

Science Olympiad Designer Genes Practice Exam (Sample)

Study Guide



Everything you need from our exam experts!

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Questions

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- 1. What role does RNA play in the synthesis of proteins?**
 - A. It acts as a storage molecule for DNA**
 - B. It synthesizes genes**
 - C. It carries amino acids to ribosomes**
 - D. It catalyzes the transcription process**
- 2. An allele that requires only one gene copy to be expressed is called what?**
 - A. Recessive**
 - B. Dominant**
 - C. Monomer**
 - D. Homozygous**
- 3. What is the structure of a chromosome primarily described as?**
 - A. A double helix of base pairs**
 - B. Single-stranded DNA**
 - C. A linear sequence of nucleotides**
 - D. A complex of DNA and protein**
- 4. In a Dihybrid cross, how many gametes can each parent produce?**
 - A. 2**
 - B. 3**
 - C. 4**
 - D. 5**
- 5. Co-dominance typically involves how many alleles?**
 - A. One**
 - B. Two**
 - C. More than one**
 - D. None**

- 6. Why did people initially believe that proteins carried genetic information rather than DNA?**
- A. Because DNA was thought to be too simple**
 - B. Because proteins were much more complex**
 - C. Because proteins are more abundant in cells**
 - D. Because nucleotides are composed of proteins**
- 7. How many non-autosomal genes does a human typically possess?**
- A. 0**
 - B. 1**
 - C. 2**
 - D. 3**
- 8. How many autosomal gene pairs does a typical human have?**
- A. 20**
 - B. 22**
 - C. 24**
 - D. 26**
- 9. What key information can phylogenetics provide to researchers?**
- A. Detailed structures of genes**
 - B. Evolutionary history and relationships among species**
 - C. Exact functions of all gene products**
 - D. Predictions regarding species extinction**
- 10. What do homologous chromosomes have in common?**
- A. Identical alleles**
 - B. The same genes**
 - C. Different chromosomes**
 - D. Unique DNA sequences**

Answers

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

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Explanations

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1. What role does RNA play in the synthesis of proteins?

- A. It acts as a storage molecule for DNA
- B. It synthesizes genes
- C. It carries amino acids to ribosomes**
- D. It catalyzes the transcription process

The correct role of RNA in protein synthesis is that it carries amino acids to ribosomes. This process is crucial because ribosomes are the sites where proteins are assembled. In particular, transfer RNA (tRNA) plays a key role by transporting specific amino acids to the ribosome, which then links these amino acids together in the correct order to form a polypeptide chain, ultimately creating a functional protein. The importance of tRNA in this process underscores the relationship between nucleotide sequence in messenger RNA (mRNA) and the sequence of amino acids in proteins. Each tRNA molecule has an anticodon on one end, which pairs with the corresponding codon on the mRNA, ensuring that the correct amino acid is incorporated into the growing protein chain. This role of RNA is fundamental to the flow of genetic information from DNA to proteins, known as the central dogma of molecular biology, which outlines how genes are expressed through mRNA transcription and subsequent translation into proteins.

2. An allele that requires only one gene copy to be expressed is called what?

- A. Recessive
- B. Dominant**
- C. Monomer
- D. Homozygous

An allele that requires only one gene copy to be expressed is referred to as dominant. This means that for a trait governed by a dominant allele, the presence of just one copy is sufficient for the trait to be exhibited in the organism's phenotype. When an individual has at least one dominant allele, it will mask the expression of any recessive alleles present. In terms of genetics, dominant alleles are represented with a capital letter, and their presence can dictate the expression of traits regardless of the other allele paired with it. For instance, if an organism has one dominant allele for a particular trait and one recessive allele, the dominant trait will be expressed. The other terms provided relate to genetic concepts but do not accurately describe the allele in question. Recessive alleles require two copies to be expressed, while homozygous refers to having two identical alleles for a gene, which can be either dominant or recessive. Monomer is not a term used to describe alleles, but rather refers to a single unit of a larger molecule, such as nucleotides in DNA. Thus, the defining characteristics of dominant alleles make them crucial in understanding inheritance patterns in genetics.

3. What is the structure of a chromosome primarily described as?

- A. A double helix of base pairs**
- B. Single-stranded DNA**
- C. A linear sequence of nucleotides**
- D. A complex of DNA and protein**

The structure of a chromosome is primarily described as a complex of DNA and protein. Chromosomes are made up of tightly coiled DNA wrapped around histone proteins, which help package the DNA into a compact, organized structure. This intricate arrangement is essential for the proper segregation of genetic material during cell division. While the DNA within each chromosome does exhibit a double helix formation at the molecular level, it is the combination of DNA and proteins that defines the structural characteristics of chromosomes as they exist in cells, particularly during the phases of mitosis and meiosis. This complex structure also plays a critical role in regulating gene expression and ensuring the stability of the genetic material.

