CHAPTER 10—DNA, RNA, AND PROTEIN SYNTHESIS

MULTIPLE CHOICE

1. Each organism has a unique combination of characteristics encoded in molecules of
   a. protein.
   b. enzymes.
   c. carbohydrates.
   d. DNA.

   ANS: D DIF: 1 OBJ: 10-4.1

2. The primary function of DNA is to
   a. make proteins.
   b. store and transmit genetic information.
   c. control chemical processes within cells.
   d. prevent mutations.

   ANS: B DIF: 2 OBJ: 10-2.4

3. All of the following are true about the structure of DNA *except*
   a. short strands of DNA are contained in chromosomes inside the nucleus of a cell.
   b. every DNA nucleotide contains a sugar, a phosphate group, and a base.
   c. DNA consists of two strands of nucleotides joined by hydrogen bonds.
   d. the long strands of nucleotides are twisted into a double helix.

   ANS: A DIF: 1 OBJ: 10-2.2

4. Molecules of DNA are composed of long chains of
   a. amino acids.
   b. fatty acids.
   c. monosaccharides.
   d. nucleotides.

   ANS: D DIF: 1 OBJ: 10-2.1

5. Which of the following is *not* part of a molecule of DNA?
   a. deoxyribose
   b. nitrogenous base
   c. phosphate
   d. ribose

   ANS: D DIF: 1 OBJ: 10-2.2

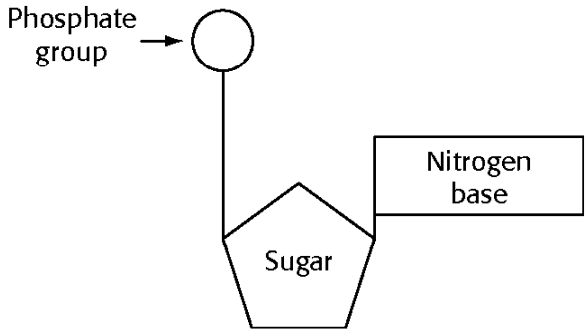
6. A nucleotide consists of
   a. a sugar, a protein, and adenine.
   b. a sugar, an amino acid, and starch.
   c. a sugar, a phosphate group, and a nitrogenous base.
   d. a starch, a phosphate group, and a nitrogenous base.

   ANS: C DIF: 1 OBJ: 10-2.2

7. The part of the molecule for which deoxyribonucleic acid is named is the
   a. phosphate group.
   b. sugar.
   c. nitrogenous base.
   d. None of the above; DNA is not named after part of the molecule.

   ANS: B DIF: 1 OBJ: 10-2.2

8.



Refer to the illustration above. The entire molecule shown in the diagram is called a(n)

a. amino acid.
b. nucleotide.
c. polysaccharide.
d. pyrimidine.

ANS: B DIF: 1 OBJ: 10-2.2

9. Purines and pyrimidines are
   a. bases found in amino acids.
   b. molecules that can replace phosphate groups from defective DNA.
   c. names of specific types of DNA molecules.
   d. bases found in nucleotides.

   ANS: D DIF: 1 OBJ: 10-2.2

10. The scientists credited with establishing the structure of DNA are

a. Avery and Chargaff.
b. Hershey and Chase.
c. Mendel and Griffith.
d. Watson and Crick.

ANS: D DIF: 1 OBJ: 10-2.1

11. X-ray diffraction photographs by Wilkins and Franklin suggested that
    a. DNA and RNA are the same molecules.
    b. DNA is composed of either purines or pyrimidines, but not both.
    c. DNA molecules are arranged as a tightly coiled helix.
    d. DNA and proteins have the same basic structure.

    ANS: C DIF: 1 OBJ: 10-2.1

12. Watson and Crick built models that demonstrated that
    a. DNA and RNA have the same structure.
    b. DNA is made of two chains in a double helix.
    c. guanine forms hydrogen bonds with adenine.
    d. thymine forms hydrogen bonds with cytosine.

    ANS: B DIF: 1 OBJ: 10-2.3

13. Chargaff's rules, the base-pairing rules, state that in DNA
    a. the amount of adenine equals the amount of thymine.
    b. the amount of guanine equals the amount of cytosine.
    c. the amount of guanine equals the amount of thymine.
    d. Both a and b

    ANS: D DIF: 1 OBJ: 10-2.4

14. The base-pairing rules state that the following are base pairs in DNA:
    a. adenine—thymine; uracil—cytosine.
    b. adenine—thymine; guanine—cytosine.
    c. adenine—guanine; thymine—cytosine.
    d. uracil—thymine; guanine—cytosine.

