathion

7.

Neurological Condition	Cells Affected	Impact of disease
Bell's Palsy	Facial Nerve inflammation	Inability to control facial muscles
Multiple Sclerosis	Brain and spinal neurons	Decreased myelination of neurons
Spinal Muscular Atrophy	Motor neurons	Decreased production of SMN, a protein needed for motor neuron survival
Tourette Syndrome	Basal ganglion of brain	Involuntary movement of face, arms, limbs, or trunk

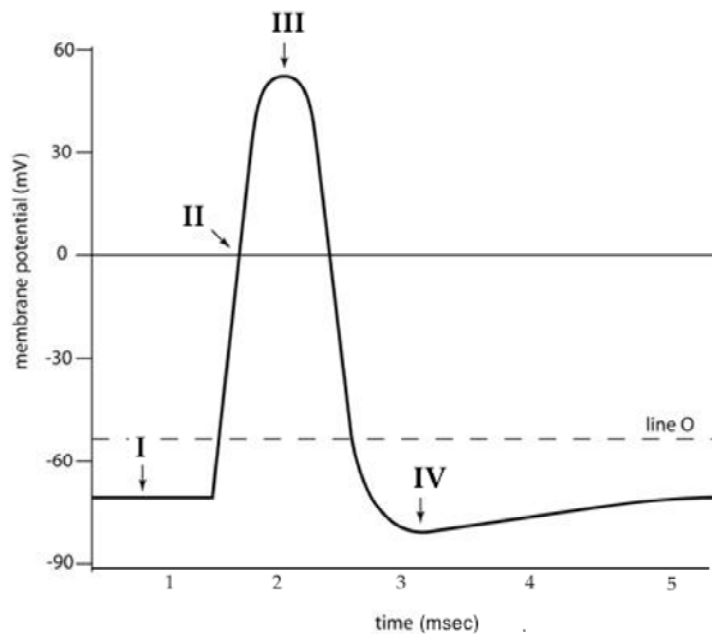
Which of the neurological conditions would be most improved by stimulating Schwann cells to work more efficiently?

- A) Bell's Palsy
- B) Multiple Sclerosis
- C) Spinal Muscular Atrophy
- D) Tourette Syndrome

8. Which of the following best explains the basic function of a motor neuron?
- The neuron receives input from thousands of transmitting neurons and responds by either transmitting or not transmitting an action potential.
 - The neuron receives inputs from one transmitting neuron and can generate thousands of different types of responses.
 - The neuron receives input from one transmitting neuron and responds by either transmitting or not transmitting an action potential.
 - The neuron receives input from thousands of transmitting neurons and can generate thousands of different types of responses.

Questions 9-12

The diagram below graphs an action potential. Use the Roman Numerals to indicate your answer to the following questions.



9. A neuron that is not conducting an action potential would have a membrane potential that is most like the value at
- I and II
 - I and III
 - I and IV
 - II and III

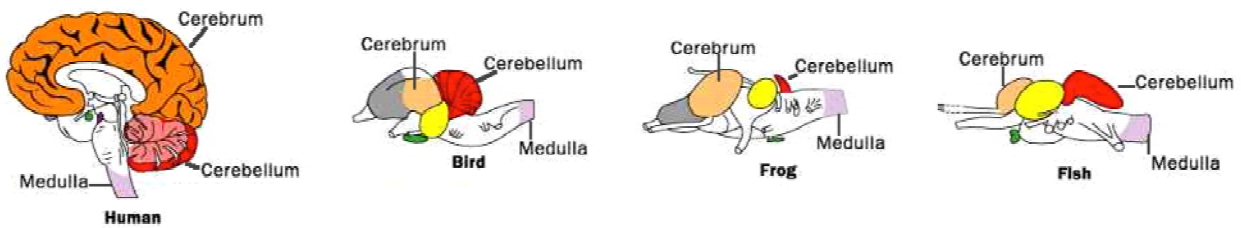
10. Region IV on the graph indicates hyperpolarization which occurs when the difference in electrical potential between two sides of a cellular membrane changes significantly, resulting in a large electrical potential across the membrane. Which of the following describes the adaptive advantage of hyperpolarization?
- A) During hyperpolarization, an action potential cannot be generated which prevents the resending of same action potential.
 - B) During hyperpolarization, the membrane becomes impermeable to all ions and stops signal transmission.
 - C) During hyperpolarization, the voltage sensitive gates open, allowing sodium to rush in to establish the resting potential.
 - D) During hyperpolarization, the ion concentration inside and outside the neuron become equal leading to homeostasis.
11. Which of the following best describes the line O on the graph?
- A) Line O indicates the resting potential when a neuron is not receiving information.
 - B) Line O indicates the threshold potential which when reached will result in the “all or none” response of action potential development.
 - C) Line O represents the time when the neuron is least likely to “fire” due to an influx of chlorine ions.
 - D) Line O represents the time periods when the repolarization is occurring.
12. Open sodium channels allow positively charged sodium ions to enter the neuron. Which Roman Numeral on the graph indicates the time during which the sodium channels are open?
- A) I
 - B) II
 - C) III
 - D) IV
13. Which of the following would result if the sodium-potassium pumps of a neuron were inoperative?
- A) The movement of chloride ions would produce an action potential.
 - B) An impulse would travel from the axon to the dendrites of the neuron.
 - C) The rate of transmission of the impulse would greatly increase
 - D) The action potential would never occur.

