Name

This exam is schedule for 75 minutes and I anticipate it to take the full time allotted. You are free to leave if you finish.

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 of these forces is not important for protein folding?

   hydrophobic hydrogen bonding electrostatic ion-dipole pi stacking

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

   carboxylate glycosidic amide phosphodiester

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

   dATP dCTP dGTP dTTP dUTP

5. Which of the following contains a ring system made of four carbons and one oxygen? Select all that apply

3'-deoxyribose histidine uracil fructofuranose tyrosine adenosine — this has a ribose

6. _____ structure is dominated by hydrogen bonding between peptide backbones

   Primary Secondary Tertiary Quaternary

7. _____ protein structure is dominated by repeating primary structure.

   Globular Fibrous Glycine Rich Membrane spanning

8. The _____ groove of B-form DNA (the common form of the DNA in a double helix) is always the side of the glycosidic bond.

   major minor mixed

9. Which amino acid side chain can commonly forms covalent bonds that stabilize protein structure?

Serine Histidine Arginine Cysteine Proline

10. Which amino acid can buffer a solution at pH 7?

cysteine lysine tyrosine histidine serine

11. _____ are commonly found at the 2nd position of the glycerol backbone of phosphoglycerides (glycerophospholipids)?

    Saturated fatty acids Unsaturated fatty acids Phosphate

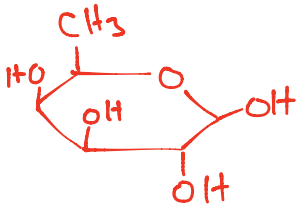
12. Glucosamine has an amine at the _____ position?

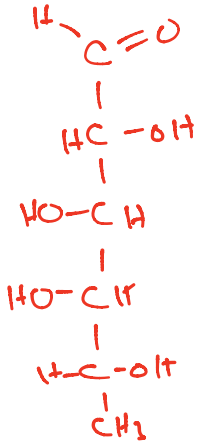
    1 2 3 4 5 6

13. Identify the sugar:
    a. Aldose isomer of fructose glucose

    b. Ketose isomer of ribose ribulose

14. Fucose is 6-deoxy galactose. Draw this sugar in the linear and cyclical form. Make sure to orient the anomeric carbon on the right-most side of the ring.





15. α helices and β sheets tend to form in the interior of globular proteins while irregular loops occur on the outside. Propose a reason for this observation.

    In helices and sheets, all backbone atoms have H-bonds that are tied up in secondary structure. Unstructured loops can use these atoms to H-bond with water. Additionally, there is a risk of destabilizing secondary structure if it is exposed to water because H_2O will H-bond with the backbone just as well as the partner H-bonder in the helix or sheet.

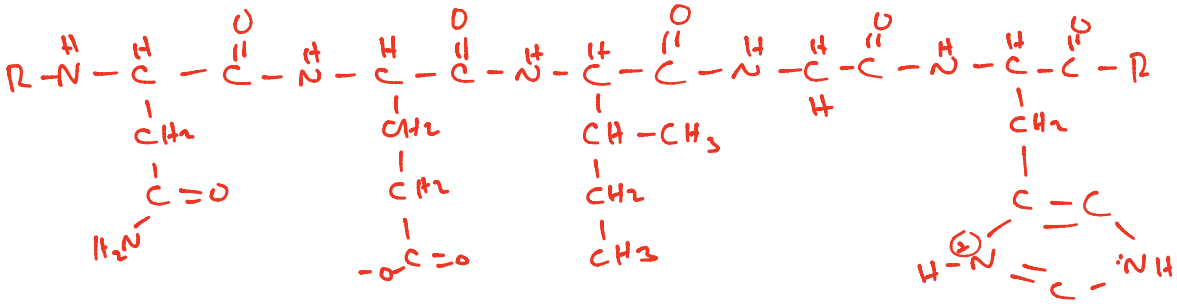
16. Protein folding is primarily driven by burying hydrophobic amino acids in the core of the protein; this spontaneous process endothermic. Discuss why there is an enthalpic penalty for this process and why it is favorable.

    When hydrophobic molecules are exposed to water, the water is forced into very rigid cages (clathrate-like) around the hydrophobic molecule. These cages are characterized by very strong H-bond and are very ordered. When the hydrophobic molecule is removed from the water and buried in a hydrophobic core or solvent, the water cage breaks. Breaking the strong H-bonds takes a lot of energy (endothermic) but there is a great deal of disorder that is produced by disrupting the cage – this is very entropically favorable.

17. Consider a peptide with the following sequence:

CREATIVITYKILLEDMYFREAKYPANTHERANDMEINEIGHTDAYS

a. Sketch the NEIGH peptide at pH 5.0.



