NBEO Ocular Physiology Practice Exam (Sample)

Study Guide

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Questions

1. **Do bipolar cells produce graded potentials or action potentials?**

   A. Graded potentials

   B. Action potentials

   C. Both graded and action potentials

   D. Neither

2. **Which accessory lacrimal gland is likely to be located within the fornices?**

   A. Glands of Zeiss

   B. Glands of Moll

   C. Glands of Krause

   D. Glands of Wolfring

3. **What is the main enzyme involved in the first step of glycolysis in the lens?**

   A. Hexokinase

   B. Pyruvate kinase

   C. Phosphofructokinase

   D. Glucose-6-phosphate dehydrogenase

4. **Where are goblet cells most concentrated within the eye?**

   A. Superior temporal fornix

   B. Inferonasal fornix

   C. Temporal bulbar conjunctiva

   D. Nasal bulbar conjunctiva

5. **What is the typical osmolarity of hypotonic eye drops such as artificial tears used to treat dry eye?**

   A. 100 mOsm/L

   B. 150 mOsm/L

   C. 200 mOsm/L

   D. 250 mOsm/L

6. What is the condition caused by Vitamin A deficiency that leads to keratinization of the conjunctiva?

A. Bitot's spots

B. Pinguecula

C. Conjunctival cysts

D. Pterygium

7. Which ion is considered the main driver of aqueous production?

A. Na+

B. K+

C. HCO3- (bicarbonate)

D. Ca2+

8. Does light absorption increase or decrease the concentration of cGMP in photoreceptors?

A. Increases

B. Decreases

C. Has no effect

D. Varies

9. Where does the majority of retinal glycolysis take place in photoreceptors?

A. Inner segment

B. Outer segment

C. Both inner and outer segments

D. In the synaptic terminal

10. What is the slight negative electrical charge maintained by photoreceptors in the dark?

A. -30 mv

B. -50 mv

C. -70 mv

D. -90 mv

Answers

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

Explanations

1. **Do bipolar cells produce graded potentials or action potentials?**

    A. Graded potentials

    B. Action potentials

    C. Both graded and action potentials

    D. Neither

Bipolar cells, which are integral components of the retina, primarily produce graded potentials. Unlike neurons that generate action potentials, bipolar cells respond to changes in light intensity and transmit signals in a graded manner. This means that their membrane potential can vary continuously based on the degree of stimulation they receive, which is essential for encoding the nuances of visual information. Graded potentials allow bipolar cells to modulate their response based on the strength of the light input, making them well-suited for processing visual stimuli. The graded signals then lead to the activation of ganglion cells, which do produce action potentials that carry the visual information to the brain. Understanding the role of bipolar cells and the nature of the signals they generate is crucial for comprehending how visual processing occurs in the retina. This specific mechanism illustrates how different types of cells in the retina have distinct roles in the visual pathway, with bipolar cells serving as intermediaries that convey information from photoreceptors to ganglion cells efficiently.

2. **Which accessory lacrimal gland is likely to be located within the fornices?**

    A. Glands of Zeiss

    B. Glands of Moll

    C. Glands of Krause

    D. Glands of Wolfring

The accessory lacrimal glands that are found within the fornices are the Glands of Krause. These glands are situated in the conjunctival fornices and play a crucial role in tear production, contributing to the overall moisture and lubrication of the ocular surface. The Glands of Krause are also considered important in the secretion of the aqueous component of tears, thus helping maintain a stable tear film. Their location allows them to effectively discharge their secretions into the conjunctival sac, assisting with the distribution of tears across the eye during blinking. To further understand, other glands mentioned do not have this specific location or function. The Glands of Zeiss are sebaceous glands located at the base of the eyelashes, contributing to the lipid layer of the tear film but not found in the fornices. The Glands of Moll are modified sweat glands located near the eyelashes as well, while the Glands of Wolfring are found along the upper and lower eyelids but not specifically within the fornices. This distinction clarifies why the Glands of Krause are the correct answer in this context.

