2015

BIOCHEMISTRY

Paper – BCO – 403

(Systems Biology)

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

Answer ***question no. 6*** and ***any two*** questions

1. Diffusion coefficient for an average protein in cytoplasm $D \approx 5\mu m^2\ sec^{-1}$. For small metabolite in water $D \approx 500\mu m^2 sec^{-1}$

(a) If protein in cytoplasm takes 10 millisec to traverse an E. coli ($2\mu m$) and 10 sec to travel a mammalian (Hela) cell ($\approx 20\mu m$)what will be the time taken for the small metabolite to travel the cell in the two cases.

(b) Can you provide any idea of the average size of small metabolites, given the average size of protein will be 10nm? 4+4

2. (a) Discuss the term Network Motif. How that is similar to or Different from a sequence motif? 3

(b) Provide an example of stable and / or oscillatory states of a Boolean Network. 3

(c) Discuss the implication scale free nature of the transcription network. 2

3. It has been reported that the number of transcription (n) factors encoded in prokaryotic genomes scales approximately their total number of genes (g). Following the scaling relation $n = n_0.g^{\alpha}\ i$

Signal transduction $n = 0.000015.g^{1.95}$

Carbohydrate metabolism $n = 0.063\ .\ g^{0.96}$

DNA repair $n = 0.37\ .\ g^{0.605}$

Interpret the variation of n_o in the specified gene categories. 2

Also interpret the variation of exponent α. 2

What will be the evolutionary significance of the fact that the repair genes show the smallest exponent and the signal transduction shows the highest exponent, and the signal transduction genes show lowest value of n_o whereas the repair genes show highest value of n_o. 4

4. (a) Express dynamical equations expressing the rate of change of protein product assuming that mRNA is produced at a constant rate β_m. and degraded at a rate α_m

(b) Further assume that each mRNA molecule produces, p protein molecules over its life time, and α is the degradation rate of proteins. Show that the system is linear with two eigen values $-\alpha_m$ and $-\alpha$.

(c) What is the expected stability behavior of the steady state?

(d) Show that the steady state concentrations of protein and mRNA and would be given by $\frac{p\beta}{\alpha\alpha_m}$ and $\frac{\beta_m}{\alpha_m}$. 2+2+2+2

5. (a) Suppose there is a N-node network. What is the maximum number of edges possible (include self edges).

(b) How a random network differs from a network in which all the nodes are connected?

(c) In a transcription network what are the entities identified as nodes and edges respectively?

(d) Explain why a transcription network is not a random network. 2+2+2+2

6. Write in 100 words the salient features of the conclusion drawn from your project (bullet form). 9