2015

## BIOCHEMISTRY

Paper – BCT: 305

(Genetics and Genomics)

Full Marks – 25

The figures in the margin indicate full marks

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

Group – A

Answer *any three* questions

1. (a) Two black female mice are crossed with the same brown male. In a number of litters, female X produced 9 blacks and 7 browns, and female Y produces 14 blacks. What is the mechanism of inheritance of black and brown coat color ? What are the genotypes of the parents ?

   (b) Genes a, b and c assort independently and are recessive to their respective alleles A, B and C. Two triply heterozygotes (*Aa Bb Cc*) individuals are crossed. What is the probability that a given offspring will be phenotypically A B C – that is, will exhibit all three dominant traits ? What is the probability that a given offspring will be homozygous for all three dominant alleles ?   2+3

2. (a)
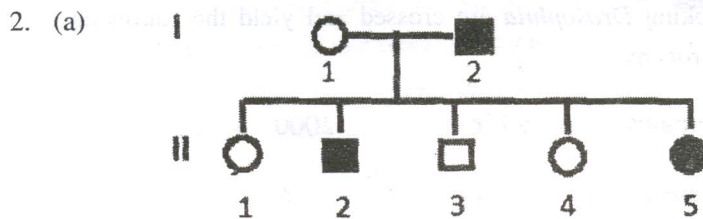
   Consider the above pedigree. In which the allele responsible for the trait (a) is recessive to the normal allele (A).

   (i) What is the genotype of the mother ?

   (ii) What is the genotype of the father ?

   (iii) What are genotypes of the children ?

   (iv) Given the mechanism of inheritance involved, does the ratio of children with the trait to children without the trait match ? What would be expected ?

   (b) In humans and the fly *Drosophila melanogaster*, XX animals are female and XY animals are male. How is the expression of X-linked genes equalized in the opposite sexes ?

[Turn Over]

(c) How many Barr bodies would be present in the majority of cells of a person with Turner syndrome and a person with Klinefelter syndrome ?   2+2+1

3. (a) When females of a particular mutant strain of *Drosophila melanogaster* are crossed to wild-type males, all the viable progeny are females. Hypothetically, the result could be consequence of either a sex-linked, male-specific lethal mutation or a maternally inherited factor that is lethal to males. What crosses would you perform to distinguish between these alternatives ?

(b) Distinguish between maternal inheritance and maternal effect.   3+2

4. (a) Distinguish dominant epistasis from recessive epistasis.

(b) Genes A. B and C are independently assorting and control the production of a black pigment.

$$\text{colorless} \xrightarrow{\;A\;} \xrightarrow{\;B\;} \xrightarrow{\;C\;} \text{black}$$
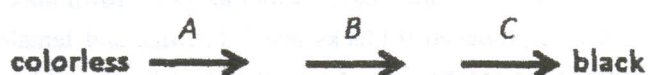
Suppose A, B and C act in the following pathway. The alternative alleles that give abnormal functioning of these genes are designated a, b and c respectively. A black A/A B/B C/C is crossed with a colorless a/a b/b c/c to give a black F_1. The F_1 is selfed. What proportion of F2 is colorless? (Assume that the product of each step except the last is colorless, so only colorless and black phenotypes are observed.)   3+2

5. Two normal looking *Drosophila* are crossed and yield the following phenotypes among their progeny.

Females:	$a^+b^+c^+$	2000
Males:	$a^+b^+c^+$	3
	a b c	1
	a^+b c	839
	a b^+c^+	825
	a b c^+	86
	a^+b^+c	90
	a b^+c	81
	a^+b c^+	75
Total		4000

Show the parental genotypes, the gene arrangement in the female parent and the map distances, and the coefficient of coincidence.   1+3+1

6. (a) In a population of 2000 gaboon vipers, a genetic difference with respect to venom exists at a single locus. The alleles are incompletely dominant. The population shows 100 individuals homozygous for the t allele (genotype, tt, nonpoisonous), 800 heterozygous (genotype Tt, mildly poisonous), and 1100

homozygous allele (genotype TT, lethaly poisonous). What is the allele frequency of the t allele in the population?

(b) The gene for sickle cell anemia exhibits heterozygote advantage. An individual who is an Hb-A/Hb-S heterozygote has increased resistance to malaria and therefore has greater fitness than the Hb-A/Hb-A homozygote who is susceptible to malaria, and the Hb-S/Hb-S homozygote who has sickle cell anemia. Suppose that the fitness values of the genotypes are as presented here:

Hb-A/Hb-A = 0.88

Hb-A/Hb-S = 1.00

Hb-S/Hb-S = 0.14

Give the expected equilibrium frequencies Hb-A and Hb-S alleles. 2+3

Group – B

Answer *any one* question

7. (a) A new protein 'X' is recently discovered from a newly sequenced eukaryotic genome. This protein contains a DNA binding domain, but no other information is available. Design a genomic-based experiment that you could use to gather information on the possible functions of this gene.

(b) What is the importance of using EMS over another type of mutants from the point of view of functional genomics ?

(c) What is the difference in chip design between a tiling microarray and gene expression based microarray ? 2+2+1

8. (a) How do you quantify the expression pattern from the raw data of RNAseq ?

(b) What precautions should be taken while designing a gene expression experiment, so that you can minimize the environmental effect ?

(c) Explain the basic difference between the present generation microarray and an old-fashioned microarray. 2+2+1

Group – C

Answer *any five* questions 1 × 5

9. The enzyme used in Maxam-Gilbert method for 32-P labelling of the DNA at 3'end is

(a) polynucleotide kinase

(b) alkaline phosphatase

[Turn Over]

(c) exonuclease

(d) terminal nucleotidyl transferase.

10. Automated DNA sequencing is an improvement of Sanger's method where

(a) ddNTPs are used for chain termination

(b) PCR is used for making sequencing templates

(c) Fluorescently labelled dNTPs are used for chain termination

(d) Fluorescently labelled ddNTPs are used for chain termination.

11. Optical mapping

(a) Uses restriction enzymes

(b) Is normally done with metaphase chromosomes

(c) Determines the position of restriction sites in a DNA molecule

(d) Always uses a fluorescent dye.

12. Whole-genome shotgun sequencing approach depends primarily on

(a) rapidly sequencing thousands of small randomly cloned fragments

(b) methodical sequencing a few large cloned fragments of DNA

(c) sequencing the bacterial chromosome while it is still intact

13. You need to use a first generation sequencing method for de novo sequencing, which template should give optimum results for this project ?

(a) Genomic DNA

(b) PCR product

(c) Bacterial artificial chromosome

(d) Plasmid DNA

14. What would happen if apyrase is omitted from a pyrosequencing reaction mixture ?

(a) DNA synthesis would stop immediately

(b) All the dNTPs, except dATP, would serve as substrates for DNA polymerase

(c) Luminescence would be detected in the wells even if the next dNTP would not be incorporated into the growing DNA chain

(d) DNA synthesis would continue, but luminescent signals would not be detected.

15. ddNTP is different from dNTP in having

(a) H in place of OH in 3' position of dNTP

(b) OH in place of H in 3' position of dNTP

(c) OH in place of H in 2' position of dNTP

(d) CH3 in place of OH in 3' position of dNTP.