INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
DEPARTMENT OF BIOSCIENCES AND BIOENGINEERING
Genetics (BT 204)
Mid-Semester Examination

Date: September 21, 2024 **Time: 2 hours** **Total Marks: 30**
Read the questions carefully. ***All questions are compulsory***

1. A cell has two pairs of submetacentric chromosomes, which we will call chromosomes I_a, I_b, II_a, and II_b. Where Chromosomes I_a and I_b are homologs, and chromosomes II_a and II_b are homologs. Allele ***M*** is located on the long arm of chromosome I_a, and allele ***m*** is located at the same position on chromosome I_b. Allele ***P*** is located on the short arm of chromosome I_a, and allele ***p*** is located at the same position on chromosome I_b. Allele ***R*** is located on chromosome II_a and allele ***r*** is located at the same position on chromosome II_b. Answer the following: **[Marks 4]**

A. Draw these chromosomes, identifying genes ***M, m, P, p, R*** and ***r***, as they might appear in Metaphase-I of meiosis. Assume that there is no crossing over.

B. Taking into consideration the random separation of chromosomes in Anaphase-I, draw the chromosomes (with genes identified) present in all possible types of gametes that might result from this cell's undergoing meiosis. Assume that there is no crossing over.

2. Give the expected phenotypic ratios and name the blood types of the offspring from these parents: **[Marks 1 x 4= 4]**

a) $I^A I^A \times I^B I^B$ **b)** $I^A I^O \times I^O I^O$ **c)** $I^A I^B \times I^A I^O$ **d)** $I^A I^O \times I^B I^B$

3. Red colour in Wheat Kernels is produced by the genotypes ***R?B?,*** White by the double recessive genotypes (***rrbb***). The Genotypes ***R?bb*** and ***rrB?*** produced Brown kernels. A Homozygous Red variety is crossed to a White variety. (i) What type of genetic interaction is this? (ii) What phenotypic results are expected in F_1 and F_2 progeny? Explain with the cross. **[Marks 4]**

4. In guinea pigs, the allele for black fur (B) is dominant over the allele for brown (b) fur. A black guinea pig is crossed with a brown guinea pig, producing five F_1 black guinea pigs and six F_1 brown guinea pigs. How many copies of the black allele (B) will be present in each cell from an F_1 black guinea pig at the following stages, assuming that no crossing over takes place: **[Marks 4]**

(i) At G_1 stage of cell cycle
(ii) At G_2 stage of cell cycle
(iii) At Metaphase of Mitosis
(iv) At Metaphase I of Meiosis
(v) At Metaphase II of Meiosis
(vi) After second cytokinesis following Meiosis

5. Palomino horses have a golden yellow coat, Chestnut horses have a brown coat, and Cremello horses have a coat that is almost white. A series of crosses between the three different types of horses produced the following offspring: **[Marks 4]**

Parental Cross	Offspring
Palomino x Palomino	13 Palomino, 6 Chestnut, 5 Cremello
Chestnut x Chestnut	16 Chestnut
Cremello x Cremello	13 Cremello
Palomino x Chestnut	8 Palomino, 9 Chestnut
Palomino x Cremello	11 Palomino, 11 Cremello
Chestnut x Cremello	23 Palomino

[A] What type of inheritance is occurring in horses Palomino, Chestnut, Cremello phenotypes? Explain briefly.

[B] Assign symbols for the alleles that determine these phenotypes, and list the genotypes of all parents and offsprings given in the preceding table.

6. Differentiate between the following, draw the figure wherever required: **[Marks 2 x 5= 10]**

a) Acentric and Acrocentric chromosomes
b) Chromomere and Chromonemata
c) Telomere and Telocentric Chromosome
d) Dominance and Epistasis
e) Polytene Chromosomes and Lampbrush Chromosome