Questions- Nucleotides & Nucleic Acids

A. The components and structures of common nucleotides are compared. (Questions 1-5)

1._____ Which structural feature is shared by both uracil and thymine?
- a) Both contain two keto groups.
- b) Both contain one methyl group.
- c) Both contain a five-membered ring.
- d) Both contain three nitrogen atoms.

2._____ Which component is found in both adenosine and deoxycytidine?
- a) Both contain a pyranose.
- b) Both contain a 1,1'-N-glycosidic bond.
- c) Both contain a pyrimidine.
- d) Both contain a 3'-OH group.

3._____ Which property is shared by both GDP and AMP?
- a) Both contain the same charge at neutral pH.
- b) Both contain the same number of phosphate groups.
- c) Both contain the same purine.
- d) Both contain the same furanose.

4._____ Which characteristic is shared by purines and pyrimidines?
- a) Both contain two heterocyclic rings with aromatic character.
- b) Both can form multiple non-covalent hydrogen bonds.
- c) Both exist in planar configurations with a hemiacetal linkage.
- d) Both exist as neutral zwitterions under cellular conditions.

5._____ Which property is found in nucleosides and nucleotides?
- a) Both contain a nitrogenous base, a pentose, and at least one phosphate group.
- b) Both contain a covalent phosphodister bond that is broken in strong acid.
- c) Both contain an anomeric carbon atom that is part of a β-N-glycosidic bond.
- d) Both contain an aldose with hydroxyl groups that can tautomerize.

B. The structures of nucleotides and their components are studied. (Questions 6-10)

6._____ Which characteristic is shared by both adenine and cytosine?
- a) Both contain one methyl group.
- b) Both are anomeric.
- c) Both contain one keto group.
- d) Both are heterocyclic.

7._____ Which component is found in both guanosine and uridine?

a) Both contain an aldohexose.
b) Both contain three hydroxyl groups.
c) Both contain a 1',9 - bond.
d) Both contain a pyranose.

8._____ Which property is shared by both CTP and dTDP?

a) Both contain the same sugar.
b) Both contain the same charge at cellular pH.
c) Both contain a planar six-membered ring.
d) Both contain phosphodiester bonds.

9._____ Which characteristic is found in both purines and pyrimidines?

a) They both have aromatic rings that undergo substantial tautomerization at neutral pH.
b) They both are weak bases that can be positively charged at neutral pH.
c) They both have multiple pKa values that result in zwitterion forms.
d) They both can form stable N-glycosidic bonds with β D-ribofuranose.

10._____ Which is a general property of both nucleosides and nucleotides?

a) Both contain a pentose in the form of a furanose.
b) Both contain at least one 5'-phosphate group.
c) Both contain a nitrogenous base that forms covalent H-bonds.
d) Both contain a hemiacetal or hemiketal bond.

C. A single-stranded DNA molecule contains 40 nucleotides with equal amounts of A, C, G, and T. This DNA strand can combine with a complementary DNA strand to form a double-stranded DNA molecule. (Questions 1-16)

11._____ Which structural feature is found in the single-stranded DNA molecule?

a) It can have a negatively-charged backbone composed of nitrogenous bases.
b) Each 3',5'-phosphodiester bond will contain one phosphate group linking two deoxyribose sugars.
c) It can have one end with a 5'-phosphate group while the other end has a 2'-hydroxyl group.
d) Each purine and pyrimidine will be paired with a complementary base.

12. _____ Which is a possible sequence and structure for this DNA molecule?

a) If the single-stranded molecule has the sequence 5'-$(ATGC)_{10}$, then its double- stranded form could assume a Z-DNA structure.
b) If the single-stranded molecule has the sequence 5'-$(GATC)_{10}$, then its double-stranded form could assume an H-DNA structure.
c) If the single-stranded molecule has the sequence 5'-$(CTGA)_{10}$, then its double-stranded form could assume a hairpin structure.
d) If the single-stranded molecule has the sequence 5'-$(TGAC)_{10}$, then its double-stranded form could assume a cruciform structure.

13._____ Which characteristic does this double-stranded molecule have when it forms a B-DNA structure?

a) The two strands will have parallel orientation and identical sequences.
b) The helix will be right-handed with 12 base-pairs per turn.
c) Every base-pair will contain one purine and one pyrimidine.
d) There are both covalent and non-covalent bonds between the two chains.

14._____ Which force can stabilize a DNA double-helix?

a) Hydrophobic bases are found in the interior of the helix where each base-pair is stabilized by the same number of hydrogen bonds.
b) Hydrophilic sugar-phosphate groups are found on the exterior of the helix where they can interact with water.
c) Non-covalent N-glycosidic bonds can form between nitrogenous bases in opposite strands in the helix.
d) Covalent base-stacking interactions can occur between adjacent bases within the same strand in the helix.

15._____ Which of the following double-stranded DNA molecules would denature at a lower temperature than the 40 base-pair double-stranded molecule described above?

a) a 40 base-pair molecule in which 25% of the bases are adenines
b) a 30 base-pair molecule in which 40% of the bases are guanines
c) a 20 base-pair molecule in which 10% of the bases are thymines
d) a 10 base-pair molecule in which 20 % of the bases are cytosines

16._____ Which characteristic will this double-stranded DNA molecule share with a double-stranded RNA molecule of the same size?

a) Both will have secondary structure.
b) Both will contain inverted repeats.
c) Both will be degraded by base.
d) Both will contain four types of base-pairs.

D. A single-stranded DNA molecule contains 40 nucleotides and has the sequence 5'-$(GA)_{20}$-3'. (Questions 17-22)

17._____ Which will be a characteristic of this one single strand?

a) The single-stranded chain will contain both ribose and deoxyribose.
b) The single-stranded chain will contain both purines and pyrimidines.
c) The single-stranded chain will contain one 5'-end and one 3'-end.
d) The single-stranded chain will contain multiple phosphodiester bonds each linking a 2'-carbon and a 5'-carbon.

