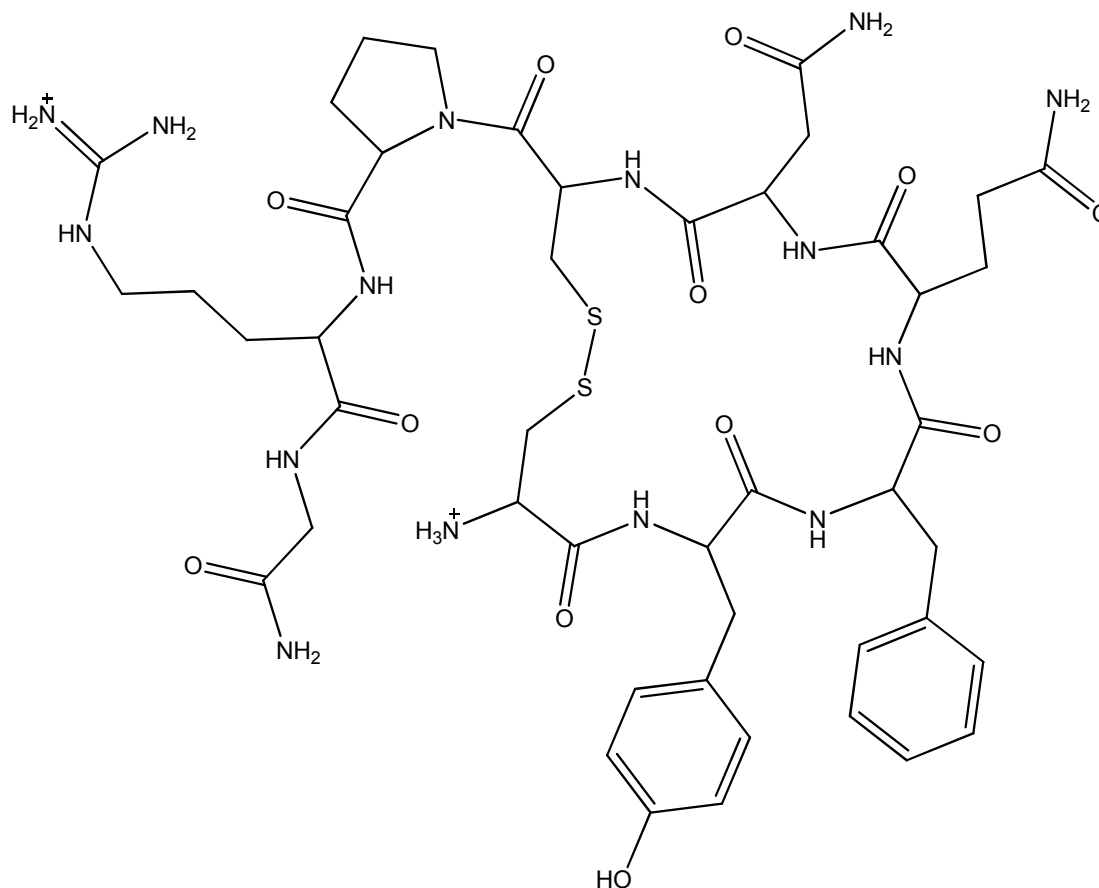


1. Vasopressin is a peptide hormone that controls the body's retention of water. It acts by increasing water permeability in the kidneys, which reduces the volume of urine produced and allows the body to reabsorb water. Vasopressin is composed of 9 residues with a C-terminal amido (-NH₂) modification. Human vasopressin has the following primary structure at physiologic pH:



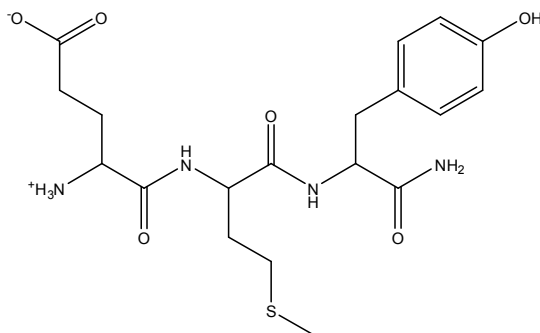
- Write the amino-acid sequence (in the correct order) of human vasopressin, using 3-letter abbreviations.
- How many ionizable groups does human vasopressin have? What is/are the approximate pKa(s) of the ionizable group(s)?
- In what pH range(s) would human vasopressin act as a buffer?
- What is the isoelectric point of human vasopressin? Show your calculation.
- What is the average net charge of human vasopressin at pH 7? Show your work.
- What are the predominant net charge states of individual vasopressin molecules at pH 7? Answer by completing the following sentence:

Most molecules of human vasopressin have a net charge of _____ at pH 7, and a few have a net charge of _____.

