Problem Set 2 Solutions
MITES Biochemistry 2010

1. Complete the table below by classifying each of the given amino acids, based on its side chain. Identify each amino acid as either polar or nonpolar. Check marks may be used in the last three columns.

Amino Acid	Polar/Nonpolar	Charged	Sulfur-containing	Aromatic
Threonine	Polar			
Tyrosine	Polar			X
Tryptophan	Non-polar			X
Alanine	Non-polar			
Arginine	Polar	X		
Asparagine	Polar			
Aspartate	Polar	X		
Leucine	Non-polar			
Valine	Non-polar			
Cysteine	Polar		X	

2. For each species below, do the following: 1) Clearly draw every ionization state and somehow label each species (A, B, C,… or α, β, δ,…). 2) Sketch a titration curve for the compound, using the pK_as given below. 3) Be sure to label the axes and the pK_as on the curve. 4) At the starting point and at each endpoint, use your labels to identify the dominant species. 5) At each midpoint, use your labels to identify the species that have equal concentrations. 6) Calculate the pI for the molecule and label it on the curve.

a. **(6)** Valine

b. Aspartate

c. Asp-Val dipeptide (Hint: draw out the structure of the dipeptide and identify protonation sites. Assume the necessary pK_a values for the dipeptide are the same as those for the individual amino acids).

Amino Acid	pK_{a1} - COOH	pK_{a2} - NH_3+	pK_{aR}
Valine	2.29	9.74	
Aspartate	1.88	9.60	3.65

$$pI = \frac{2.29 + 3.65}{2} = 2.97$$

3. Identify the following as L- or D- amino acids.

a. b. c. d.

D

L

D

L

4.

How many chiral centers does each of the following molecules have? Circle any chiral carbons.

carbon(s).

(2) By convention, nucleic acid sequences are typically written in which direction?

5' → 3' (five prime to three prime)

5.

6. According to Watson and Crick, will RNA form a double helix? In your own words, explain their reasoning for why this will or will not occur.

The extra oxygen atom in ribose would come too close to other atoms in the structure.

7.

For each of the molecules to the right, answer the following:

i. (1) Give the name of the molecule.
ii. (1) Is this molecule a nucleoside or a nucleotide?
iii. (1) Is the base a purine or pyrimidine?
iv. (1) Is the sugar ribose or deoxyribose?

a. i. Deoxyadenosine ii. Nucleoside iii. Purine iv. Deoxyribose
b. i. Cytidine monophosphate (CMP) or cytidylate or cytidylic acid
ii. Nucleotide iii. Pyrimidine iv. Ribose

8.

9.

Which one has the highest melting point (t_m)? How many C residues are in DNA sequence **b**?
A has the highest melting point. 400C residues (because DNA is double Stranded).

10.

All purine ring nitrogens. N-1 participates in H bonding by Watson-Crick base pairing. N-9 is involved in N-glycosidic linkage w/deoxyribose so it has limited H- bonding capacity. So, N-3 and N-7 are the 2 available for further H bonding.

11.

adenine thymine

guanine cytosine

O6 Methyl Guanine Cytosine

O6 Methyl Guanine Thymine

As you can see, the O6 Methyl Guanine can form two double bonds with Thymine, and 2 with Cytosine