NCEA Level 2 Biology Genetics Practice Exam (Sample)

Study Guide

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Questions

1. What is the role of the DNA polymerase enzyme?

A. To cut DNA into fragments

B. To synthesize new RNA strands

C. To degrade old DNA strands

D. To synthesize new DNA strands during replication

2. Which of the following mutations may affect gene expression?

A. Insertion mutation

B. Substitution mutation

C. Translocation mutation

D. All of the above

3. Which law of inheritance states that different traits are inherited independently?

A. Law of Segregation

B. Law of Dominance

C. Law of Independent Assortment

D. Law of Inheritance

4. What does the term 'genotype' refer to?

A. The observable characteristics

B. The genetic makeup of an organism

C. The physical traits of an organism

D. The environmental factors affecting an organism

5. What does a test cross help determine?

A. The phenotype of an organism

B. The genotype of an organism with a dominant phenotype

C. The environmental effects on traits

D. The specific traits of a recessive organism

6. What is the primary purpose of adaptation in evolutionary terms?

- **A. The process of gene duplication**
- **B. The evolutionary process of being better suited to an environment**
- **C. The random mutation of DNA sequences**
- **D. The inheritance of acquired characteristics**

7. What is a chiasma in the context of meiosis?

- **A. A type of chromosome that is inactive**
- **B. A point where chromatids exchange genetic material during prophase I**
- **C. A stage of the cell cycle**
- **D. A ribosome subunit**

8. In genetic terms, what is an allele?

- **A. A form of a gene**
- **B. A mechanism of mutation**
- **C. A type of chromosomal aberration**
- **D. A cellular reproduction process**

9. What genetic cross demonstrates the inheritance of a single trait?

- **A. Dihybrid cross**
- **B. Monohybrid cross**
- **C. Test cross**
- **D. Back cross**

10. Which scientific field primarily studies SNPs and their implications?

- **A. Cytology**
- **B. Genomics**
- **C. Botany**
- **D. Biochemistry**

Answers

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

Explanations

1. What is the role of the DNA polymerase enzyme?

A. To cut DNA into fragments

B. To synthesize new RNA strands

C. To degrade old DNA strands

D. To synthesize new DNA strands during replication

The role of the DNA polymerase enzyme is to synthesize new DNA strands during the process of DNA replication. This enzyme is essential for the accurate duplication of the genetic material, ensuring that each new cell receives an exact copy of the DNA. DNA polymerase adds nucleotides to the growing DNA strand by matching them with the corresponding bases on the template strand, following the base-pairing rules. This process is highly coordinated and ensures fidelity in the replication of the genetic code, which is critical for cell division and the inheritance of traits in living organisms. The other options describe processes that do not align with the primary function of DNA polymerase. For example, cutting DNA into fragments is usually performed by restriction enzymes, while synthesizing new RNA strands is a function of RNA polymerase, not DNA polymerase. Additionally, degrading old DNA strands is not a role of DNA polymerase, as its function is specifically focused on building rather than breaking down DNA.

2. Which of the following mutations may affect gene expression?

A. Insertion mutation

B. Substitution mutation

C. Translocation mutation

D. All of the above

All types of mutations can potentially affect gene expression in various ways. Insertion mutations involve the addition of one or more nucleotide bases into a DNA sequence. This can disrupt the reading frame during translation, potentially leading to a completely different and nonfunctional protein. If the insertion occurs in a regulatory region, it might alter how readily the gene is expressed. Substitution mutations involve replacing one nucleotide with another. While some substitutions may be silent and have no effect on protein function, others can lead to missense or nonsense mutations. A missense mutation causes a change in one amino acid, which might impact protein function or stability, while a nonsense mutation introduces a premature stop codon, leading to truncated proteins that are often nonfunctional. Translocation mutations, where segments of DNA are moved from one location to another within the genome, can disrupt gene sequences or regulatory elements. This can lead to altered expression of the affected genes. Furthermore, translocations can result in fusion genes that may be expressed at inappropriate levels or under incorrect regulatory conditions. Given these mechanisms, it's evident that any of these mutations—insertions, substitutions, and translocations—can significantly influence gene expression, making the comprehensive option the correct choice.

3. Which law of inheritance states that different traits are inherited independently?

A. Law of Segregation

B. Law of Dominance

C. Law of Independent Assortment

D. Law of Inheritance

The law of inheritance that states that different traits are inherited independently is the law of independent assortment. This principle suggests that the alleles for separate traits are passed on to offspring independently of one another during the formation of gametes. During meiosis, the distribution of one pair of alleles into gametes does not influence the distribution of other pairs of alleles. This means that if an organism has multiple traits, the inheritance of one trait will not affect the inheritance of another trait. For example, when considering two traits, such as seed shape and seed color in pea plants, the combination of these traits in the offspring can vary independently, leading to a variety of genetic combinations. This law is important for understanding genetic variation in populations and helps explain the genetic diversity observed in offspring as a result of independent assortment during reproduction. The law of independent assortment particularly applies when genes are located on different chromosomes or are far apart on the same chromosome, as their inheritance patterns are not linked. The other laws mentioned do not address the concept of independent inheritance of traits. The law of segregation focuses on how alleles for a single trait separate during gamete formation, while the law of dominance describes how dominant alleles can mask the presence of recessive alleles in determining

4. What does the term 'genotype' refer to?

A. The observable characteristics

B. The genetic makeup of an organism

C. The physical traits of an organism

D. The environmental factors affecting an organism

The term 'genotype' specifically refers to the genetic makeup of an organism, encompassing the specific alleles and genes that contribute to the organism's hereditary traits. It is distinct from observable characteristics, which are influenced not just by genetics but also by environmental factors. The genotype can influence physical traits, but it does not directly represent those traits themselves, which are categorized as the phenotype. While environmental factors can impact the expression of a genotype, they do not define the genotype itself. Therefore, the accurate understanding of genotype is essential for studying genetics, as it forms the blueprint that guides the development and functioning of an organism's traits.

