GENETICS
(BIOT 3101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) In a population of fruit flies the allele for large wings is dominant over the allele for small wings. Two heterozygous parents are crossed and produce sixteen offspring. How many of these offspring will have large wings?
(a) Twelve (b) Four (c) Sixteen (d) Eight.

(ii) A man is brought to a court in a paternity case. He has blood group B, Rh positive. The mother has blood group B, Rh negative. The child's blood group is A, Rh negative. Which statement about the man is correct?
(a) He is the father (b) He might be the father
(c) He is not the father (d) He might not be the father.

(iii) Which one of the following is NOT a property of cancer cells?
(a) They compete with normal cells for vital nutrients
(b) They do not remain confined in the area of formation
(c) They divide in an uncontrolled manner
(d) They show contact inhibition.

(iv) The portion of the *Drosophila* body plan which will produce the wing is called
(a) Telson (b) Dorsal (c) Abdomen (d) Thorax.

(v) If $^{16}P_{r-1}:^{15}P_{r-1} = 16 : 7$ then r will be
(a) 10 (b) 12 (c) 7 (d) 8.

(vi) In a Binomial Distribution, if 'n' is the number of trials and 'p' is the probability of success, then the mean value is given by _____.
(a) np (b) n (c) p (d) np(1-p)

(vii) Genetic recombination between bacterial cells is first demonstrated by
(a) Ochoa and Kornberg (b) Har Gobind Khorana
(c) H. J. Muller (d) Lederberg and Tatum.

(viii) Bacterial sex factor is
(a) F-factor (b) col-factor (c) R-factor (d) RNA.

(ix) Which one of the following is NOT a property of cancer cells?
(a) They compete with normal cells for vital nutrients
(b) They do not remain confined in the area of formation
(c) They divide in an uncontrolled manner
(d) They show contact inhibition.

(x) Which of the following would eliminate X-linkage as a possible mode of inheritance?
(a) An affected female has an affected mother
(b) An affected female does not have an affected mother
(c) An affected female has an affected father
(d) An affected female does not have an affected father.

Fill in the blanks with the correct word

(xi) The substitution of a purine base with a pyrimidine base is known as_____.

(xii) _____ is the process by which malignant cells spread throughout normal cells.

(xiii) 9p:22q translocation in Chronic Myelogenous Leukemia patients is seen in _____ chromosome.

(xiv) Variables whose values cannot be expressed numerically are called _____ variables.

(xv) Consanguinity shows a strong association with _____ pattern of inheritance.

Group – B

2. (a) Female Drosophila heterozygous for ebony (e), scarlet (sc) and spineless (ss) were test-crossed and the following progenies were obtained:

Progeny phenotypes	Number
wild type	67
ebony	8
ebony scarlet	68
ebony spineless	347
ebony scarlet spineless	78
scarlet	308
scarlet spineless	10
spineless	54

(i) Write the genotypes of the flies involved in the parental cross and test cross.
(ii) Construct the genetic map of the 3 genes indicating the map distance and correct sequence of the genes.
(iii) Calculate the coefficient of coincidence. *[(CO1,2)(Evaluate/HOCQ)]*

(b) Joe is colour blind. His mother and father have normal vision, but his maternal grandfather is colour blind. All of Joe's other grandparents have normal vision. Joes has three sisters – Patty, Betsy and Lara, all with normal colour vision. Joe's eldest sister, Patty, is married to a man with normal colour vision; they have two children, a 9-year old colour blind boy and a 4-year old girl with normal colour vision.
(i) Using correct symbols and labels, draw a pedigree of Joe's family.
(ii) If Joe marries a woman who has no history of colour blindness, what is the probability that their first child will be a colour blind boy?

(iii) If Patty and her husband have another child, what is the probability that it will be a colour blind boy? *[(CO2)(Analyze/IOCQ)]*

(2 + 2 + 2) + (2 + 2 + 2) = 12

3. (a) Analyze the phenomenon of Bombay phenotype. *[(CO1,2)(Understand/LOCQ)]*

(b) In a maternity ward of a hospital, four babies were accidentally mixed up. The blood groups of the four babies are known to be O, A, B and AB. The ABO types of the four sets of the parents are determined. Indicate which baby belongs to each set of parents.

