Chem153A
Biochemistry: Introduction to Structure, Enzymes and Metabolism
Exam 1

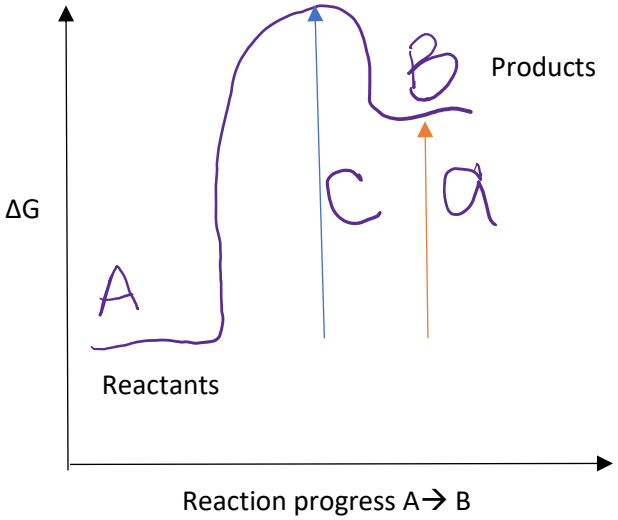
Name: Date:

Instructions: Refer to page 10 for pKa values to use in Exam1. Limit your answers to 2 brief sentences. Graders are not required to grade more than 2 sentences per question. This exam is open notes/ book. Follow the honor code specified in the syllabus.

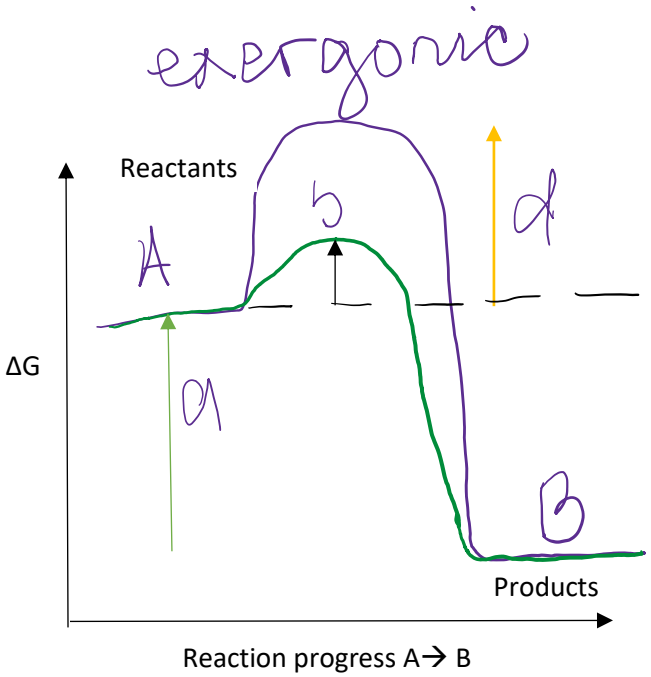
1. Label the following statements as True or False (4 points):
   a. Bacteria lack membrane bound organelles; however, they contain a well-defined nucleus. _____ False
   b. Gram positive bacteria have a thick peptidoglycan layer. _____ True
   c. The mitochondrion is the location of protein synthesis. _____ False
   d. The Golgi apparatus is the site of protein processing and packaging. _____ True

2. Below are 2 free energy diagrams for 2 different reactions. State whether each diagram is exergonic or endergonic. Label the 5 **arrows** correctly based upon the below choices, which may or may not be used more than once. (6 points)
   a. ΔG
   b. ΔG‡catalyzed
   c. ΔG‡
   d. ΔG‡uncatalyzed

