SACE Stage 2 Biology Practice Exam (Sample)

Study Guide

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Questions

1. What molecule is primarily produced by autotrophs during photosynthesis?

A. Oxygen

B. Carbon Dioxide

C. Ethanol

D. Glucose

2. What type of ends do restriction enzymes create when they cut straight across the double helix?

A. Blunt ends

B. Sticky ends

C. Sharp ends

D. Pliable ends

3. How do spindle fibres function during Anaphase I?

A. They disassemble to allow chromatid separation

B. They contract to pull chromosome pairs apart

C. They form new structures for cytokinesis

D. They attach to centromeres

4. How does an enzyme interact with a substrate?

A. By changing its shape to fit the substrate

B. By binding strongly to the substrate active site until the reaction is done

C. By chemically altering the substrate before binding

D. By increasing the temperature of the substrate

5. What is a primary function of the cell membrane?

A. To generate energy for the cell

B. To control the intake and output of substances

C. To contribute to cell division

D. To produce cellular components

6. Which of the following is NOT a characteristic of sensory neurons?

A. They sense external stimuli

B. They transmit impulses to the CNS

C. They are predominantly multipolar

D. They have specialized nerve endings

7. What structural feature of the centrosomes aids in cell division?

A. Chromatin

B. Spindle fibers

C. Nuclear envelope

D. Centromeres

8. In Metaphase I, how do the chromosomes align on the metaphase plate?

A. In single file

B. In homologous pairs

C. Randomly

D. Attached to spindle fibres

9. What key event does NOT occur during Prophase II?

A. Differentiation of chromosomes into haploid cells

B. Replication of DNA

C. Condensation of chromatids

D. Movement of centrioles to cell poles

10. What role do ribozymes play in biological systems?

A. They serve as structural components of cells.

B. They catalyze biochemical reactions.

C. They store genetic information.

D. They assist in protein synthesis only.

Answers

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

Explanations

1. What molecule is primarily produced by autotrophs during photosynthesis?

A. Oxygen

B. Carbon Dioxide

C. Ethanol

D. Glucose

The primary product of photosynthesis in autotrophs is glucose. During this process, autotrophs, which are organisms capable of producing their own food using light energy (such as plants), use carbon dioxide and water in the presence of sunlight to synthesize glucose. The equation for photosynthesis illustrates this: carbon dioxide plus water, in the presence of sunlight, yields glucose and oxygen as byproducts. While oxygen is generated during photosynthesis and is vital for aerobic organisms, it is not the main product that autotrophs utilize for growth and energy. Glucose serves as a key energy source and is fundamental for the structure and function of the plant, being used in cellular respiration to generate ATP or stored as starch for later use. In the context of the other options, carbon dioxide is used as a reactant, not a product, and while ethanol is related to fermentation processes, it is not produced by autotrophs during photosynthesis. Therefore, glucose is the correct answer, as it is the primary organic molecule synthesized by autotrophs through the process of photosynthesis.

2. What type of ends do restriction enzymes create when they cut straight across the double helix?

A. Blunt ends

B. Sticky ends

C. Sharp ends

D. Pliable ends

Restriction enzymes are biological tools that can cut DNA at specific sequences, and the type of cut they create significantly influences subsequent DNA manipulation techniques. When restriction enzymes cut straight through both strands of the double helix at the same position, they produce blunt ends. These ends are characterized by having no overlapping bases; instead, they are even at the cut site. Blunt ends are particularly useful in cloning because they can be ligated with other blunt-end DNA fragments without the need for complementary overhangs. This creates a more uniform and straightforward means of joining DNA fragments, although it typically requires higher concentrations of DNA and ligase compared to sticky ends, which have overhangs and can easily anneal with similarly cut DNA. The other choices describe types of DNA ends that do not correspond to a straight cut across the double helix. Sticky ends, for instance, result from enzymes that cut the DNA in a staggered fashion, leaving single-stranded overhangs that can easily bind to complementary sequences. Sharp and pliable ends are not standard terms used in molecular biology to describe DNA ends produced by restriction enzymes. Thus, the clear and precise nature of blunt ends aligns perfectly with the action of restriction enzymes making a straight cut across the DNA double helix

