CHEM523 Test 1 **Name:** Key

Answer the following questions as completely you can. Follow the instructions as closely as possible for each section.

Section 1: (2 points each) Fun!
Circle the correct answer.

1. Which of the following is not a reason that water is important for life?

acid-base heat capacity hyperchromic effect dielectric constant

2. Which Watson-Crick base pair is the most stable?

A-G A-T A-C G-C G-T T-C

3. Which of the following contains a ring system made of four carbons and one oxygen?

Sucralose Histidine Ribulofuranose Phenylalanine Cytosine

4. Which of these forces is not important for protein folding?

London Forces Dipole/Dipole Midichlorian Force Electrostatic Ion-dipole

5. Which of the following is not a common bond in biological polymers?

Glycosidic Carboxylate Ester Sulfhydryl

6. Which of these 2'-deoxy-nucleotides are not commonly found in biological systems?

dATP dCTP dGTP dTTP dUTP

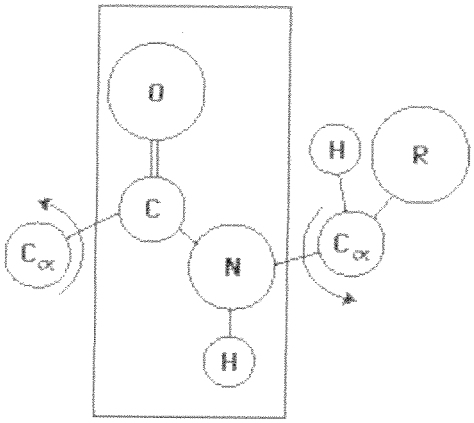
7. The rate limiting step in protein folding is often the cis-trans isomerization of the peptide bond for which amino acid?

Alanine Proline Lysine Histidine Serine

8. _____ structure is dominated by hydrogen bonding between members of the peptide bond.

Primary Secondary Tertiary Quaternary Pentavalent

9. In the diagram below, the plane drawn behind the peptide bond indicates the:



A) Plane of rotation around the C_α—N bond.

B) Absence of rotation around the C—N bond because of the partial sp^2 character of the nitrogen.

C) Region of steric hindrance determined by the large C=O group.

D) Region of the peptide bond that contributes to a Ramachandran plot.

E) Theoretical space between –180 and +180 degrees that can be occupied by the ϕ and ψ angles in the peptide bond.

10. Amino acid residues commonly found in the middle of β turn are:

A) Ala and Gly.

B) hydrophobic.

C) Pro and Gly.

D) those with ionized R-groups.

E) two Cys.

11. In the α helix the hydrogen bonds:

A) Occur only near the amino and carboxyl termini of the helix.

B) Are roughly perpendicular to the axis of the helix.

C) Occur mainly between electronegative atoms of the R groups.

D) Occur only between some of the amino acids of the helix.

E) Are roughly parallel to the axis of the helix.

12. In which of the following systems is the entropy the lowest?

A) Salt water (1M NaCl) at 20C

B) Liquid water at pH 7.0 at 37C

C) Water with sufficient acid added to lower the pH to 2.0

D) Supercooled water (liquid water at a temperature less than 0C)

E) Ice

13. Proline disrupts α-helical structure in proteins because it is

A) an acidic amino acid

B) an aromatic amino acid

C) an imino acid

D) a basic amino acid

E) a sulfur-containing amino acid

1 2
Bad question

Section 2: (10 points per question) Games!

14. Draw the structure of the three Basic and two Acidic Amino Acids at physiological pH, give their full names their 3-letter abbreviation and their 1-letter abbreviation. Write the approximate pKa of each ionizable group next to it.

Lysine, Lys, K	Arginine, Arg, R	Histidine, His, H
Aspartic Acid, D, Asp	Glutamic Acid, Glu, E	**Bonus (2 pts) Draw Glutamine/Gln/Q**

15. Draw the structure of a G/C nucleotide base pair. Label each of the nucleotides and indicate the hydrogen bonds between the nitrogenous bases with dotted lines.