14.



The diagram above shows the typical pathway of information flow in a simple reflex arc in an organism. Which of the structures shown is located in the spinal cord?

- A) Sensory receptor
- B) Sensory neuron
- C) Interneuron
- D) Motor neuron

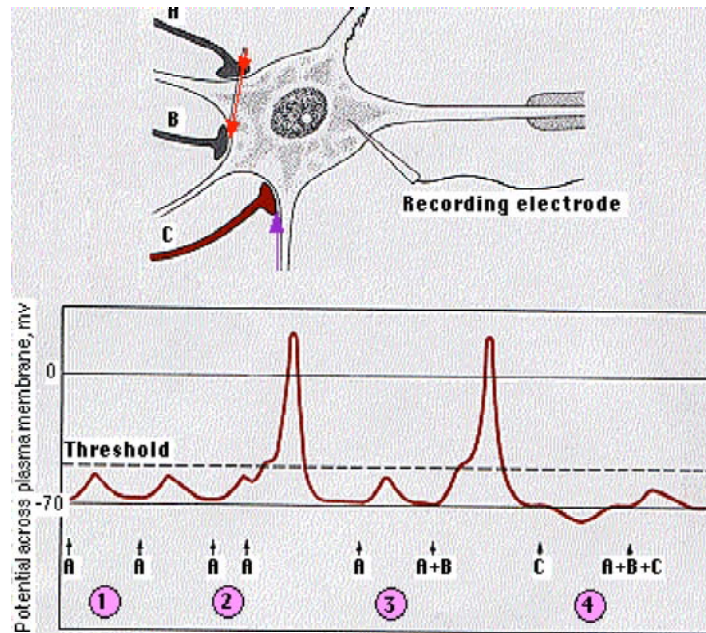


15.

The diagram above shows the evolutionary trends in brain components of four organisms. Which of the following best describes the trends?

- A) As the brain evolved, proportional size of the medulla and cerebrum remained the same.
- B) As the brain evolved the proportional size of medulla increased.
- C) As the brain evolved the proportional size and convolutions of the cerebrum increased.
- D) As the brain evolved the proportional size of the cerebellum increased.

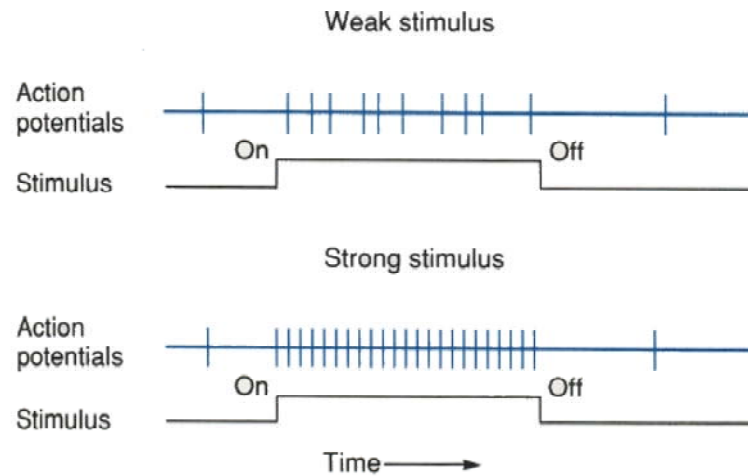
16. The diagram shows three synapses associated with a single motor neuron. A recording electrode was inserted in the axon hillock to measure the membrane potential when synapse A, B and then C were activated.