(i) AB x O, (ii) A x O, (iii) A x AB, (iv) O x O. *[(CO1,2)(Justify/HOCQ)]*

(c) Vermilion eye colour in Drosophila is determined by the recessive allele v; the wild type eye colour produced by the v+ allele is brick red. What phenotypic ratios are expected from the crosses:

(i) vermilion female with wild type male

(ii) homozygous wild type female with vermilion male

(iii) heterozygous female with vermilion male. *[(CO2)(Deduce/HOCQ)]*

2 + (1 × 4) + (2 + 2 + 2) = 12

Group - C

4. (a) Analyze the cellular events behind formation of 'Philadelphia Chromosome'. *[(CO3)(Analyse/IOCQ)]*

(b) Describe the event that led to the discovery of retroviral oncogenes. *[(CO3)(Remember/LOCQ)]*

(c) As a genetic counsellor, you are asked to assess the risk for a couple who plans to have children. Both the husband and wife are phenotypically normal, but the husband has a sister with familial retinoblastoma in both eyes. What is the probability that this couple will have a child with retinoblastoma? Are there any tests that you could recommend to help in this assessment? *[(CO1,3)(Examine/HOCQ)]*

4 + 4 + 4 = 12

5. (a) Design an experiment by which you can detect a prospective mutagen with confirmation. *[(CO4)(Apply/HOCQ)]*

(b) A single nucleotide polymorphism changes one nucleotide in a gene sequence. As a result, the gene gains a stop codon 500 base pairs to soon and the protein—when it is translated—is truncated or cut short. Which of the following types of mutations did the point mutation cause? Analyze with reasons. *[(CO4)(Analyze/IOCQ)]*

(c) Can mutations be reversed back to the normal state? If yes, discuss by citing one example. *[(CO4)(Understand/LOCQ)]*

4 + 4 + 4 = 12

Group - D

6. (a) Discuss the interrupted mating technique devised by Wollman and Jacob to establish bacterial gene mapping. *[(CO4)(Remember/LOCQ)]*

(b) Describe the role of maternal effect genes in *Drosophila* development. *[(CO4)(Understand/LOCQ)]*

(c) How do mitochondrial mutations affect cellular ageing? *[(CO4)(Analyze/IOCQ)]*

4 + 4 + 4 = 12

7. (a) Differentiate between Complementation and Recombination. *[(CO4)(Differentiate/IOCQ)]*

(b) Five different rII deletion strains of phage T_4 were tested for recombination by pairwise crossing in E. coli B. The following results were obtained, where + = r^+ recombinants and 0 = no recombinants produced:

	A	B	C	D	E
E	0	+	0	+	0
D	0	0	0	0	
C	0	0			
B	+	0			
A	0				

Draw a deletion map compatible with these data. *[(CO4) (Calculate/HOCQ)]*

(c) What do you mean by positive complementation and negative complementation? *[(CO4)(Understand/LOCQ)]*

4 + 4 + 4 = 12

Group - E

8. (a) A sample of 1000 students of a college showed the following distribution of blood groups: A 430; B 140; AB 50; O 380. Calculate the frequencies of I^A, I^B and I^O. *[(CO6)(Analyse/IOCQ)]*

(b) In order to find the effect of Azolla growth on the rice field and experimentally grown Azolla in 10 similar field plots before rice planting and other 10 similar plots were taken as control without Azolla growth. Rice was grown in all these plots and yields were noted.

Plot no	1	2	3	4	5	6	7	8	9	10
With Azolla	15.3	15.8	16.1	17.0	15.5	16.5	16.2	15.5	17.1	16.3
Without Azolla	14.5	13.8	15.9	13.9	14.8	14.9	15.2	15.0	14.1	13.7

Verify whether there is any significant effect of Azolla growth on the gain of yield of rice. Given that $t_{0.05, 18} = 2.10$. *[(CO5)(Calculate/HOCQ)]*

(c) How many mammalian cells would be killed if an irradiation dose administered to a cell population was sufficient for an average of 5 lethal hits per target, when in fact only 2 hits are needed for lethality? (Given $e^{-m} = 0.0067$) *[(CO5)(Calculate/HOCQ)]*

4 + 4 + 4 = 12

9. (a) Discuss at least 3 instances which are deviations to the Hardy-Weinberg Equilibrium. *[(CO6) (Understand/LOCQ)]*

(b) Cystic fibrosis, an autosomal recessive trait, has an incidence of about 1/2500. Calculate the frequency of heterozygotes. *[(CO6) (Deduce/IOCQ)]*

(c) In the evening primrose pure red flowered plants were crossed with white flowered plants, F_1 are all pink coloured. Inbred F_1 plants produced 113 red, 242 pink and 129 white flowered plants. This phenotypic ratio also seems to be genotypic ratio of the F_2 of a Mendelian monohybrid cross involving a gene responsible for flower pigmentation. Analyse the result with suitable statistical test. Given that x^2 value for 2 *df* at 0.05 is 5.99. *[(CO5) (Deduce/IOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	31.25	41.66