See book

16. Draw the chemical structure of the repeating unit of peptidoglycan. Label the figure appropriately.

NAG – NAM

|

D-Ala

|

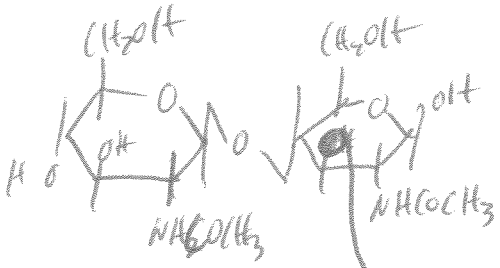
Isoglutamate

|

L-lysine

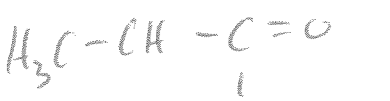
|

D-Ala

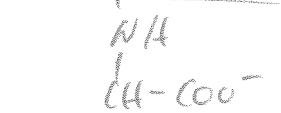


NAM

NAG



L-Ala



Isoglutamate

L-lys

D-Ala

Section 3: (4 points per question) Fun and Games! Two great things that go great together! Answer the following questions.

17. Complete the following sentences:

a. The dipole moment of a solvent is (directly or indirectly) proportional to the dielectric constant of that solvent.

b. Disulfide bonds are covalent bonds that stabilize the tertiary structure of some proteins. They are formed through the (choose one: oxidation or reduction) of two Cysteine amino acids.

c. Glycogens are the energy-storage carbohydrates of animals.

d. Biological polymers are directional molecules.

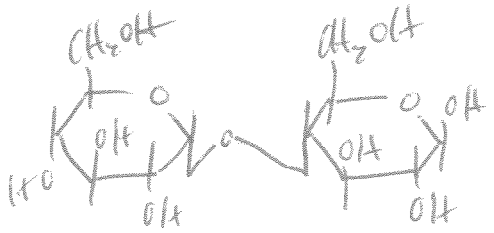
Polypeptides run from the NH_3-terminus to the COO^--terminus.

Nucleic acids run from the 5' end to the 3' end.

Polysaccharides run from the nonreducing terminus to the reducing terminus.

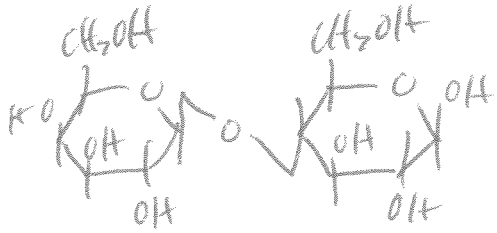
18. Draw the Haworth structures of Maltose and Lactose.

Maltose



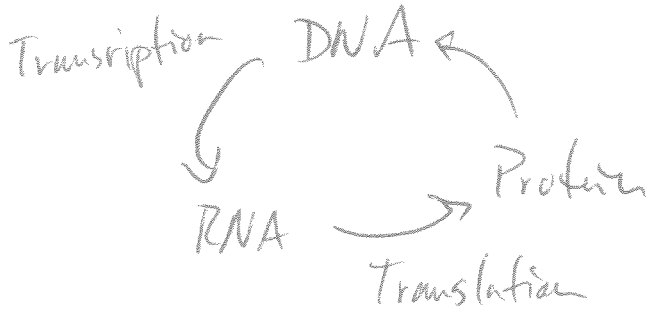
α-D-Glu-(1,4)-β-D-Glu

Lactose



β-D-Gal-(1,4)-β-D-Glu

19. Draw a schematic of the Central Dogma of Molecular Biology.



20. Briefly describe how proteins fold. Your answer must lay out the facts in a logical, chronological form that fully describes the chemical entities, forces and energies involved. You must include a description of the hydrophobic effect and the roles of the solvent and polypeptide. Finally, relate your description to features of the current best model of the protein folding funnel we discussed in class.