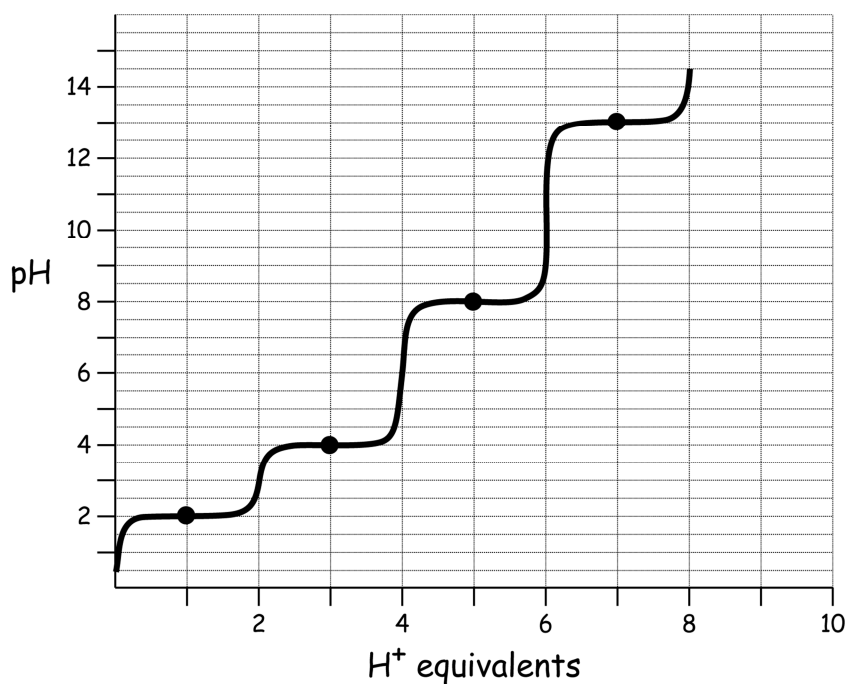
2. True or False?

- There is no rotation about the bonds that sit in a peptide plane.
- Related proteins that have the same function, but are found in different species, are homologs.
- Phosphorylation is a reversible modification of proteins.

3. After taking this class, you decide you love biochemistry so much that you want to study it more in graduate school. So you end up being a TA for a class like 153A. On the first exam you grade a titration curve problem. The question asks the students to draw a pH titration curve for the following peptide, and to label the axes of the curve.

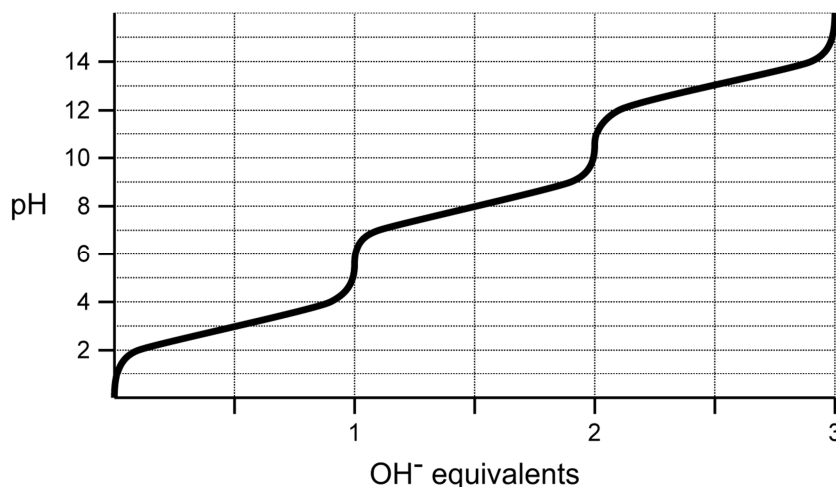


One student gives this drawing:

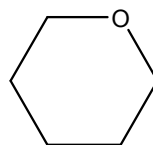
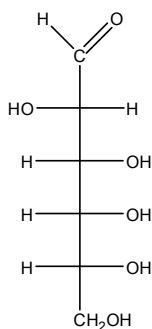


- What errors in the drawing would cause you to deduct points? List each error. If there are no errors, list 'none.'
- The exam also asks the students to calculate the average charge of this peptide at pH 7. What is the correct answer? (Show your work.)

