1. Answer *any three* of the following questions:

(a) Let us consider a data set for which the frequency for each of the first three consecutive natural numbers (1, 2, 3) is the number itself. Calculate the mean, median and the mode of the data.

[5]

(b) Consider a set of observations with mean 14 and variance 9. Suppose the observations are transformed as follows:

A number c is subtracted from each observation and then the difference is divided by a number d (where, $d < 0$). If the mean and the variance of the transformed observations are 2 and 3, respectively obtain the values of c and d.

[5]

(c) Consider the following paired observations on two variables X and Y:

X	2	-3	1	0	3	-2	-1
Y	-2	-3	-1	0	-3	-2	-1

Show that X and Y are uncorrelated. Is this a contradiction to the fact that X and Y seem to be mathematically related?

[5]

(d) The regression line of Y on X is given by

$$1.5\,Y + 3X - 4.5 = 0.$$

Explain whether the correlation coefficient between X and Y is positive, negative, or zero. Is it possible to generate the regression line of X on Y by inverting the above equation? Justify your answer.

[3 + 2]

2. (a) What is the evidence that genetic predisposition has an important role in autoimmune diseases? Give two examples, and for each explain why the example implicates genetics.

(b) Are their intrinsic differences between herd immunities achieved due to vaccination for a DNA and a RNA virus infection?

(c) If the father has blood group *A* and the mother has blood group *AB*, enumerate the different possible blood groups of an offspring along with their corresponding probabilities. Assume that the proportions of alleles *A*, *B* and *O* are 0.3, 0.5 and 0.2 respectively and the population is in Hard-Weinberg equilibrium.

[6+4+5]

3. (a) Describe any one method used to identify DNA-binding proteins and the location of DNA control elements in regulatory regions of genes.

(b) Compare the events involved in transcription initiation for prokaryotic and eukaryotic mRNA synthesis.

(c) Explain the mechanism of drug resistance in bacteria.

[5+5+5]

4. (a) Explain why all self-reactive lymphocytes are not eliminated in the thymus or bone marrow.

   (b) How are the surviving self-reactors prevented from harming the host?

   (c) In a PCR experiment, generally a cycle of three temperatures (say, 94° C, 55° C and 72° C) are used for about 30 cycles to complete the reaction. If an investigator does the reaction with a cycle of two temperatures of either (i) [94° C and 55° C] or, (ii) [55° C and 72° C] or (iii) [94° C and 72° C], explain whether he/she will or not get PCR product in each of the above-mentioned temperature combinations.

[5+5+5]

5. (a) A protein has isoecletric point 5.6. What will happen, in respect to electrical charge of the protein, when pH of the solution is raised to 9.0 and lowered to 2.1?

   (b) What are the functions of Chaperones in protein folding?

   (c) Write down the sequential steps of oxidative decarboxylation of pyruvic acid.

[5+4+6]

6. Briefly describe the role of CpG methylation in

   (a) Genomic imprinting

   (b) X-chromosome inactivation

   (c) Gene regulation

[5+5+5]