your answer must include (in order)

- Hydrophobic effect and Clathrate cages
- Solvent entropy increases
- Hydrophobic core formation / Polar, charged residues on surface
- Secondary structure formation by residues in close proximity
- Tertiary structure formation by interaction of secondary structures
- The landscape funnel with localized minima that can trap folding intermediates

21. Briefly (in 30 words or less) describe the following domains with respect to amino acid sequence (if appropriate), secondary structural elements, tertiary structure, identifying features and active site location (if appropriate):

A) TIM Barrel

β8/α8 fold with sheets in the core the circular arrangement. Active site is on the C-terminal side of the circular β-sheet at center of barrel. Called the "Perfect Fold"

B) HTH Domain

Helix-Turn-Helix. Exactly as the name implies. Commonly found in transcription factors.

C) Zn^{2+} finger domain

Two Cys / Two His coordinating a zinc ion. Frequently found in DNA binding proteins.

22. Describe a β-turn with respect to the size, types of amino acids involved and their position within the secondary structural element.

Four residue turn that frequently connects Antiparallel β-strands. Glycine and proline are often found at positions 2 and 3.

Section 4: (5 points each) Closing time. You are almost done. Answer the following questions and let's get out of here.

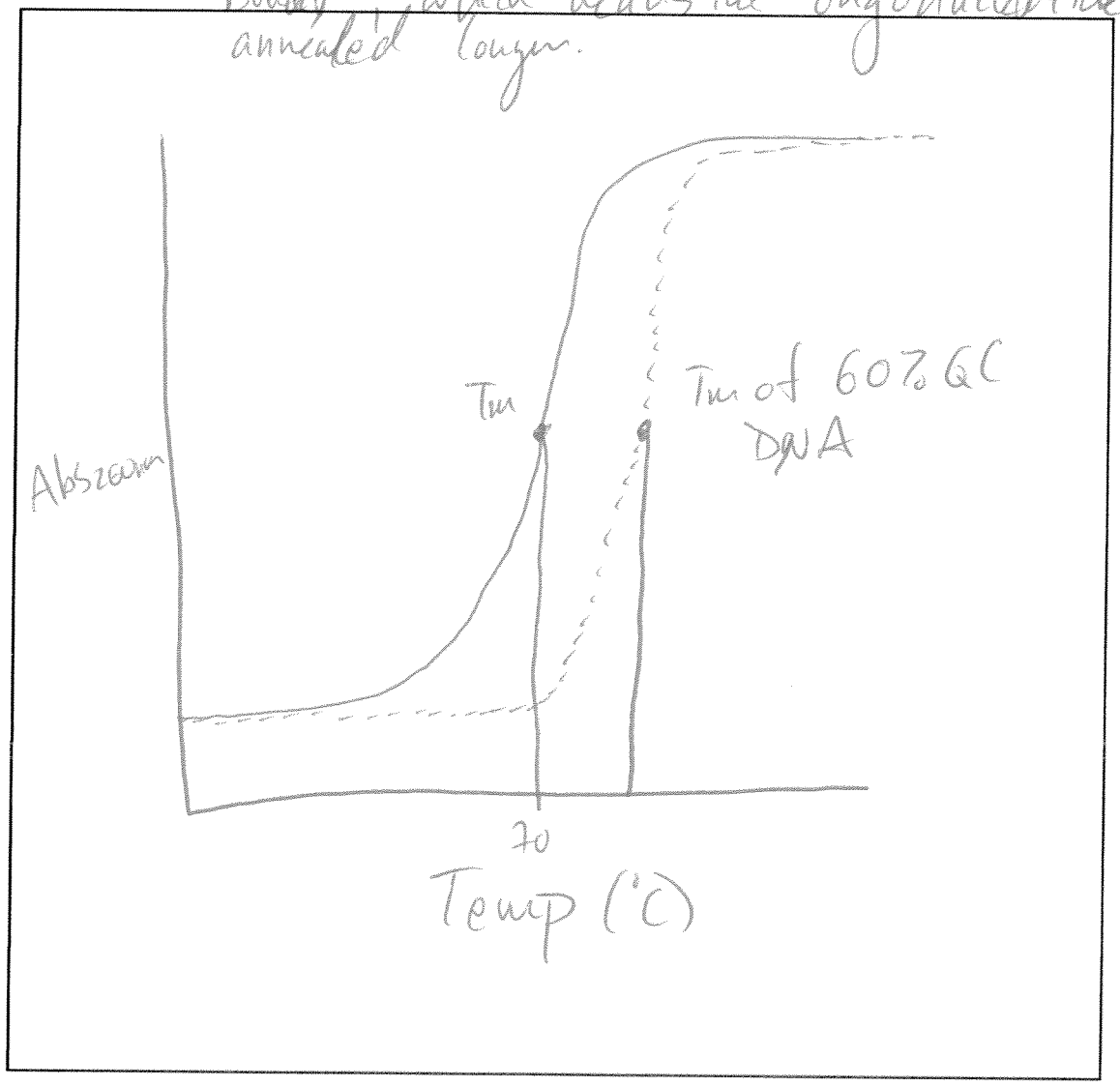
22. Please sketch the melting curve for DNA with a Tm of 70°C. Be certain that you completely label the axes of the plot, failure to do so will result in no points for this question.