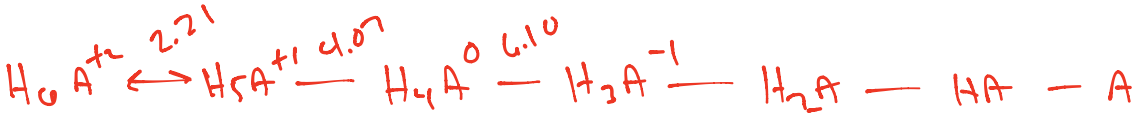
b. Please indicate where cyanogen bromide (CNBr) would cut the peptide. C-term of Met

c. At pH 6.50, what is the charge of the C-terminal peptide created by treatment with CNBr? You may use the last page of the exam for scratch paper. If you didn't get part B, assume that the peptide starts at NEIGH

$6.50 = 6.10 + \log \frac{A}{HA}$

$10^{0.4} = \frac{A}{HA} = \frac{1-HA}{HA}$ $\quad 10^{0.4} HA = 1 - HA$ $\quad (1 + 10^{0.4}) HA = 1$ $\quad 1 - HA = 0.28$

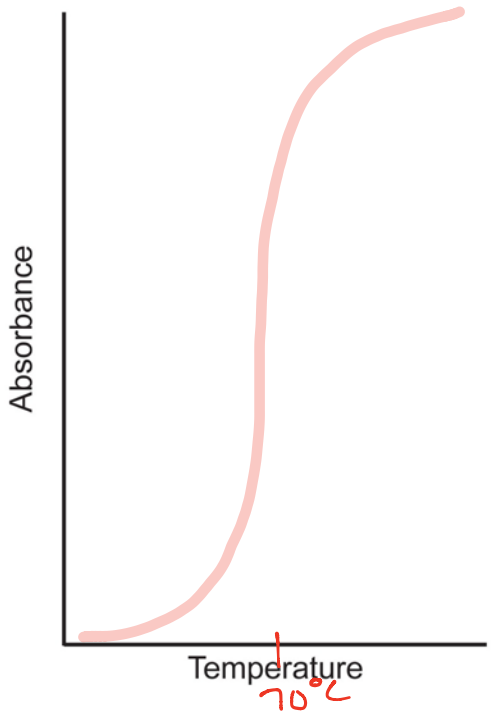
d. Calculate the pI of the C-terminal peptide created by CNBr.



$\frac{4.07 + 6.10}{2} = 5.085$

18. What are three factors that can influence membrane fluidity? Temperature, cholesterol, lipid length, degree of saturation.

19. On the image below, please sketch the melting curve for DNA with a Tm of 70ºC.



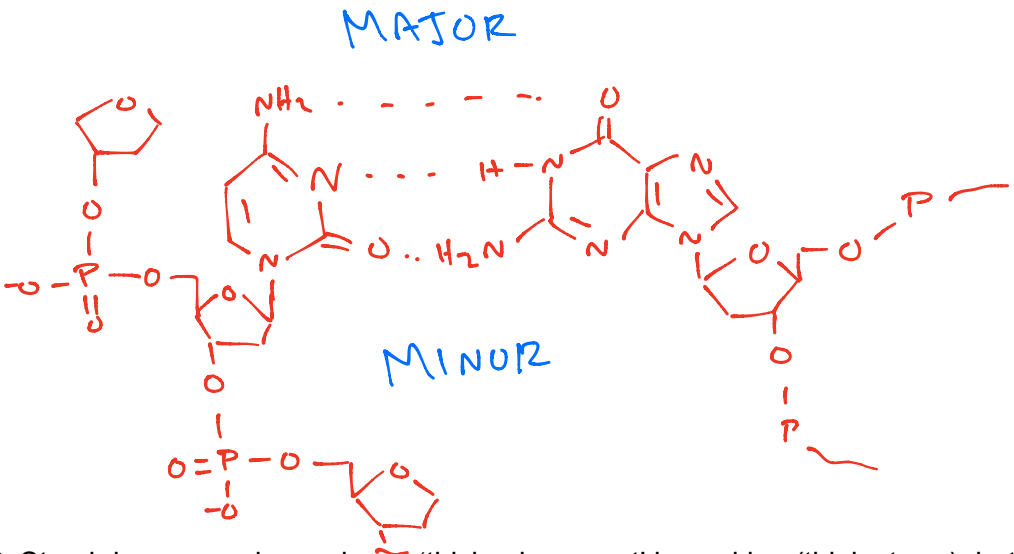
a. What can be learned about DNA stability from the shape of this curve? Folding/unfolding is cooperative.

b. Why does the y-axis have the units of absorbance? Hyperchromic effect – bases have a higher molar absorptivity when exposed to water as compared to when stacked in a double helix.

