

Quiz 2: Fundamentals of Biology II by Dr. Gaurav Ahuja Date: 19/09/2025

Max Marks = 36 (20 + 16)

Multiple Choice Questions (4 x 4 = 16 marks)

1. Unlike normal cells, cancer cells often exhibit genetic instability and can proliferate in the absence of external growth factors. Which of the following is a key characteristic that cancer cells show when grown in a petri dish?
 - a) They grow in a single, flat layer called a monolayer.
 - b) Their growth stops when they touch neighboring cells.
 - c) They grow in multilayered clumps known as foci.
 - d) They depend on external growth factors to stimulate division.

2. Cytosine methylation plays a key role in the "epigenetic code". Which enzyme is primarily responsible for de novo methylation, which is crucial for establishing new methylation patterns during development?
 - a) Dnmt1.
 - b) Dnmt2.
 - c) Dnmt3a and Dnmt3b.
 - d) G protein-coupled receptor kinase (GRK)

3. Barr bodies are visible in the nuclei of female cells and represent an inactive X chromosome. What is the molecular mechanism responsible for this X-inactivation?
 - a) The XIST gene produces XIST RNA that binds to the chromosome and turns off its genes.
 - b) DNA polymerase adds a large number of methyl groups to the entire chromosome.
 - c) A specific G protein activates a cascade that leads to chromosomal condensation.
 - d) The entire chromosome is silenced by histone deacetylation only

4. The "epigenetic code" is a non-sequence dependent form of inheritance. Which of the following modifications can be added to DNA to repress gene activity?
 - a) Methyl marks.
 - b) Phosphate groups.
 - c) Glucose molecules.
 - d) Adenine bases.

Subjective Questions (Attempt one question between Q1 and Q2; and one question from Q3 and Q4). Each question = 10 marks

1.(a) Explain Waddington's concept of the "epigenetic landscape," describing how the "ball" and the "valleys" represent a cell's developmental potential and fate. (5 marks)

(b) Discuss the molecular mechanisms, such as DNA methylation and histone modification, that influence a cell's movement in this landscape, and provide a real-world example (e.g., phenotypic variation in monozygotic twins). (5 marks)

2.(a) Explain the primary purpose of X-inactivation in mammalian females and describe the molecular mechanism by which it occurs, starting from the expression of the XIST gene to the formation of a Barr body. (5 marks) (b) Discuss how the presence of Barr bodies supports the role of cytosine methylation in regulating gene expression and maintaining chromosomal stability. (5 marks)

3. (a) Differentiate between somatic and germ-line mutations in terms of their location and inheritance potential. Explain the different types of point mutations (silent, missense, nonsense) with their effects on proteins. (5 marks)

(b) Describe the mechanism of a transition mutation caused by wobble base pairing, explain why mismatch repair corrects this error, and outline how the Ames test is used to identify chemical mutagens. (5 marks)

4. (a) Explain how DNA methylation patterns change as a cell develops from a totipotent zygote to a differentiated unipotent cell. Discuss the significance of these changes in regulating developmental potential, with reference to pluripotency and multipotency. (5 marks)

(b) Explain why reprogramming a differentiated cell back to a pluripotent state is challenging, focusing on the role of established DNA methylation patterns. (5 marks)