MDCM601 2023 Exam 4

Zarko V. Boskovic

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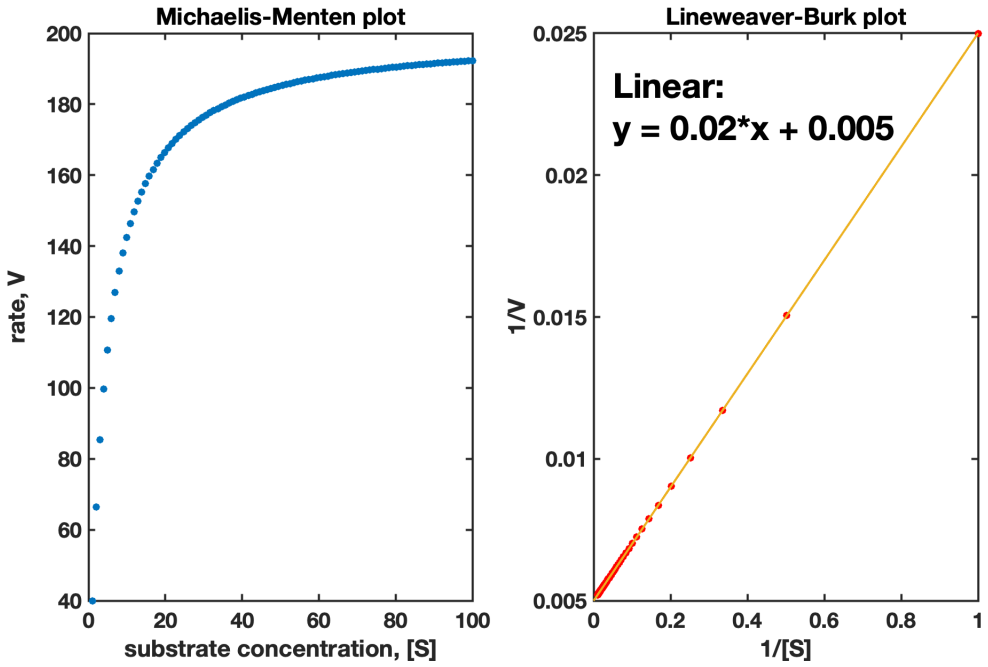
1 Problems

Problem 1. Use the plotted enzymatic reaction kinetic data to find V_{max} and K_M.



Michaelis-Menten equation:

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

Problem 2. Data on enzymatic reaction kinetics were acquired in the absence and in the presence of two different inhibitors, A and B, at 10 µM, the data was converted to a double reciprocal form, and the slopes of the linear fit and the intercepts with the y-axis are reported below:
no inhibitor: slope = 0.002; intercept = 0.01

Inhibitor A: slope = 0.012; intercept = 0.06
Inhibitor B: slope = 0.042; intercept = 0.21

Note: factor multiplying K_M (for competitive inhibitors) or dividing V_{max} (for non-competitive inhibitors) has the form:

$$1 + \frac{[I]}{K_i}$$

where [I] is the concentration of the inhibitor and K_i is the dissociation constant of enzyme-inhibitor complex.

Answer the following questions:

1. What is the V_{max} of the non-inhibited enzyme?
2. What is the K_M of the non-inhibited enzyme?
3. What is the V_{max} with inhibitor A?
4. What is the K_M with inhibitor A?
5. What is the V_{max} with inhibitor B?
6. What is the K_M with inhibitor B?
7. Are these inhibitors competitive or non-competitive?
8. What is the K_i of the inhibitor A?
9. What is the K_i of the inhibitor B?
10. Which one is a better inhibitor?

Problem 3. K_i for an enzyme inhibitor is an equilibrium constant for the following process: $EI \overset{K_i}{\rightleftharpoons} E + I$. True or false?

Problem 4. At what concentration of the substrate (as function of K_M) will the rate of enzymatic reaction be 95% of V_{max}?

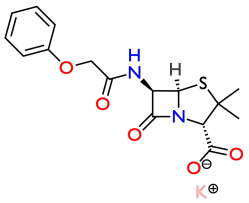
Problem 5. Calculate V_{max} of an enzyme if the rate of the enzymatic reaction is 20 nM/s at the substrate concentration $5 \times K_M$.

Problem 6. For a process $A \rightleftharpoons B$ the first-order rate constant of a forward reaction is $k_f = 100\,s^{-1}$ and the rate of the backward reaction is $k_b = 0.1\,s^{-1}$. If the reaction starts with 20 mM in A, calculate the ratio of concentrations [B]/[A] at the equilibrium.

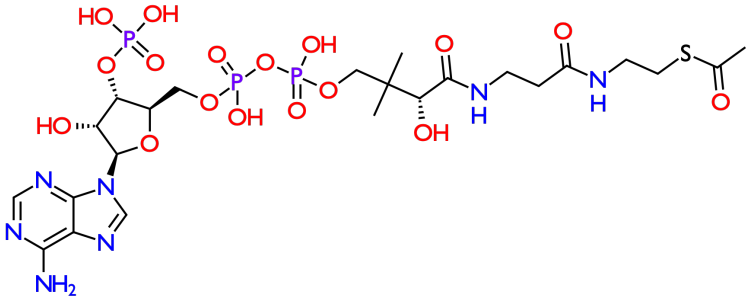
Problem 7. What is the co-substrate in a dehydrogenase enzyme?
What is the co-substrate in a kinase?

Problem 8. True or false: The enzyme changes the equilibrium constant of a chemical reaction.

Problem 9. What are the two functional groups that are formed when the molecule below inhibits the bacterial carboxypeptidase enzyme by making a covalent bond with an active site serine?



Problem 10. Acetyl CoA is a common reactant in metabolic reactions that produce C–C bonds. Click on the electrophilic carbon in its structure that is the site of the nucleophilic attack in such reactions.



Problem 11. Which three residues constitute a catalytic triad in chymotrypsin?

Problem 12. Log-form of the Arrhenius equation is given below:

$$\ln k = -\frac{E_a}{R} \times \frac{1}{T} + \ln A$$

If the activation energy is 80 kJ/mol and A = 1, by what factor does the rate constant of the reaction increase when the temperature is increased by 20 degrees (e.g., going from 298 K to 318 K?

Problem 13. What are the units of K_M?

2 Solutions

1. $V_{max} = 200$; $K_M = 4$
2. 100; 0.2; 16.67; 0.2; 4.76; 0.2; non-competitive; 2; 0.5; B
3. True
4. 19
5. 24 nm/s
6. 1000
7. NAD^+; ATP
8. False
9. ester and amine
10.
11. Ser, His, Asp
12. 7.62
13. M