Which of the following best explains the data?

- A) Synapse A caused the generation of a membrane potential that exceeded the threshold potential at point 1.
- B) Summation of input from synapses A, B, and C exceeded the threshold potential at point 4.
- C) Synapse C is an inhibitory synapse lowering the internal charge at point 4.
- D) Synapse A is an excitatory synapse while synapse B is an inhibitory synapse.

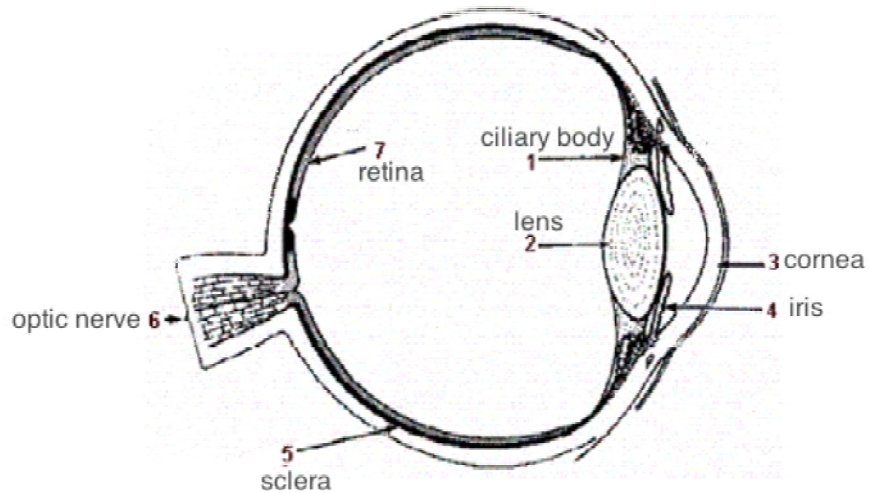
17.



Based on the information depicted above, which of the following best explains the relationship between the action potential and the strength of the stimulus?

- A) A strong stimulus increases the length of time an action potential lasts.
- B) A weak stimulus creates a stronger action potential.
- C) A strong stimulus increases the frequency of the action potentials.
- D) A weak stimulus increases the duration and frequency of the action potential.

18.



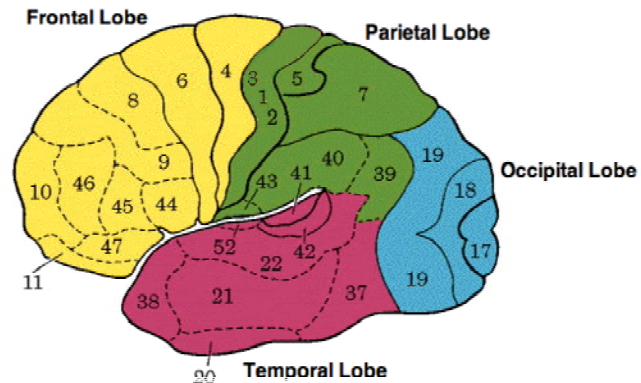
Which components of the eye are areas where an action potential can be generated and conducted?

- A) 2 and 4
 - B) 4 and 5
 - C) 6 and 7
 - D) 1 and 3
19. Maintenance of the ion concentration inside the neuron requires the action of sodium-potassium pumps. Which of the following best describes the action of the sodium- potassium pumps in the membrane of a motor neuron?
- A) Sodium is pumped out and chlorine is pumped into the neuron using energy supplied by ATP.
 - B) Sodium is pumped in and potassium is pumped into the neuron using energy supplied by a concentration gradient.
 - C) Sodium is pumped out and potassium is pumped into the neuron using energy supplied by ATP.
 - D) Sodium is pumped out while both potassium and chlorine are pumped into the neuron using energy supplied by a concentration gradient.

20.