20. How does pyrosequencing work and why is it useful? You don't need to list all reactions, just a couple general reactions will suffice. Make sure your discussion identifies why it is named 'pyro'

A single dNTP is added to a template DNA strand. If it is complementary to the next base, a reaction will occur that links the dNTP to the growing chain and producing a pyrophosphate (hence pyro). The pyrophosphate can then be added onto AMP using a sulfate-modified AMP and the pp_i as a substrate. The ATP produced will then be a substrate for luciferase which produces a burst of light through chemiluminescence. If a burst of light is observed, you know that that specific base reacted.

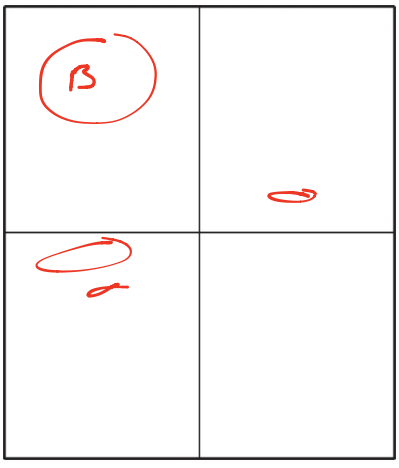
21. Please sketch a G:C base pair. Please show connectivity to an adjacent monomer at least one time. You may abbreviate backbones with X in any other relevant places. Identify the where the major groove and minor groove of B-form DNA would be found.



22. Starch is commonly used as a 'thickening agent' in cooking (think stews), but only if the process included heating. Based on what you know about the structure of starch (amylose), justify this observation. Starch is a helical polymer stabilized by H-bonds. When it is heated, it can dissolve in water (or stew). When it cools back down, these H-bonds reform, but they are now significantly further apart. The solid doesn't completely reform, but it does form a psuedosolid that takes on the "thick" properties.

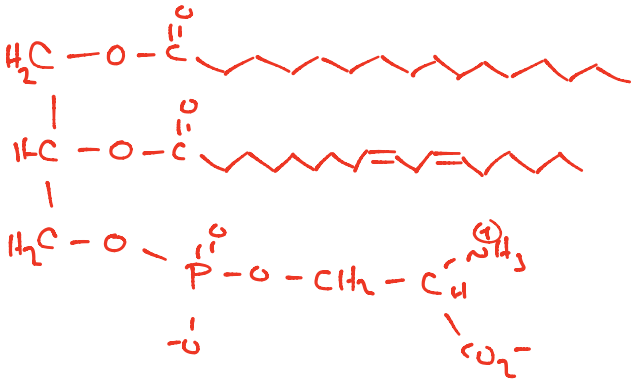
23. Please describe the importance of ψ and ϕ angles in protein structure. In your discussion, make sure to include what these angles describe, common/restricted values and why. Sketches are highly encouraged. Feel free to use the empty grid, but you'll want to include a title (what would you call this plot?) and label the axes appropriately.

These angles report on stable rotational configurations of bonds within a protein. Common values correspond with common secondary structural features. A value of 0 is not stable unless overcome by enough favorable interactions to outweigh the unfavorable steric strain.

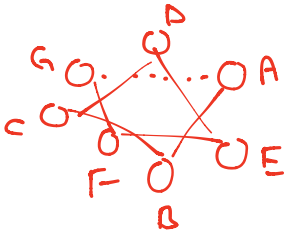


24. Consider the statement “protein folding is a hierarchical process.” Please justify this statement. It may be useful to think about what you know about the protein unfolding process. Proteins fold in a cooperative and systematic way. Secondary structure forms before tertiary or quaternary. Often, one domain will fold prior to other domains.

25. Sketch a phosphoglyceride with serine as the polar head group that contains these two fatty acids (make sure to put them at the appropriate positions): 18:2n-6 and 16:0



26. Predict a 10 amino acid peptide that would have one polar face and one non-polar face. You may choose to do this with a β sheet or α helix, but make it clear which you are choosing.



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Amino Acid	α-carboxylic acid	α-amino	Side chain
Alanine	2.35	9.87	
Arginine	2.01	9.04	12.48
Asparagine	2.02	8.80	
Aspartic Acid	2.10	9.82	3.86
Cysteine	2.05	10.25	8.00
Glutamic Acid	2.10	9.47	4.07
Glutamine	2.17	9.13	
Glycine	2.35	9.78	
Histidine	1.77	9.18	6.10
Isoleucine	2.32	9.76	
Leucine	2.33	9.74	
Lysine	2.18	8.95	10.53
Methionine	2.28	9.21	
Phenylalanine	2.58	9.24	
Proline	2.00	10.60	
Serine	2.21	9.15	
Threonine	2.09	9.10	
Tryptophan	2.38	9.39	
Tyrosine	2.20	9.11	10.07
Valine	2.29	9.72	