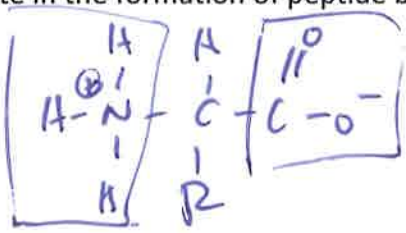
CHEM106 Problem Set 2 Fall 2019
Due on 9 October, 2019

Name: Key

Answer the following questions. Each question is worth 5 points.

1) Draw the general structure of an amino acid and indicate the chemical groups that participate in the formation of peptide bonds.



R = side chain
The bolded amino and carboxylic acid groups form peptide bonds with neighboring amino acids

2) Define the term $pK_A$ and explain why some amino acids have two $pK_A$ and others have three.

$pK_A$ is pH @ which a weak acid is 50% deprotonated (and, therefore, 50% protonated) in solution. All amino acids have amino and carboxylic acid functional groups, so that's 2 $pK_A$'s. Some have side chains that can ionize for a 3rd $pK_A$.

3) Distinguish between the structures of an α-helix and a β-sheet.

α-helix
ϕ: -60 to -180
ψ: -60 to -90
5.4 Å b/w residues
3.6 residues per turn

β-sheet
ϕ: -90 to -140
ψ: 90 to 180
7 Å b/w residues

Both held together by hydrogen bonds between C=O of one group and the H-N of another amino acid.

4) Summarize the molten globule model for protein folding.

See section 3.4.2.

1° structure → hydrophobic collapse → molten globule → 2° structure → 3° structure

5) Most proteins denature at temperatures above approximately 50°C because of the disruptive effects the heat has on the chemical bonds that stabilize secondary and tertiary structures. However, some bacteria live at high temperatures, for example in hot springs, and their proteins retain their tertiary structures at temperatures up to 95°C. Speculate on the structural innovations that might enable a protein to survive such high temperatures. more disulfide bonds, tighter packing of the hydrophobic core, more ion-dipole interactions

6) Why is the free energy of the transition state central to any discussion of enzyme-catalyzed reactions?

Enzymes must make $\Delta G_B$ interactions to help knock the $\Delta G^{\ddagger}$ down and accelerate the rate of reaction.

7) How does substrate concentration affect the rate of an enzyme-catalyzed reaction?

In the first order region of the curve, increasing substrate concentration increases the rate. When [S] is very high, every enzyme molecule is bound with substrate so the rate is maximized

8) Define the term "allosteric inhibition" and describe why allosteric inhibition is important in the control of metabolic pathways.

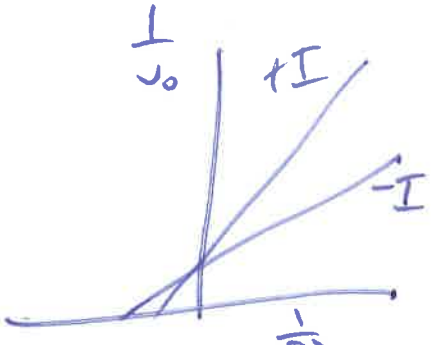
Other site. Feedback inhibition is a great example Book Page 148

9) Describe how the Lineweaver-Burk plot is derived from the Michaelis-Menton equation, and draw examples from the Lineweaver-Burk plots expected in the presence of: a) a competitive, reversible inhibitor and (b) a non-competitive reversible inhibitor.

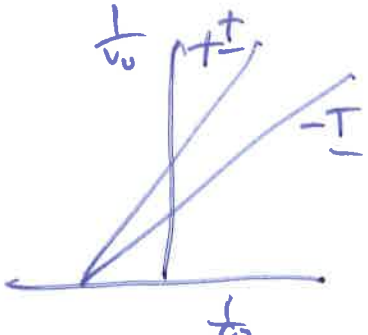
Take the reciprocal of the Michaelis-Menton equation to get the Lineweaver-Burk equation

Michaelis-Menton equation: $V_0 = \frac{V_m[S]}{K_m + S}$

Lineweaver-Burk equation: $\frac{1}{V_0} = \frac{K_m}{V_m}\left(\frac{1}{[S]}\right) + \frac{1}{V_m}$




Competitive Inhibitor




Pure Non-competitive Inhibitor

10) The initial velocity was measured for an enzyme-catalyzed reaction at different substrate concentrations, with and without the presence of two different inhibitors. Using the data in the table below, determine $V_{max}$ and $K_m$ values for the enzyme with and without the inhibitors and identify the type of inhibition that is occurring in each case.

| Substrate Concentration (mM) | Initial velocity (μM/sec) | | |
|---|---|---|---|
| | No inhibitor | Inhibitor 1 | Inhibitor 2 |
| 1.0 | 2.0 | 1.1 | 1.0 |
| 2.0 | 3.3 | 2.0 | 1.7 |
| 5.0 | 5.9 | 4.0 | 3.0 |
| 10.0 | 7.7 | 5.9 | 4.0 |
| 20.0 | 10.0 | 8.3 | 5.0 |
| | | | |

| $\frac{1}{[S]}$ | $\frac{1}{V_0}$ | $\frac{1}{V_0}$ | $\frac{1}{V_0}$ |
|---|---|---|---|
| 0.05 | 0.1 | 0.120 | 0.2 |
| 0.10 | 0.130 | 0.169 | 0.25 |
| 0.2 | 0.169 | 0.25 | 0.333 |
| 0.5 | 0.303 | 0.5 | 0.588 |
| 1.0 | 0.5 | 0.909 | 1.0 |

① Equation of no inhibitor line: $\frac{1}{V_0} = 0.42\left(\frac{1}{[S]}\right) + 0.086$

$\frac{1}{V_m} = 0.086$, so $V_m = 11.62\ \mu M/sec$

$\frac{K_m}{V_m} = 0.42$, so $K_m = V_m(0.42) = 11.62(0.42)$

$K_m = 4.88\ mM$

(2) Equation of line for inhibitor 1: $\frac{1}{V_0} = 0.827\left(\frac{1}{[S]}\right) + 0.084$

The slope has changed, but the y-intercept has remained the same. This is the hallmark of a Competitive inhibitor.

$\frac{1}{V_m} = 0.084$, so $V_m = 11.9\ \mu M/sec$

$\frac{K_m}{V_m} = 0.827$, so $K_m = V_m(0.827)$

$K_m = 11.9(0.827)$

$K_m = 9.84$

(3) Equation for inhibitor 2: $\frac{1}{V_0} = 0.838\left(\frac{1}{[S]}\right) + 0.163$

The slope and the y-intercept have changed. This is the hallmark of a non-competitive inhibitor.

$\frac{1}{V_m} = 0.163$, so $V_m = 6.13\ \mu M/sec$

$K_m = V_m(0.838)$

$K_m = (6.13)(0.838)$

$K_m = 5.13$