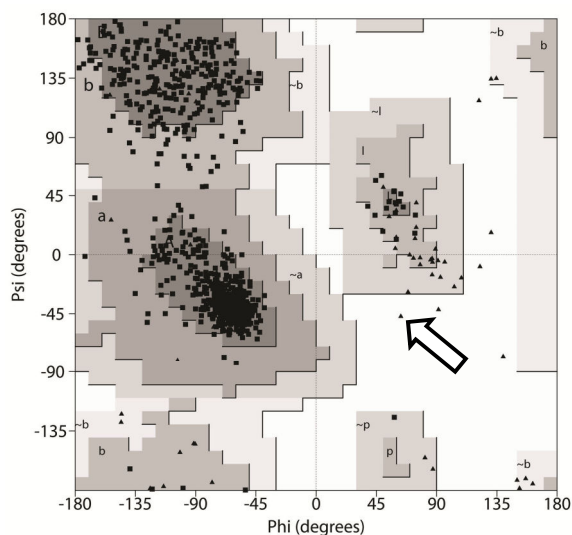
8. Consider the 20 protein amino acids:
- Which have *side chains* that can:
 - participate in an *ion pair* at pH 7?
 - participate in a *disulfide bond* at pH 7?
 - participate in a *hydrogen bond* at pH 7?
 - participate in a *van der Waals contact* at pH 7?
 - ionize* (i.e. lose or gain a proton) in the range of pH 1-14?
 - The pH titration of a dipeptide gives the curve shown below. How many different dipeptides could give rise to this curve? Show your reasoning.



- Calculate the pI of this dipeptide (from part b). Show your work.
9. Which of the following are most common in nature?
- L-sugars and D-amino acids
 - L-sugars and L-amino acids
 - D-sugars and L-amino acids
 - D-sugars and D-amino acids
10. Below is the open-chain structure of one isomer of altrose. On the backbone provided, draw the cyclic form, and circle the anomeric carbon. What is the full name of the sugar you have drawn?

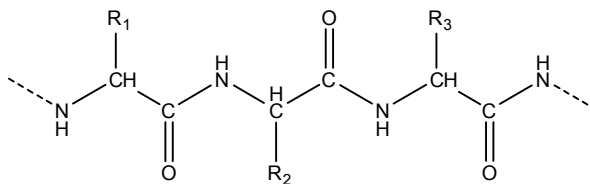


11. Briefly define 'dihedral angle.' (10 words or fewer.)
12. The dihedral angles for the structure of hexokinase are plotted below. In addition, the angles are listed for a portion of the structure:



Position			Position		
No.	ϕ ($^{\circ}$)	ψ ($^{\circ}$)	No.	ϕ ($^{\circ}$)	ψ ($^{\circ}$)
373	-55.3	-56.3	389	-63.7	-38.4
374	-66.0	-36.0	390	-122.6	136.1
375	-66.1	-40.0	391	-96.4	138.3
376	-58.4	-29.4	392	-130.0	113.3
377	-69.6	-36.1	393	-152.1	166.2
378	-72.7	-29.8	394	-120.6	129.8
379	-72.8	-51.3	395	-106.3	127.7
380	-53.2	-40.0	396	-89.7	117.1
381	-61.4	-44.7	397	-111.4	154.3
382	-65.5	-37.3	398	-170.6	163.9
383	-64.5	-36.1	399	134.6	134.8
384	-73.6	-40.9	400	-56.5	-43.3
385	-61.6	-39.1	401	-59.6	-57.3
386	-87.8	-1.9	402	-56.8	-43.6
387	59.1	4.7	403	-75.8	-22.2
388	-78.9	139.8	404	-111.4	-19.8

- What kind of plot is shown?
- What does the shading on the plot indicate? Briefly explain the darkest, medium, and white gradations (15 words or fewer).
- Provide an explanation for the position of the spot indicated by the arrow (20 words or fewer). *Hint: Each spot corresponds to an amino acid in the sequence; consider how they differ.*
- On the provided peptide backbone, draw arrows to the bonds about which the ϕ and ψ dihedral angles are measured (and label them ϕ or ψ). Circle the bonds about which there is no rotation.



- In the full listing of ϕ and ψ values for hexokinase, position 1 has the following values: $\phi = \text{NA}$, $\psi = -53.5^{\circ}$. Why is no ϕ value assigned? Briefly explain in 15 words or fewer.