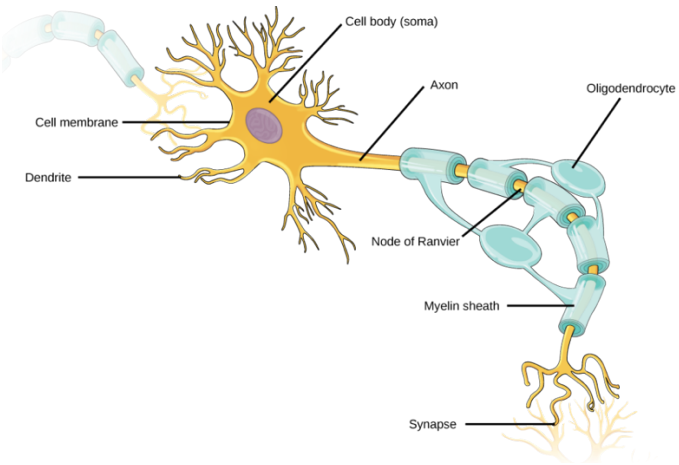
Biology 2e
Unit 7: Animal Structure and Function
Chapter 35: The Nervous System

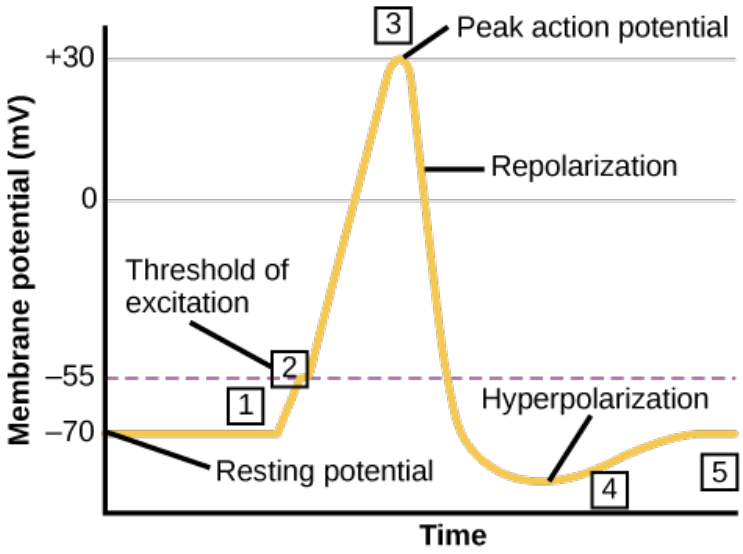
Visual Connection Questions

1. Which of the following statements is false?



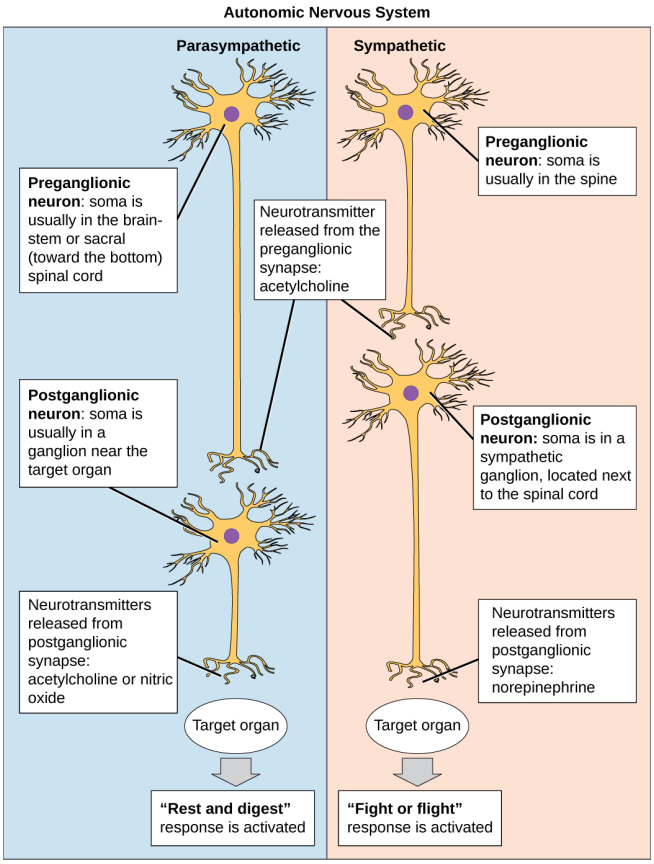
b. Myelin sheath provides an insulating layer to the dendrites.

