Chapter 12

DNA and RNA

Section 12–1 DNA (pages 287–294)

This section tells about the experiments that helped scientists discover the relationship between genes and DNA. It also describes the chemical structure of the DNA molecule.

Griffith and Transformation (pages 287–289)

1. What did Frederick Griffith want to learn about bacteria? ________________________________

2. The strain of bacteria that caused pneumonia grew into ____________ colonies on culture plates; harmless bacteria produced colonies with ____________ edges.

3. Circle the letter of each sentence that is true about Griffith’s experiment.
   a. Mice injected with bacteria from smooth colonies died.
   b. Mice injected with bacteria from rough colonies died.
   c. Mice injected with heat-killed bacteria from smooth colonies died.
   d. Mice injected with a mixture of bacteria from heat-killed smooth colonies and live rough colonies died.

4. What result from Griffith’s experiment suggested that the cause of pneumonia was not a chemical poison released by the disease-causing bacteria? ________________________________

5. What is transformation? ________________________________

6. What hypothesis did Griffith form from the results of his experiments? ________________________________

Avery and DNA (page 289)

7. Is the following sentence true or false? Avery and his colleagues thought that the molecule required in transformation might also be the molecule of the gene. ________________

8. Briefly describe how Avery and his group determined which molecule was most important for transformation? ________________________________

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9. Transformation did not occur when ______________ was destroyed.

10. What was the conclusion from Avery’s experiments? ____________________________

The Hershey-Chase Experiment (pages 289–290)

11. What is a bacteriophage? ____________________________

12. Circle the letter of each part that makes up a bacteriophage.
   a. lipid coat     c. carbohydrate core
   b. protein coat   d. DNA core

13. What happens when a bacteriophage infects a bacterial cell? ____________________________

14. How would Hershey and Chase learn whether genes were made of protein or DNA? ____________________________

15. Circle the letter of the molecule for which phosphorus-32 (32P) is used as a radioactive marker.
   a. protein  b. lipid  c. DNA  d. carbohydrate

16. Is the following sentence true or false? If 35S was found in the bacteria, it would mean that the viruses’ DNA had been injected into the bacteria. __________

17. What results did Hershey and Chase observe? ____________________________

18. Hershey and Chase concluded that the genetic material of the bacteriophage was ________________.

The Structure of DNA (pages 291–294)

19. List the three critical things that genes were known to do.
   a. ____________________________
   b. ____________________________
   c. ____________________________

20. Adenine, guanine, cytosine, and thymine are four kinds of ____________________________ bases in DNA.
21. Identify the parts of a nucleotide in the diagram below. Label the bases as purines or pyrimidines.

22. Is the following sentence true or false? Adenine and guanine are larger molecules than cytosine and thymine because they have two rings in their structure. ______________

23. What forms the backbone of a DNA chain? ____________________________________________________________________________

24. Is the following sentence true or false? The nucleotides must be joined together in a specific order. ______________

25. According to Chargaff’s rules, the percentages of ______________ are equal to thymine and the percentages of ______________ are equal to guanine in the DNA molecule.

26. Rosalind Franklin’s work with X-ray diffraction showed that the DNA molecule is shaped like a(an) ______________ and contains ______________ strands.

27. How did Francis Crick and James Watson try to understand the structure of DNA? ____________________________________________________________________________

28. How did Watson and Crick describe the structure of DNA? ______________

29. Is the following sentence true or false? According to the principle of base pairing, hydrogen bonds could form only between adenine and cytosine. ______________

Chapter 12, DNA and RNA (continued)
Section 12–2 Chromosomes and DNA Replication (pages 295–299)
This section describes how DNA is packaged to form chromosomes. It also tells how the cell duplicates its DNA before cell division.

DNA and Chromosomes (pages 295–296)
1. Circle the letter of the location of DNA in prokaryotic cells.
   a. nucleus  b. mitochondria  c. cytoplasm  d. vacuole
2. Is the following sentence true or false? Most prokaryotes contain a single, circular DNA molecule. ________________
3. Eukaryotic DNA is generally located in the cell in the form of a number of chromosomes. ________________
4. Is the following sentence true or false? All organisms have the same number of chromosomes. ________________
5. Is the following sentence true or false? The *E. coli* chromosome is longer than the diameter of an individual *E. coli* bacterium. ________________
6. Circle the letter of each sentence that is true about chromosome structure.
   a. The DNA in eukaryotic cells is very loosely packed.
   b. Prokaryotic cells contain more DNA than eukaryotic cells.
   c. A human cell contains more than 1 meter of DNA.
   d. The DNA of the smallest human chromosome is nearly 10 times as long as many bacterial chromosomes.
7. Eukaryotic chromosomes contain both DNA and protein, packed together to form ________________.
8. What are histones? ________________
9. Why are individual chromosomes visible only during mitosis? ________________
10. Is the following sentence true or false? Changes in chromatin structure and histone-DNA binding may be associated with changes in gene activity. ________________
11. List two roles of nucleosomes.
   a. ________________
   b. ________________
DNA Replication (pages 297–299)

12. What occurs during the process of replication? 

13. Complete the flowchart to describe the process of DNA replication.

The DNA molecule ________________, or unzips, into two strands.

