Mastering A&P Neurophysiology Practice Test (Sample)

Study Guide

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Questions

1. **What is the function of the neurotransmitter acetylcholine?**
   - A. To modulate pain perception
   - B. To transmit signals across synapses
   - C. To facilitate the return of neurons to resting potential
   - D. To enhance blood flow to the brain

2. **In a(n) ________ synapse, current flows directly between cells.**
   - A. Chemical synapse
   - B. Electrical synapse
   - C. Axodendritic synapse
   - D. Axosomatic synapse

3. **Which ion primarily causes hyperpolarization when its channels open?**
   - A. Sodium
   - B. Potassium
   - C. Calcium
   - D. Chloride

4. **Which type of synapse is most common in the nervous system?**
   - A. Electrical synapse
   - B. Chemical synapse
   - C. Axodendritic synapse
   - D. Axosomatic synapse

5. **What is the role of the sodium-potassium pump?**
   - A. To generate neurotransmitters for communication
   - B. To maintain the resting membrane potential by actively transporting sodium out and potassium into the cell
   - C. To create action potentials in the neuron
   - D. To promote the release of hormones into the bloodstream

6. What type of channels open or close in response to binding specific molecules?

A. Voltage-gated channels.

B. Leak channels.

C. Chemically gated channels.

D. Mechanically gated channels.

7. At the normal resting membrane potential of a typical neuron, its sodium-potassium exchange pump transports how many intracellular sodium ions for how many extracellular potassium ions?

A. 2 intracellular sodium ions for 3 extracellular potassium ions.

B. 3 intracellular sodium ions for 2 extracellular potassium ions.

C. 1 intracellular sodium ion for 1 extracellular potassium ion.

D. 4 intracellular sodium ions for 3 extracellular potassium ions.

8. What describes the process of membrane repolarization?

A. Increased influx of sodium ions

B. Return to a more negative membrane potential

C. Excessive potassium ion influx

D. Constant resting membrane potential

9. What is one important function of the integration center in a reflex arc?

A. To relay messages to muscles directly

B. To process sensory input and generate motor output

C. To initiate sensation

D. To complete muscle contraction

10. What type of summation occurs when multiple EPSPs occur at the same time in different locations on the neuron?

A. Temporal summation

B. Spatial summation

C. Inhibitory summation

D. Action potential summation

Answers

1. B
2. B
3. B
4. B
5. B
6. C
7. B
8. B
9. B
10. B

Explanations

1. What is the function of the neurotransmitter acetylcholine?

A. To modulate pain perception

B. To transmit signals across synapses

C. To facilitate the return of neurons to resting potential

D. To enhance blood flow to the brain

Acetylcholine plays a crucial role in the transmission of signals across synapses, making it a vital neurotransmitter in both the central and peripheral nervous systems. Its primary function involves binding to receptors on the postsynaptic membrane, which results in various excitatory or inhibitory effects, depending on the type of receptor activated. In the peripheral nervous system, acetylcholine is essential for the communication between motor neurons and skeletal muscles, leading to muscle contraction. In the central nervous system, it is involved in various functions such as attention, memory, and learning. By facilitating the communication between neurons, acetylcholine ensures that signals are effectively and efficiently transmitted, which is vital for proper neurological function. This neurotransmitter's diverse roles in signal transmission pervade numerous physiological processes, making it fundamental to our understanding of neurophysiology.

2. In a(n) _______ synapse, current flows directly between cells.

A. Chemical synapse

B. Electrical synapse

C. Axodendritic synapse

D. Axosomatic synapse

In an electrical synapse, current flows directly between cells through gap junctions. These specialized connections allow ions and small molecules to move freely from one cell to another, creating a direct passage for electrical signals. This type of synapse enables rapid communication and is critical in regions where quick responses are necessary, such as in certain reflex pathways and in cardiac muscle. The direct transfer of electrical activity allows for synchronous activity and is particularly important in coordinating actions between neighboring cells. Chemical synapses, on the other hand, involve the release of neurotransmitters from one neuron that bind to receptors on another neuron, resulting in a delay in signal transmission. Axodendritic and axosomatic synapses refer to the specific locations where synapses occur (on dendrites or cell bodies, respectively) but do not indicate the mechanism of current flow between cells. Thus, these options do not describe the direct electrical connection characteristic of electrical synapses.

