

Note: (a) All questions are compulsory.

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

(c) Use of calculator is allowed

Q.No	Question	CO	Marks
Q.1.	Consider a gene Y, activated by a transcription factor X. Once activated, gene Y produces protein Y at a constant production rate of $\beta = 8 \text{ nM/min}$. Protein Y is removed from the cell through two processes: (1) Degradation – with a specific rate constant $\alpha_{\text{deg}} = 0.04 \text{ min}^{-1}$ (2) Dilution – due to cell growth, with a rate constant $\alpha_{\text{dil}} = 0.01 \text{ min}^{-1}$. Assuming that initially there is no protein Y in the cell, i.e., $Y(0) = 0$, calculate: (1) The total removal rate constant α . (2) The steady-state concentration (Y_{ss}) of protein Y. (3) The half-life ($T_{1/2}$) of protein Y. (4) The concentration of protein Y after exact 20 minutes. (5) The time required for protein Y to reach 90% of its steady-state concentration.	2	5
Q.2.	A biological system contains several interacting components such as genes, proteins, metabolites, and signaling molecules. Explain why studying these components as a network can provide more information than studying them individually.	1	2
Q.3.	Consider a gene regulatory network consisting of five genes: A, B, C, D, and E. The regulatory relationships are as follows: - Gene A activates B and C. - Gene B represses C and activates D. - Gene C activates E. - Gene D represses E. Represent the above regulatory relationships as a GRN, clearly indicating activation and repression using different types of arrows.	2	3
Q.4.	A cancer-associated transcription factor regulates several genes involved in cell proliferation, apoptosis, and metabolism. Explain how Systems Biology and multi-omics analysis can be used to study its role in cancer. Name TFs types and their various parameters.	1	3
Q.5.	What is a biological network? Give two examples of biological networks and mention what their nodes and edges represent.	1	2