END SEM: Fundamentals of Biology II by Dr. Gaurav Ahuja **Date:** 05/12/2025

Max Marks = 25

Short Answer Questions (Attempt any 3). Each question = 2 marks

1. Describe how epigenetic mechanisms provide a plausible explanation for phenotypic variation in genetically identical organisms (e.g., monozygotic twins).
2. What is the primary function of a plasmid vector in recombinant DNA technology?
3. Discuss one major technical challenge and one ethical consideration associated with the clinical use of CRISPR-Cas9 for human germline editing.
4. Explain why a phylogenetic tree is considered a hypothesis, not a definitive fact. What kind of evidence can cause a tree to be revised?
5. Discuss how the integration of genomics, bioinformatics, and synthetic biology could lead to a "personalized medicine" approach for treating a complex disease like cancer.

Multiple Choice Questions. Each question = 2 marks; 50% Negative marking

Q1: A drug that acts as an antagonist at GABA-A receptors in the brain would likely have what overall effect on neural activity?
a) Decrease neural activity, acting as a sedative.
b) Increase neural activity, potentially causing seizures or anxiety.
c) Have no effect, as GABA is excitatory.
d) Block all action potentials.

Q2: A pathogen successfully evades the immune system by frequently changing the surface proteins recognized by antibodies. This is an example of evading immunity through:
a) Antigenic variation
b) Producing superantigens
c) Inhibiting complement
d) Hiding in intracellular niches

Q3: The finding that the Pax6 gene can induce eye formation in both flies and mice suggests that:
a) The last common ancestor of insects and vertebrates had complex camera-type eyes.
b) The genetic regulatory toolkit for initiating eye development is evolutionarily ancient and shared.
c) Eyes evolved independently in these lineages without any shared genetic basis.
d) Mouse Pax6 and fly eyeless are not truly homologous genes.

Q4: In a population at Hardy-Weinberg equilibrium, the frequency of the recessive homozygous genotype (aa) is 0.09. What is the frequency of the dominant allele (A)?
a) 0.3
b) 0.7

c) 0.49
d) 0.91

Q5: In a cladistic analysis, a shared derived character (synapomorphy) is used to:
a) Define an outgroup.
b) Identify convergent evolution.
c) Group organisms into clades.
d) Determine the age of a fossil.

Long Questions (Attempt Any One)

Question 1: Describe the central dogma of molecular biology. Then, explain how modern concepts in epigenetics, recombinant DNA technology, and evolutionary developmental biology (EvoDevo) have expanded, challenged, or refined our understanding of the relationship between genotype and phenotype. Use specific examples for each area.

Question 2: Trace the flow of biological information and regulation from the cellular level to the organismal level. Your answer should integrate concepts from signal transduction, gene regulation (including epigenetic factors), endocrine function, and neural signaling. Use a specific physiological process (e.g., the body's response to low blood sugar) as a framework to illustrate these connections.