Each strand serves as a(an) ________________, or model, to produce the new strands.

Two new ________________ strands are produced, following the rules of ________________.

14. Is the following sentence true or false? In eukaryotic chromosomes, DNA replication begins at a single point in the chromosome and proceeds in two directions. ________________

15. The sites where DNA replication and separation occur are called ________________.

16. What occurs when a molecule of DNA is “unzipped”? ________________

17. What is the complimentary strand of bases for a strand with the bases TACGTT? ________________

18. Is the following sentence true or false? Each DNA molecule resulting from replication has one original strand and one new strand. ________________

19. List two major roles of DNA polymerase in the process of DNA replication.
   a. ________________
   b. ________________

Reading Skill Practice

The illustrations in textbooks can help you better understand a difficult concept. Look at Figure 12–10 on page 297. List in order, beginning with DNA, the levels of organization of eukaryotic DNA to form chromosomes. Do your work on a separate sheet of paper.
Section 12–3 RNA and Protein Synthesis  (pages 300–306)
This section describes RNA and its role in transcription and translation.

The Structure of RNA  (page 300)
1. List the three main differences between RNA and DNA.
   a. ____________________________
   b. ____________________________
   c. ____________________________

2. Is the following sentence true or false? RNA is like a disposable copy of a DNA segment. _________________

3. What is the importance of the cell’s ability to copy a single DNA sequence into RNA? ____________________________

Types of RNA  (pages 300–301)
4. What is the one job in which most RNA molecules are involved? ____________________________

5. Complete the compare-and-contrast table about the types of RNA.

<table>
<thead>
<tr>
<th>TYPES OF RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Carries copies of the instructions for assembling amino acids from DNA to the rest of the cell</td>
</tr>
<tr>
<td>Ribosomal RNA</td>
</tr>
</tbody>
</table>

Transcription  (page 301)
6. Circle the letter of each sentence that is true about transcription.
   a. During transcription, DNA polymerase binds to RNA and separates the DNA strands.
   b. RNA polymerase uses one strand of DNA as a template to assemble nucleotides into a strand of RNA.
   c. RNA polymerase binds only to DNA promoters, which have specific base sequences.
   d. Promoters are signals in RNA that indicate to RNA polymerase when to begin transcription.
Chapter 12, DNA and RNA  (continued)

RNA Editing  (page 302)
7. Many RNA molecules from eukaryotic genes have sections, called ____________, edited out of them before they become functional. The remaining pieces, called ________________, are spliced together.

8. Is the following sentence true or false? RNA editing occurs in the cytoplasm of the cell. ________________

9. What are two explanations for why some RNA molecules are cut and spliced?
   a. _______________________________________________________________________
   b. _______________________________________________________________________

The Genetic Code  (pages 302–303)
10. Proteins are made by joining ____________ into long chains called polypeptides.

11. How can only four bases in RNA carry instructions for 20 different amino acids?
    _______________________________________________________________________

12. What is a codon? _______________________________________________________________________

13. Circle the letter of the number of possible three-base codons.
    a. 4          b. 12          c. 64          d. 128

14. Is the following sentence true or false? All amino acids are specified by only one codon. ________________

15. Circle the letter of the codon that serves as the “start” codon for protein synthesis.
    a. UGA          b. UAA          c. UAG          d. AUG

Translation  (pages 303–305)
16. What occurs during the process of translation? _______________________________________________________________________

17. Where does translation occur? ___________________________________________________________________
18. Circle the letter of each sentence that is true about translation.
   a. Before translation can occur, messenger RNA must be transcribed from DNA in the nucleus.
   b. Translation occurs in the nucleus.
   c. It is the job of transfer RNA to bring the proper amino acid into the ribosome to be attached to the growing peptide chain.
   d. When the ribosome reaches a stop codon, it releases the newly formed polypeptide and the mRNA molecule.

19. What is an anticodon? __________________________

The Roles of RNA and DNA  (page 306)

 Match the roles with the molecules. Molecules may be used more than once.

<table>
<thead>
<tr>
<th>Roles</th>
<th>Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Master plan</td>
<td>a. DNA</td>
</tr>
<tr>
<td>21. Goes to the ribosomes in the cytoplasm</td>
<td>b. RNA</td>
</tr>
<tr>
<td>22. Blueprint</td>
<td></td>
</tr>
<tr>
<td>23. Remains in the nucleus</td>
<td></td>
</tr>
</tbody>
</table>

Genes and Proteins  (page 306)

24. Many proteins are ________________, which catalyze and regulate chemical reactions.

25. Is the following sentence true or false? Genes are the keys to almost everything that living cells do. ________________

Reading Skill Practice

A flowchart is useful for organizing the steps in a process. Make a flowchart that shows the steps in the process of translation. Look at Figure 12–18 on pages 304–305 for help. For more information about flowcharts, see Appendix A. Do your work on a separate sheet of paper.

