MDCM601 2024 Exam 4

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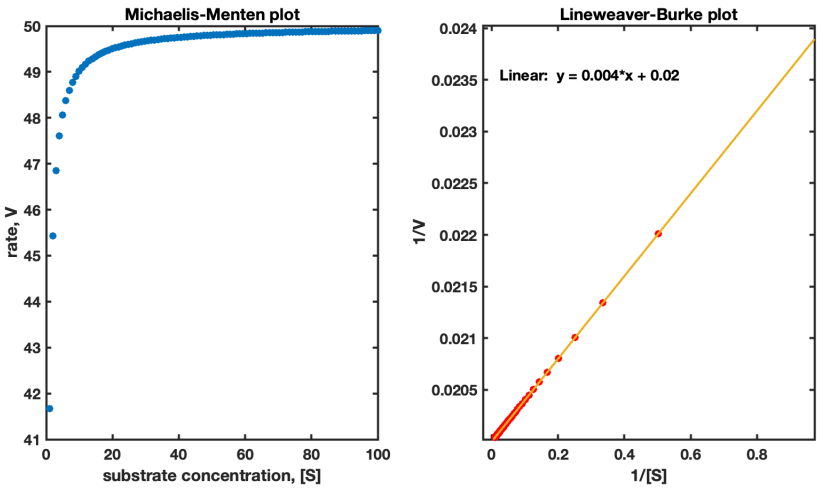
1 Problems

Problem 1. Using the kinetic data provided in the figure, determine the V_{max} and K_M values for the enzyme.



Michaelis-Menten equation:

$$v = \frac{V_{max} \times [S]}{K_M + [S]} \tag{1}$$

Problem 2. Kinetic data were collected for an enzymatic reaction under three conditions: without an inhibitor, with inhibitor A (at a concentration of 2 µM), and with Inhibitor B (at a concentration of 10 µM). The data were transformed into double-reciprocal form, yielding the slopes and intercepts for linear fits as follows:

- Without inhibitor: slope = 0.02, intercept = 0.02
- With Inhibitor A: slope = 0.028, intercept = 0.02
- With Inhibitor B: slope = 0.42, intercept = 0.42

Based on this data, answer the following:

(a) What is V_{max} of the enzyme without an inhibitor?

(b) What is the K_M of the enzyme without an inhibitor?

(c) What is the V_{max} with Inhibitor A?

(d) What is the K_M with Inhibitor A?

(e) What is the V_{max} with Inhibitor B?

(f) What is the K_M with Inhibitor B?

(g) What type of inhibitor is Inhibitor A?

(h) What type of inhibitor is Inhibitor B?

Problem 3. Please answer the following questions about units:

(a) What are the units of the y-axis in a Lineweaver-Burke plot?

(b) What are the units of K_i?

(c) A micromolar inhibitor is more effective than a nanomolar inhibitor.

Problem 4. What is the reaction rate (expressed as a percentage of V_{max}) when the substrate concentration is 5 K_M ?

Problem 5. For an equilibrium reaction A $\rightleftharpoons$ B the forward rate constant k_f is $200\,\text{min}^{-1}$ and backward rate constant is $k_b = 0.5\,\text{min}^{-1}$. What is the ΔG° for this reaction at T = 298 K? R = 8.314 J/molK.

Problem 6. The integrated rate law for an irreversible reaction A $\longrightarrow$ B is given by $[A] = [A]_0 e^{-kt}$ where k is the first order rate constant and t is time. If $k = 10\,\text{s}^{-1}$, at what time will half of the initial concentration of A be consumed?
Will this time change if the initial concentration of A changes?

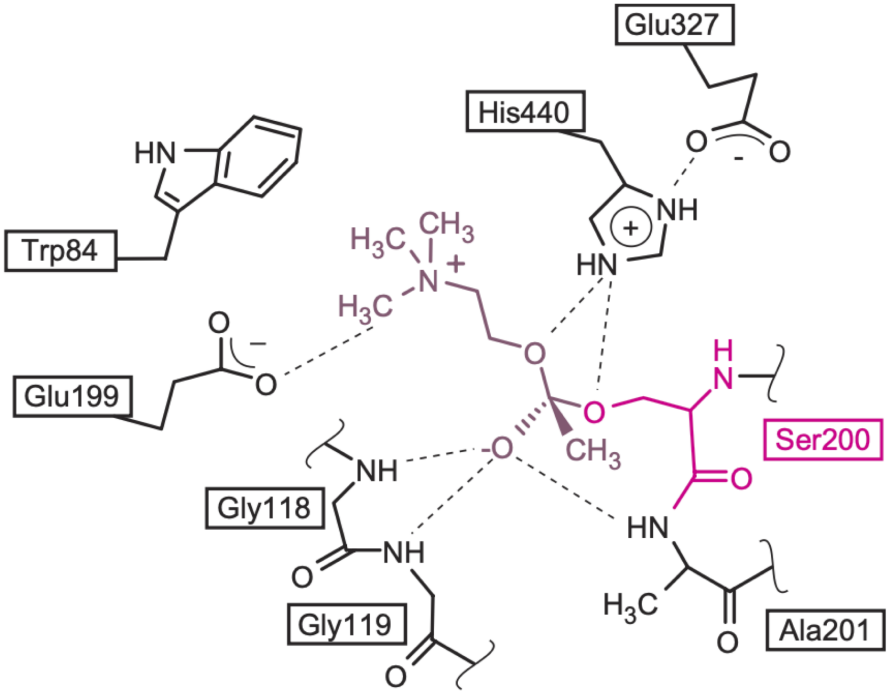
Problem 7. For the non-catalyzed reaction, the forward rate constant $k_f = 20\mu M/s$ and the reverse rate constant $k_b = 0.1\mu M/s$. For the catalyzed reaction, the forward rate constant is $k' = 100\mu M/s$.
Determine the following:

(a) The reverse rate constant k_b for the catalyzed reaction (in $\mu M/s$)

(b) The equilibrium constant K_{eq} for the non-catalyzed reaction

(c) The equilibrium constant K_{eq} for the catalyzed reaction.

Problem 8. The diagram of the active site of the enzyme acetylcholinesterase with the substrate acetylcholine bound to it is shown. Click on the "tetrahedral intermediate" carbon.



Problem 9.

(a) In the shown diagram of acetylcholinesterase with the substrate acetylcholine bound to it, which amino acid is covalently attached to the substrate? (use 3-letter abbreviation)

(b) Which amino acid makes an ionic interaction with the tetraalkylammonium portion of the substrate? (use 3-letter abbreviation)

(c) Which amino acid stabilizes the negative charge formed on the tetrahedral carbon?

(d) Which 3 residues (with numbers) constitute the catalytic triad? in increasing sequence number)

2 Solutions

1. 50; 0.2
2. 50; 1; 50; 1.4; 2.38; 1; competitive; non-competitive
3. s/M; M; False
4. 83.3 %
5. -14.8 kJ/mol
6. 0.0693 s ; No
7. $0.5\mu M/s$; 200; 200
8.
9. Ser; Glu; Gly; Ser200, Glu327, His400