NUCLEIC ACIDS -- EXTRA QUESTIONS

1. What type of interaction is involved in the **<u>specificity</u>** of the interactions in a double-stranded structure between the complementary strands of nucleic acid?
2. In DNA melting, which factor favors strand separation?
   a. hydrogen bonding between bases
   b. repulsion between phosphate groups
   c. van der Waals interactions between bases.
   d. high content of G + C
3. Explain how each of these factors will affect the melting temperature of DNA.
   a. an increase in the salt concentration of the solution
   b. a high G + C content in the DNA
4. Why can't RNA can adopt both the A and B conformation like DNA can?
5. What interactions are responsible for stabilizing tRNA structure?
6. DNA exists in three conformations: A-DNA, B-DNA and Z-DNA. Match the name of the DNA to the text that best describes the corresponding helix.
   a. Right-handed helix; narrow and deep major groove; wide and shallow minor groove, largest diameter.
   b. Right-handed helix; wide and deep major groove; narrow and deep minor groove, medium diameter.
   c. Left-handed helix; flat major groove; narrow and deep minor groove, most narrow diameter.
7. You have isolated DNA from a new organism and found that its base composition is 32%A, 16%G, 40%T and 12% C. Do you think this DNA forms a double helix? Why?
8. You are given 2 samples of bacterial DNA to analyze and find that one contains 12% A (adenine) and the other 35% A. If you were told that one bacterium had been isolated from a hot spring, which sample would you guess was the DNA from the thermophilic bacterium and why?
9. Compare the helix-turn-helix and zinc finger DNA-binding protein motifs.
10. If you wanted to specifically label DNA and not RNA in an *in vitro* cell culture experiment, what labeled compound could you use?

11. Why would an RNA molecule that contains only A and C not have any secondary structure?

12. A common biological modification of cytosine within DNA is methylation to produce 5-methyl cytosine, which base pairs with guanine. However 5-methyl cytosine spontaneously deaminates at a low rate to form thymine. (A) At sites where this deamination occurs, what would be the base pairing in the DNA? (B) Would this deamination lead to a mutation in a daughter DNA? If so, what would be the mutant base in one daughter DNA?

13. In very concentrated NaCl solutions (5M) the melting temperature of DNA begins to *decrease* with increasing salt concentration, rather than increasing as occurs at lower salt concentration. Why should this happen? (Hint: think about the water in very concentrated salt solutions.)

14. The viscosity of native DNA solutions is quite high because of the resistance of the long rod-like molecules to movement in the solution. However, after thermal denaturation, the viscosity decreases markedly. Why?

ANSWERS

1. Hydrogen bonds, which define the complementary relationship between strands by the specific hydrogen bonding of G to C and of A to T.

2. b- Electrostatic repulsion favors strand separation.

3. Melting temperature will be affected because:

    a. A major force favoring melting of the DNA duplex is electrostatic repulsion between phosphates, which will be diminished at higher salt concentration.

    b. A major force favoring stability of the DNA duplex is base stacking, and interactions between stacked G and C bases are greater than those between stacked A and T bases. While it's tempting to attribute the greater stability of double helices with higher GC content to the additional hydrogen bond in a G-C base pair compared with an A-T base pair, that reasoning is incorrect -- hydrogen bonds contribute little to the *stability* of the double helix, since bases in the separated strands can hydrogen bond to H_2O.

4. The extra OH on the ribose ring sterically inhibits RNA from adopting the B conformation.

5. The structure of tRNA arises from the formation of intramolecular base pairs, and in the final structure, the maximum number of such base pairs has been formed. Because the structure depends on how these base pairs are formed, different tRNAs have quite different three-dimensional structures.

6. (a) A-DNA; (b) B-DNA; (c) Z-DNA

7. No; the content of G does not equal the content of C, and the content of A does not equal the content of T.

8. The sample with the lower A content, which implies a higher content of G + C, should be from the thermophilic bacterium, because the sample with the higher G + C content should be more heat-stable (not due to the higher number of hydrogen bonds per base pair, but to the better base stacking interactions with G-C base pairs).

9. In the helix-turn-helix, the protein associates with DNA through one of the helices, the recognition helix. In the zinc finger the DNA-binding helix is created by the tetrahedral coordination of zinc to the polypeptide chain. This coordination stabilizes the secondary and tertiary structure of the finger.

10. Radiolabeled thymine or thymidine, because T is only found in DNA; use labeled base or nucleoside, because the phosphorylated derivatives can't cross the cell membrane.

11. There is no possibility of forming base pairs.

12. (A) The base pairing changes from G-C to G-T. (B) Yes. One daughter DNA would have an A, instead of the expected G because the parental stand had T instead of C.

13. Water is mostly tied up solvating ions and little is available to be involved in the hydrophobic effect. Thus, the favorable entropy involved in base stacking, which involves removing bases from contact with water, diminishes at high salt concentrations.

14. After thermal denaturation, the DNA duplex is destroyed and DNA assumes a random coil structure, which moves more easily through the solution.