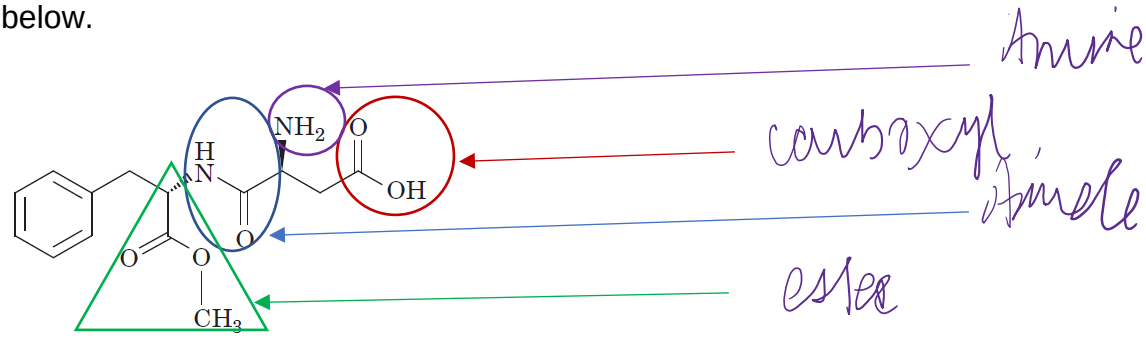
endergonic



exergonic



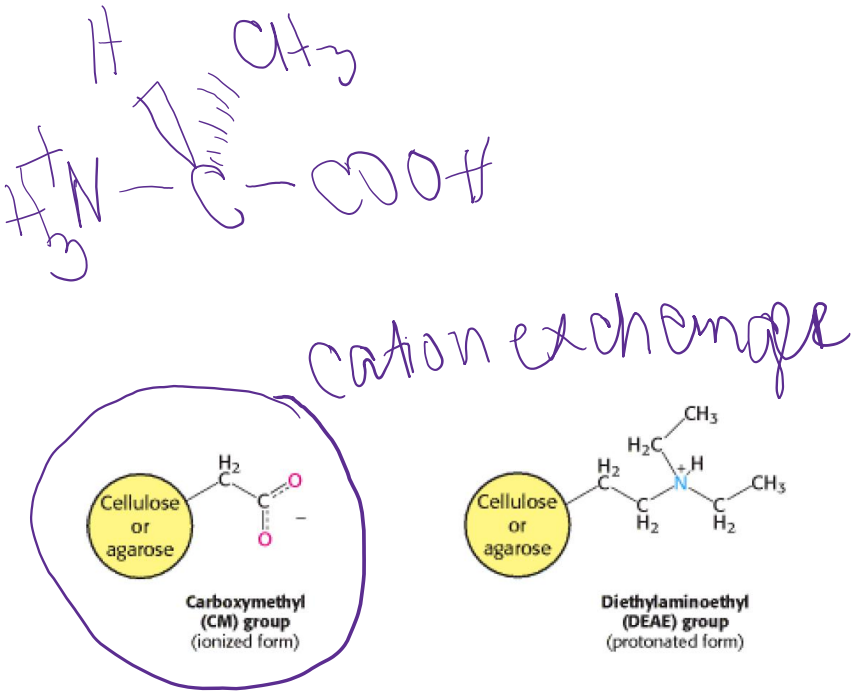
3. Identify the functional groups that are circled (and in the triangle) in the diagram below.



4. Can a reaction that is nonspontaneous with a ΔGo value of +20 kJ/mol be made to become favorable? If so, then how?

Yes, by coupling it with an exergonic reaction.

5. Draw the species of alanine that dominates at pH 1.0. Circle the stationary phase that will better retain the species that dominates at pH 1.0, and state whether the circled stationary phase is a cation exchanger or anion exchanger.



6. Calculate the ratio of conjugate base to weak acid at pH 7.0 for a molecule with a pKa of 8.2.

$$pH = pKa + \log\frac{[CB]}{[WA]}$$

$$7.0 = 8.2 + \log\frac{[CB]}{[WA]}$$

$$-8.2 \quad -8.2$$

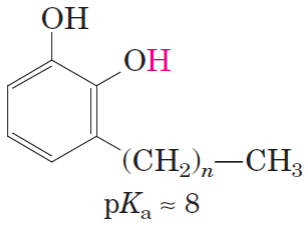
$$-1.2 = \log\frac{[CB]}{[WA]}$$

$$10^{-1.2} = [CB]/[WA] = 0.063$$

7. What is the name of the buffering system that buffers the blood and cytoplasm of the cell, respectively?
   a. Bicarbonate only
   b. Bicarbonate and phosphate
   c. Phosphate and ammonium
   d. None of the above

