

※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

**I. Vocabulary (2 points each)**

- Both the change in the genetic material and the process by which the change occurs is referred to as a/an: \_\_\_\_\_
- \_\_\_\_\_ : Use of different exons in formation of mRNA from initially identical transcripts. This results in the generation of related proteins from one gene, often in a tissue or developmental stage-specific manner.
- \_\_\_\_\_ : Three bases in a DNA or RNA sequence that specify a single amino acid.
- In prokaryotes, genes with related functions often are present in coordinately regulated genetic units called \_\_\_\_\_
- Traits in which phenotypic variation can be measured in a sample of individuals from the population are known as \_\_\_\_\_
- \_\_\_\_\_ is the study of changes in gene function that are heritable and that are not attributed to alterations of the DNA sequence.
- \_\_\_\_\_ occurs when a single mutation or gene/allele affects more than one phenotypic characteristic.
- \_\_\_\_\_ : The combination of linked marker alleles (may be polymorphisms or mutations) for a given region of DNA on a single chromosome.
- \_\_\_\_\_ : Study of a collection of genetic material (genomes) from a mixed community of organisms.
- \_\_\_\_\_ : The substitution of a purine for a pyrimidine nucleotide or vice versa (eg, an A for a C or T) in a DNA sequence.

**II. Multiple Choice: Choose one best answer from the options (3 points each)**

- Hershey and Chase used radiolabeled T2 phages to identify which component of the phage entered *E. coli* during infection. Which of the following correctly pairs the radiolabel with the appropriate phage component?
  - $^{32}\text{P}$  DNA,  $^{35}\text{S}$  Protein
  - $^{32}\text{P}$  Protein,  $^{35}\text{S}$  RNA
  - $^{32}\text{P}$  RNA,  $^{35}\text{S}$  DNA
  - $^{32}\text{P}$  Protein,  $^{35}\text{S}$  DNA
- Base-pair additions and deletions that alter the reading frame of all subsequent base-pair triplets are collectively referred to as:
  - Inversions
  - Transversions
  - Frameshift mutations
  - Point mutations

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3. In a gene cloning procedure the GFP gene is inserted into a plasmid and the plasmid is then taken up through transformation into an *E.coli* cell where it replicates. In which portion of this gene cloning procedure is the recombinant DNA molecule constructed?
- 1) The GFP is inserted into the plasmid
  - 2) The plasmid is taken up via transformation
  - 3) The plasmid replicates in the *E. coli* cell
- A. 1  
B. 2  
C. 3  
D. 1 and 2
4. What is the total phenotypic variance for a wheat population if the environmental variance is  $12.3 \text{ days}^2$  and the genetic variance is  $3.7 \text{ days}^2$ ?
- A.  $12.3 \text{ days}^2$   
B.  $3.7 \text{ days}^2$   
C.  $16.0 \text{ days}^2$   
D.  $45.5 \text{ days}^2$
5. Alzheimer's patients who inherit the mutant allele can exhibit a range of phenotypes, ranging from mild cognitive impairment to severe dementia. This is an example of:
- A. sex-influenced expression  
B. incomplete penetrance  
C. variable expressivity  
D. epistasis

### III. Short Answer Questions (4 points each)

1. Two parents who are not affected with cystic fibrosis are known carriers for the disease, which is controlled by the inheritance of a single gene. What is the probability that these parents will produce a female offspring who is affected with cystic fibrosis, assuming that the probability of producing a female offspring is 0.51?
2. Curly hair is caused by a dominant gene in humans. This trait is rare among northern Europeans. If a curly-haired northern European marries a person with straight hair, what proportion of their offspring would be expected to have curly hair, assuming the curly haired individual was a heterozygote?
3. 130 out of 1000 chromosomes are recombinant between two genes. How far apart are they located on a genetic map?
4. In a sample of 400 men, 48 have X-linked color blindness and all the others have normal color vision. What is the frequency for the X-linked color blindness allele?
5. The frequency of sickle cell anemia, caused by a homozygous condition ( $\text{Hb}^S\text{Hb}^S$ ) is approximately 0.0016. Assuming the Hardy-Weinberg equilibrium applies, what is the frequency of the  $\text{Hb}^S$  allele?

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**IV. Essay**

1. Illustrate and Explain how chromosomes that have undergone reciprocal translocation most often pair during meiosis. (5 points)
2. A researcher crosses a white-eyed female *Drosophila* with a red-eyed male. Knowing that the gene for eye color is sex-linked, he expects to observe only red-eyed females and white-eyed males in the progeny. However, he observes that while most of the progeny are as expected, a small percentage of the females have white eyes. Explain what may have occurred to cause this result. (5 points)
3. You are given a set of slides to analyze, but you do not know if you are looking at an example of mitosis or meiosis. What clues can you look for at each of these stages that might help you distinguish between cells that are going through mitosis or cells that are going through meiosis I? Can you distinguish between cells undergoing mitosis and cells in meiosis II? Explain your answer. (10 points)
4. How are the telomeric regions on the ends of the linear eukaryotic chromosomes preserved during replication? (5 points)
5. Briefly explain two ways the study of genetics has influenced agriculture. (5 points)
6. Huntington's disease is associated with the *HD* mutation, which contains 42 to 100 copies of a (CAG)<sub>n</sub> trinucleotide repeat on chromosome 4. Describe a simple molecular technique that is often used to test for this defect. (5 points)
7. How does the phenomenon of RNA interference regulate gene expression on a post-transcriptional level? (5 points)
8. Given the following data set, calculate the proportional contributions of each genotype to the next generation. What type of selection is demonstrated by this genetic trait? (5 points)

Genotype:	AA	Aa	aa
Frequency at fertilization:	0.25	0.50	0.25
Relative fitness:	0.8	1	0.4

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