3. Which ion primarily causes hyperpolarization when its channels open?

A. Sodium

B. Potassium

C. Calcium

D. Chloride

Hyperpolarization occurs when the membrane potential of a neuron becomes more negative than its resting potential. This typically results from the opening of ion channels that allow certain ions to flow across the neuronal membrane. When potassium channels open, potassium ions (K+) flow out of the cell due to the concentration gradient, as there is a higher concentration of potassium inside the cell compared to the outside. As positively charged potassium ions exit, the interior of the neuron becomes more negatively charged relative to the outside, leading to hyperpolarization. While other ions can influence the membrane potential, potassium is the primary ion associated with the hyperpolarization phase of action potentials in neurons. This mechanism helps to establish the resting membrane potential and facilitates the refractory period following an action potential, thereby regulating neuronal excitability and firing rates. In contrast, sodium ions would cause depolarization, calcium ions might contribute to various signaling functions, and chloride ions, when open, can also lead to hyperpolarization but are not the primary contributors in most neurons compared to potassium. Thus, the opening of potassium channels is a key process underpinning hyperpolarization in neuronal activity.

4. Which type of synapse is most common in the nervous system?

A. Electrical synapse

B. Chemical synapse

C. Axodendritic synapse

D. Axosomatic synapse

Chemical synapses are the most common type of synapse found in the nervous system. They enable communication between neurons through the release of neurotransmitters, which are chemical messengers. When an electrical signal, or action potential, reaches the end of a neuron, it triggers the release of these neurotransmitters into the synaptic cleft, the tiny gap between neurons. The neurotransmitters then bind to receptors on the postsynaptic neuron, leading to a response that can either excite or inhibit the next neuron. The prevalence of chemical synapses allows for complex regulatory mechanisms in neural communication, including modulation of signal strength and timing. This complexity is essential for processes such as learning and memory, where synaptic plasticity—changes in the strength of connections based on activity—is crucial. In contrast, electrical synapses do occur in the nervous system but are less common; they allow for direct ionic current flow between neurons through gap junctions, enabling rapid communication but not the extensive modulation offered by chemical synapses. Axodendritic and axosomatic synapses refer to specific types of chemical synapses based on the parts of the neurons they connect—typically the axon of one neuron to the dendrite or soma of another. While these are important,

5. What is the role of the sodium-potassium pump?

A. To generate neurotransmitters for communication

B. To maintain the resting membrane potential by actively transporting sodium out and potassium into the cell

C. To create action potentials in the neuron

D. To promote the release of hormones into the bloodstream

The sodium-potassium pump plays a crucial role in maintaining the resting membrane potential of neurons and other cells. It accomplishes this by actively transporting sodium ions out of the cell and potassium ions into the cell. This active transport mechanism is essential because it helps to establish and maintain the concentration gradients of these ions across the cell membrane. The typical resting state of a neuron is characterized by a higher concentration of potassium ions inside the cell and a higher concentration of sodium ions outside the cell. The sodium-potassium pump uses ATP to move three sodium ions out of the cell for every two potassium ions it brings in, contributing to a net negative charge inside the cell relative to the outside. This difference in charge is vital for the excitability of neurons and is a fundamental aspect of their ability to respond to stimuli. While neurotransmitter generation, action potentials, and hormone release are important physiological processes, they are not directly linked to the primary function of the sodium-potassium pump. Instead, the pump's activity lays the groundwork for the electrical properties of the neuron that enable these processes to occur efficiently.

6. What type of channels open or close in response to binding specific molecules?

A. Voltage-gated channels.

B. Leak channels.

C. Chemically gated channels.

D. Mechanically gated channels.

Chemically gated channels, also known as ligand-gated channels, are specialized ion channels that open or close in response to the binding of specific molecules, typically neurotransmitters or other signaling molecules. When a ligand (the specific molecule) binds to the receptor site on these channels, it induces a conformational change that allows ions to flow through the channel. This mechanism is crucial in neuronal signaling, as it allows for the transmission of electrical signals in response to various chemical signals from the synaptic cleft. In contrast, voltage-gated channels open or close in response to changes in the membrane potential, allowing ions to move across the membrane based on electrical signals. Leak channels, on the other hand, are not gated by specific intra- or extracellular signals; rather, they remain open under normal physiological conditions to help maintain the resting membrane potential. Mechanically gated channels respond to physical changes in the environment, such as pressure or stretch, rather than to specific molecules. Therefore, it is the chemically gated channels that are specifically characterized by their ability to respond to binding events, making them the correct choice in this context.

7. At the normal resting membrane potential of a typical neuron, its sodium-potassium exchange pump transports how many intracellular sodium ions for how many extracellular potassium ions?

