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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) Which statement about alleles is not true?
(a) They may occupy different loci on the same chromosome
(b) There may be several at one locus
(c) One may be dominant over another
(d) They may show incomplete dominance

(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) What is the source of the genetic mutation for Huntington's disease?
(a) a mutation in the non-coding region
(b) a CAG repeat
(c) a mutation in a non-critical amino acid in a protein
(d) an X-linked mutation

(iv) Which process does not lead to a change in chromosome number?
(a) Poisoning of the nuclear spindle   (b) Non-disjunction
(c) Endomitosis   (d) Duplication

(v) Scientists studying the genetics of a congenital disease analyzed the chromosomes of the patient and found a large portion of chromosome 23 in chromosome 1, and a small part of chromosome 1 in chromosome 23. What is this an example of?
(a) Deletion   (b) Translocation
(c) Inversion   (d) Duplication

(vi) Each of the following have been observed as mechanisms resulting in the activation of a proto-oncogene except:
(a) a point mutation altering the function of the oncogene protein product
(b) inactivation of an oncogene by telomerase activity
(c) Capture of the oncogene sequence by a retrovirus
(d) a chromosome translocation fusing portions of the oncogene and another cellular gene

(vii) Bicoid gene in Drosophila helps in
(a) Anterior-posterior polarity   (b) Body segmentation
(c) Specification of body structures   (d) Wing development

(viii) Find the number of rectangles and squares in an 8 by 8 chess board respectively.
(a) 296, 204   (b) 1092, 204   (c) 204, 1092   (d) 204, 1296

(ix) If the distribution of sample and population changes then the mean of Sampling distribution must be equal to _____
(a) standard deviation of population   (b) variance of population
(c) sample of population   (d) mean of population

(x) If 'm' is the mean of a Poisson Distribution, then variance is given by _____
(a) m^2 (b) $m^{1/2}$ (c) m (d) $m/2$

Group- B

2. (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) (Examine/IOCQ)]

(c) A black guinea pig crossed with an albino guinea pig produced 5 black offspring. When the albino was crossed with a second black one, 4 blacks and 3 albinos were obtained. Deduce the pattern of inheritance for the black and albino trait.
[(CO2)(Deduce/HOCQ)]
(2 + 2 + 1) + 3 + 4 = 12

3. (a) A girl of normal vision marries a boy of normal vision. Fathers of both girls and boys are colour-blind. What type of vision do you expect in their offspring? Note that gene for colour blindness is sex-linked recessive. [(CO2) (Analyze/IOCQ)]

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

   (c) Elucidate the Genic Balance theory for sex determination in *Drosophila*.
   [(CO2)(Analyze/IOCQ)]
   4 + 4 + 4 = 12

Group - C

4. (a) The gene p53 is said to have dual role in cell cycle and apoptosis. Justify the statement with proper reasons. [(CO3) (Justify/IOCQ)]

   (b) Analyze how a gene translocation leads to the development of chronic myelocytic leukemia. [(CO3) (Analyze/IOCQ)]

   (c) What do you mean by a triculeotide repeat disorder? Discuss the pathophysiology with an example. [(CO3)(Remember/LOCQ)]
   4 + 4 + 4 = 12

5. (a) 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)]

   (b) Can mutations be reversed back to the normal state? If yes, discuss by citing one example. [(CO4) (Understand/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?
   [(CO1,4)(Examine/HOCQ)]
   4 + 4 + 4 = 12

Group - D

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

   (b) In *E. coli* four Hfr strain donate the following genetic markers shown in the order denoted:

Strain 1	M	Z	X	W	C
Strain 2	L	A	N	C	W
Strain 3	A	L	B	R	U
Strain 4	Z	M	U	R	B

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

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

4 + 4 + 4 = 12

7.   (a)   Imagine a situation where two novel mutations have been identified in a bacterium. Design an experiment to test whether these mutations are present in the same gene or not.   [(CO4) (Analyze/IOCQ)]

(b)   The anterior-posterior axis of the embryo is therefore specified by three sets of genes – justify the statement with reference to *Drosopshila*.

[(CO4) (Justify/IOCQ)]

(c)   Discuss the significance of segment polarity genes in *Drosophila* embryonic development.   [(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) (Understand/LOCQ)]

(b)   What is the difference between paired and unpaired t test?

[(CO5) (Remember/LOCQ)]

(c)   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)]

4 + 2 + 6 = 12

9.   (a)   A committee of 7 people is to be formed randomly from a group of 10 women and 6 men. Find the probability that the committee has
(i) 2 women and 5 men.
(ii) 4 women and 3 men.
(iii) 7 women.
(iv) At least 3 men.   [(CO5) (Analyze/IOCQ)]

(b)   The grades of a group of 1000 students in an exam are normally distributed with a mean of 65 and a standard deviation of 9. A student from this group is selected randomly.
(i)   Find the probability that his/her grade is greater than 70.

(ii) Find the probability that his/her grade is less than 50.
(iii) Find the probability that his/her grade is between 50 and 80.
(iv) Approximately, how many students have grades greater than 90?

[(CO5) (Analyze/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27%	49%	24%

Course Outcome (CO):

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

1. Understand the basic principles of Mendelian mode of inheritance and also analyze the reasons behind the exceptions to this phenomenon.
2. Interpret the different modes of linkage, sex determination patterns and chromosomal abnormalities.
3. Identify and analyze the genetic network of carcinogenesis to reach out for novel therapeutic strategies.
4. Comprehend the mechanism of action of microbial genetics and genetic patterns of embryonic development.
5. Apply the mathematical and biostatistical models in biological systems for testing of hypotheses, estimation of group differences and case-control studies.
6. 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

Department & Section	Submission Link
BT	https://classroom.google.com/c/MzQ1Nzc2MzIzNTgy/a/NDY0MTU2NDgxMjAz/details