DEPARTMENT OF BIOSCIENCES AND BIOENGINEERING INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI Genetics (BT 204

Mid-Semester Examination

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

Total Marks: 30

allele m is located at the same position on chromosome lb. Allele P is located on the short arm of chromosome la, and allele p is located at the same position on chromosome Ib, Allele R is located on chromosome IIa and allele r is located at the same position 1. A cell has two pairs of submetacentric chromosomes, which we will call chromosomes Is, Ib, IIs, and IIb. Where Chromosomes Is and Is are homologs, and chromosomes IIa and IIb are homologs. Allele M is located on the long arm of chromosome Ia, and on chromosome IIb. Answer the following:

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. 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.

Give the expected phenotypic ratios and name the blood types of the offspring from these parents:

[Marks 1 x 4= 4]

a) IA IA X IB IB

b) A lo x lo lo

c) IA IB X IA 10

a) A lo x IB IB

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 F1 and F2 progeny? Explain with the cross.

guinea pig, producing five F₁ black guinea pigs and six F₁ brown guinea pigs. How many copies of the black allele (B) will be 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 present in each cell from an F1 black guinea pig at the following stages, assuming that no crossing over takes place:

At G1 stage of cell cycle

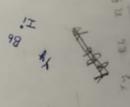
B warest At Metaphase of Mitosis

At Metaphase II of Meiosis

(ii) At G₂ stage of cell cycle(iv) At Metaphase I of Meiosis(vi) After second cytokinesis following Meiosis

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

Parental Cross	Offspring	
Palomino x Palomino 🧈 🏲 🖰	13 Palomino, 6 Chestnut, 5 Cremello	B
Chestnut x Chestnut	16 Chestnut	if .
Cremello x Cremello	13 Cremello	8
Palomino x Chestnut	8 Palomino, 9 Chestnut	
Palomino x Cremello	11 Palomino, 11 Cremello	tr.
Chestnut x Cremello	23 Palomino	



What type of inheritance is occurring in horses Palomino, Chestnut, Cremello phenotypes? Explain briefly, Ξ

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

[Marks 2 x 5= 10]

6. Differentiate between the following, draw the figure wherever required:

Acentric and Acrocentric chromosomes

Telomere and Telocentric Chromosome 6 6 C P 2

Dominance and Epistasis

Polytene Chromosomes and Lampbrush Chromosome

Dated: 20-09-2024 Time: 9.00-11.00

a) Write stepwise equation for DNA curving using k, t and N* [p= pitch, k= curvature, twist, N*= bp steps in complete one turn]

b) Write stepwise equation for DNA curving using P, k and t [p= pitch, k= curvature, t=

twist, N*= bp steps in complete one turn]

Assume that Histone Octamers form a cylinder of diameter 12 nm with a height of

What volume of nucleus (having 8-micron diameter) is occupied by Histone 6 nm, where human genome has 35 million nucleosomes

What fraction (in percent) of the nuclear volume do the DNA and Histone

Octamers occupy?

nucleosomes about 30 contains chromatin fiber nucleosome= 200 bp) per 75 nm of DNA. Assume that 30 nm

Calculate the degree of compaction of DNA associated with the level of chromatin structure.

percent) of 15000-fold condensation does this DNA What fractions (in packing represent?

experiment is continued for 4 generations in E. coli, then what would be the ratio steps of Meselson and Stahl's experiment. If Meselson and Stahl's

of 15N/15N:15N/14N:14N/14N in the end?

Excess of ³H labeled DNA replicated in a medium with ³²PdCTP. Incubation was continued for the cell cycles and then DNA was extracted by CSCI gradient. Show the graph(s) radioactivity vs time for i) one cycle ii) two 3

A 200 nucleotide segment is responsive for replication of a gene X of a cell. It is found that this segment is moved different places in genome and those new sites

are also amplified in cells.

3) Sketch the amplified DNA cluster.

c) What is the role of 200 nucleotide amplification control element of the gene X b) Calculate the fold of DNA amplification after 6 round of replications.

formed are fragments Okazaki diagram why

(Marks: $3 \times 8 = 24$) What are the steps in base excision repair? Show the diagram.

N

a) What are the major activities of Klenow enzyme?

b) Write the final structure when the partial DNA (shown below) is placed in a enzyme? [Bold letters buffer and Klenow mixture containing four dNTPs, indicate the complementary bases]

3/OH-ATGCGAATTAGCGACATCGATCGCGCATCGCTA-p 5/ p-ATCGGTACGACGTTAAC-OH-3/4144CT46 5/ p-TTAGC-OH-3/

(Marks 2+4: 6)