2. Potassium channel blockers, such as amiodarone and procainamide, which are used to treat abnormal electrical activity in the heart, called cardiac dysrhythmia, impede the movement of K+ through voltage-gated K+ channels. Which part of the action potential would you expect potassium channels to affect?



Potassium channel blockers slow the repolarization phase, but have no effect on depolarization.

3. Which of the following statements is false?



d. Parasympathetic neurons are responsible for releasing norepinephrine on the target organ, while sympathetic neurons are responsible for releasing acetylcholine.

Review Questions

4. Neurons contain _____, which can receive signals from other neurons.

c. dendrites

5. A(n) _____ neuron has one axon and one dendrite extending directly from the cell body.

b. bipolar

6. Glia that provide myelin for neurons in the brain are called _____.

b. oligodendrocytes

7. Meningitis is a viral or bacterial infection of the brain. Which cell type is the first to have its function disrupted during meningitis

a. Astrocytes

8. For a neuron to fire an action potential, its membrane must reach _____.

b. the threshold of excitation

9. After an action potential, the opening of additional voltage-gated _____ channels and the inactivation of sodium channels, cause the membrane to return to its resting membrane potential.
b. potassium

10. What is the term for protein channels that connect two neurons at an electrical synapse?
c. gap junction protein

11. Which of the following molecules is **not** involved in the maintenance of the resting membrane potential?
d. Calcium cations

12. The _____ lobe contains the visual cortex
d. occipital

13. The _____ connects the two cerebral hemispheres.
b. corpus callosum

14. Neurons in the _____ control motor reflexes.
b. spinal cord

15. Phineas Gage was a 19th century railroad worker who survived an accident that drove a large iron rod through his head. If the injury resulted in him becoming temperamental and capricious what part of his brain was damaged?
a. Frontal lobe

16. Activation of the sympathetic nervous system causes:
c. an increased heart rate

17. Where are parasympathetic preganglionic cell bodies located?
b. brainstem

18. _____ is released by motor nerve endings onto muscle.
a. Acetylcholine

19. Parkinson's disease is a caused by the degeneration of neurons that release _____.
b. dopamine

20. _____ medications are often used to treat patients with ADHD.
c. Stimulant

21. Strokes are often caused by _____.
b. blood clots or burst blood vessels

22. Why is it difficult to identify the cause of many nervous system disorders?
d. All of the above. (The genes associated with the diseases are not known, There are no obvious defects in brain structure, The onset and display of symptoms varies between patients)

23. Why do many patients with neurodevelopmental disorders develop secondary disorders?
d. Dysfunction in the brain can affect many aspects of the body.

Critical Thinking Questions

24. How are neurons similar to other cells? How are they unique?
Neurons contain organelles common to all cells, such as a nucleus and mitochondria. They are unique because they contain dendrites, which can receive signals from other neurons, and axons that can send these signals to other cells.

25. Multiple sclerosis causes demyelination of axons in the brain and spinal cord. Why is this problematic?
Myelin provides insulation for signals traveling along axons. Without myelin, signal transmission can slow down and degrade over time. This would slow down neuronal communication across the nervous system and affect all downstream functions.

26. Many neurons have only a single axon, but many terminals at the end of the axon. How does this end structure of the axon support its function?
A single axon means that a neuron can only send one signal at a time (one electrical impulse down the length of the axon). However, since the axon has multiple terminals it can send the signal to several other cells at once. This ensures that the signal is rapidly propagated to the rest of the body.

27. How does myelin aid propagation of an action potential along an axon? How do the nodes of Ranvier help this process?
Myelin prevents the leak of current from the axon. Nodes of Ranvier allow the action potential to be regenerated at specific points along the axon. They also save energy for the cell since voltage-gated ion channels and sodium-potassium transporters are not needed along myelinated portions of the axon.