18._____ When this single strand binds to a complementary DNA strand,

a) the complementary strand has the sequence 5'-$(CT)_{20}$-3' and a cruciform structure could form.
b) the complementary strand has the sequence 5'-$(CT)_{20}$-3' and a Z-DNA structure could form.
c) the complementary strand has the sequence 5'-$(TC)_{20}$-3' and an H-DNA structure could form.
d) the complementary strand has the sequence 5'-$(TC)_{20}$-3' and a hairpin structure could form.

19._____ When this single strand binds to a complementary DNA strand to form a B-DNA structure,

a) half the base-pairs will be A-G pairs and half will be C-T pairs.
b) each base will form at least two hydrogen bonds with a base in the opposite strand.
c) the two strands will form an antiparallel left-handed helix with 12 base-pairs per turn.
d) there will be covalent phosphodiester bonds between the two strands.

20._____ Which of the following forces can stabilize a normal DNA double-helix?

a) Base-stacking is a non-covalent interaction that occurs between the relatively hydrophobic bases in the interior of the helix.
b) Base-pairing is a non-covalent interaction that occurs between adjacent bases in the same strand of the DNA molecule.
c) The hydrophilic sugar-phosphate groups are on the exterior of the helix where they can interact with each other.
d) The deoxyribose rings form N-glycosidic bonds with the phosphate groups that link neighboring nucleotides.

21._____ Which of the following double-stranded DNA molecules would denature at about the same temperature as the double-stranded molecule containing a 5'-$(GA)_{20}$-3' strand?

a) a molecule which contains a $(GC)_{20}$ strand
b) a molecule which contains a $(TA)_{20}$ strand
c) a molecule which contains a $(GACT)_{10}$ strand
d) a molecule which contains a $(GGGA)_{10}$ strand

22._____ Which characteristic will be shared when comparing the single 5'-$(GA)_{20}$-3' strand to another single-stranded DNA molecule with the sequence 5'-$(AT)_{20}$-3'?

a) Both contain a palindromic sequence.
b) Both can form the same secondary structures.
c) Both could hybridize to the same RNA molecule.
d) Both will have the same overall charge.

E. Genetic material is examined in several organisms. (Questions 23-28)

23._____ Which of the following experimental results, if obtained, would be evidence **against** proteins being the genetic material?

a) The viral components labeled with ^{35}S are found inside the bacterial cell during a successful infection.
b) The viral components labeled with ^{32}P are found outside the bacterial cell during a successful infection.
c) The transforming factor isolated from a virulent bacterium is resistant to proteases.
d) The transforming factor isolated from a virulent bacterium is resistant to deoxyribonucleases.

24._____ Assume that DNA molecules are studied in a variety of organisms and found to have the following properties. Which property would be consistent with the hypothesis that genetic material is composed of DNA?

a) DNA in all organisms is composed of the same nucleotides.
b) DNA in an organism remains constant as the organism ages.
c) DNA from two different organisms has the same base composition.
d) DNA is different in two different cells of the same organism.

25._____ A new virus, virus X, is isolated and studied. Which molecule is most likely to be the genetic material of virus X?

a) a linear DNA molecule containing 10,000 base-pairs
b) a linear RNA molecule containing plasmids
c) a circular DNA molecule containing nucleosomes
d) a circular RNA molecule with a molecular weight of 10 billion

26._____ Which are characteristics of bacterial genetic material?

a) It is double-stranded and supercoiled.
b) It is single-stranded and relaxed.
c) It is circular and compacted into palindromes.
d) It is linear and attached to a protein scaffold.

27._____ Which describes the structural properties of a eukaryotic chromosome?

a) It contains a double-helix composed of nucleosomes each with four million base-pairs.
b) It is one double-stranded linear DNA molecule bound to proteins for compaction.
c) It is arranged into a 30 nm fiber which is attached to the cell membrane.
d) It contains linker regions which are arranged into loops and coiled to form a helix.

28._____ Which property is shared by the five histone proteins?

a) They are acidic proteins with relatively large molecular weights.
b) They are multimeric proteins with high levels of Arg and Lys.
c) They are fibrous proteins with high amounts of α-helix.
d) They are globular proteins with a positive charge.

F. Genetic material is examined in several organisms. (Questions 29-32)

29._____ If the following experimental results were obtained, which would be evidence **against** DNA being the genetic material?

a) The base composition of DNA is the same in two different cells of the same organism.
b) The viral components labeled with ^{32}P remain outside the cell during a successful infection.
c) The transforming factor isolated from a virulent bacterium is sensitive to deoxyribonucleases.
d) The base composition of DNA in an organism remains constant as the organism ages.

30._____ Which is a property of both viral genetic material and bacterial genetic material?

a) Both can be double-stranded, circular DNA.
b) Both can be single-stranded, linear RNA.
c) Both can be compacted into inverted repeats.
d) Both can be compacted into plasmids.

31._____ Which is a characteristic of eukaryotic genetic material?

a) Eukaryotic genetic material consists of supercoiled circular DNA molecules complexed with proteins into chromosomes.
b) Eukaryotic genetic material consists of relaxed linear DNA molecules complexed with RNA into a 30 nm fiber.
c) Eukaryotic genetic material is compacted by wrapping the double-helix around histone proteins to form nucleosomes.
d) Eukaryotic genetic material is compacted by folding linker regions around non-histone proteins to form a scaffold.

32._____ Histones

a) are negatively-charged globular proteins.
b) contain both α-helix and β-pleated sheet.
c) have molecular weights in excess of 100,000.
d) contain high amounts of basic amino acids.