1. (a) Consider a set of 10 observations such that the sum of squares of all the observations is 100. The minimum of the set is 1 and the maximum is 40. When these two observations are removed, the mean of the new set remains the same. Examine what happens to the following measures:

    (i)   median
    (ii)   standard deviation

(b) Consider the following bivariate data on (X, Y)

X	0	-1	1	2	-2
Y	0	-1	-1	-4	-4

Calculate the correlation coefficient between X and Y. Comment on the nature of relationship between X and Y.

[(3+6)+(6+3)]

2. Consider a dominant disorder controlled by an autosomal biallelic locus in Hardy-Weinberg equilibrium. Suppose the prevalence of the disease is 0.51. If an individual is affected, what is the probability that both parents of the individual are affected? If both parents are unaffected, does the probability of an offspring being affected depend on the prevalence of the disease?

[12]

3. (a) Describe at least three different mechanisms by which a localized viral infection might contribute to the development of an organ specific autoimmune disease.

    (b) Briefly explain what is meant by T-cell anergy.

[8+4]

4. (a) Enhancers and classical promoters both act as positive regulators of gene expression. By what criteria can these two classes of regulatory sequences be distinguished?

(b) A specific gene is down-regulated in cancer cells compared to normal cells isolated from adjacent normal tissues. Describe at least three strategies to identify possible reasons for the down-regulation.

[6+6]

5. (a) pBR322 carries both ampicillin and tetracycline resistance genes. You have cloned a gene in the BamHI restriction enzyme site, which is located within the tetracycline resistance gene. What would be your experimental strategy to identify the correct clone using ampicillin and tetracycline as selection markers?

(b) Briefly describe the mechanism of CRISPR-Cas9 in gene editing.

[6+6]

6. What do you mean by β-oxidation of fatty acids? Why is β-oxidation of fatty acids important? How many ATPs are produced in β-oxidation of fatty acids? Describe the biological importance of Omega-3 fatty acids.

[3+3+2+4]

7. (a) What are allosteric enzymes? Describe in brief the role of enzymes in clinical diagnosis.

(b) Name three histone modifications that are believed to affect gene expression. Briefly describe their roles in altering the chromatin structure and gene expression.

[(2+4)+(2+4)]