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2023190

Genetics and Molecular Biology (BIO214) (Mid-Sem Examination) Year: 2024
Attempt Any Five (5) Questions Only.

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Instructions
1. No negative marks.
2. Each question carries **ten** marks.
3. All questions are compulsory
4. The maximum mark is 50.
5. Time= 1.5 hrs (90 minutes)

Question 1: Explain the concepts of incomplete dominance, co-dominance, and dominant-recessive inheritance patterns. Provide an example for each, illustrating how the phenotype of the offspring differs in each case. Additionally, discuss how these patterns challenge the simple Mendelian view of inheritance and how they can lead to greater genetic diversity in populations.

Question 2: Yuvraj Singh, a renowned cricketer, was diagnosed with lung cancer due to a somatic mutation in his cells, which did not affect his offspring. Using this case as a starting point, explain the concept of mutations. Differentiate between somatic and germline mutations, highlighting how they impact individuals and inheritance. Additionally, describe the various types of mutations such as point mutations, insertions, deletions, and chromosomal mutations. How do these mutations contribute to diseases like cancer?

Question 3: During ISRO's Mars Orbiter Mission (MOM), a new organism has been discovered on Mars. As a scientist, you are tasked with identifying and characterizing the nature of the nucleic acid in this organism. Considering all possibilities for the type of nucleic acid (DNA, RNA, or others), outline a detailed investigative approach.

Create a flowchart to demonstrate the following:
1. Possible types of nucleic acids (DNA, **RNA**, or any unknown form),
2. Experimental methods to test for each type, explaining how to accept or reject each possibility,
3. Biochemical assays to measure the properties of the nucleic acid, such as its stability, composition, and replication mechanisms, with a focus on DNA properties.

Question 4: In humans, the ABO blood group system is determined by three alleles: I^A, I^B, and i, where I^A and I^B are co-dominant, and i is recessive. The Rh factor is determined by two alleles: Rh+ Rh⁺ Rh⁺ (dominant) and Rh− Rh⁻ Rh⁻ (recessive).

Given the following parental genotypes:

- Parent 1: I^Ai, Rh⁺Rh⁻
- Parent 2: $I^B I^B$, Rh⁻Rh⁻

1. Calculate all possible genotypes and phenotypes of the offspring for both the ABO and Rh blood group systems.
2. What is the probability of the offspring having:
   - Blood group AB, Rh-positive?
   - Blood group O, Rh-negative?
3. Explain in detail the human ABO blood group at the genotype-phenotype level.

Question 5: An explorer discovers a strange new plant species and sends some of the plant tissue to a geneticist to study. The geneticist isolates chromatin from the plant and examines it with an electron microscope. She observes what appears to be beads on a string. She then adds a small amount of nuclease, which cleaves the string into individual beads containing 280 bp of DNA. After digestion with more nuclease, a 120-bp fragment of DNA remains attached to a core of histone proteins. Analysis of the histone core reveals histones in the following proportions:

H1	12.5%
H2A	25%
H2B	25%
H3	0%
H4	25%
H7 (a new histone)	12.5%

Based on these observations, what conclusions could the geneticist make about the probable structure of the nucleosome in the chromatin of this plant?

Question 6: Describe Transformation, Transduction, and Conjugation. In addition to the text, please depict the underlying processes graphically.