4. In a Dihybrid cross, how many gametes can each parent produce?

- A. 2**
- B. 3**
- C. 4**
- D. 5**

In a Dihybrid cross, each parent organism can produce four unique gametes when considering two traits, each with two alleles. This is due to the principle of independent assortment, which states that alleles for different genes segregate independently during gamete formation. To understand this, consider a parent organism that has two traits, with each trait represented by two different alleles. For example, let's say one trait is seed shape (round or wrinkled) and the other is seed color (yellow or green). If we denote the shape alleles as R (round) and r (wrinkled) and the color alleles as Y (yellow) and y (green), then the possible gametes produced by this parent would be a combination of these alleles. The possible combinations of alleles for the two traits are: 1. RY (round and yellow) 2. Ry (round and green) 3. rY (wrinkled and yellow) 4. ry (wrinkled and green) Thus, a parent with these two traits can produce four distinct gametes. This concept applies to any dihybrid cross involving two traits with two alleles each, leading to the conclusion that each parent can generate four unique

5. Co-dominance typically involves how many alleles?

- A. One
- B. Two
- C. More than one**
- D. None

Co-dominance involves multiple alleles, specifically two alleles that can be expressed equally in the phenotype of a heterozygous individual. In this genetic scenario, both alleles contribute to the organism's observable traits without one being dominant over the other. This results in a phenotype that displays characteristics of both alleles simultaneously. A classic example of co-dominance is seen in the ABO blood group system, where individuals with the genotype IAIB express type AB blood, showcasing both A and B antigens on the surface of red blood cells. Understanding that co-dominance requires at least two alleles is essential, as it distinguishes it from other forms of inheritance like simple dominance, where one allele masks the expression of another. The presence of more than one allele allows for the unique phenotypic outcomes typical of co-dominance, reinforcing the concept that both alleles actively influence the trait being expressed.

6. Why did people initially believe that proteins carried genetic information rather than DNA?

- A. Because DNA was thought to be too simple
- B. Because proteins were much more complex**
- C. Because proteins are more abundant in cells
- D. Because nucleotides are composed of proteins

The belief that proteins carried genetic information rather than DNA stemmed from the perceived complexity of proteins compared to DNA. Scientists observed that proteins, made up of long chains of amino acids, exhibited a vast array of structures and functions, which suggested to them that they could perform the intricate tasks necessary for inheritance and cell function. In contrast, DNA, composed of only four types of nucleotides, seemed simpler and less variable. This simplicity led some researchers to underestimate its potential role in encoding genetic information. The diverse functions of proteins, including enzymes, hormones, and structural components, further supported the notion that they were responsible for heredity and traits observed in organisms. As a result, the understanding of molecular biology shifted over time as more evidence emerged, revealing that DNA is the primary carrier of genetic information, ultimately disproving the initial belief regarding proteins.

7. How many non-autosomal genes does a human typically possess?

- A. 0
- B. 1**
- C. 2
- D. 3

Humans typically possess one non-autosomal gene. This gene is located on the Y chromosome, which is one of the two sex chromosomes in humans (the other being the X chromosome). While most genes are located on the 22 pairs of autosomes, the genes located on the X and Y chromosomes are classified as non-autosomal. In human males, who possess one X and one Y chromosome, the only non-autosomal gene is found on the Y chromosome. This gene has crucial functions related to sex determination and spermatogenesis. In females, who have two X chromosomes, there are no Y-linked genes present, which reinforces the understanding that typically only one non-autosomal gene exists in the context of the entire human genome. The other potential answers misinterpret the number of non-autosomal genes. While zero suggests the absence of these genes, and options suggesting two or three would exceed the count related to non-autosomal genes in a typical human genome.

8. How many autosomal gene pairs does a typical human have?

- A. 20
- B. 22**
- C. 24
- D. 26

Humans have a total of 22 pairs of autosomal chromosomes, which contain the vast majority of our genetic information. Each pair consists of one chromosome inherited from each parent, resulting in 44 individual autosomal chromosomes. Autosomes are defined as the non-sex chromosomes, meaning they are not involved in determining an individual's sex. In addition to these 22 pairs of autosomes, humans have 2 sex chromosomes (X and Y), making up the total of 23 pairs of chromosomes overall. However, when the question specifies only autosomal gene pairs, the accurate count is indeed 22. Understanding the distinction between autosomal chromosomes and sex chromosomes is critical in genetics, particularly when examining inheritance patterns and genetic variation.

9. What key information can phylogenetics provide to researchers?

- A. Detailed structures of genes**
- B. Evolutionary history and relationships among species**
- C. Exact functions of all gene products**
- D. Predictions regarding species extinction**

Phylogenetics is a branch of biology that focuses on understanding the evolutionary relationships among various species. It utilizes data from genetic, morphological, and biochemical characteristics to construct evolutionary trees or phylogenies, which depict how species have diverged from common ancestors over time. This approach helps researchers trace the lineage of organisms and provides insights into the processes of evolution, speciation, and adaptation. The information derived from phylogenetics can reveal patterns of descent, identify shared characteristics, and often provide a timeline indicating when specific evolutionary changes occurred. This offers a foundational framework for further research in evolutionary biology, conservation efforts, and understanding the biodiversity of life on Earth. While other options mention important concepts in genetics and biology, they do not specifically pertain to the unique contributions of phylogenetic analysis. For instance, the detailed structures of genes and the exact functions of gene products are more closely related to molecular genetics rather than evolutionary relationships. Predictions regarding species extinction primarily hinge on ecological studies, risk assessments, and environmental factors rather than directly on phylogenetic data. Thus, the strongest emphasis of phylogenetics lies in elucidating the evolutionary history and relationships among species.

10. What do homologous chromosomes have in common?

- A. Identical alleles**
- B. The same genes**
- C. Different chromosomes**
- D. Unique DNA sequences**

Homologous chromosomes share the same genes, which means that they contain corresponding gene sequences at the same loci, or positions, along the chromosome. Each homologous chromosome is inherited from one parent, resulting in pairs that can possess different versions of the same gene, known as alleles. For instance, one chromosome may carry an allele for blue eye color while the other carries an allele for brown eye color. This genetic variability is essential for the processes of sexual reproduction and genetic diversity. The characteristic that allows homologous chromosomes to be recognized as such is their relationship in terms of gene content, regardless of whether the alleles for those genes are identical or different. Therefore, while homologous chromosomes may have variations in allele form, they fundamentally share the same set of genes.