5. What does a test cross help determine?

A. The phenotype of an organism

B. The genotype of an organism with a dominant phenotype

C. The environmental effects on traits

D. The specific traits of a recessive organism

A test cross is a breeding experiment used to determine the genotype of an organism with a dominant phenotype. When an organism exhibits a dominant phenotype, it is not immediately clear whether it possesses a homozygous dominant genotype (having two copies of the dominant allele) or a heterozygous genotype (having one dominant and one recessive allele). By crossing this organism with another that is homozygous recessive (which expresses the recessive phenotype), the offspring produced can provide insight into the parent's genotype. If all the offspring display the dominant phenotype, it suggests that the parent in question is likely homozygous dominant. However, if any offspring show the recessive phenotype, it indicates that the parent must be heterozygous. Thus, the test cross allows for determination of whether the dominant phenotype observed is due solely to a homozygous dominant genotype or a mix with a recessive allele.

6. What is the primary purpose of adaptation in evolutionary terms?

A. The process of gene duplication

B. The evolutionary process of being better suited to an environment

C. The random mutation of DNA sequences

D. The inheritance of acquired characteristics

The primary purpose of adaptation in evolutionary terms is to enhance the survival and reproductive success of organisms in their specific environments. This process involves the gradual accumulation of traits that provide a better fit to the ecological niche an organism occupies. Over time, these advantageous traits become more common within a population due to natural selection, which acts on variations that improve an organism's ability to obtain resources, avoid predators, or thrive in varying environmental conditions. In contrast, gene duplication refers to a mechanism that can create genetic diversity but is not the end goal of adaptation itself. Random mutations contribute to variation but don't inherently aim to optimize an organism's fit to its environment. The idea of the inheritance of acquired characteristics, proposed by Lamarck, has been largely discredited in favor of modern understanding of genetic inheritance through natural selection. Adaptation specifically focuses on how organisms adjust over generations to become better suited to their environments, making choice B the most accurate representation of adaptation's purpose in evolution.

7. What is a chiasma in the context of meiosis?

A. A type of chromosome that is inactive

B. A point where chromatids exchange genetic material during prophase I

C. A stage of the cell cycle

D. A ribosome subunit

In the context of meiosis, a chiasma refers to the physical point where two homologous chromosomes align and exchange genetic material during prophase I. This process, known as crossing over, is essential for increasing genetic diversity in sexual reproduction. During meiosis, the homologous chromosomes pair up, and as they do so, they can form chiasmata at specific points along their lengths. This exchange leads to new combinations of alleles, contributing to variation in the offspring. By facilitating the recombination of genes, the chiasma plays a crucial role in producing gametes with different genetic compositions, which is a key advantage for evolution and adaptation. This process of genetic exchange is not involved with inactive chromosomes, cell cycle stages, or ribosome subunits, which pertain to entirely different aspects of cellular biology.

8. In genetic terms, what is an allele?

A. A form of a gene

B. A mechanism of mutation

C. A type of chromosomal aberration

D. A cellular reproduction process

An allele refers to a specific version or form of a gene that occupies a particular locus on a chromosome. These variations can result in different traits being expressed, such as flower color in plants or blood type in humans. Genes can have multiple alleles, leading to a range of phenotypes. For example, the gene that determines flower color might have one allele for red flowers and another for white flowers. Each individual inherits two alleles for each gene, one from each parent, which can be the same (homozygous) or different (heterozygous). The concept of alleles is fundamental to understanding genetic variation and inheritance patterns in organisms.

9. What genetic cross demonstrates the inheritance of a single trait?

A. Dihybrid cross

B. Monohybrid cross

C. Test cross

D. Back cross

A monohybrid cross specifically involves examining the inheritance of a single trait or characteristic, focusing on the alleles that contribute to that trait. In these crosses, typically one trait is analyzed, such as flower color or seed shape, allowing for a clear understanding of how dominant and recessive alleles are inherited. In a monohybrid cross, one parent has two dominant alleles for the trait (homozygous dominant), while the other has two recessive alleles (homozygous recessive). The offspring have a predictable ratio of dominant to recessive phenotypes based on Mendelian genetics, often resulting in a 3:1 phenotype ratio in the F2 generation when using a homozygous dominant and a homozygous recessive parent. This focused approach allows for straightforward tracking of inheritance patterns without the added complexity introduced by examining multiple traits, which is seen in dihybrid crosses. A test cross or back cross, although related to determining the genotype of an organism, do not solely demonstrate the inheritance of a single trait but rather are methods used to analyze genetic diversity or confirm genotypes.

10. Which scientific field primarily studies SNPs and their implications?

A. Cytology

B. Genomics

C. Botany

D. Biochemistry

The field that primarily studies single nucleotide polymorphisms (SNPs) and their implications is genomics. Genomics focuses on the structure, function, evolution, and mapping of genomes, which are the complete set of genes or genetic material present in a cell or organism. SNPs are variations in a single nucleotide that occur at specific positions in the genome and can influence how individuals develop diseases or respond to pathogens, chemicals, drugs, and vaccines. Therefore, understanding SNPs is crucial for personalized medicine, genetic research, and evolutionary studies, all of which are core elements of genomics. This field employs advanced techniques, such as sequencing and bioinformatics, to analyze genetic data at a genomic level, making it the best choice when studying SNPs and their implications.