Functional Areas of the Brain

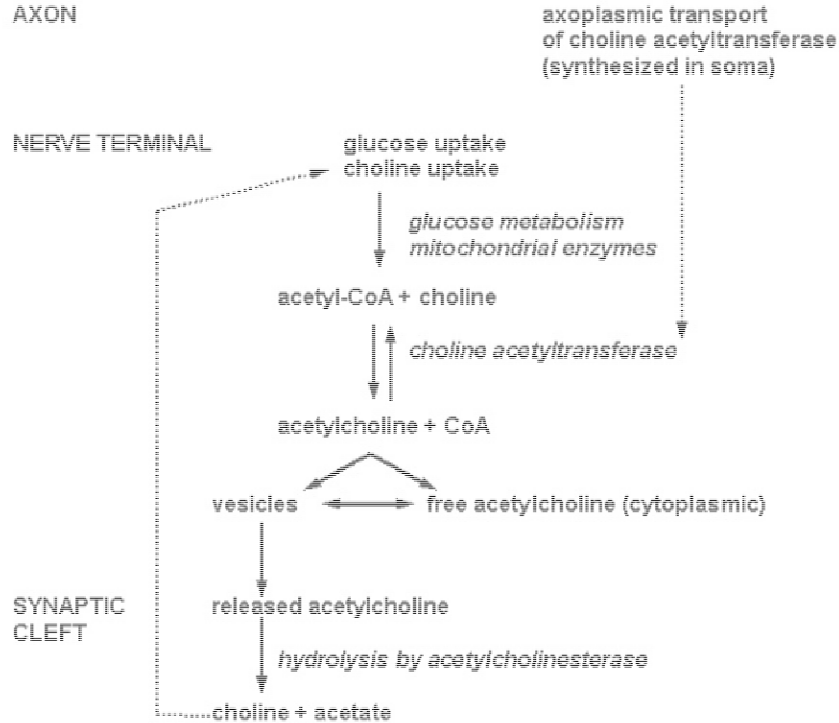
Function	Brodmann Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41
secondary	22, 42
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye mov't	8
speech	44
Motor, tertiary	9, 10, 11, 45, 46, 47

**Sagittal view**

The human forebrain consists of several regions that have different functions. Based on the data provided, what area of the brain is likely damaged in a stroke patient who symptoms include the inability to move the right arm and slurred speech?

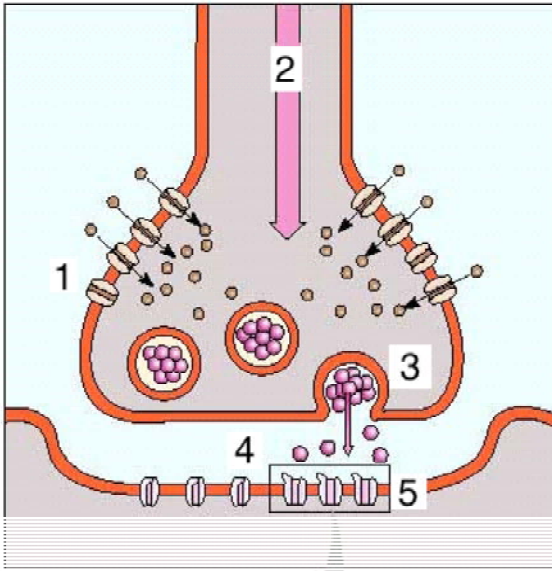
- A) Frontal lobe
- B) Parietal lobe
- C) Occipital lobe
- D) Temporal lobe

Synthesis and Release of Acetylcholine



21. Acetylcholine, a common neurotransmitter, is synthesized in the pre-synaptic end of a neuron and released into the synaptic cleft as shown in the illustration above. What would be a likely result of an increase in the amount of acetylcholinesterase present in the synaptic cleft?
- A) More sodium would enter the sodium/potassium ion channels of the postsynaptic dendrite
 - B) More potassium would enter sodium/potassium ion channels of the postsynaptic dendrite
 - C) Fewer sodium/potassium ion channels would be opened in the postsynaptic dendrite
 - D) Fewer vesicles in the pre-synaptic axon terminal would contain acetylcholine

22.



Membrane proteins are critical components of nerve function. The diagram above depicts several events involved with impulse transmission from one neuron to the next. Which of the events shown does not require a membrane protein?

