Chemistry 333
Principles of Biochemistry
Spring 2012
First Exam
February 10, 2012

NAME: KEY

To be eligible for a regrade, the exam must be done in ink.

SHOW ALL WORK FOR PARTIAL CREDIT!
1. A. How many moles each of sodium acetate and acetic acid would you add to make a 2 liter solution of 0.4 M acetate/acetic acid buffer at pH 5.5? Show all work for partial credit.

\[
\begin{align*}
\text{pH} &= \text{pK}_a + \log \frac{[A^-]}{[HA]} \\
5.5 &= 4.75 + \log \frac{[A^-]}{[HA]} \\
0.75 &= \log \frac{[A^-]}{[HA]} \\
\frac{[A^-]}{[HA]} &= \frac{5.42}{1} \quad \text{Total} = 6.42 \\
[A^-] &= \frac{5.42}{6.42} = 0.85 \\
[HA] &= \frac{1}{6.42} = 0.15
\end{align*}
\]

\[2L \times 0.4 \text{ moles} = 0.8 \text{ TOTAL moles}\]

\[\text{moles A}^- + \text{moles HA} = 0.8\]

\[(0.85)(0.8) = 0.68 \text{ moles sodium acetate}\]

\[(0.15)(0.8) = 0.12 \text{ moles acetic acid}\]

B. What would the final pH of the buffer you made in Part A be if you ADDED 0.1 mol of the strong acid HCl? Show all work for partial credit.

Add 0.1 mol HCl

\[
\text{moles HA} \uparrow \quad \text{moles A}^- \downarrow
\]

\[
\begin{align*}
\text{pH} &= 4.75 + \log \frac{[(0.68 - 0.1)]}{2L} \\
&= 4.75 + \log \frac{0.29}{2L} \\
&= 5.17
\end{align*}
\]
2. Shown below is the structure of the amino acid TYROSINE. (8 points)
Draw the predominate form(s) of TYROSINE at the following pH values:

A. pH 5

B. pH 10.0

C. pH 10.9

3. Match the amino acid at left (designated with their full names or three letter abbreviation) with the best matching characteristic at right by entering each amino acid’s number in the appropriate blank. Not all amino acids will be used. There will be one answer per line. (14 points)

1. proline
2. glycine
3. alanine
4. asp
5. tryptophan
6. lysine
7. cys
8. leucine
9. met

4. acidic R-group
3. non-chiral
6. basic R-group
5. hydrophobic aromatic amino acid
7. involved in disulfide cross links
1. nitrogen of the α-amino group is in a ring
3. the side chain is a methyl group
4. The figure below is a ribbon diagram of a protein molecule. (12 points)

1 identifies the \textit{C-terminal} end of the protein.

2 and 3 identify elements of secondary structure are known as \textit{\(\beta\)-sheets}.

Because the two arrowheads on 2 and 3 point in opposite directions, this element of secondary structure can be most fully described as being \textit{anti-parallel (\(\beta\) sheets)}.

4 identifies an element of secondary structure known as \textit{\(\alpha\)-helix}.

5 identifies the \textit{N-terminal} end of the protein.

6 identifies an element of secondary structure known as \textit{loop/turn}.
5. **Peptide Structure:** (25 points)

A. Draw the **COMPLETE** structure of the peptide with the amino acid sequence **FCTKD** at pH 1.5. (13 points)

B. What is the sequence of amino acids written as the **THREE** letter code? (5 points)

   **Phe-Cys-Thr-Lys-Asp**

C. Put a star (*) next to the C-terminus of the peptide you drew in A. (1 point)

D. Draw a circle around ONE peptide bond in the peptide you drew in A. (1 point)

E. What is the net charge of this peptide at pH 7.5? (2 points)

   -

F. Would this peptide likely be **soluble** or **insoluble** in water at pH 7.5? (1 point)

   **Soluble**

G. Estimate the **pI** of **FCTKD**. (2 points)

\[
\begin{align*}
&+2 \quad \text{pK}_a = 2.0 \\
&+1 \quad \text{pK}_a = 3.9 \\
&0 \quad \text{pK}_a = 8.3 \\
&\frac{(3.9 + 8.3)}{2} = 6.1
\end{align*}
\]
6. **Multiple Choice: 4 points each (28 points)**

1. The amino acid substitution that would most likely cause a change in the tertiary structure of a protein is:
   A. Ser to Thr
   B. Arg to Lys
   C. Val to Leu
   D. Glu to Asp
   E. Lys to Tyr

2. **Which of the following is NOT true about an α-helix?**
   A. The side chains extend radially outward from the helix axis
   B. It is held together primarily by hydrogen bonds
   C. It usually involves multiple polypeptide chains
   D. The peptide backbone is on the inside of the helix
   E. It has a rod-like structure

3. **Which of the following compounds would make the best buffer at pH 8?**
   A. acetic acid, pKa = 4.8
   B. N-tris(hydroxymethyl)methylglycine (Tricine), pKa = 8.15
   C. N-2-hydroxyethylpiperazine-N'-ethanesulfonic acid, pKa2 = 7.6
   D. glycine, pKa2 = 9.9
   E. tris(hydroxymethyl)aminomethane (Tris), pKa = 8.3

4. **What is the primary characteristic that distinguishes prokaryotes from eukaryotes?**
   A. Prokaryotic cells are always larger than eukaryotic cells.
   B. Prokaryotic cells have internal organelles; prokaryotes do not.
   C. Eukaryotes produce and use ATP; most prokaryotes do not.
   D. Eukaryotic cells have both DNA and RNA; prokaryotic cells possess RNA only.
   E. None of the above.
5. In sickle cell anemia, the molecular basis of the malfunction of the hemoglobin molecule is:
   A. faulty binding of iron by the heme groups.
   B. incorrect secondary structure.
   C. reduced affinity for oxygen.
   D. substitution of a single amino acid in the primary sequence.
   E. none of the above.

6. Which of the following occurs when proteins fold?
   A. The protein adopts its lowest energy state form
   B. Most of the non-polar and hydrophobic residues are found buried in the protein
   C. The charged residues are found on the outside of the protein
   D. Secondary structural elements form
   E. All of the above

7. The double bond character of the peptide bond is important because it
   A. allows the peptide bond to be protonated
   B. allows the R-groups to interact with each other
   C. limits free rotation about the peptide backbone
   D. promotes cis configuration of the R-groups
   E. none of the above, the peptide bond does not have double bond character

8. EXTRA CREDIT: 4 points
   Translate the following peptide into the one letter code and reveal a sentence!
   IleLeuIleLysGluCysAlaAsnAspTyr!
   I LIKE CANDY!