3. How do spindle fibres function during Anaphase I?

A. They disassemble to allow chromatid separation

B. They contract to pull chromosome pairs apart

C. They form new structures for cytokinesis

D. They attach to centromeres

During Anaphase I of meiosis, spindle fibers play a crucial role by contracting to pull chromosome pairs apart. This phase is characterized by the separation of homologous chromosomes, which are pulled towards opposite poles of the cell. The spindle fibers, which are composed of microtubules, attach to the kinetochore regions of the chromosomes at their centromeres. When the spindle fibers contract, they generate a force that effectively moves each homologous chromosome in opposite directions, ensuring that each daughter cell will receive one complete set of chromosomes. This action is vital for maintaining genetic diversity and reducing chromosome number by half, which is a key outcome of meiosis. The proper functioning of spindle fibers is essential for the accurate distribution of genetic material, and any errors during this process can lead to genetic disorders or aneuploidy.

4. How does an enzyme interact with a substrate?

A. By changing its shape to fit the substrate

B. By binding strongly to the substrate active site until the reaction is done

C. By chemically altering the substrate before binding

D. By increasing the temperature of the substrate

An enzyme interacts with a substrate primarily by binding to it at the active site, which is specifically shaped to accommodate the substrate molecules. This binding occurs through various interactions, such as hydrogen bonds, ionic bonds, and hydrophobic interactions. Once the substrate is bound to the enzyme, it can then undergo a chemical transformation, facilitating the reaction and producing the desired product. The significant aspect of choice B is that the enzyme forms a strong and specific complex with the substrate during the catalytic process. This ensures that the reaction occurs efficiently and specifically, ultimately leading to the conversion of the substrate into products. The enzyme does not permanently change its shape in this process; it typically returns to its original form after facilitating the reaction, which allows it to catalyze additional reactions with more substrate molecules. In contrast, changing its shape to fit the substrate might imply a more flexible model (like the induced fit model), but it does not capture the essence of the strong binding that characterizes the interaction during the reaction completion. The idea of chemically altering the substrate before binding misrepresents the sequence of events, as the alteration occurs after the substrate has bound to the enzyme. Finally, the role of temperature is not a direct interaction method of enzymes with substrates; while temperature can influence

5. What is a primary function of the cell membrane?

A. To generate energy for the cell

B. To control the intake and output of substances

C. To contribute to cell division

D. To produce cellular components

The primary function of the cell membrane is to control the intake and output of substances, which is fundamental to maintaining the internal environment of the cell. The cell membrane acts as a selective barrier, allowing certain molecules to enter or exit the cell while preventing others from passing through. This selective permeability is crucial for various cellular processes, including nutrient intake, waste removal, and the maintenance of ion concentrations necessary for cellular functions. The phospholipid bilayer of the cell membrane, along with embedded proteins, plays a key role in its ability to transport substances. For example, transport proteins facilitate the movement of specific ions and molecules across the membrane, contributing to the overall homeostasis of the cell. In contrast, the other choices do not accurately reflect the main role of the cell membrane in a way that encompasses its essential functions. The generation of energy occurs primarily in organelles like mitochondria, cell division is facilitated by a combination of mechanisms involving numerous cellular structures, and production of cellular components typically takes place within the cytoplasm or specific organelles rather than being a direct function of the membrane itself.

6. Which of the following is NOT a characteristic of sensory neurons?

A. They sense external stimuli

B. They transmit impulses to the CNS

C. They are predominantly multipolar

D. They have specialized nerve endings

Sensory neurons are specialized cells responsible for converting external stimuli into electrical impulses that can be interpreted by the central nervous system (CNS). One distinguishing feature of sensory neurons is that they typically have specialized structures or receptors at their endings which allow them to detect specific types of stimuli, such as light, sound, or touch. This aligns closely with the options stating that they sense external stimuli and have specialized nerve endings. In terms of structure, sensory neurons are primarily classified as unipolar or bipolar rather than multipolar. Unipolar neurons contain a single extension that branches into two parts: one that receives sensory information and the other that transmits impulses to the CNS. Bipolar neurons, on the other hand, have one axon and one dendrite. In contrast, multipolar neurons, which have multiple dendrites, are more commonly associated with motor functions or interneuron roles within the CNS. This is why the characteristic stating that sensory neurons are predominantly multipolar is not applicable to them.