- A) Diffusion of a neurotransmitter
- B) Active transport of sodium
- C) Propagation of an action potential
- D) Binding of neurotransmitter

24. Given the steps shown below, which of the following is the correct transmission sequence at a chemical synapse?

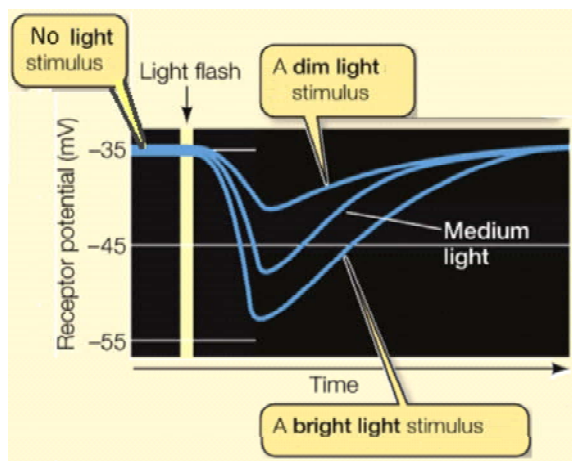
1. Neurotransmitter binds with receptor
2. Sodium ions rush into neuron's cytoplasm
3. Action potential depolarizes the presynaptic membrane
4. Ion channel opens to allow particular ion to enter cell
5. Synaptic vesicles release neurotransmitter into the synaptic cleft

- A) 4-3-1-2-5
- B) 2-3-5-4-1
- C) 1-2-3-4-5
- D) 3-2-5-1-4

23. Lidocaine is a local anesthetic that works as a temporary pain reliever. Lidocaine works by binding to voltage sensitive Na^+ gates on pain receptors and prevents the gates from opening. Which of the following best describes why Lidocaine is an effective anesthetic?

- A) Lidocaine limits sodium influx, which increases the production of presynaptic vesicles.
- B) Lidocaine increases sodium influx, which stimulates the propagation of the action potential.
- C) Lidocaine decreases sodium influx, which decreases the propagation of the action potential.
- D) Lidocaine increases sodium influx, which decreases the release of neurotransmitters.

25.



The diagram above shows the effect of dim, medium and low light on the membrane potential of receptor cells called rods. Rods are the primary source of human visual information in the dark. Based on the data, which of the following best describes the functioning of rods.

- A) Rod cells are hyperpolarized in the light and depolarized in the dark.
 B) Rod cells are hyperpolarized in the light and in the dark.
 C) Rod cells are depolarized in the light and hyperpolarized in the light.
 D) Rod cells are depolarized in the dark and in the light.
26. Schwann cells are a type of glial cells that produce myelin. In a controlled experiment, rat Schwann cells were exposed to various nonlethal levels of ethanol. The results of the experiment are shown below.

Schwann Cell Concentration <i>in situ</i> Sample				
Age of Culture (days)	Culture 1	Culture 2	Culture 3	Culture 4
	0 mM ethanol	48 mM ethanol	86 mM ethanol	172 mM ethanol
1	1.0×10^5	1.0×10^5	1.0×10^5	1.0×10^5
6	2.6×10^5	2.1×10^5	2.0×10^5	1.9×10^5
11	4.5×10^6	1.3×10^6	7.8×10^5	3.5×10^5
16	2.4×10^7	0.1×10^7	8.0×10^6	7.0×10^5

Based on this information, which of the following best represents the predicted rank order of the cultures arranged from highest to lowest levels of myelin present on day 16?

- A) Culture 4—Culture 3—Culture 2—Culture 1
 B) Culture 3—Culture 4—Culture 1—Culture 2
 C) Culture 2—Culture 1—Culture 4—Culture 3
 D) Culture 1—Culture 2—Culture 3—Culture 4