Section 12–4 Mutations  (pages 307–308)

This section describes and compares gene mutations and chromosomal mutations.

Introduction  (page 307)

1. What are mutations? __________________________

Guided Reading and Study Workbook/Chapter 12
2. Is the following sentence true or false? Chromosomal mutations result from changes in a single gene. ________________

Gene Mutations (pages 307–308)

3. Mutations that occur at a single point in the DNA sequence are ________________ mutations.

4. A mutation involving the insertion or deletion of a nucleotide is a(an) ________________ mutation.

5. Circle the letter of each sentence that is true about gene mutations.
   a. Point mutations affect just one nucleotide.
   b. The substitution of one nucleotide for another in the gene never affects the function of the protein.
   c. Point mutations that involve the insertion or deletion of a nucleotide change the reading frame of the genetic message.
   d. Frameshift mutations affect every amino acid that follows the point of the mutation.

Chromosom al Mutations (page 308)

6. Complete the compare-and-contrast table of types of chromosomal mutations.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplication</td>
<td>Part of a chromosome becomes oriented in the reverse of its usual direction</td>
<td>ABC•DEF → AC•DEF</td>
</tr>
<tr>
<td>Translocation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 12–5 Gene Regulation (pages 309–312)
This section explains how some genes in prokaryotes and eukaryotes are controlled.

Introduction (page 309)
1. Label the parts of a typical gene in the diagram below.

![Gene Diagram]

2. Where does RNA polymerase bind?

3. Is the following sentence true or false? The actions of DNA-binding proteins help to determine whether a gene is turned on or turned off.

Gene Regulation: An Example (pages 309–310)
4. What is an operon?

5. What is the function of the genes in the lac operon?

6. Circle the letter of each sentence that is true about lactose.
   a. Lactose is a simple sugar.
   b. To use lactose for food, *E. coli* must take lactose across its cell membrane.
   c. The bond between glucose and galactose must be broken in order for *E. coli* to use lactose for food.
   d. Proteins encoded by the genes of the lac operon are needed only when *E. coli* is grown on a medium containing glucose.

7. Circle the letter of the number of genes in the lac operon found in *E. coli*.
   a. 1    b. 2    c. 3    d. 4
8. What turns the lac operon off and on?

9. Complete the concept map to show how the lac operon is regulated.

10. How does the repressor protein prevent transcription?

11. How does lactose cause the lac operon to turn on?

12. Circle the letter of each sentence that is true about gene regulation in prokaryotic genes.
   a. The lac operon is the only example of genes regulated by repressor proteins.
   b. Many other genes are regulated by repressor proteins.
   c. Some genes are regulated by proteins that enhance the rate of transcription.
   d. Cells cannot turn their genes on and off as needed.

Eukaryotic Gene Regulation (page 311)

13. Is the following sentence true or false? Operons are frequently found in eukaryotes. ________________
14. How are eukaryotic genes usually controlled?

15. What is the function of the TATA box?

16. Eukaryotic promoters are usually found just _________ the TATA box, and they consist of a series of short _________ sequences.

17. List three ways in which proteins that bind to enhancer sequences of a gene can work to regulate gene expression.
   a. 
   b. 
   c. 

18. Why is gene regulation in eukaryotes more complex than in prokaryotes?

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**Regulation and Development** (page 312)

19. What role do the hox genes play in the development of an organism?

20. Circle the letter of each sentence that is true about hox genes.
   a. A mutation in a hox gene has no effect on the organs that develop in specific parts of the body.
   b. In fruit flies, a mutation affecting the hox genes can replace a fly’s antennae with a pair of legs.
   c. The function of the hox genes in humans seems to be almost the same as it is in fruit flies.
   d. A copy of the gene that controls eye growth in mice does not function in fruit flies.

21. Why do common patterns of genetic control for development exist among animals?
Chapter 12, DNA and RNA  (continued)

WordWise

Answer the questions by writing the correct vocabulary term in the blanks. Use the circled letter from each term to find the hidden word. Then, write a definition for the hidden word.

1. What is the substance that is made up of DNA and protein tightly packed together?

   __ __ __ __ __ __ __ __ __ __

2. What are the three bases on the tRNA molecule that are complimentary to mRNA?

   __ __ __ __ __ __ __ __ __ __ __

3. What is the process in which one strain of bacteria has been changed into another?

   __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

4. What is a change in the DNA sequence that affects genetic information?

   __ __ __ __ __ __ __ __ __ __ __ __

5. What is a group of genes that is operated together?

   __ __ __ __ __ __ __ __ __ __ __ __

6. What are the intervening sequences of RNA molecules that are cut out before the messenger RNA leaves the nucleus?

   __ __ __ __ __ __ __ __ __ __

7. What is the region of DNA to which RNA polymerase binds?

   __ __ __ __ __ __ __ __ __ __

Hidden Word: __ __ __ __ __ __ __ __

Definition: ____________________________________________________________

______________________________________________________________________