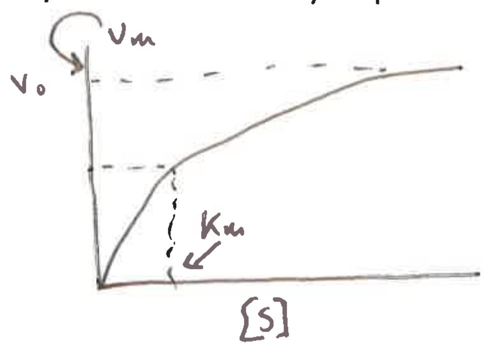
CHEM106 Section 001 Test 2 **Name:** Key

Answer each of the following questions as thoroughly and completely as possible. You have 75 minutes to take this exam.

1) (15 points) What is the Michaelis-Menton equation? What does the plot of an enzyme that follows Michaelis-Menton kinetics look like? What 2 kinetic parameters can be determined from a Michaelis-Menton plot? Label each on your plot.

$$V_0 = \frac{V_m [S]}{K_m + S}$$

5pts



5pts for plot
2.5pts for each parameter

2) (4 points each, 16 points total) Give the full name, three letter abbreviation, one letter abbreviation and chemical structure at physiological pH of an amino acid that meets the given requirement:

a) Polar, uncharged amino acid

Asparagine, Asn, N
Glutamine, Gln, Q
Serine, Ser, S
Threonine, Thr, T
Cysteine, Cys, C

Look in your textbook for the structures of each

b) Hydrophobic amino acid

Leucine, Leu, L
Isoleucine, Ile, I
Valine, Val, V
Phenylalanine, Phe, F
Tryptophan, Trp, W
Tyrosine, Tyr, Y
Methionine, Met, M

c) Acidic amino acid

Aspartic Acid, Asp, D
Glutamic Acid, Glu, E

d) Basic amino acid

Histidine, His, H
Lysine, Lys, K
Arginine, Arg, R

3) (10 points) Describe the process of protein folding from the point the polypeptide exits the ribosome until it becomes a fully folded globular protein. Your answer must include specific thermodynamic driving forces, levels of protein structure, their descriptions, and IMFs involved.

Exit Ribosome → Clathrate cages form around hydrophobic residue side chains so entropy decreases → hydrophobic collapse forces the hydrophobic side chains together to form molten globule state → Secondary structures begin to form via hydrogen bonds → Secondary structures interact to form tertiary structures (Disulfide bonds, salt bridges, metal ions stabiliz

4) (15 points) Briefly describe the roles of phosphorylation, zymogen production and feedback inhibition in the control of enzyme activity. Your answer must include specific biological examples of phosphorylation and zymogen production.

(1) Phosphorylation: Attachment of a phosphate group to serine, threonine or tyrosine by a protein kinase. Causes a conformational change that activates or deactivates an enzyme. Eg: Glycogen phosphorylase

(2) Zymogen production: Enzyme is produced in an inactive state until activated by covalent cleavage of the protein backbone. Example: chymotrypsin

(3) Feedback inhibition: Product from late stage of a multi enzyme pathway inhibits an initial enzyme in pathway

5) (10 points) What is allostery? What is cooperativity? How do they serve to regulate the activity of enzymes?

Allostery is regulation of an enzyme's activity by the binding of an effector molecule to a site other than the active site.

Cooperativity is when more than one subunit of a protein with quaternary structure influences the activity of another subunit (may be positive or negative).

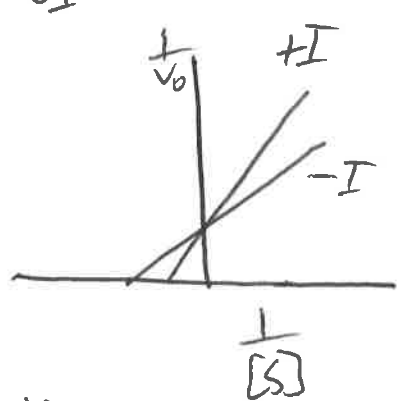
6) (18 points) What are the 3 types of non-covalent, reversible enzyme inhibition? For each type of inhibition, a) name the species that the inhibitor binds to (for example: the inhibitor binds to the substrate or the inhibitor binds to the product), b) draw a typical Lineweaver-Burk plot for each type of inhibition, making certain to include an uninhibited reaction for each plot to serve as the basis for comparison.

Competitive

$E + S \rightleftharpoons ES \rightarrow E + P$

$+I \downarrow\uparrow$

EI



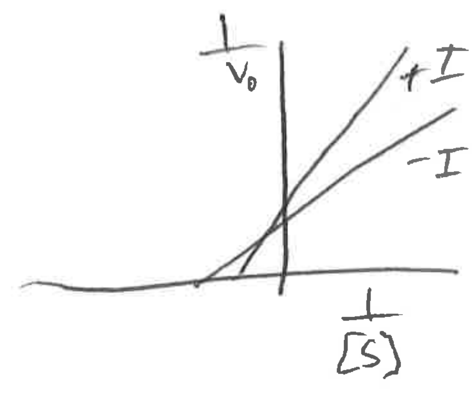
Kmapp Changes

Noncompetitive

$E + S \rightleftharpoons ES \rightarrow E + P$

$+I \downarrow\uparrow$

ESI



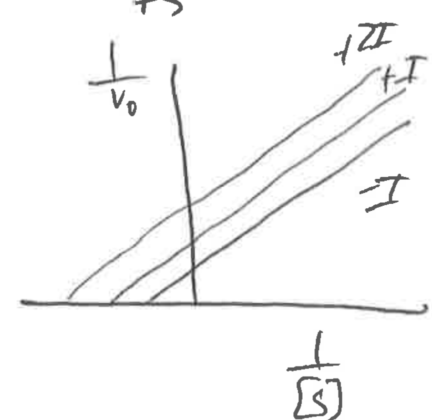
Kmapp and Vmapp change by differing amounts

Uncompetitive

$E + S \rightleftharpoons ES \rightarrow E + P$

$+I \downarrow\uparrow \quad +I \downarrow\uparrow$

$EI \underset{+S}{\rightleftharpoons} ESI$



Kmapp and Vmapp change

7) (20 points) How are enzymes able to decrease the free energy barrier of a chemical reaction? Be specific (Remember that in class we mentioned 4 specific things that happen when enzymes interact with substrate).

(1) Restricts substrate rotational/translational freedom

(2) Disrupts IMFs between solvent/substrate and solvent/active site

(3) ΔG_{TB} is @ maximum during transition state

(4) Enzyme itself changes conformation during the reaction cycle.

From slides 17/18 of the Enzyme Introduction lecture

8) (10 points) Determine the Km and Vm for an enzyme given the following kinetic data. Your answer must include the linear regression equation for the best fit line and the work you did to calculate each kinetic parameter based upon that equation. **No credit will be given for simply reporting the Km and Vm values.**

[Substrate] (μmol/L)	Vo (μmol/L/min)
0.10	0.30
2.00	5.00
10.00	20.00
20.00	40.00
40.00	64.00
60.00	80.00
100.00	100.00
200.00	120.00
1000.00	150.00
2000.00	155.00

$$\frac{1}{V_o} = \frac{K_m}{V_m}\left(\frac{1}{[S]}\right) + \frac{1}{V_m}$$

$$\frac{1}{V_o} = 0.332\left(\frac{1}{[S]}\right) + 0.011$$

$$\frac{1}{V_m} = 0.011$$

$V_m = 90.9$ μmol/L/min

$$\frac{K_m}{V_m} = 0.332$$

$K_m = (0.332)(V_m) =$ 30.18 μmol/L