

**GENETICS**  
**(BIOT 3101)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**  
**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) How many Barr bodies would you find in a human cell containing XXY chromosomes?  
(a) 1 (b) 1 or 2 (c) 2 (d) 3.
- (ii) Which of the following mutations would be least detrimental to the function of a protein?  
(a) Frameshift (b) Silent (c) Nonsense (d) Missense.
- (iii) In a family, father is having a disease and mother is normal. The disease is inherited to only daughters and not to sons. What type of disease is this?  
(a) Sex-linked dominant (b) Sex-linked recessive  
(c) Autosomal dominant (d) Autosomal recessive.
- (iv) Which definition is correct?  
(a) A dominant allele is expressed only if heterozygous  
(b) A dominant allele is expressed only if homozygous  
(c) A recessive is expressed only if homozygous  
(d) A recessive allele is expressed only if heterozygous.
- (v) The 'Two-hit hypothesis' explains  
(a) what happens when a trait is influenced by two genes  
(b) why some families have a high incidence of cancer  
(c) why Mendel observed a 9:3:3:1 ratio in his F<sub>2</sub>S  
(d) why heterozygotes are the most common genotype in the F<sub>2</sub> generation of a monohybrid cross.
- (vi) Which of the following is a single gene disorder?  
(a) Cystic Fibrosis (b) Type 2 diabetes mellitus  
(c) Cardiovascular disease (d) Obesity.
- (vii) Which of the following is NOT a requirement for Hardy-Weinberg equilibrium?  
(a) Random mating (b) Immigration and emigration rate is equal  
(c) Population is infinitely large (d) Population is at carrying capacity.
- (viii) Standard deviation is the square of  
(a) Mode (b) Standard error (c) Regression (d) Variance.

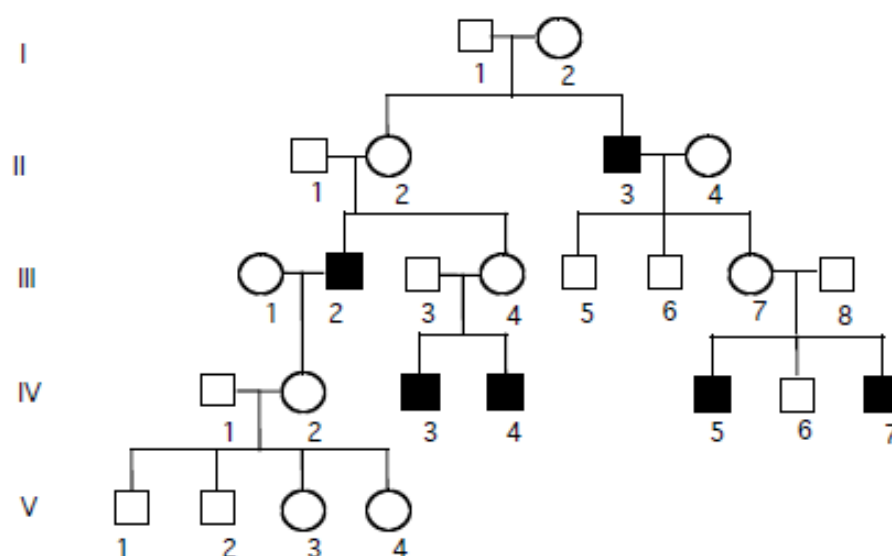
- (ix) Which is NOT a characteristic of normal distribution?  
 (a) Symmetric (b) Mean = Median = Mode  
 (c) Bell-shaped (d) Negative skewness.
- (x) Variables whose values cannot be expressed numerically are called  
 (a) Quantitative variables (b) Qualitative variables  
 (c) Absolute variables (d) Continuous variables.

**Group- B**

2. (a) The following three recessive markers are known in lab mice: hot foot (h), obese (o) and waved (wa). A trihybrid of unknown origin is test crossed, producing the following offsprings:

Phenotypes	Number
hot foot, obese, waved	357
hot foot, obese	74
waved	66
obese	79
wild type	343
hot foot, waved	61
obese, waived	11
hot foot	9
<b>Total</b>	<b>1000</b>

- (i) Find out the correct order of the 3 genes.  
 (ii) Determine the relative map distances between the 3 genes.  
 (iii) Calculate the coefficient of coincidence. [[CO1,2](Evaluate/HOCQ)]
- (b) The following pedigree illustrates the inheritance of Nance-Horan syndrome, a rare genetic condition in which affected person have cataracts and abnormally shaped teeth.



- (i) On the basis of this pedigree, what is the most likely mode of inheritance?  
 (ii) If couple III-7 and III-8 have another child, what is the probability that the child will have Nance-Horan syndrome?  
 (iii) If III-2 and III-7 married, what is the probability that one of their children would have Nance-Horan syndrome?