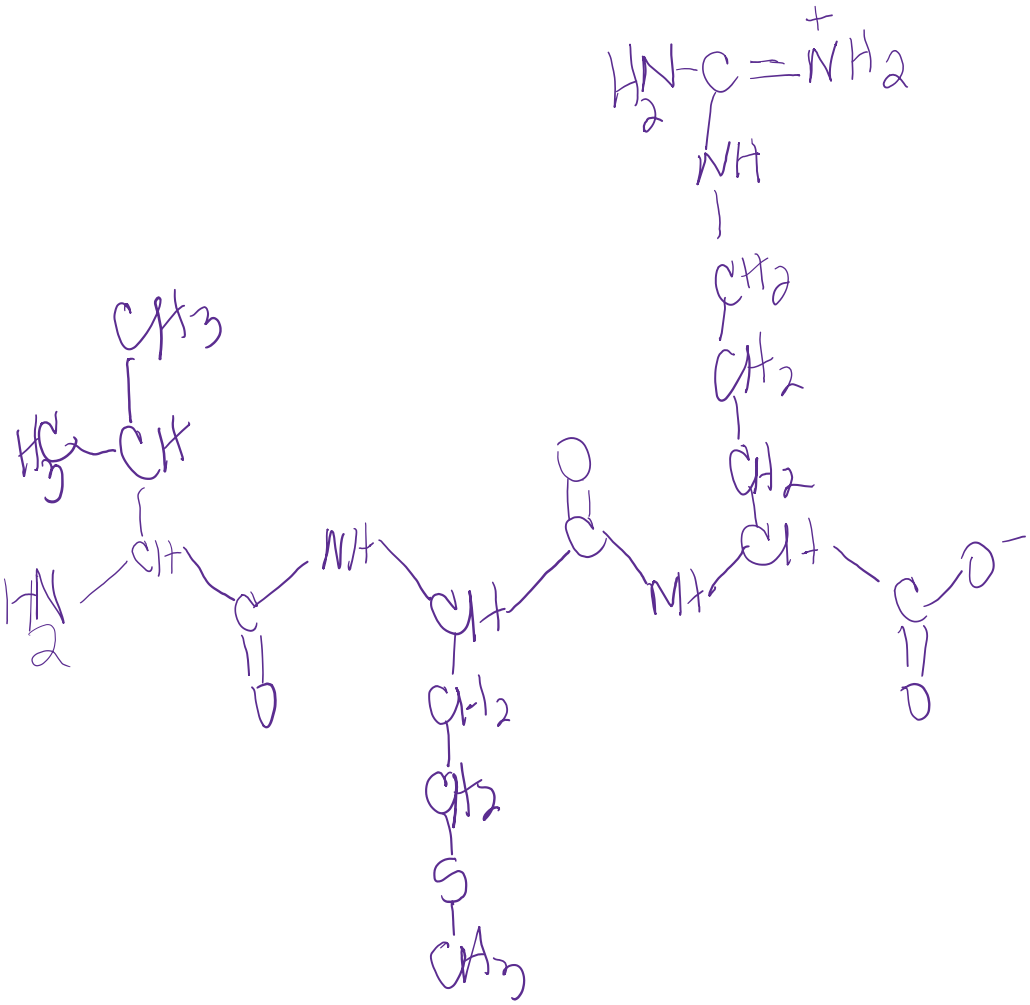
B

8. Is the following compound more water soluble in an aqueous solution of 0.1 M NaOH or 0.1 M HCl. Briefly explain why.

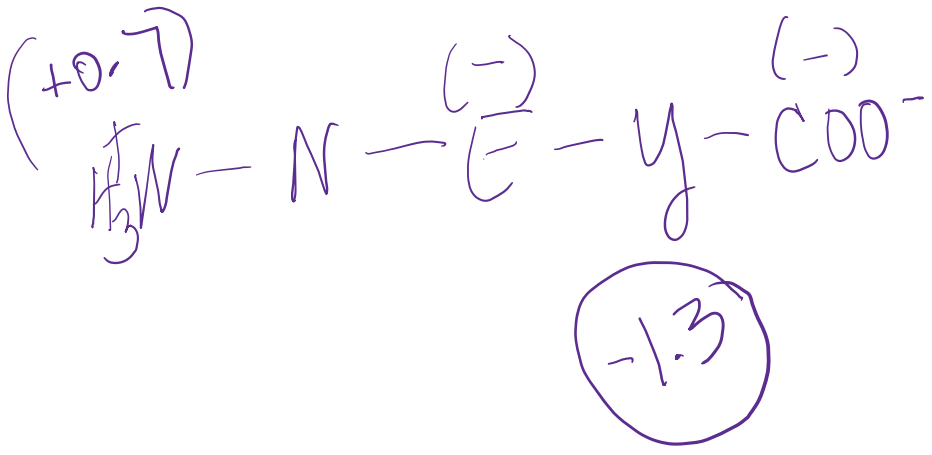


0.1 M NaOH, because the solution will be at a pH of 13, which deprotonates the compound to have a charged species that will soluble in water.

