GENETICS
(BTC3101)

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) A man who carries an X-linked allele will pass it on to
(a) all of his daughters (b) half of his daughters
(c) all of his sons (d) half of his sons

(ii) If there is a non-disjunction in the X chromosome, the progeny being XXY, what will be the constitution of the chromosome(s) in the gamete?
(a) X and Y (b) X and XY
(c) XX and Y (d) XXY with no separation

(iii) Which of the following is a classic example of point mutation?
(a) Sickle cell anaemia (b) Thalassemia
(c) Phenyketonuria (d) Haemophilia

(iv) Which of the following mutations would be least detrimental to the function of a protein?
(a) Frameshift (b) Silent (c) Nonsense (d) Missense

(v) Scientists studying the genetics of a congenital disease analyzed the chromosomes of the patient and found a large portion of chromosome twenty-three in chromosome one, and a small part of chromosome one in chromosome twenty-three. What is this an example of?
(a) Deletion (b) Translocation (c) Inversion (d) Duplication

(vi) Which of the following methods of reproduction proved for the first time that DNA is genetic material?
(a) Binary fission (b) Conjugation
(c) Transduction (d) Transformation

(vii) During bacterial recombination, which of the enzymes are used to cut the recipient DNA?
(a) Endonuclease (b) Exonuclease
(c) Ligases (d) Polymerase

(viii) In a Poisson distribution, if 'n' is the number of trials and 'p' is the probability of success, then the mean value is given by
(a) m = np (b) m = $(np)^2$ (c) m = np(1-p) (d) m = p

(ix) In the Caucasian population of the US, 1 in 2500 babies is affected by a recessive condition – cystic fibrosis. In this population, the frequency of the dominant allele is
(a) 0.02 (b) 0.36 (c) 0.56 (d) 0.98

(x) This is true of the population which are included in Hardy-Weinberg equilibrium
(a) entities migrate constantly (b) populations should be limited and small
(c) mating is random (d) process of natural selection is occurring

Fill in the blanks with the correct word

(xi) _____ is an example of a sex-linked recessive disorder in humans.

(xii) The transfer of naked DNA from one cell to another is referred to as _____.

(xiii) The number of Barr Bodies present in a XXXYY individual is _____.

(xiv) An interaction between non-allelic genes in which an allele at one locus prevents expression of an allele at another locus, but not vice versa, is called _____.

(xv) _____ gene has dual role in cell cycle and apoptosis.

Group - B

2. (a) Describe with an example how maternal influence plays an important role in sex determination. *[(CO1,2)(Understand/LOCQ)]*

(b) Elucidate the 'Genic Balance Theory' for sex determination in *Drosophila*. *[(CO2)(Analyze/IOCQ)]*

(c) What is the role played by Y chromosome in human sex determination? *[(CO2)(Understand/LOCQ)]*

4 + 4 + 4 =12

3. (a) Three of the many recessive mutations in *Drosophila melanogaster* that affect body colour, wing shape or bristle morphology are black (b), body versus grey in wild type, dumpy (dp), obliquely truncated wing versus long wing in the wild type, and hooked (hk) bristles at the tip versus not hooked in the wild type. From a cross of a dumpy female with a black and hooked male, all the F_1 are wild type for all three characters. The test cross of an F_1 female with a dumpy, black, hooked male gave the following results:

wild type – 169	black – 19
black hooked – 301	dumpy hooked – 21
hooked – 8	hooked dumpy black – 172
dumpy black – 6	dumpy – 304

(i) Find out the correct order of the three genes.
(ii) Construct a linkage map of the linkage group that these three genes occupy showing the map distances between the genes.
(iii) Determine the coefficient of coincidence. *[(CO1,2) (Evaluate/HOCQ)]*

(b) How can you examine a recessive disorder in a pedigree to comment whether the trait is X-linked or autosomal? *[(CO2)(Remember/LOCQ)]*

(c) Analyze with reasons why colour blindness is more common in males. *[(CO1,2) (Analyze/IOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) What do you mean by Missense and Nonsense mutations? Discuss with examples. *[(CO4) (Remember/LOCQ)]*

(b) What was the significance of the "Fluctuation test" (1943) conducted by Luria and Delbruck? *[(CO4) (Remember/LOCQ)]*

(c) The starting sequence of a gene changed from AUGTTCGACGTG to AUGTTTCGACGTG. What type of mutation is this? Analyze with reasons. *[(CO4) (Analyze/IOCQ)]*

4 + 4 + 4 = 12

5. (a) How do Cdk-cyclin complexes exert their effect of cell cycle progression? *[(CO3) (Understand/LOCQ)]*

(b) Suppose that you had the ability to introduce normal copies of a gene into tumour cells in which mutations in the gene caused it to promote tumour growth. In this context, answer the following questions:

(i) If the mutations were in tumour suppressor gene, would you expect these normal transgenes to block the tumour-promoting activity of the mutations? Why or why not?

(ii) If the mutations were of the oncogene type, would you expect the normal transgenes to lock their tumour-promoting activity? Why or why not? *[(CO3) (Analyze/IOCQ)]*

(c) Relatively few inherited forms of cancer involve the inheritance of mutant oncogenes. Instead most inherited forms of cancer are defects in tumour suppressor genes or DNA repair genes. Give two or more reasons why we seldom see inherited forms of cancer involving activated oncogenes. *[(CO3) (Apply/HOCQ)]*

4 + (2 + 2) + 4 = 12

Group - D

6. (a) Illustrate the main steps involved in bacterial gene transformation. *[(CO4) (Remember/LOCQ)]*

(b) Five deletion mutations within the B cistron of the rII region of the phage T_4 were tested in all pairwise combinations for wild type recombinants. In the following table of results, + = recombination, 0 = no recombination. Construct a topological map for these deletions.

	1	2	3	4	5
1	0	+	+	0	0
2		0	+	0	+
3			0	+	0
4				0	0
5					0

[(CO4) (Calculate/HOCQ)]

(c) Differentiate between the three main types of bacterial homologous recombination. *[(CO4) (Differentiate/IOCQ)]*

4 + 4 + 4 =12

7. (a) Illustrate the different stages in the life cycle of any animal virus. *[(CO4) (Remember/LOCQ)]*

(b) Analyze the genetic control of body segmentation in *Drosophila*. *[(CO4) (Analyze/IOCQ)]*

(c) Comment on the bizarre conditions caused by mutations in the homeotic genes in *Drosophila*. *[(CO4)(Understand/LOCQ)]*

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

[(CO5) (Understand/LOCQ)]

4 + 2 + 6 = 12

9. (a) What is the frequency of heterozygotes Aa in a random mating population in which frequency of all dominant allele is 0.19? *[(CO6) (Analyze/IOCQ)]*

(b) What is the difference between paired and unpaired t test? *[(CO5) (Understand/LOCQ)]*

(c) Ten students were given intensive coaching in Statistics. The marks obtained in the 1st and 5th test are given below:

Sl. No.	1	2	3	4	5	6	7	8	9	10
Marks in 1st	50	52	53	60	65	67	48	69	72	80
Marks in 5th	65	55	65	65	60	67	49	82	74	86

Does the score from the 1st test to 5th test show an improvement? Test at 5% level of significance. Critical value of 't' at 0.05 for df 9 = 1.833. *[(CO5)(Calculate/HOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	52.08	31.25	16.67