    ANS: B DIF: 1 OBJ: 10-2.4

15. ATTG : TAAC ::
    a. AAAT : TTTG
    b. TCGG : AGAT
    c. GTCC : CAGG
    d. CGAA : TGCG

    ANS: C DIF: 2 OBJ: 10-2.4

16. The addition of nucleotides to form a complementary strand of DNA
    a. is catalyzed by DNA polymerase.
    b. is accomplished only in the presence of tRNA.
    c. prevents separation of complementary strands of RNA.
    d. is the responsibility of the complementary DNA mutagens.

    ANS: A DIF: 1 OBJ: 10-3.2

17. Which of the following is *not* true about DNA replication?
    a. It must occur before a cell can divide.
    b. Two complementary strands are duplicated.
    c. The double strand unwinds while it is being duplicated.
    d. The process is catalyzed by enzymes called DNA mutagens.

    ANS: D DIF: 1 OBJ: 10-3.1

18. During DNA replication, a complementary strand of DNA is made for each original DNA strand. Thus, if a portion of the original strand is CCTAGCT, then the new strand will be
    a. TTGCATG.
    b. AAGTATC.
    c. CCTAGCT.
    d. GGATCGA.

    ANS: D DIF: 2 OBJ: 10-3.3

19. The enzymes responsible for adding nucleotides to the exposed DNA template bases are
    a. replicases.
    b. DNA polymerases.
    c. helicases.
    d. nucleotidases.

    ANS: B DIF: 1 OBJ: 10-3.2

20. The function of tRNA is to
    a. synthesize DNA.
    b. synthesize mRNA.
    c. form ribosomes.
    d. transfer amino acids to ribosomes.

    ANS: D DIF: 1 OBJ: 10-4.5

21. Which of the following types of RNA carries instructions for making proteins?
    a. mRNA
    b. rRNA
    c. tRNA
    d. All of the above

    ANS: A DIF: 2 OBJ: 10-4.5

22. RNA differs from DNA in that RNA
    a. is sometimes single-stranded.
    b. contains a different sugar molecule.
    c. contains the nitrogenous base uracil.
    d. All of the above

    ANS: D DIF: 1 OBJ: 10-4.2

23. Which of the following is *not* found in DNA?
    a. adenine
    b. cytosine
    c. uracil
    d. None of the above

    ANS: C DIF: 1 OBJ: 10-2.2

24. RNA is chemically similar to DNA except that its sugars have an additional oxygen atom, and the base thymine is replaced by a structurally similar base called
    a. uracil.
    b. alanine.
    c. cytosine.
    d. codon.

    ANS: A DIF: 1 OBJ: 10-4.2

25. In RNA molecules, adenine is complementary to
    a. cytosine.
    b. guanine.
    c. thymine.
    d. uracil.

    ANS: D DIF: 1 OBJ: 10-4.2

mRNA: CUCAAGUGCUUC
Genetic Code:

	U	C	A	G	
U	Phe	Ser	Tyr	Cys	**U**
	Phe	Ser	Tyr	Cys	**C**
	Leu	Ser	stop	stop	**A**
	Leu	Ser	stop	Trp	**G**
C	Leu	Pro	His	Arg	**U**
	Leu	Pro	His	Arg	**C**
	Leu	Pro	Gln	Arg	**A**
	Leu	Pro	Gln	Arg	**G**
A	Ile	Thr	Asn	Ser	**U**
	Ile	Thr	Asn	Ser	**C**
	Ile	Thr	Lys	Arg	**A**
	Met	Thr	Lys	Arg	**G**
G	Val	Ala	Asp	Gly	**U**
	Val	Ala	Asp	Gly	**C**
	Val	Ala	Glu	Gly	**A**
	Val	Ala	Glu	Gly	**G**

26. Refer to the illustration above. Which of the following is the series of amino acids encoded by the piece of mRNA shown above?
    a. Ser—Tyr—Arg—Gly
    b. Val—Asp—Pro—His
    c. Leu—Lys—Cys—Phe
    d. Pro—Glu—Leu—Val

    ANS: C DIF: 2 OBJ: 10-4.4

27. Refer to the illustration above. Which of the following would represent the strand of DNA from which the mRNA strand was made?
    a. CUCAAGUGCUUC
    b. GAGUUCACGAAG
    c. GAGTTCACGAAG
    d. AGACCTGTAGGA

    ANS: C DIF: 2 OBJ: 10-4.1

28. Refer to the illustration above. The anticodons for the codons in the mRNA in the diagram are
    a. GAG—UUC—ACG—AAG.
    b. GAG—TTC—ACG—AAG.
    c. CUC—GAA—CGU—CUU.
    d. CUU—CGU—GAA—CUC.