9. Draw the structure of the oligopeptide V-M-R at pH 10



10. What is the net charge of the oligopeptide N-E-Y at pH 7.5?



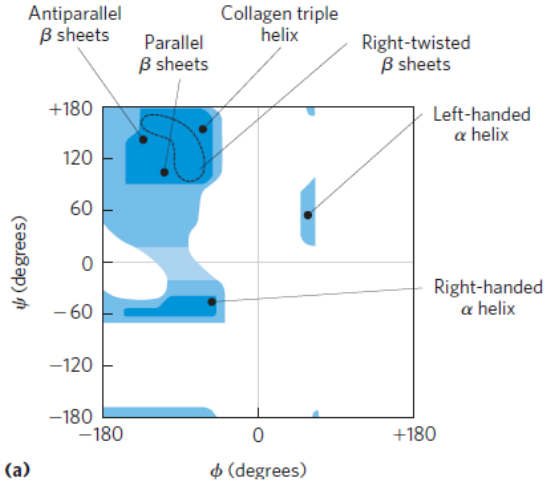
11. Calculate the pI of the oligopeptide M-K-S.

+2 $\overset{3}{\rightleftharpoons}$ +1 $\overset{8}{\rightleftharpoons}$ 0 $\overset{10.5}{\rightleftharpoons}$ -1

H$_3$N-M-K(+)-S-COOH

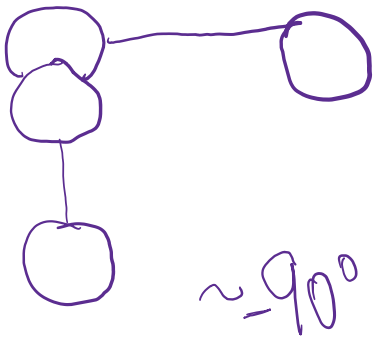
$pI = \frac{10.5 + 8}{2} = 9.25$

12. Below is the Ramachandran plot depicting the location of several secondary structures. Draw the phi dihedral angle for parallel β sheets in the designated boxe. Also state the degree of the dihedral and in the box. Use the structure of a dihedral angle below (adjacent to the Ramachandran plot) as a model to draw your dihedral angles.



Model Dihedral angle

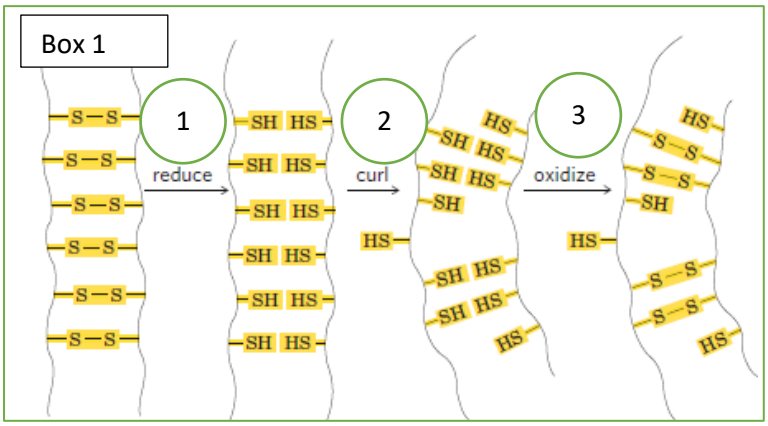
Phi dihedral angle for antiparallel beta sheet

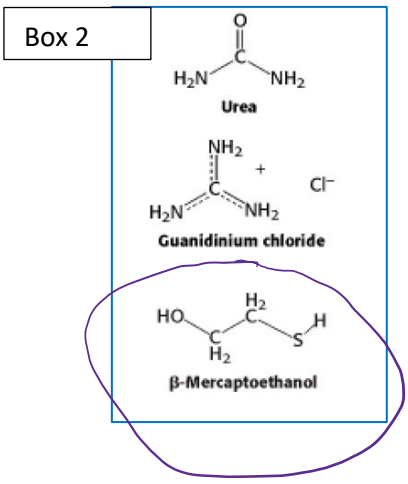


13. A polyaspartate polypeptide, made of only L-Asp residues, adopts a random coil structure at a pH above 7.0; however, it adopts an alpha helix conformation at pH of 2.0. Provide a brief explanation of this phenomenon.