[[CO2] (Examine/HOCQ)]  
**(2 + 2 + 1) + (3 + 2 + 2) = 12**

3. (a) A normal woman whose father was colour blind has a son. Nothing is known about the colour vision phenotype of the father. What is the probability that the son will be colour blind? Explain with reasons. [[CO2](Analyze/IOCQ)]

- (b) Describe with an example how infectious heredity plays an important role in transmission of extra-nuclear inheritance. [(CO1,2)(Understand/LOCQ)]
- (c) What is Barr Body? Analyze the mechanism of X-inactivation in female cells. [(CO2)(Analyze/IOCQ)]
- 4 + 4 + (1 + 3) = 12**

**Group - C**

4. (a) Analyze with reasons how a single mutation in the CFTR gene results in the deadly disease like Cystic Fibrosis. [(CO4)(Analyze/IOCQ)]
- (b) Differentiate between Transition and Transversion mutations. [(CO4)(Understand/LOCQ)]
- (c) Discuss the impaired clotting process during Haemophilia-A as compared to a normal person. [(CO4)(Understand/LOCQ)]
- 4 + 4 + 4 = 12**
5. (a) Cancer is a multi-step, multi-mutation disease. Justify the statement with a proper example. [(CO3)(Justify/IOCQ)]
- (b) What do you mean by Gatekeeper and Caretaker genes? Give examples. [(CO3)(Remember/LOCQ)]
- (c) Explain with a diagram how inactivation of Rb gene leads to development of retinoblastoma. [(CO3)(Understand/LOCQ)]
- 4 + 4 + 4 = 12**

**Group - D**

6. (a) Give a comparative analysis between Generalized and Specialized transduction. [(CO4)(Remember/LOCQ)]
- (b) In *E. coli* four Hfr strain donate the following genetic markers shown in the order denoted:

Strain 1	Q	W	D	M	T
Strain 2	A	X	P	T	M
Strain 3	B	N	C	A	X
Strain 4	B	Q	W	D	M

All these Hfr strains are derived from the same F<sup>+</sup> strain. What is the order of these markers on the chromosome of the original F<sup>+</sup>? [(CO4)(Evaluate/HOCQ)]

- (c) Analyze the process of Hfr conjugation. [(CO4)(Analyze/IOCQ)]
- 4 + 4 + 4 = 12**
7. (a) Analyze the role of 'pair-rule genes' in the embryonic development in *Drosophila*. [(CO4)(Analyze/IOCQ)]
- (b) Discuss the genetic control of anterior-posterior pattern formation in *Drosophila* embryonic development. [(CO4)(Understand/LOCQ)]
- (c) "Mitochondria have a vital role to play in cellular ageing". Justify the statement with suitable logic. [(CO4)(Analyze/IOCQ)]
- 4 + 4 + 4 = 12**

**Group - E**

8. (a) Discuss the main assumptions of a population existing in Hardy-Weinberg equilibrium. [(CO6)(Remember/LOCQ)]
- (b) Albinism, an autosomal recessive trait, has an incidence of about 1/10,000. What percentage of the population is heterozygous for this gene? [(CO6)(Calculate/IOCQ)]
- (c) Find the missing value of the frequency distribution of number of tablets needed to cure person affected from fever. It is given that the mean number of tablets to cure fever is 19.92. Find thereafter the mode of distribution.

No of tablets	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40
No of persons	11	13	16	14	-	9	17	6	4

[(CO6)(Understand/LOCQ)]

$$4 + 2 + 6 = 12$$

9. (a) A couple is heterozygous for albinism (Aa). What is the probability that
- (i) 4 out of 6 children born them are normal
- (ii) 4 normal and 2 albino out of 6 children. [(CO5)(Understand/LOCQ)]
- (b) An oil exploration firm finds that 5% of the test wells it drills yield a deposit of natural gas. If it drills 6 wells, find the probability that at least one well will yield gas?

[(CO5)(Analyze/IOCQ)]

$$6 + 6 = 12$$

---

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	45.83%	37.5%	16.67%

**Course Outcome (CO):**

After completing the course, the students will be able to:

- Understand the basic principles of Mendelian mode of inheritance and also analyze the reasons behind the exceptions to this phenomenon.
- Interpret the different modes of linkage, sex determination patterns and chromosomal abnormalities.
- Identify and analyze the genetic network of carcinogenesis to reach out for novel therapeutic strategies.
- Comprehend the mechanism of action of microbial genetics and genetic patterns of embryonic development.
- Apply the mathematical and biostatistical models in biological systems for testing of hypotheses, estimation of group differences and case-control studies.
- Use the Hardy-Weinberg model to quantify the allele frequency in a population for better understanding of evolutionary changes and gene flow.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.