28. What are the main steps in chemical neurotransmission?
An action potential travels along an axon until it depolarizes the membrane at an axon terminal. Depolarization of the membrane causes voltage gated Ca^{2+} channels to open and Ca^{2+} to enter the cell. The intracellular calcium influx causes synaptic vesicles containing neurotransmitter to fuse with the presynaptic membrane. The neurotransmitter diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane. Depending on the specific neurotransmitter and postsynaptic receptor, this action can cause positive (excitatory postsynaptic potential) or negative (inhibitory postsynaptic potential) ions to enter the cell.

29. Describe how long-term potentiation can lead to a nicotine addiction.

Long-term potentiation describes the process whereby exposure to a stimulus increases the likelihood that a neuron will depolarize in response to that stimulus in the future. Nicotine exposure causes long-term potentiation of neurons in the amygdala, and activates reward centers of the brain. As nicotine exposure continues, long-term potentiation reinforces the activation of the reward pathways in response to nicotine consumption.

30. What methods can be used to determine the function of a particular brain region?

To determine the function of a specific brain area, scientists can look at patients who have damage in that brain area and see what symptoms they exhibit. Researchers can disable the brain structure temporarily using transcranial magnetic stimulation. They can disable or remove the area in an animal model. fMRI can be used to correlate specific functions with increased blood flow to brain regions.

31. What are the main functions of the spinal cord?

The spinal cord transmits sensory information from the body to the brain and motor commands from the brain to the body through its connections with peripheral nerves. It also controls motor reflexes.

32. Alzheimer's disease involves three of the four lobes of the brain. Identify one of the involved lobes and describe the lobe's symptoms associated with the disease.

Potential answers:
1. Frontal lobe. Alzheimer's patients experience changes in personality, judgment, and behavior.
2. Parietal lobe. Alzheimer's patients experience difficulties with recalling and using language as disease progresses.
3. Temporal lobe. The hippocampus is one of the main areas of the brain affected in Alzheimer's disease. Patients lose the ability to make new memories and access memories.

33. What are the main differences between the sympathetic and parasympathetic branches of the autonomic nervous system?

The sympathetic nervous system prepares the body for "fight or flight," whereas the parasympathetic nervous system allows the body to "rest and digest." Sympathetic neurons release norepinephrine onto target organs; parasympathetic neurons release acetylcholine. Sympathetic neuron cell bodies are located in sympathetic ganglia. Parasympathetic neuron cell bodies are located in the brainstem and sacral spinal cord. Activation of the sympathetic nervous system increases heart rate and blood pressure and decreases digestion and blood flow to the skin. Activation of the parasympathetic nervous system decreases heart rate and blood pressure and increases digestion and blood flow to the skin.

34. What are the main functions of the sensorysomatic nervous system?

The sensory-somatic nervous system transmits sensory information from the skin, muscles, and sensory organs to the CNS. It also sends motor commands from the CNS to the muscles, causing them to contract.

35. Describe how the sensory-somatic nervous system reacts by reflex to a person touching something hot. How does this allow for rapid responses in potentially dangerous situations?

A person's skin comes into contact with a hot object, and the high temperature is recognized by the thermoreceptors of a sensory neuron. The signal is relayed to the spinal cord, and sent to a motor neuron. The motor neuron relays the signal to its axon, and produces acetylcholine to contract the muscle that will pull the person away from the hot object. By connecting the sensory and motor neurons in the spinal cord (instead of integrating the signal in the brain) the body can respond faster.

36. Scientists have suggested that the autonomic nervous system is not well-adapted to modern human life. How is the sympathetic nervous system an ineffective response to the everyday challenges faced by modern humans?

Many events in modern human life are not physical dangers; instead they are events we think of as "stress." Finding the money to pay your student loans or being nervous before a test still activate the sympathetic nervous system, but these situations do not require the fight-or-flight response to survive.

37. What are the main symptoms of Alzheimer's disease?

Symptoms of Alzheimer's disease include disruptive memory loss, confusion about time or place, difficulties planning or executing tasks, poor judgment, and personality changes.

38. What are possible treatments for patients with major depression?

Possible treatments for patients with major depression include psychotherapy and prescription medications. MAO inhibitor drugs inhibit the breakdown of certain neurotransmitters (including dopamine, serotonin, norepinephrine) in the synaptic cleft. SSRI medications inhibit the reuptake of serotonin into the presynaptic neuron.