    ANS: A DIF: 2 OBJ: 10-4.5

29. During translation, a ribosome binds to
    a. DNA.
    b. mRNA.
    c. protein.
    d. a peptide bond.

    ANS: B DIF: 1 OBJ: 10-4.5

30. Suppose that you are given a polypeptide sequence containing the following sequence of amino acids: tyrosine, proline, aspartic acid, isoleucine, and cysteine. Use the portion of the genetic code given in the table below to determine the DNA sequence that codes for this polypeptide sequence.

mRNA	**Amino acid**
UAU, UAC	tyrosine
CCU, CCC, CCA, CCG	proline
GAU, GAC	aspartic acid
AUU, AUC, AUA	isoleucine
UGU, UGC	cysteine

a. AUGGGUCUAUAUACG
b. ATGGGTCTATATACG
c. GCAAACTCGCGCGTA
d. ATTGGGCTTTAAACA

ANS: B DIF: 3 OBJ: 10-4.1

31. Each of the following is a type of RNA *except*
a. carrier RNA.
b. messenger RNA.
c. ribosomal RNA.
d. transfer RNA.

ANS: A DIF: 1 OBJ: 10-4.5

32. In order for protein synthesis to occur, mRNA must migrate to the
a. ribosomes.
b. *lac* operon.
c. RNA polymerase.
d. heterochromatin.

ANS: A DIF: 1 OBJ: 10-4.1

33. During transcription,
a. proteins are synthesized.
b. DNA is replicated.
c. RNA is produced.
d. translation occurs.

ANS: C DIF: 1 OBJ: 10-4.3

34. Transcription proceeds when RNA polymerase
a. attaches to a ribosome.
b. binds to a promoter on a strand of DNA.
c. binds to a strand of RNA.
d. unwinds the DNA molecule.

ANS: B DIF: 1 OBJ: 10-4.3

35. Transcription is the process by which genetic information encoded in DNA is transferred to a(n)
a. RNA molecule.
b. DNA molecule.
c. uracil molecule.
d. transposon.

ANS: A DIF: 1 OBJ: 10-4.1

36. Each nucleotide triplet in mRNA that specifies a particular amino acid is called a(n)
    a. mutagen.
    b. codon.
    c. anticodon.
    d. exon.

    ANS: B DIF: 1 OBJ: 10-4.4

37. The human genome contains
    a. 30,000 genes.
    b. 3.2 billion base pairs.
    c. 23 chromosomes.
    d. All of the above

    ANS: D DIF: 1 OBJ: 10-4.6

38. During translation, the amino acid detaches from the transfer RNA molecule and attaches to the end of a growing protein chain when
    a. the ribosomal RNA anticodon is paired up with the messenger RNA codon.
    b. the transfer RNA anticodon is paired up with the messenger RNA codon.
    c. a "stop" codon is encountered.
    d. the protein chain sends a signal through the nerve cells to the brain.

    ANS: B DIF: 1 OBJ: 10-4.5

39. The transfer of genetic material from one cell to another, which Frederick Griffith studied, is called
    a. transduction.
    b. transformation.
    c. recombination.
    d. genetic transfer.

    ANS: B DIF: 1 OBJ: 10-1.1

40. Oswald Avery showed that
    a. cells missing protein and RNA were able to transform *R* cells into *S* cells and kill mice, but cells missing DNA could not.
    b. cells missing DNA were able to transform *R* cells into *S* cells and kill mice, but cells missing protein and RNA could not.
    c. cells missing DNA, protein, and RNA were able to transform *R* cells into *S* cells and kill mice.
    d. cells missing DNA, protein, and RNA were not able to transform *R* cells into *S* cells and kill mice.

    ANS: A DIF: 2 OBJ: 10-1.2

41. In their experiments, Hershey and Chase used
    a. DNA labeled with radioactive sulfur.
    b. protein labeled with radioactive phosphorus.
    c. DNA labeled with radioactive phosphorus.
    d. protein labeled with both radioactive sulfur and radioactive phosphorus.

    ANS: C DIF: 1 OBJ: 10-1.3

42. An error in DNA replication can cause
    a. mutations.
    b. cancer.
    c. genetic variation.
    d. All of the above

    ANS: D DIF: 1 OBJ: 10-3.5

COMPLETION

1. Hershey and Chase concluded that _____ is the hereditary material in viruses.

   ANS: DNA

   DIF: 1 OBJ: 10-1.3

2. The name of the five-carbon sugar that makes up a part of the backbone of molecules of DNA is _____.

   ANS: deoxyribose

   DIF: 1 OBJ: 10-2.2

3. Watson and Crick determined that DNA molecules have the shape of a double _____.

   ANS: helix

   DIF: 1 OBJ: 10-2.1

4. Due to the strict pairing of nitrogenous base pairs in DNA molecules, the two strands are said to be _____ to each other.