At a pH above 7.0 the aspartate residues will be deprotonated and have a negative charge, which will contribute to repulsive forces.

14. The process of hair, which is made up of α-keratin helices, getting permed is depicted in the diagram below in box 1. Circle the reagent in Box 2 that will most likely be used in step1 of Box 1.





15. Briefly explain how the heme protoporphyrin ring changes from the deoxygenated state to the oxygenated state of hemoglobin.

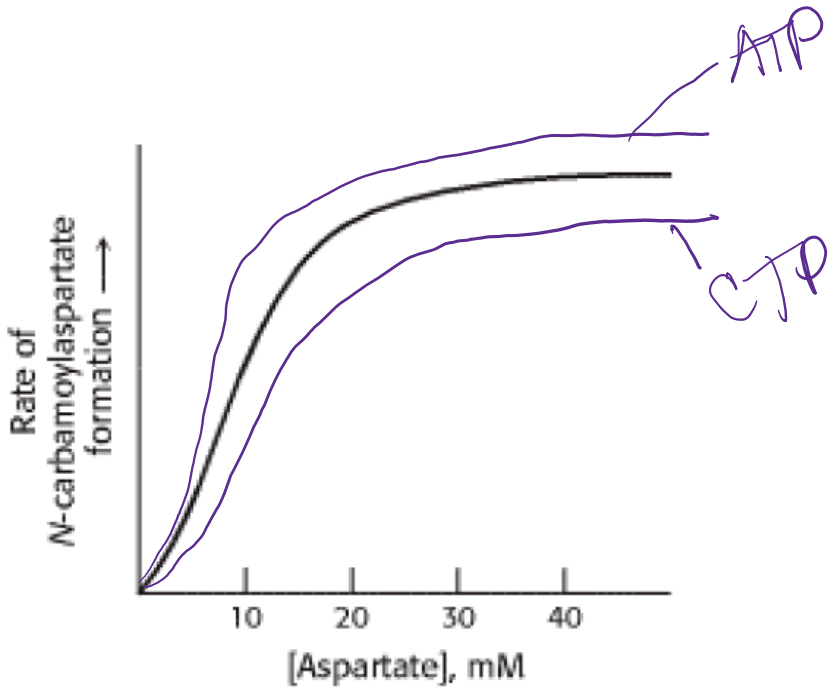
In the deoxygenated state of hemoglobin the protoporphyrin ring is puckered and in the oxygenated state it is planar.

16. Below is a list of hypothetical Hemoglobin variants. Circle the name of the variant that is most likely to show an increase in BPG binding. Does such a hypothetical variant cause an increase or decrease in hemoglobin's affinity for oxygen?
    a. Hb Minnesota: substitutes Pro for Leu in an alpha helix
    b. Hb Towncow: substitutes Lys for Val
    c. Hb New Orleans: substitutes Met for Tyr, which disrupts the hydrogen bonding at the $\alpha_1\beta_1$ interface.
    d. All of the above

