Chemistry/Biochemistry 3511 Exam 1

Name _____Key_____ Signature _____

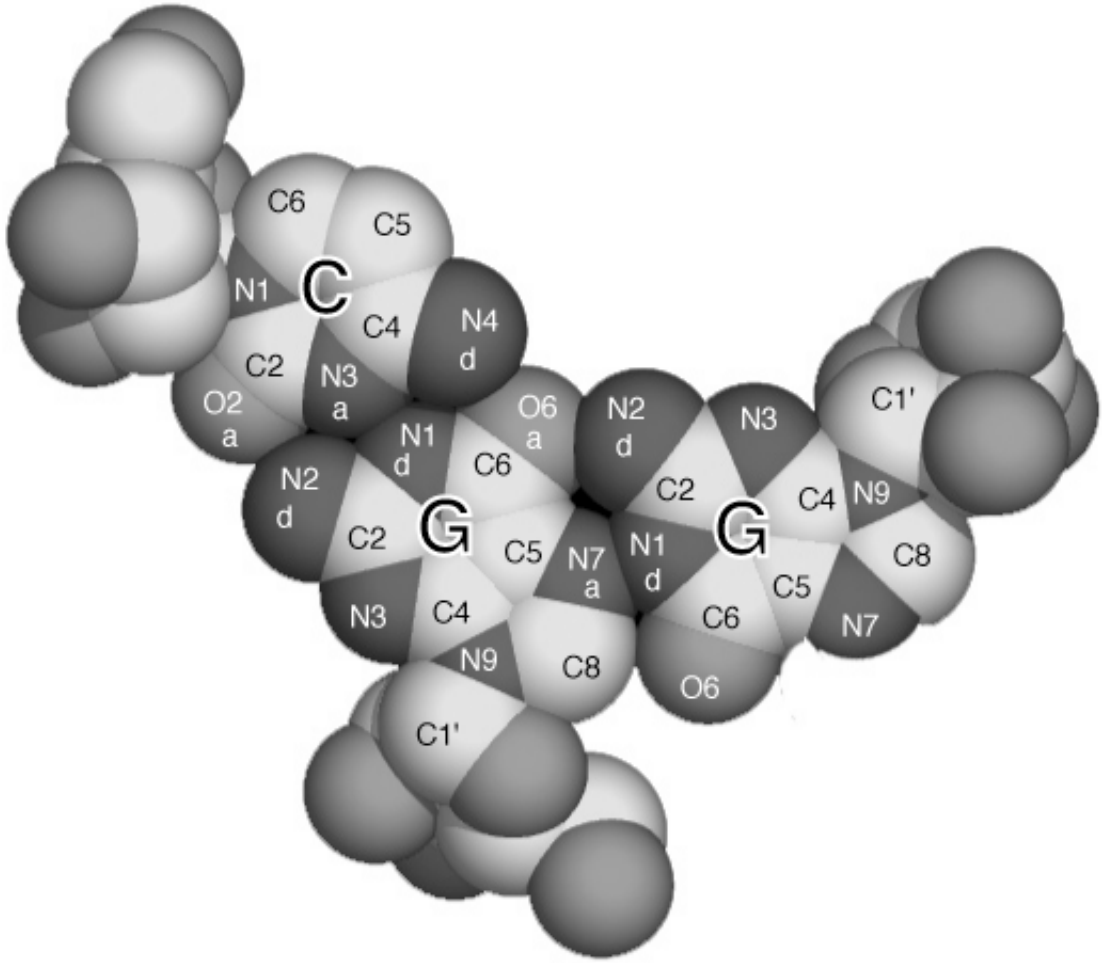
1

a) Indicate the nucleotide identities (C, G , A, T or U, use uppercase characters).
(9 points)

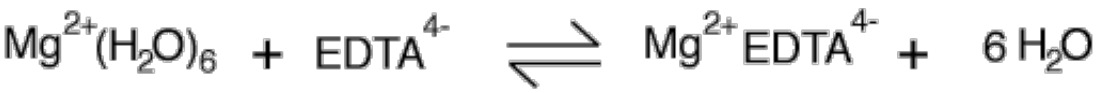
b) Label ALL the atoms of the bases.
(10 points)

c) Indicate one C1' atom.
(1 point)

d) For the hydrogen bonds, indicate each hydrogen bond donor with a 'd' and each acceptor with an 'a' (use lower case characters).
(10 points)



2) For the reaction below, if one mole of reactants goes to one mole of products, would entropy increase of decrease? Explain why in one sentence. (10 points)



(EDTA = ethylenediamine tetraacetic acid)

The entropy would increase because there are 7 product molecules and only 2 reactant molecules. The total number of degrees of freedom (rotational and transnational states) is much greater for the products than for the reactants. Note that we are ignoring heat dissipation effects here (delta S = q/T).

3) List all the types of molecular interactions between molecules in liquid water. Give a one or two (no more than two) sentence description of each. (25 points total)

(A) Repulsive Interactions. *Overlap of the occupied orbitals of non-bonded atoms results in* ***short-range*** *(r^12) electrostatic repulsion between the electrons of those atoms. This interaction makes molecules act like pool balls (hard spheres) with 'van der Waals radii'.*

(B) Dipole-Dipole Interactions. *Dipoles, caused by* ***charge separation*** *or atoms with* ***partial charge*** *within a molecule that contains atoms of differential electronegativity, can be attractive when antiparallel and repulsive when parallel. In water the oxygen carries a partial negative charge and hydrogen carries a partial positive charge. In addition a dipole can interact can induce a dipoles (always attractive) in an adjacent molecules.*

(C) Fluctuating Dipoles (aka London Forces or Dispersive Forces). *Whenever any two molecules are nearby in space they experience coupled* ***fluctuating/oscillating/resonating/time-dependent*** *dipoles, that cause favorable electrostatic interactions.*

(D) Hydrogen Bonding Interactions. *An acceptor atom (A) with a basic lone pair of* ***electrons*** *can interact favorably with a donor atom (D) that bears an acidic* ***proton****. Both the acceptor and the donor must be* ***electronegative****. In water D and A are both oxygen atoms.*

The terms van der Waals attraction, covalent bond, ionic interaction, charge-charge, and hydrophobic effect are not correct responses to this question.

4-1) Write out the acid/base reaction of ammonia (NH_3) in water.
(10 points)

NH3 + H2O = NH4+ + OH-
or
NH4+ = NH3 + H+

4-2) Explicitly define the pKa of ammonia, using [acid] and [base] notation. (10 points)
The truth is that I intended to ask for the definition of the pKb. This question will not be graded. But the answer is not hard to *Ka = [H+][NH3]/[NH4+]*
when [NH3] = [NH4+], Ka = [H+] and pKa = pH

True/False Questions (2 points each, 10 points total, 20 points total)

5-1) Enzymes change equilibrium constants. (T/**F**)

5-2) Enzymes change forward rate constants. (**T**/F)

5-3) Enzymes change reverse rate constants. (**T**/F)

5-4) Enzymes stabilize reactants. (T/**F**)

5-5) Enzymes stabilize products. (T/**F**)

5-6) Enzyme stabilize transition states. (**T**/F)

5-7) The concentration of ATP in a cell is around 1 nanomolar. (T/**F**)

5-8) The concentration of ATP in a cell is around 1 micromolar. (T/**F**)

5-9) The concentration of ATP in a cell is around 1 millimolar. (**T**/F)

5-10) Living systems are at equilibrium. (T/**F**)