- **A. 2 intracellular sodium ions for 3 extracellular potassium ions.**
- **B. 3 intracellular sodium ions for 2 extracellular potassium ions.**
- **C. 1 intracellular sodium ion for 1 extracellular potassium ion.**
- **D. 4 intracellular sodium ions for 3 extracellular potassium ions.**

The sodium-potassium exchange pump, also known as the Na+/K+ ATPase, plays a critical role in maintaining the resting membrane potential of neurons and other cells. This pump is essential for the movement of sodium and potassium ions across the cell membrane, which is vital for the electrical excitability of neurons. Specifically, for each cycle of the pump, it transports three sodium ions out of the cell while bringing in two potassium ions. This active transport process is crucial because it helps maintain a higher concentration of potassium ions inside the cell and a lower concentration of sodium ions inside the cell relative to the extracellular environment. This differential distribution of ions across the membrane contributes to the negative resting membrane potential typically observed in neurons, which ranges around -70 mV. The net movement of positive charge (three positive sodium ions out for every two positive potassium ions in) creates a slight excess of negative charge inside the cell, reinforcing the resting membrane potential. Understanding this mechanism is essential as it underpins neuronal function, including action potential generation and neurotransmitter release, making the sodium-potassium pump a fundamental component of neurophysiology.

8. What describes the process of membrane repolarization?

- **A. Increased influx of sodium ions**
- **B. Return to a more negative membrane potential**
- **C. Excessive potassium ion influx**
- **D. Constant resting membrane potential**

Membrane repolarization refers to the process in which a neuron's membrane potential returns to a more negative value after depolarization, typically following the action potential. During depolarization, the membrane potential becomes more positive due to the influx of sodium ions. Repolarization is characterized by the rapid efflux of potassium ions, which helps restore the membrane potential back towards its resting state. The correct answer highlights that during repolarization, the membrane potential moves closer to its resting value, making it more negative after having been positively charged during depolarization. This return to a negative membrane potential is crucial for resetting the electrical state of the neuron, preparing it for the next action potential. In contrast, the other options do not accurately describe the process of membrane repolarization. An increased influx of sodium ions would contribute to further depolarization rather than repolarization, while excessive potassium influx is not a characteristic of this process. Maintaining a constant resting membrane potential doesn’t describe the dynamic nature of repolarization, which involves a temporary shift in ion concentrations across the membrane.

9. What is one important function of the integration center in a reflex arc?

A. To relay messages to muscles directly

B. To process sensory input and generate motor output

C. To initiate sensation

D. To complete muscle contraction

The integration center in a reflex arc plays a critical role in processing sensory information and generating appropriate motor responses. When a sensory neuron transmits a signal regarding a stimulus, the integration center—often located in the spinal cord—receives and analyzes this sensory input. It assesses the information and determines the needed response, which is then conveyed via motor neurons to the appropriate muscles. This process is crucial for reflex actions, allowing for rapid responses to stimuli without the need for conscious thought, thereby optimizing reaction times for protective or automatic behaviors. The other options focus on aspects that do not accurately capture the primary function of the integration center. For example, relaying messages to muscles directly occurs at the level of motor neurons, while initiating sensation pertains to the role of sensory receptors rather than the integration center itself. Similarly, completing muscle contraction is part of the motor output phase but does not specifically highlight the integrative function of processing inputs and formulating outputs.

10. What type of summation occurs when multiple EPSPs occur at the same time in different locations on the neuron?

A. Temporal summation

B. Spatial summation

C. Inhibitory summation

D. Action potential summation

The correct answer is spatial summation, which occurs when multiple excitatory postsynaptic potentials (EPSPs) generated at different locations on a neuron's membrane simultaneously contribute to the overall depolarization of the neuron. By having inputs from various presynaptic neurons arriving simultaneously, these local excitatory potentials can combine their effects, potentially reaching the threshold needed to trigger an action potential in the postsynaptic neuron. In contrast, temporal summation refers to the situation where multiple EPSPs from a single presynaptic neuron occur in rapid succession at the same synapse, leading to a cumulative effect over time. Inhibitory summation involves the interplay of inhibitory postsynaptic potentials (IPSPs) with EPSPs, affecting the neuron's ability to reach the threshold for an action potential. Action potential summation is not a recognized term within the context of neurophysiology; instead, action potentials are typically all-or-nothing events that result from reaching a specific threshold, regardless of how they are generated. Therefore, the distinct process of spatial summation focuses specifically on simultaneous input from multiple sources, making it the correct choice for this question.