

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)*