19 Dec. 2024

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1090 **I**

Unique Paper Code : 2492013502

Name of the Paper : Concepts of Genetics and Evolution

Name of the Course : **B.Sc. (Hons.) Biochemistry**

Semester : V

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are **6** questions.
3. Attempt any **four** questions.
4. Q. No. **1** is compulsory.
5. **All** questions carry equal marks.

P.T.O.

1. (a) Give **one** word for the following :

(i) A gene present on Y chromosome responsible for a human embryo to develop as a male.

(ii) An allele that causes death frequently at an early developmental stage, resulting in missing of one or more genotypes as well as phenotypes of a cross.

(iii) The test/tool used for analyzing genetic crosses in which one individual of unknown genotype is crossed with another individual with a homozygous recessive genotype for the trait in question.

(iv) The phenomenon responsible for appearance of white-eyed females and red-eyed males in the F1 progeny of Drosophila flies in a cross between a white-eyed female and a red-eyed male.

(v) A short stretch of DNA that has a higher frequency of methylation of cytosine than the rest of the genome as represents an epigenetic mark.

(vi) A method for estimating the age of evolutionary divergence between two species by comparing the differences in mutation rate in their DNA or protein sequences.

(vii) A condition in which the heterozygous genotype has a higher relative fitness than either the homozygous dominant or homozygous recessive.

(viii) A region of DNA that is shown to statistically be associated with a specific phenotype or trait that shows polygenic and continuous variation within a population.

(ix) A phenomenon in genetics where one or more genes modify or mask the expression of another gene

(x) The situation that occurs when one copy of a gene is inactivated or deleted and the remaining functional copy of the gene is not adequate to shown the complete phenotype.

(xi) A condition where an organism has both male and female reproductive organs

(xii) A technique used to study genetic linkage in fungi and other lower eukaryotes which can define the position of the centromere in a chromosome.

(b) Comment on the following statements :

(i) In the experiments conducted by Carl Correns on *Mirabilis jalapa*, the variegated branch produce progeny with three different phenotypes.

(ii) Bridges experiment was conclusive proof for the chromosomal theory of inheritance.

(iii) In a dihybrid cross a ratio of 9:3:3:1 can be both a Mendelian as well as Non-Mendelian inheritance.

(iv) Recombination frequency cannot exceed 50%.

(v) Complementation tests are used to identify gene interactions.

(vi) Genetic imprinting is an example of a nonrandom monoallelic expression.

(6,9)

2. (a) Differentiate between :

(i) Uniparental inheritance and uniparental disomy.

(ii) Continuous and discontinuous variation

(iii) Hemizygous and heterozygous

(iv) Incomplete dominance and codominance

(v) Chromosomal sex determination and genic sex determination

(vi) Pre and post reproductive isolation

(b) Albinism in humans is a recessive condition. What would be the probability of two out of the five children having albinism if both of their parents are carriers? (12,3)

3. (a) What is dosage compensation? Differentiate between the dosage compensation mechanism in humans and Drosophila.

(b) With a suitable example explain how the alleles encoding different traits separate independently. Show the genotypes as well as phenotypes.

(c) Two plants with white flowers, each from true breeding strains, were crossed. All the F1 plants had red flowers. When these F1 plants were intercrossed, they produced F2 plants consisting of 177 plants with red flowers and 142 with white flowers. (i) Propose an explanation for inheritance of flower color in this plant species and (ii) Propose a biochemical pathway for this flower pigmentation.

(d) A color blind man married a homozygous normal woman. After 2 years they had 2 children but unfortunately, they both had Turners syndrome, although one had normal vision the other was colorblind. What accounts for this situation.

(6,3,3,3)

4. (a) The first chromosome to be mapped is the X chromosome of Drosophila. Why does mapping the X chromosome not require a tester while for an autosomal map a test cross is essential? What do you understand by the terms map function and Lod score?

(b) What are different modes of speciation? Explain.

(c) Four alleles of the Agouti gene are known to control coat colour in mice. The alleles form a dominance series Ay > A > a1 > a. A researcher investigating mouse genetics traps a wild male mouse showing yellow coat colour. If the wild mouse's coat is due to Ay, describe and explain a single mating experiment that would identify the other Agouti allele.

