

Bioengineering Study Program – School of Life Science and Technology – ITB

Second Exam

BE-2103 Biological Thermodynamics

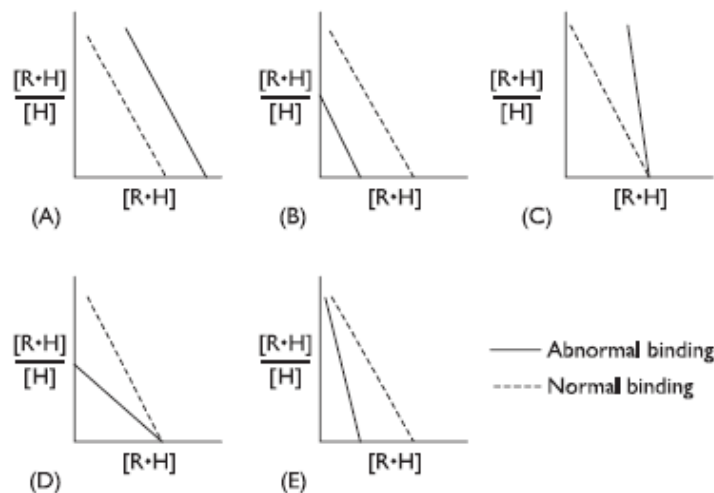
(Termodinamika Sistem Hayati)

Date: November 27, 2017

Hours: 13.00 – 16.00 (180 minutes)

Closed book and notes. Only text book of Biological Thermodynamics (Donald T. Haynie) is allowed be opened

1. When $[L] = K_d$, $F_b = 0.5$. Calculate the concentration of ligand required for 90% saturation and 99% saturation?
2. Show that $\phi/[L] = nK_a - \phi K_a$ for n identical binding sites
3. Consider a homotrimeric protein with three identical and independent binding sites and microscopic association constants of 10^6 . Plot the fractional saturation of the protein against the three ligand concentration. Write down equations describing the macroscopic binding constants (K_1 , K_2 , K_3) in terms of the microscopic binding constant.



4. Why does plant life tend to be more robust in tropical climates than closer to the poles? (Hint: There must be something about enzyme here) (10)

5. The rate of hydrogen exchange is a function of temperature. Assuming that the rate increase threefold for every increase in temperature of 10 °C, calculate the activation energy for exchange. (Hint: Use the initial temperature of 25 °C) (10)
6. Skeletal muscle is involved in maintaining body warmth. Explain how this might occur. (Hint: What drives skeletal tension? It must be something that generates heat) (10)
7. The rate of ATP hydrolysis to ADP and P_i is influenced by the muscle protein of myosin. The following data are tabulated at 25 °C and pH 7.0.

Velocity of reaction in μmoles inorganic phosphate produced $\text{l}^{-1} \text{s}^{-1}$	[ATP] in μM
0.067	7.5
0.095	12.5
0.119	20.0
0.149	32.5
0.185	62.5
0.191	155.0
0.195	320.0

Find the Michaelis constant of myosin. (10)

8. The following statements pertain to energy transfer within a cell and between a cell and its surroundings.
 - a. A cell can convert energy into useful form by allowing carbon and hydrogen to combine with oxygen).
 - b. Chemical energy is converted by a cell to heat, where the energy is transferred into a more ordered form
 - c. A cell obeys the Second Law of Thermodynamics by acting like a closed system.

- d. Enzymes are important for cell catabolism because they lower the change in free energy of the reaction.

Determine and **explain** whether these statement true or false. (10)