

blue-SHOW ALL WORK!!

EXAM 1

1. (4) What are two features of RNA that make it attractive as a possible "original" basis of life.

Name two problems with the hypothesis of RNA as an original basis of life

2. (3) Alpha helices:

- a. interact by hydrogen bonding between backbone amide groups in different strands
- b. show hydrogen bonding interaction within a strand
- c. have hydrogen bonds between amino acid C=O and N-H groups 4 residues apart
- d. both a and b
- e. b and c

3. (15) What is the $[\text{H}_3\text{O}^+]$ of

a. orange juice, pH 3.5

b. liver juice, pH 6.9

c. Stomach juice, pH 1.8

4. (5) What is the [OH⁻] in:

a. urine, pH 6.2

5. (3) What is the ratio of deprotonated/protonated in the histidine imidazole side chain at pH 7.5 ?

a. 100% since you are above the pK

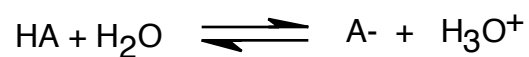
b. 0% since you are above the pK

c. 32

d. 0.032

6. (3) Give a reasonable maximum buffering range for lactic acid/lactate, $K_a = 1.38 \times 10^{-4}$.

7. (4) Consider a weak acid, HA, with a pK= 6.4 in the following reaction:



In order to make 100 ml of a 0.1M solution of about pH 7.0, one would mix:

a. 40 ml 0.1M A⁻ and 60 ml 0.1M HA

b. 60 ml 0.1M A⁻ and 40 ml 0.1M HA

c. 80 ml 0.1M A⁻ and 20 ml 0.1M HA

d. 20 ml 0.1M A⁻ and 80 ml 0.1M HA

e. none of the above

8. (20) Draw the tetrapeptide K-A-L-N at pH 1.0 (predominant expected species) .

9. (10) A peptide sample was treated with trypsin and another sample of the same peptide was treated with chymotrypsin. The fragments were sequenced by Edman degradation and are shown below.

a. Give the sequence of the original peptide.

TRYPSIN: M-V-S-T-K
 V-I-W-T-L-M-I
 L-F-N-E-S-R

CHYMOTRYPSIN:

 N-E-S-R-V-I-W
 T-L-M-I
 M-V-S-T-K-L-F

b. Write the peptides that would result from CNBr cleavage of this peptide.

10.(10) a. For the following 2 peptides compute the isoelectric point.

#1 Y-G-G-R-I-L

#2 C-G-G-R-I-L

b. Give a reasonable pH where these peptides could be separated by cation exchange chromatography.

What charge would the predominant species of each peptide have at the pH which you have chosen?

11.(5) How long would a collagen helix be if it contained 100 amino acids?

12.(5) What is the pH of a buffer with 0.25 M NaHCO_3 and 0.15 M Na_2CO_3 ? $\text{pK} = 10.3$

Extras:

pK' s of amino acid side chains and buffers

- ◆ Serine, Ser: $pK_a = 13$
- ◆ Threonine, Thr: $pK_a = 13$
- ◆ Tyrosine, Tyr: $pK_a = 10.1$
- ◆ Arginine, Arg: $pK_a(\text{guanidino group}) = 12.5$
- ◆ Aspartic Acid, Asp: $pK_a = 3.9$
- ◆ Cysteine, Cys: $pK_a = 8.3$
- ◆ Glutamic Acid, Glu: $pK_a = 4.3$
- ◆ Histidine, His: $pK_a = 6.0$
- ◆ Lysine, Lys: $pK_a = 10.5$
- ◆ Alpha carboxyl group - $pK_a = 2$
- ◆ Alpha amino group - $pK_a = 9$
- ◆ pK_2 of phosphoric acid (phosphate buffer)=7.20

Alpha helix

- ◆ Residues per turn: 3.6
- ◆ Rise per residue: 1.5 Angstroms
- ◆ Rise per turn (pitch): $3.6 \times 1.5\text{A} = 5.4$ Angstroms

Beta Strands

- ◆ Rise per residue:
- ◆ 3.47 Angstroms for antiparallel strands
- ◆ 3.25 Angstroms for parallel strands

Collagen Helix:

- ◆ Rise per residue of 2.9 Angstroms
- ◆ 3.3 residues per turn

Jane Richardson's classifications of proteins

- ◆ Antiparallel alpha helix proteins
- ◆ Parallel or mixed beta sheet proteins
- ◆ Antiparallel beta sheet proteins
- ◆ Metal- and disulfide-rich proteins
- ◆

$$V = \frac{1390q_1q_2}{\epsilon r}$$