B

Decrease in Hb affinity for oxygen

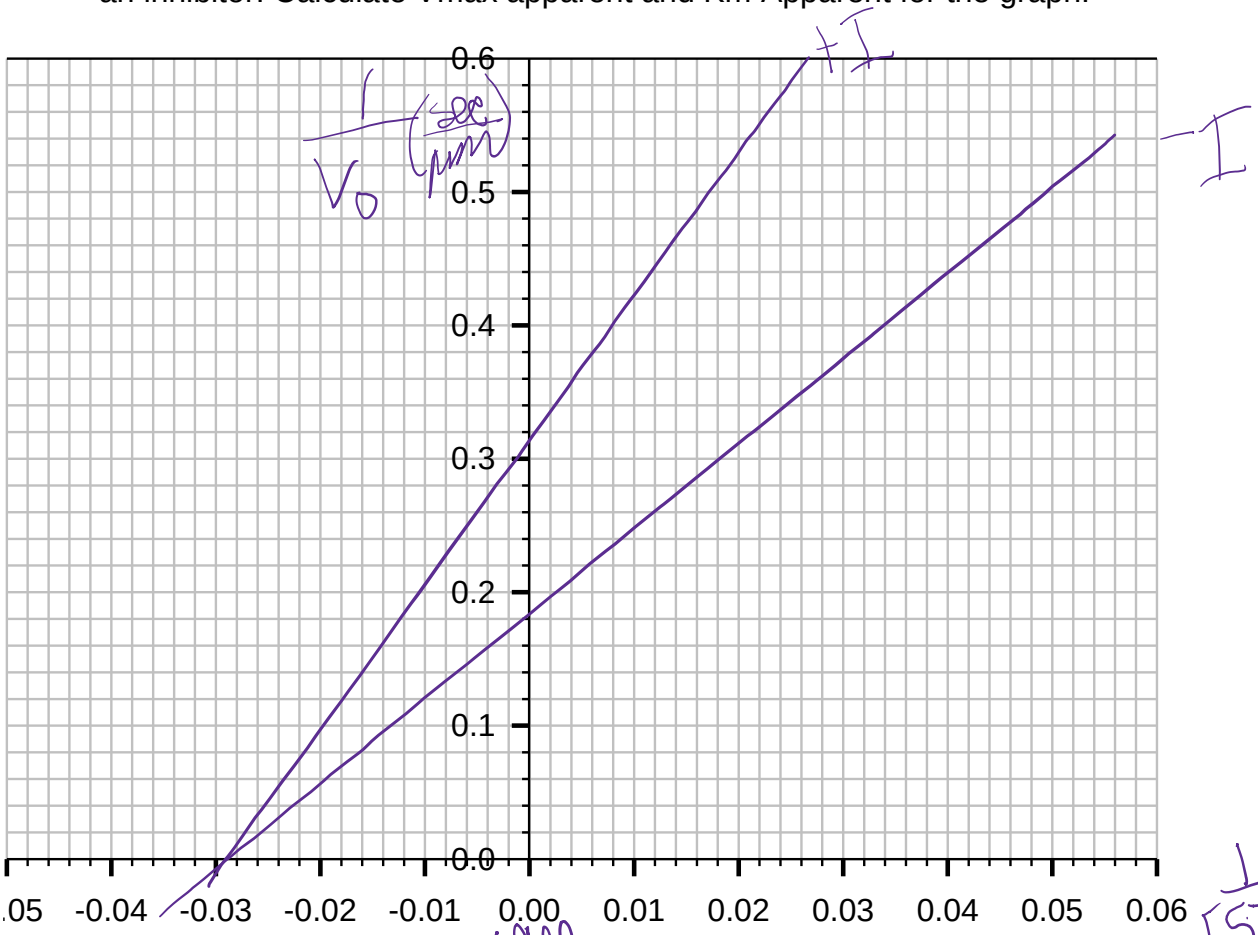
17. Below is a rate vs [substrate] curve for the enzyme aspartate transcarbamolyase (ATCase). ATP is known to stabilize the R-state of ATCase and makes it easier for the aspartate substrate to bind. While CTP, on the other hand stabilizes the T-state of ATCase. Draw the curves for the binding of ATP and CTP and label the curves clearly with ATP or CTP.



18. Enzyme X follows simple Michaelis-Menten kinetics and has different affinities for substrates A and B. Km for substrate A is equal to 20mM and the Km for substrate B is 15mM. What is the preferred substrate for enzyme X?

Substrate B.

19. Below is a Lineweaver-Burke plot for an enzyme in the absence and presence of an inhibitor. Calculate Vmax apparent and Km Apparent for the graph.



$0.32 = \frac{1}{V_{max}^{app}} \Rightarrow V_{max}^{app} = 3.1\ \mu M/sec$

$0.03 = \frac{1}{K_M^{app}} \Rightarrow K_M^{app} = 33\ mM$

20. Based upon the graph in question 17, what type of inhibitor is depicted, and does this inhibitor have a greater affinity for the enzyme only, enzyme-substrate complex only, or both?

Pure non-competitive inhibitor, which has an affinity for both.

Functional Group	**pKa**
Terminal α-carboxyl group	3.0
Terminal α-amino group	8.0
α-carboxyl (free amino acid)	2.0
α-amino (free amino acid)	9.5
Aspartic acid	4.1
Glutamic acid	4.1
Histidine	6.0
Cysteine	8.3
Tyrosine	10.0
Lysine	10.5
Arginine	12.5