(d) What is somatic cell hybridization? The following data shows different cell lines which were created from human mouse somatic cell fusions. Each line was examined for the presence of human chromosomes and for the production of human haptoglobin. The following results were obtained:

Cell line	Homan haptoglobin	Human chromosomes						
		1	2	3	14	15	16	21
A	–	+	–	+	–	+	–	–
B	+	+	–	+	–	–	+	–
C	+	+	–	–	–	+	+	–
D	–	+	+	–	–	+	–	–

Based upon the data, locate haptoglobin gene to its respective chromosome and justify your answer. (4,4,3,4)

5. (a) In D. melanogaster, cherub wings (ch), black body (b). and cinnabar eyes (cn) result from recessive alleles that are all located on chromosome 2. A homozygous wild-type fly was mated with a cherub,

black, and cinnabar fly, and the resulting F_1 females were test-crossed with cherub, black, and cinnabar males. The following progeny were produced from the testcross :

ch	b^+	cn	109
ch^+	b^+	cn^+	757
ch^+	b	cn	45
ch^+	b^+	cn	7
ch	b	cn	761
ch	b^+	cn^+	45
ch^+	b	cn^+	105
ch	b	cn^+	8

(i) Determine the order of the genes on the chromosome. Justify which gene is in the middle.

(ii) Calculate the distance between the three loci.

(iii) Determine the coefficient of coincidence and the interference for these three loci.

(iv) What does the interference tell us about the effect of one crossover on another?

(b) Differentiate between sex determination in humans and Drosophila.

(c) What is Broad-sense heritability and how does it differ from Narrow-sense heritability? A study of quantitative variations for abdominal bristle number in female Drosophila yielded estimates of VT = 7.08, Vg = 4.17, and Ve = 2.91. Calculate broad-sense heritability from the given data?

(7,5,3)

6. (a) What is the probability of getting a female with pattern baldness from a bald man and a heterozygous normal female? (Pattern Baldness trait is sex influenced) If a man shows pattern baldness and his father is not bald, what are the possible genotype(s) of the mother? If a woman's

parents are not bald, she is not bald, and her husband and older daughter are both homozygous for pattern baldness, then what is the genotype of both the woman and her parents? What is the probability that the woman and her husband would have the bald daughter.

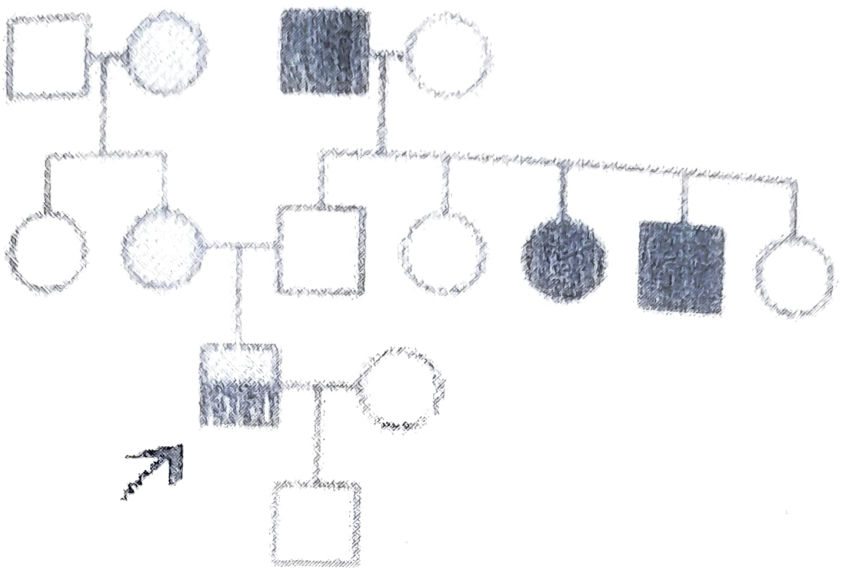
(b) In the following pedigree, the individual 1-2 and her daughter are suffering from an autosomal dominant condition Neurofibromatosis(n) and individual 1-3 and his two children are suffering from a rare autosomal dominant condition (d) and individual III-1 is suffering from both conditions. If the penetrance of n is 0.5 and the penetrance of d is 0.8. Based on the above, answer the following :

What is penetrance? How is it different from variable expressivity?

What is the probability that the IV-1 would be suffering from both condition.

What does the arrow represent? Explain.

What is the genotype of the parents in Generation 1?



(c) What is maternal effect? The shell coiling in snail is a maternal effect. A snail produced by a cross between two individuals has a shell with a dextral (right-handed) coil. This snail produces only sinistral (left-handed) progeny on selfing. What are the genotypes of the snail and its parents?

(5,5,5)