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

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Date: September 24, 2022 **Time: 2 hours** **Total Marks: 30**

Read the questions carefully. All questions are compulsory.

1. For each of the following definitions, give the appropriate term: **[Mark 3]**

(i) Any chromosome other than a sex chromosome

(ii) Site on a chromosome to which spindle fibres attach

(iii) Term applicable to a chromosome with arms of about equal length

2. A homozygous dominant black female guinea pig is crossed to a recessive white male. If an F1 individual is backcrossed to the female parent, what is the genotypic and phenotypic ratio of the individual? **[Marks 3]**

3. The two genotypes Aa Bb Cc Dd **x** Aa Bb Cc Dd are crossed. Give the proportions of the progeny of this cross having each of the following genotypes: **[Marks 3]**

(i) Aa Bb Cc Dd **(ii)** aa bb cc dd **(iii)** Aa Bb cc Dd

4. Coat colors of dogs depend upon the action of at least two genes. At one locus a dominant epistatic inhibitor of coat color pigment (**I–**) prevents the expression of color alleles at another independently assorting locus, producing white coat color. When the recessive condition exists at the inhibitor locus (**ii**), the alleles of the hypostatic locus may be expressed, **iiB–** producing black and **iibb** producing brown. When dihybrid white dogs are mated together, determine the phenotypic ratios expected in the progeny? **[Marks 3]**

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]**

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.

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6. The shape and the colour of radishes are controlled by two independent pairs of alleles that show NO Dominance; each genotype is distinguishable phenotypically. The colour may be red (**RR**), purple (**R'R**), or white (**R'R'**) and the shape may be long (**LL**), oval (**L'L**), or round (**L'L'**). Diagram a cross between red, long (**RRLL**) and white, round (**R'R'L'L'**) radishes and summarize the F_2 results under the headings phenotypes, genotypes, genotypic frequency and phenotypic ratio. **[Marks 4]**

7. A cell has two pairs of submetacentric chromosomes, which we will call chromosomes $\mathbf{I_a}$, $\mathbf{I_b}$, $\mathbf{II_a}$, and $\mathbf{II_b}$. Where Chromosomes $\mathbf{I_a}$ and $\mathbf{I_b}$ are homologs, and chromosomes $\mathbf{II_a}$ and $\mathbf{II_b}$ are homologs. Allele ***M*** is located on the long arm of chromosome $\mathbf{I_a}$, and allele ***m*** is located at the same position on chromosome $\mathbf{I_b}$. Allele ***P*** is located on the short arm of chromosome $\mathbf{I_a}$, and allele ***p*** is located at the same position on chromosome $\mathbf{I_b}$. Allele ***R*** is located on chromosome $\mathbf{II_a}$ and allele ***r*** is located at the same position on chromosome $\mathbf{II_b}$. Answer the following: **[Marks 5]**

   (i) 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.

   (ii) 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.

8. Give the expected phenotypic ratios and name the blood types of the offspring from these parents: **[Marks 5]**

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