3. What is the main enzyme involved in the first step of glycolysis in the lens?

A. Hexokinase

B. Pyruvate kinase

C. Phosphofructokinase

D. Glucose-6-phosphate dehydrogenase

The main enzyme involved in the first step of glycolysis in the lens is hexokinase. This enzyme catalyzes the phosphorylation of glucose to form glucose-6-phosphate, which is a crucial step in the glycolytic pathway. By converting glucose into its phosphorylated form, hexokinase ensures that glucose is retained within the cell for further metabolic processing. This step is essential because once glucose is phosphorylated, it cannot easily diffuse out of the cell, thus allowing the lens cells to utilize glucose for energy production. In the context of the lens, which depends heavily on anaerobic glycolysis for energy, hexokinase's role is particularly vital. The lens does not have a rich supply of blood vessels and therefore relies on glycolysis, facilitated by hexokinase, for its energy needs. The activity of this enzyme ensures that the lens can maintain its transparency and refractive properties by providing the necessary ATP for cellular functions without oxidative stress.

4. Where are goblet cells most concentrated within the eye?

A. Superior temporal fornix

B. Inferonasal fornix

C. Temporal bulbar conjunctiva

D. Nasal bulbar conjunctiva

Goblet cells are specialized epithelial cells that secrete mucin, which is a component of the tear film that helps to maintain the stability and health of the ocular surface. In the eye, these cells are most concentrated in the fornices of the conjunctiva, where they play a crucial role in lubricating the eye and protecting it from environmental irritants. The inferonasal fornix is known to have a higher density of goblet cells compared to other areas within the eye. This location ensures that the inferior nasal conjunctiva has ample mucin available to optimize tear film coverage especially during blinking and to facilitate the movement of the eyelid across the surface of the eye. Other areas, such as the superior temporal fornix or the temporal and nasal bulbar conjunctiva, have comparatively fewer goblet cells. This distribution reflects the anatomical and functional requirements of the conjunctival surfaces, where areas with higher mechanical stress or exposure to debris require greater mucin production to ensure proper lubrication and protection. Thus, the correct answer is based on the physiological need for enhanced mucin secretion in the inferonasal fornix, where goblet cells are most densely concentrated.

5. What is the typical osmolarity of hypotonic eye drops such as artificial tears used to treat dry eye?

A. 100 mOsm/L

B. 150 mOsm/L

C. 200 mOsm/L

D. 250 mOsm/L

Artificial tears used for treating dry eye are typically formulated to have an osmolarity that is lower than that of normal human tears, which range between approximately 300 to 330 mOsm/L. The goal of using hypotonic eye drops is to provide relief by rehydrating the ocular surface and reducing osmotic stress on the corneal cells. The correct answer reflects an osmolarity of 150 mOsm/L, which is appropriately lower than the physiological values for tears. This hypotonic formulation can help in soothing the eyes by minimizing the dryness sensation and supporting the overall health of the corneal epithelium. Thus, the osmolarity of these drops is designed to optimize comfort while effectively managing the symptoms associated with dry eye syndrome. The choice of 150 mOsm/L is strategically beneficial in promoting tear stability without leading to further irritation or discomfort.

6. What is the condition caused by Vitamin A deficiency that leads to keratinization of the conjunctiva?

A. Bitot's spots

B. Pinguecula

C. Conjunctival cysts

D. Pterygium

Vitamin A deficiency can lead to a condition known as Bitot's spots, which are characterized by the accumulation of keratin in the conjunctiva. This keratinization results from a lack of the necessary vitamin A that is crucial for maintaining healthy epithelial tissues, particularly in the eyes. When the conjunctiva becomes affected, it doesn't remain moist and healthy, leading to this buildup of keratinized cells that appear as foamy, white lesions on the conjunctival surface. In contrast, conditions like pinguecula, conjunctival cysts, and pterygium are typically not associated with Vitamin A deficiency. Pinguecula is a growth on the conjunctiva related to UV exposure and aging, conjunctival cysts are fluid-filled sacs usually resulting from obstruction of the conjunctival glands, and pterygium is a growth of tissue that can invade the cornea, often linked to environmental factors such as sun exposure. These conditions do not directly involve the keratinization process that occurs due to Vitamin A deficiency, hence why Bitot's spots is the correct answer.