   ANS: complementary

   DIF: 1 OBJ: 10-2.4

5. According to base-pairing rules for DNA, adenine pairs with _____ and guanine pairs with _____.

   ANS: thymine, cytosine

   DIF: 1 OBJ: 10-2.4

6. The enzyme that is responsible for replicating molecules of DNA by attaching complementary bases in the correct sequence is _____.

   ANS: DNA polymerase

   DIF: 1 OBJ: 10-3.2

7. Enzymes called helicases are responsible for unwinding the DNA double helix by breaking the _____ bonds that hold the complementary strands together.

   ANS: hydrogen

   DIF: 1 OBJ: 10-2.3

8. The process by which DNA copies itself is called _____.

   ANS: replication

   DIF: 1 OBJ: 10-3.1

9. The nitrogenous base that is found only in RNA is _____.

   ANS: uracil

   DIF: 1 OBJ: 10-4.2

10. The enzyme responsible for transcribing RNA is called _____.

    ANS: RNA polymerase

    DIF: 1 OBJ: 10-4.3

11. The form of ribonucleic acid that carries genetic information from the DNA to the ribosomes is _____.

    ANS:
    mRNA
    messenger RNA
    mRNA (messenger RNA)
    messenger RNA (mRNA)

    DIF: 1 OBJ: 10-4.5

12. A(n) _____ is a sequence of DNA at the beginning of a gene that signals RNA polymerase to begin transcription.

    ANS: promoter

    DIF: 1 OBJ: 10-4.3

13. Messenger RNA is produced during the process of _____.

    ANS: transcription

    DIF: 1 OBJ: 10-4.3

14. Of the 64 codons of mRNA, 61 code for _____, three are _____ signals, and one is a(n) _____ signal.

    ANS: amino acids, stop, start

    DIF: 1 OBJ: 10-4.4

15. Nucleotide sequences of tRNA that are complementary to codons on mRNA are called _____.

    ANS: anticodons

    DIF: 1 OBJ: 10-4.5

16. A sequence of three nucleotides that codes for a specific amino acid in the synthesis of protein is called a(n) _____.

    ANS: codon

    DIF: 1 OBJ: 10-4.4

17. The information contained in a molecule of messenger RNA is used to make protein during the process of _____.

    ANS: translation

    DIF: 1 OBJ: 10-4.1

18. During translation, amino acids are brought to the ribosomes by molecules of _____.

    ANS:
    tRNA
    transfer RNA
    tRNA (transfer RNA)
    transfer RNA (tRNA)

    DIF: 1 OBJ: 10-4.5

ESSAY

1. The DNA molecule is described as a double helix. Explain this expression and describe the general structure of a DNA molecule. Also describe the bonding in a DNA molecule. Write your answer in the space below.

    ANS:
    DNA molecules are composed of two complementary strands of nucleotides arranged in a structure resembling a spiral staircase. Each nucleotide consists of a sugar molecule, a phosphate group, and one of four possible bases. The nucleotides are connected to each other by covalent bonds between the sugar of one nucleotide and the phosphate group of the next nucleotide. The double helix arrangement is maintained by the formation of hydrogen bonds between complementary bases.

    DIF: 2 OBJ: 10-2.3

2. Describe how a molecule of DNA is replicated. Write your answer in the space below.

   ANS:
   To begin the replication process, enzymes called helicases break the hydrogen bonds that hold the two complementary strands of the DNA double helix together, allowing the helix to unwind. At a replication fork, the point at which the double helix separates, a molecule of DNA polymerase attaches to the DNA and begins to add nucleotides to the exposed bases according to the base-pairing rules. Covalent bonds form between nucleotides, and hydrogen bonds form between complementary nitrogenous bases. When the DNA polymerase has finished replicating the DNA, it falls off.

   DIF: 2 OBJ: 10-3.3

3. Identify the three types of RNA and briefly describe the function of each. Write your answer in the space below.

   ANS:
   The three types of RNA are messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA). Messenger RNA carries hereditary information from the DNA in the nucleus to the site of translation on the ribosomes; tRNA carries amino acids to the ribosomes for assembly into proteins; and rRNA is a structural molecule, forming part of the ribosomes upon which translation occurs.

   DIF: 2 OBJ: 10-4.5