a. What can be learned about the stability of DNA from the shape of this curve?

That DNA unfolding is cooperative.

b. If you were told that the DNA molecule with a Tm of 70°C was composed of 40% GC base pairs, draw a second curve for a molecule of the same length that has a 60% GC content. What is the basis for the difference? (Be certain that I know which curve is which since they will be on the same plot!)

The higher GC content means more hydrogen bonds which means the oligonucleotide stays annealed longer.



22. Describe a) an alpha helix and b) beta sheets with respect to their geometries and hydrogen bonding patterns. Use figures to help you make your point.

α-helix has 3.6 residues per turn. Has favorable/allowed Φ/Ψ angles and maximized hydrogen bonding. It is right handed, n-4 hydrogen bonding pattern. May be amphipathic.

β-sheet is an extended conformation in which strands lie next to each other and the carbonyl oxygen and amide hydrogen form a dipole/dipole interaction. Side chains point above and below the sheet in alternating arrangement.

23. Calculate the pH at the equivalence point of the titration of 25.00 mL of 0.165 M benzoic acid, C_6H_5COOH, with 0.185 M KOH. [K_A for $C_6H_5COOH = 6.6 \times 10^{-5}$]

0.165M C_6H_5COOH

$C_6H_5COOH + OH^- \rightarrow C_6H_5COO^- + H_2O$

For every 1 mole of benzoic acid, you need 1 mole of OH^- to neutralize it.

$0.025L \times \frac{0.165 \text{ moles benzoic acid}}{L} = 4.125 \times 10^{-3} \text{ moles benzoic acid}$

$4.125 \times 10^{-3} \text{ moles benzoic acid} \times \frac{1 \text{ mole } OH^-}{1 \text{ mole benzoic acid}} = 4.125 \times 10^{-3} \text{ moles } OH^- \text{ needed}$

$\frac{0.185 \text{ moles } OH^-}{L}(xL) = 4.125 \times 10^{-3} \text{ moles } OH^-$, $x = 0.022$ L of 0.185M KOH needed to reach equivalence or end point.

