

2025

**M.Sc. 1st Semester Examination**

**ZOOLOGY**

**Paper : ZOOC402X1**

**[Cytogenetics and Evolutionary Process]**

**Full Marks : 35**

**Time : 1 Hour 30 Minutes**

*The figures in the margin indicate full marks.  
Candidates are required to give their answers  
in their own words as far as practicable.*

**Group - A**

**Answer any five questions :            2×5=10**

1. A streptomycin sensitive Hfr strain of *E. coli* of genotype  $a^+b^+c^+d^+e^+$  was mated with a streptomycin resistant F<sup>-</sup> strain of genotype  $a^-b^-c^-d^-$  for a period of 30 minutes.  $e^+$  type bacteria were selected for survival colonies and the following frequencies of other + genes were found : 70% were  $a^+$ , No  $b^+$  found, 85% were  $c^+$ , 10% were  $d^+$ . What is the gene order?
2. State the importance of performing complementation test in genetic study.
3. Why is deletion mapping more informative than recombination mapping for fine-structure analysis?

**P.T.O.**

4. In *E. coli* four Hfr strains transfer their markers in the order shown below :

|          |           |
|----------|-----------|
| Strain 1 | A B C D E |
| Strain 2 | G H I E D |
| Strain 3 | J K L G H |
| Strain 4 | J A B C D |

Arrange the markers on the circular chromosome showing origin and direction of transfer with an arrow in each case considering that all Hfr strains were derived from same  $F^+$  strains.

5. Why human  $\alpha$  globin gene sequence and horse  $\alpha$  globin gene sequences are much similar than human  $\alpha$  and  $\beta$ -globin gene sequences?
6. What is meant by heterozygous superiority? Give example.
7. Order che A, che B, eda and sup D from the following data :

| Markers       | Cotransduction |
|---------------|----------------|
| Che A - eda   | 15             |
| Che A - sup D | 5              |
| Che B - eda   | 28             |
| Che B - sup D | 2.7            |
| eda - sup D   | 0              |

8. Determine whether the genotypes of North-West territories of Canada 12 MM individuals, 53 MJ individuals and 12 JT individuals are in Hardy-Weinberg equilibrium.

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**Group - B**

Answer any *three* questions :  $4 \times 3 = 12$

9. In a transduction experiment, the donor was  $c^+ d^+ e^+$  and recipient was  $c d e$ . Selection was for  $c^+$ . The different classes of transductants from this experiment are shown in the table:

| Class | Genetic composition | Number of individuals |
|-------|---------------------|-----------------------|
| 1     | $c^+ d^+ e^+$       | 57                    |
| 2     | $c^+ d^+ e$         | 76                    |
| 3     | $c^+ d e$           | 365                   |
| 4     | $c^+ d e^+$         | 2                     |

- (a) Determine the cotransduction frequency for  $c^+$  and  $d^+$
- (b) Determine the contrasduction frequency for  $c^+$  and  $e^+$
- (c) Which of the cotransduction frequency calculated in (a) and (b) represents the greater actual distance between genes and why?  $1\frac{1}{2} + 1\frac{1}{2} + 1$
10. While studying a bacteriophage, you are trying to determine how many genes are required for the phage to infect and lyse the host bacterium. You have eight mutants, all of which are unable to lyse a particular host bacterium. You performed pairwise infections with each of your mutant strains and observed the following results.

P.T.O.

|    | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | wt |
|----|----|----|----|----|----|----|----|----|----|
| M1 | -  | +  | +  | -  | -  | +  | +  | +  | +  |
| M2 |    | -  | +  | +  | +  | +  | +  | +  | +  |
| M3 |    |    | -  | +  | +  | -  | -  | -  | +  |
| M4 |    |    |    | -  | -  | +  | +  | +  | +  |
| M5 |    |    |    |    | -  | +  | +  | +  | +  |
| M6 |    |    |    |    |    | -  | -  | -  | +  |
| M7 |    |    |    |    |    |    | -  | -  | +  |
| M8 |    |    |    |    |    |    |    | -  | +  |
| wt |    |    |    |    |    |    |    |    | +  |

“+” denotes pair of phages lysed bacterium, and “-” denotes pair of phages failed to lyse bacterium. What are the complementation groups, and how many genes have you identified?

11. In a region where industrial pollution has been under control for a number of years, the fitness of *Biston betularia* moth is 0.47 for dark form and 1 for light form. Calculate the allele frequency of dark form in next generation where  $p = 0.1$ .
12. A homologous DNA region which has 1000 bp in length was sequenced among four primates. The following number of nucleotide differences were observed.

|            | Human | Baboon | Chimpanzee | Gorilla |
|------------|-------|--------|------------|---------|
| Human      | 0     | 44     | 72         | 50      |
| Baboon     | 44    | 0      | 79         | 40      |
| Chimpanzee | 72    | 79     | 0          | 77      |
| Gorilla    | 50    | 40     | 77         | 0       |

Construct a phylogenetic tree.

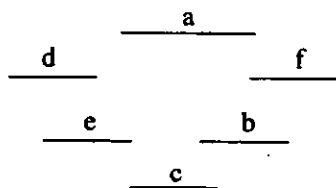
( 5 )

13. Considering the allele frequency of A is 0.7 in the continent population and 0.3 in the island population, a group of 20 individuals migrates from the continent and joins the island population, which originally had 80 members. Estimate the change in frequency of allele A due to migration and calculate the allele frequency in the conglomerate population.

**Group - C**

Answer any *one* question :  $8 \times 1 = 8$

14. The accompanying map shows the genetic interval defined by the end points of deletion



Seven rII mutants t through z thought to carry point mutations are crossed to six deletion mutants shown above and score for the ability to produce  $r^+$  recombinants. The result are given below :

|   | a | b | c | d | e | f |
|---|---|---|---|---|---|---|
| t | - | - | - | + | + | + |
| u | - | + | - | + | + | + |
| v | + | + | + | - | + | + |
| w | + | + | + | + | + | - |
| x | - | + | + | + | + | - |
| y | - | - | + | + | + | - |
| z | - | + | + | - | - | + |

P.T.O.

Using the given deletion end point to define genetic intervals along the rII gene position mark each point mutation within an interval. Define the deletion end points if necessary.

15. Hutt collected the following data from the families of Cornell University Veterinary students :

| Matings                        | No. of Couples | <u>Number of offsprings</u> |            |
|--------------------------------|----------------|-----------------------------|------------|
|                                |                | Taster                      | Non-taster |
| taster $\times$ taster         | 160            | 654                         | 76         |
| taster $\times$ non-taster     | 100            | 354                         | 205        |
| non-taster $\times$ non-taster | 40             | 7(?)                        | 98         |

Calculate whether this population of taster and non-taster is in equilibrium with respect to genotype frequencies using Snyder's test.

**Internal Assessment : 5 marks**

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