MDCM601 2021 Exam 4

Zarko V. Boskovic

October 8, 2022

1 Problems

Problem 1. The rate constant for an enzyme-substrate complex turning into an enzyme and a product is $1 \times 10^3\,\mathrm{s}^{-1}$. The amount of free enzyme is 0.1 µM and enzyme paired with substrate is 0.5 µM. Calculate the V_{max} (use units of µM/s).

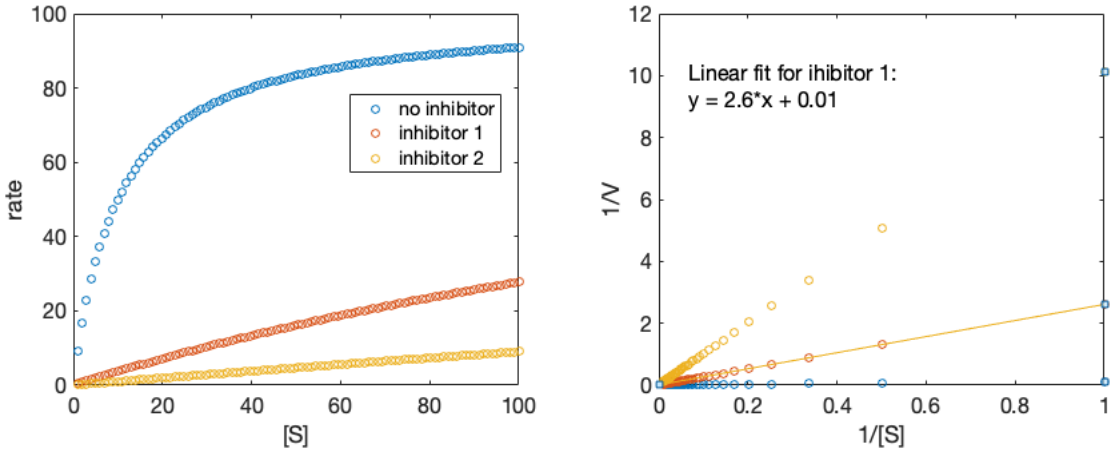
Problem 2. For an enzyme that follows Michaelis-Menten kinetics (use equation 1), calculate V_{max} if the enzymatic reaction rate is 10 µmol/min at the substrate concentration 0.4 K_M.
Michaelis-Menten equation:

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

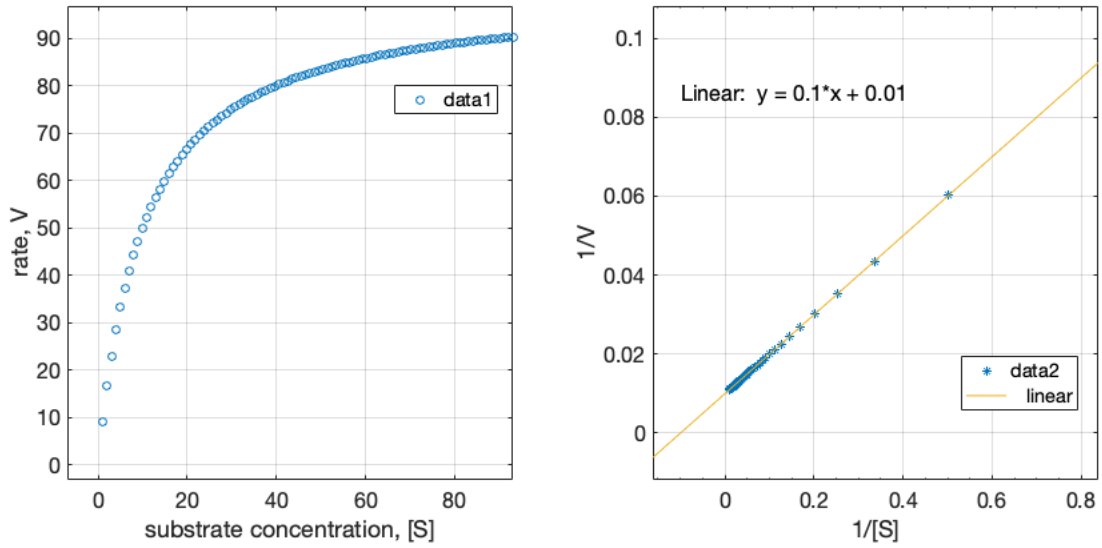
Problem 3. The two plots show how enzymatic reaction rate (as a function of substrate concentration) is different without an inhibitor (blue) and in the presence of two inhibitors (yellow and orange). Linear fit in Lineweaver-Burke plot for non-inhibited enzyme is $y = 0.1x + 0.01$, and for the data with inhibitor 1 it is $y = 2.6x + 0.01$.
The two inhibitors are _____
. In this type of inhibition _____ stays the same, while Michaelis constant goes _____.
Factor multiplying the Michaelis constant has the form:

$$1 + \frac{[I]}{K_i} \tag{2}$$

From the linear fit of the Lineweaver-Burk plot, what is the new Michaelis constant? _____
If the concentration of the inhibitor is 50, and Michaelis constant of non-inhibited enzyme is 10, what is the Ki of inhibitor 1? _____
Inhibitor 2 is a _____ inhibitor than inhibitor 1.



Problem 4. The left figure shows enzymatic reaction rate (v) as a function of substrate concentration, $[S]$, while the right figure shows the same data in a double reciprocal form ($1/v$ versus $1/[S]$). Equation of the linear fit for the data in right figure is also shown.
What is the maximum rate (V_{max}) for this enzyme? _____
What is the Michaelis constant? _____
Does the data (shown in left figure) ever reach the maximum rate? _____



Problem 5. In carboxypeptidases two essential catalytic residues are Arg145 and Glu270. How can these two amino acids, 125 residues apart, both be involved in catalysis?

1. Enzyme changes its conformation from one state to another.
2. Substrate first binds one, and then the other active site.
3. These two residues are close in three-dimensional structure.

4. Proton transfer from Arg to Glu is a very fast process.

Problem 6. True or false? Enzyme accelerates forward and reverse reaction equally.

Problem 7. True or false? Enzyme accelerates reactions by stabilizing products of the reaction.

Problem 8. Which of the following statements best describes an allosteric binding site?

1. It is a binding site containing amino acids with aliphatic side chains.
2. It is a binding site that can accept a wide variety of differently shaped molecules.
3. It is a binding site, which is separate from the active site, and affects the activity of an enzyme when it is occupied by a ligand.
4. It is a description of an active site which has undergone an induced fit.

Problem 9. Citrate synthase catalyzes a prototypical aldol reaction. Which two statements are true about this process?

1. Oxaloacetate is deprotonated by aspartate and then the enolate is acylated by acetyl CoA.
2. Acetyl coenzyme A is deprotonated and oxaloacetate is the electrophile.
3. Thioester intermediate is hydrolyzed to release coenzyme A.
4. Citrate formed is a chiral molecule.

Problem 10. When k_{-1} is much greater than k_2, K_M can be interpreted as which one of the following?

1. Association constant for the process $\mathrm{E} + \mathrm{S} \longrightarrow \mathrm{ES}$
2. Dissociation constant for the proces $\mathrm{ES} \longrightarrow \mathrm{E} + \mathrm{S}$
3. k_{cat} for the process $\mathrm{ES} \longrightarrow \mathrm{E} + \mathrm{P}$
4. $1/k_{cat}$ for the process $\mathrm{E} + \mathrm{P} \longrightarrow \mathrm{ES}$

Problem 11. Rate constant for a reaction is given by the Arrhenius equation(3)

$$k = Ae^{-\frac{E_a}{RT}} \tag{3}$$

If the activation energy is 50 kJ/mol, R = 8.314 J/molK, and A = 1, by what factor does the rate increase when the temperature increases by 10 degrees (e.g. going from 300 K to

310 K)?
The rate at higher temperature is _____(use three significant figures) times greater than the rate at lower temperature.

Problem 12. Which three residues can form a charge-relay system in the active site of some hydrolytic enzymes?

1. Ser, Tyr, Glu
2. Lys, His, Asp
3. Ser, His, Glu
4. Pro, Ser, Gly

2 Solutions

1. 600
2. 35
3. competitive; V_{max}; up; 260; 2; better
4. 100; 10; no
5. 3
6. True
7. False
8. 3
9. 2 and 3
10. 2
11. 1.91
12. 3
13.