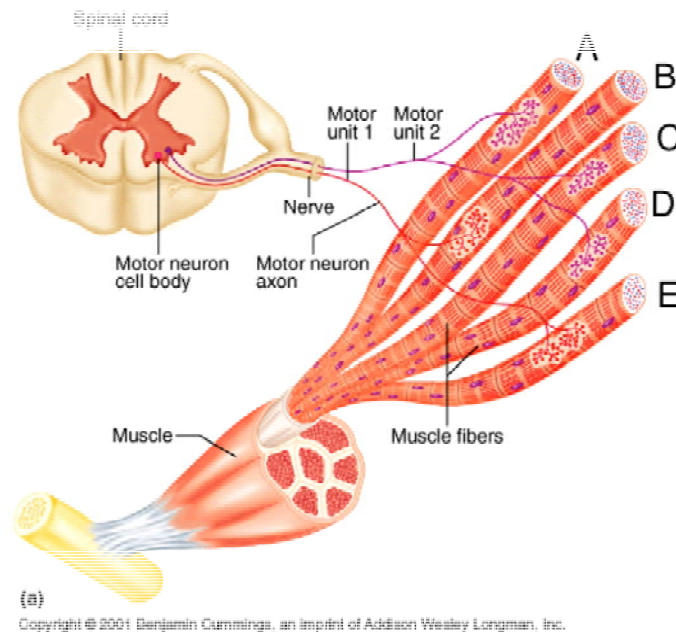
27. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- A) frequency of the impulse production to increase
 - B) strength of the neuronal impulse to increase
 - C) impulse to move faster
 - D) neuron membrane to become more negatively polarized
28. The dendrites of olfactory receptor cells bind specific odor molecules present in the environment. The olfactory cells are located in the nasal cavity and have axons that connect to the olfactory bulb of the brain. Which of the following best describes the role of olfactory cells?
- A) They generate a response to the odor molecule.
 - B) They convert sensory stimuli into changes in membrane potential.
 - C) They integrate and interpret the sensory stimuli.
 - D) They process and discriminate among odors detected in the environment.
29. If a stimulus on the receptor portion of a sensory neuron is above the threshold level, a further increase in the intensity of this stimulus will most likely cause the
- A) frequency of impulse production to increase
 - B) strength of the neuronal impulse to increase
 - C) impulse to move faster
 - D) neuron membrane to become less permeable to sodium
30. Which of the following best describes the function of acetylcholinesterase in neurotransmission?
- A) It decomposes, providing a source of choline for muscle contraction.
 - B) It binds acetylcholine to receptors on the postsynaptic membrane.
 - C) It blocks acetylcholine reception on the post-synaptic membrane.
 - D) It breaks down acetylcholine, preventing neurotransmission.

31. The following data was collected during an experiment to determine the relationship between the amount a smooth muscle was stretched and the membrane potential of its neurons.

Length of strip	Membrane potential	Firing rate	Contractile force
10 mm	-50 mV	0.8 Hz	5 g
20 mm	-40 mV	1.2 Hz	10 g
30 mm	-35 mV	1.6 Hz	15 g

Which of the following statements is supported by the data shown?

- A) As the amount the muscle was stretched increases, the rate at which action potentials are generated increases.
- B) A lower membrane potential generates a stronger contractile force.
- C) The highest rate of action potential generation occurs when the muscle is stretched the least.
- D) The firing rate increases as the contractile force decreases.
- 32.



Based on the information shown in the diagram above, which muscle fibers will most likely contract with the same strength and length of time?

- A) Muscle fiber A and muscle fiber B
- B) Muscle fiber B and muscle fiber C
- C) Muscle fiber C and muscle fiber D
- D) Muscle fiber D and muscle fiber E

Questions 1 and 2

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⊖	●	⊘	⊘	⊘	●
		0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4
	5	5	5	5	5
	6	6	6	6	6
	7	7	7	7	7
	8	8	8	8	8
	9	9	9	9	9

- Calculate the standard deviation for the control group scores. Give your answer to the nearest hundredth.

⊖	●	⊘	⊘	⊘	●
		0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4
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	6	6	6	6	6
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3. Serotonin interacts with at least 15 different receptors in the body. Serotonin receptors in the human brain begin to decline after age 25. A reduction in the serotonin receptor known as 5-HT2A has been linked to depression in middle aged humans. Data from a study comparing the number of 5-HT2A receptors found in patients cells over a 10 year period are shown below.

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Year 6	201
Year 8	195
Year 10	190

Use the data above to calculate the rate of decline in 5-HT2A receptors for the 10 years of this study. Give your answer to the nearest whole number.

		⊘	⊘	⊘	
⊖	●	●	●	●	●
		0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9