We have 4.125×10^{-3} moles of benzoate @ the endpoint in 47ml of solution (K_B for benzoate = 1.515×10^{-10}) New total volume = 47ml

0.087M benzoate $C_6H_5COO^- + H_2O \rightleftharpoons C_6H_5COOH + OH^-$

$K_B = \frac{[C_6H_5COOH][OH^-]}{[C_6H_5COO^-]}$, $\frac{x^2}{0.087} = 1.515 \times 10^{-10}$ $x = [OH^-] = 3.63 \times 10^{-6}$

pOH = 5.44

pH = 8.56

24. Nitrous acid, HNO_2 has a K_A value of 6.0×10^{-4}. Calculate the initial concentration of HNO_2 if a solution of this acid has a pH of 3.65.

$$HNO_2 + H_2O \rightleftharpoons NO_2^- + H_3O^+$$

$$K_A = \frac{[NO_2^-][H_3O^+]}{[HNO_2]}$$

$pH = -\log[H_3O^+]$

$[H_3O^+] = 10^{-pH} = [NO_2^-]$

$[H_3O^+] = 2.24 \times 10^{-4}\ M$

$[NO_2^-] = 2.24 \times 10^{-4}\ M$

$$6.0 \times 10^{-4} = \frac{(2.24 \times 10^{-4})^2}{[HNO_2]}$$

$$[HNO_2] = 8.35 \times 10^{-5}$$

BONUS! Answer the following questions for the bonus points indicated. There is no arguing and no discussion on bonus points awards. You are either clear, concise and correct and you get the points or you are not and you do not. Capiche?

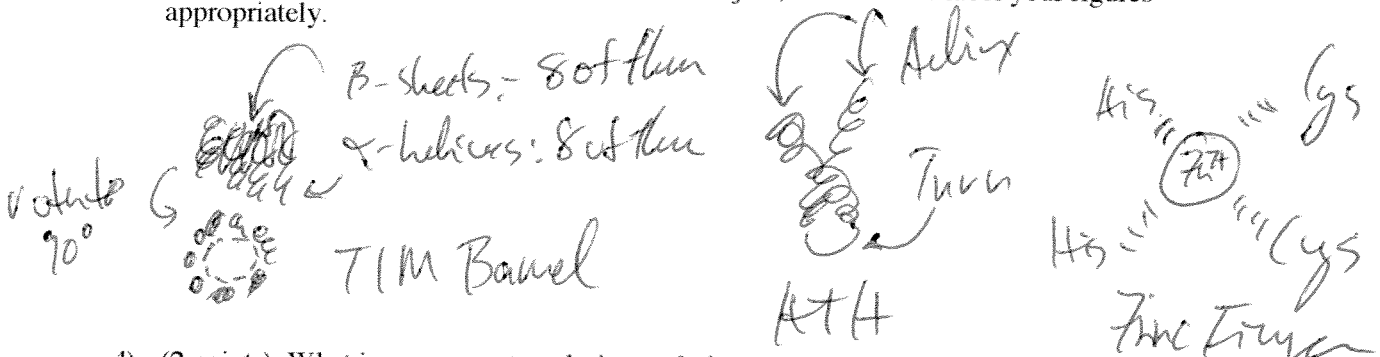
1) (2 points) Why might animals make glycogen and not amylose?

More highly branched, therefore there are more places that enzymes can hydrolyze single glucose units off. This means that more energy is available for running and fighting and other things animals do.

2) (2 points) What would the DNA unfolding curve look like if there was no hyperchromic effect? You'd should probably define the hyperchromic effect in your answer.

A flat line. The hyperchromic effect is the phenomenon exhibited by DNA where the absorbance of a DNA solution increases as the molecule unfolds.

3) (3 points) For each of the domains listed in question 21, draw a brief figure illustrating what they look like. Since none of us are art majors, be certain to label your figures appropriately.



4) (2 points) What is convergent evolution and give an example that we discussed in class that serves to illustrate your point.

Convergent evolution is a type of evolutionary result whereby different organisms evolve similar protein folds to catalyze the same reaction. For example Subtilisin, Chymotrypsin and Elastase all use the catalytic triad to hydrolyze proteins but they are not evolutionarily related