Quiz 3: Fundamentals of Biology II by Dr. Gaurav Ahuja Date: 17/10/2025

Max Marks = 36 (16 + 20)

Multiple Choice Questions (2 x 8 = 16 marks, 0.5 marks negative)

1. Which of the following characteristics makes pBR322 a useful plasmid vector in recombinant DNA technology?
   A) It lacks restriction enzyme sites to prevent unwanted DNA cuts
   B) It contains antibiotic resistance genes for selection and a unique restriction site for cloning
   C) It cannot replicate independently in host cells
   D) It is a viral vector used to insert RNA sequences

2. In the CRISPR-Cas9 genome editing system, which sequence is essential for Cas9 to recognize and cut the target DNA?
   A) Intron sequence
   B) Protospacer Adjacent Motif (PAM)
   C) Enhancer element
   D) Telomeric repeat

3. During X-chromosome inactivation (Lyonization) in females, what is the function of the XIST gene?
   A) It methylates cytosine residues on autosomal chromosomes
   B) It produces RNA molecules that coat and silence one X chromosome
   C) It activates transcription of both X chromosomes
   D) It recruits histone acetyltransferases to open chromatin

4. In a phylogenetic tree, what does a node represent?
   A) A random mutation event
   B) A common ancestor shared by descendant lineages
   C) The most recently evolved species in the clade
   D) The rate of evolutionary change over time

5. Which of the following statements correctly describes the action of 5-Bromouracil in inducing mutations?

   A) It replaces adenine in DNA and causes transversions
   B) It resembles thymine and can pair with guanine, leading to base substitution mutations
   C) It blocks DNA polymerase activity and halts replication
   D) It enhances DNA repair by stabilizing hydrogen bonds

6. Oxidative radicals convert guanine into 8-oxo-7,8-dihydroguanine by attacking which position?

A) N7
B) C8
C) C2
D) N1

7. When designing crRNA for CRISPR-Cas9, which of the following criteria must be satisfied?

   A) The crRNA must bind to RNA instead of DNA.
   B) A PAM site must be immediately downstream of the target DNA, and the crRNA must be complementary to the target sequence.
   C) The target DNA must be methylated, and the crRNA should be identical to the PAM site.
   D) The crRNA must form a hairpin structure independent of the target DNA.

8. Why do biologists often prefer one sequence alignment over another when constructing a phylogenetic tree?

   A) Because the longest alignment is always the most accurate.
   B) Because the alignment requiring fewer evolutionary steps is preferred, following the principle of parsimony.
   C) Because alignments that match computer predictions exactly are always chosen.

   D) Because the alignment with the most gaps is considered the simplest.

Subjective Questions: Attempt any 4 Questions (4 marks each)

1. Explain the major steps involved in the creation of recombinant DNA, highlighting the role of restriction enzymes and vectors.
2. What are the sources of evidence of phylogeny and explain homologous characteristics with examples?
3. Explain the principle and procedure of the Ames test. How does it help in identifying potential chemical mutagens and carcinogens?
4. Describe the mechanism of the CRISPR-Cas9 system in gene editing. How do the guide RNA (gRNA) and PAM sequence contribute to the specificity of DNA cleavage?
5. What is insertional inactivation in recombinant DNA technology? Explain how it is used to identify recombinant colonies using the example of the pBR322 plasmid.