7. What structural feature of the centrosomes aids in cell division?

A. Chromatin

B. Spindle fibers

C. Nuclear envelope

D. Centromeres

Centrosomes play a crucial role in cell division, primarily by organizing microtubules that form the spindle apparatus during mitosis and meiosis. The structural feature that aids in this process is the presence of spindle fibers, which are crucial for separating chromosomes during cell division. These spindle fibers extend from the centrosomes to the chromosomes, attaching to the kinetochores located at the centromeres of the chromosomes. This connection allows the spindle apparatus to exert forces that pull the sister chromatids apart, ensuring that each daughter cell receives an identical set of chromosomes. The other options do not directly contribute to the specific function of centrosomes in cell division. Chromatin refers to the material that makes up chromosomes, the nuclear envelope encloses the nucleus and separates it from the cytoplasm, and centromeres are specific regions on chromosomes that are crucial for chromosome segregation but do not themselves aid in the structural organization provided by the centrosomes.

8. In Metaphase I, how do the chromosomes align on the metaphase plate?

A. In single file

B. In homologous pairs

C. Randomly

D. Attached to spindle fibres

During Metaphase I of meiosis, chromosomes align along the metaphase plate in homologous pairs. This means that each pair consists of one chromosome from the mother and one from the father that are similar in shape and size, and they contain genetic information for the same traits. This arrangement is crucial for the process of crossing over and genetic variation, as it allows for the exchange of genetic material between the chromosomes of each pair. The alignment in homologous pairs is essential for ensuring that when the homologs are separated during Anaphase I, each resulting gamete will receive an appropriate mix of maternal and paternal genes. The alignment is distinct from the alignment seen during mitosis, where chromosomes align in a single file. This pairing is a unique aspect of meiosis that aids in maintaining genetic diversity in sexually reproducing organisms. Therefore, the correct response reflects the specific behavior of chromosomes during this stage of meiosis.

9. What key event does NOT occur during Prophase II?

A. Differentiation of chromosomes into haploid cells

B. Replication of DNA

C. Condensation of chromatids

D. Movement of centrioles to cell poles

During Prophase II, the processes that occur involve the preparation of the cells for another round of division without further DNA replication. In this phase, the chromosomes condense, and the centrioles move to the poles of the cell, setting the stage for the separation of sister chromatids in the upcoming stages of meiosis. The critical aspect of Prophase II is that it follows Meiosis I, where the homologous chromosomes have already been separated into haploid cells. Therefore, differentiation of chromosomes into haploid cells is indeed significant in this stage, as the cells are preparing to handle the separation of chromatids. However, DNA replication does not occur in Prophase II, distinguishing it from Prophase I of Meiosis I. Instead, each resultant cell from Meiosis I enters Prophase II with the haploid number of chromosomes, and those chromosomes consist of two sister chromatids. This absence of DNA replication is a key feature of Prophase II, making it a crucial distinction in understanding the differences between the phases of meiosis.

10. What role do ribozymes play in biological systems?

A. They serve as structural components of cells.

B. They catalyze biochemical reactions.

C. They store genetic information.

D. They assist in protein synthesis only.

Ribozymes play a crucial role in biological systems by catalyzing biochemical reactions. These are RNA molecules that possess catalytic activity, enabling them to facilitate chemical reactions without the need for protein enzymes. This unique property demonstrates the versatile nature of RNA beyond its traditional role in carrying genetic information. Ribozymes are involved in various cellular processes, including RNA processing and the catalysis of peptide bond formation during protein synthesis. Their ability to promote reactions suggests that RNA may have been integral to early life forms, possibly supporting the hypothesis of an "RNA world" in the evolution of life. The other roles mentioned, such as serving as structural components, storing genetic information, or exclusively assisting in protein synthesis, are primarily attributed to proteins or DNA. While ribozymes contribute to protein synthesis, they are not limited to this function alone, further emphasizing their significance as catalysts in biochemical reactions across different biological systems.