7. Which ion is considered the main driver of aqueous production?

A. Na+

B. K+

C. HCO3- (bicarbonate)

D. Ca2+

The main driver of aqueous humor production in the eye is bicarbonate ion (HCO3-). In the process of aqueous humor formation, the ciliary epithelium utilizes bicarbonate ions actively transported into the posterior chamber. The secretion of bicarbonate creates an osmotic gradient that draws water into the aqueous humor, significantly contributing to its production. The presence of bicarbonate not only helps in maintaining the proper ionic composition of the aqueous humor but also plays a crucial role in creating the necessary conditions for the transport of essential nutrients and waste products. While other ions like sodium may be involved in regulating fluid movement and maintaining osmotic balance, bicarbonate is specifically pivotal in stimulating the production of aqueous humor by enhancing the movement of water, thus establishing its primary role in this physiological process.

8. Does light absorption increase or decrease the concentration of cGMP in photoreceptors?

A. Increases

B. Decreases

C. Has no effect

D. Varies

In photoreceptors, specifically in rod and cone cells, the absorption of light is crucial for the phototransduction cascade, which converts light signals into electrical signals. When photons are absorbed by the photopigment (rhodopsin in rods and photopsins in cones), it triggers a biochemical cascade that leads to the closure of ion channels in the photoreceptor membrane. Under dark conditions, cGMP (cyclic guanosine monophosphate) is kept at relatively high levels, which keeps certain cation channels open, allowing the influx of sodium ions and thus maintaining a depolarized state of the cell. However, when light is absorbed, the phototransduction cascade activates phosphodiesterase (PDE), an enzyme that breaks down cGMP into GMP. As a result, the concentration of cGMP decreases. This decrease in cGMP leads to the closure of the cation channels, which in turn leads to hyperpolarization of the photoreceptor cell. This hyperpolarization causes a decrease in the release of neurotransmitters at the synaptic terminals of the photoreceptors, ultimately transmitting the visual signal to bipolar cells and subsequently to ganglion cells in the retina. Thus, the absorption of

9. Where does the majority of retinal glycolysis take place in photoreceptors?

A. Inner segment

B. Outer segment

C. Both inner and outer segments

D. In the synaptic terminal

The majority of retinal glycolysis occurs in the inner segment of photoreceptors. The inner segment of photoreceptors is rich in mitochondria, which are essential for producing ATP through aerobic respiration. However, glycolysis, which takes place in the cytoplasm, is the primary process for generating energy in environments where oxygen is limited, as is the case in the retina, especially under dark conditions. In photoreceptors, the outer segment is responsible for phototransduction, which involves capturing light photons and converting them into electrical signals. This part is highly specialized and contains the photopigments necessary for sensing light, but it has a lower metabolic activity compared to the inner segment. Therefore, while some metabolic processes can occur in both segments, the inner segment is where the bulk of glycolytic activity takes place due to its structural characteristics and the abundance of energy demands related to the visual process. The synaptic terminal is involved in transmitting signals to bipolar cells and does not primarily focus on energy production through glycolysis. Consequently, the inner segment remains the key area for glycolysis in photoreceptors.

10. What is the slight negative electrical charge maintained by photoreceptors in the dark?

A. -30 mv

B. -50 mv

C. -70 mv

D. -90 mv

The slight negative electrical charge maintained by photoreceptors in the dark is typically around -70 mV. This resting membrane potential is due to the permeability of the photoreceptor cell membrane to potassium ions, as well as the activity of ion pumps, particularly the sodium-potassium pump, which helps maintain the ion gradients essential for phototransduction. In the dark, photoreceptors are depolarized relative to their surrounding environment because the channels for sodium ions are open. This depolarization causes the release of neurotransmitters at the synapse with bipolar cells, effectively communicating the state of the photoreceptors to the downstream retinal cells. When light hits the photoreceptors, it causes a cascading biochemical response that closes these sodium channels, leading to hyperpolarization and a decrease in neurotransmitter release. The -70 mV resting potential is therefore crucial for the phototransduction process, which is the conversion of light into electrical signals in the retina. This resting membrane potential is slightly less negative than -90 mV, indicating that while there is a steady state of negative charge, it fluctuates based on the activation of specific ion channels during the phototransduction pathway. A value of -30 mV would suggest a significant depolarization that