Biology 12 **Name:** _____

Cell Biology **Per:** _____ **Date:** _____

Chapter 4 – DNA Structure & Gene Expression

Complete using BC Biology 12, pages 108 - 153

4.1 DNA Structure pages 112 - 114

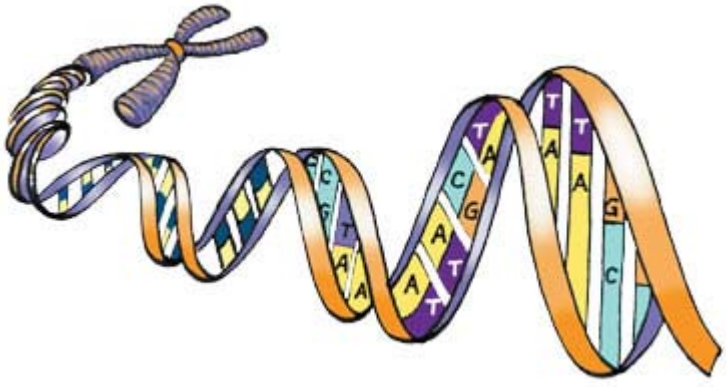
1. **DNA** stands for _____ and is the genetic material of life.
2. Researchers knew that the genetic material must be
   (1) able to _____[(a)] that pertains to the _____[(b)] , _____[(c)] , and _____[(d)] activity.
   (2) _____[(e)] so that it can be replicated with _____[(f)] during _____[(g)] and can be _____[(h)] from generation to generation.

The Nature of the Genetic Material

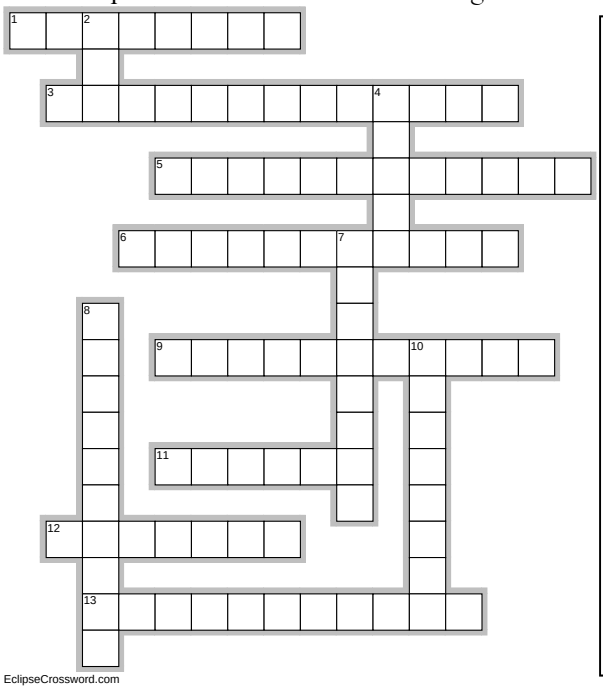
3. Contrast the *phenotype* versus *genotype* of an organism. _____
   _____
   _____
4. How are DNA, proteins, chromosomes and genes all associated? _____
   _____
   _____
5. By the 1940s, there was scientific debate whether DNA or proteins were the genetic material of the cell. While DNA was proven to be the genetic material, summarize the evidence that supported proteins instead of DNA.
   _____
   _____
   _____
6. An experiment by _____[(a)] and _____[(b)] in the early 1950s helped to firmly establish DNA as the genetic material of the cell.

Structure of DNA

7. _____[(a)] and _____[(b)] determined the structure of DNA in the early 1950s.



8. Complete the crossword below using the terms found on page 114.



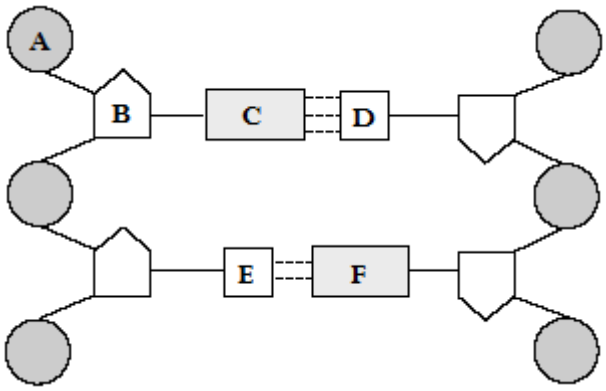
Across

1. The complementary base for guanine.
3. A purine always binds to a pyrimidine (A-T and C-G) is described as "_____ base pairing"
5. Refers to the two DNA strands being oriented in opposite directions.
6. Term used to describe the overall structure of DNA (2 words).
9. The specific type of sugar in each DNA nucleotide.
11. Nitrogen-containing base with a double ring.
12. The complementary base for thymine.
13. DNA is made of chains of these.

Down

2. A is bonded to T by _____ (#) bonds.
4. C is bonded to G by _____ (#) bonds.
7. Two strands of DNA are held to each other with ___ bonds between the nitrogenous bases.
8. Nitrogen-containing base with a single ring.
10. The phosphoric acid and pentose sugar make up the _____ of DNA.

9. Use Figure 4.3 to label the diagram below.



A _____

B _____

C _____

D _____

E _____

F _____

10. In the above molecule, on one sugar molecule on each strand label the carbons as 1', 2', 3', 4' and 5'.
    a) Label each of the ends of the strands as 3' or 5'
11. Fill in the complementary strand of DNA

G C T A T A T C T G T C T A T A G C T C

_____

12. When the body _____(a) or _____(b) itself, cells divide. Each new cell requires an exact copy of the DNA contained in the _____(c).

13. Match the terms with the descriptions.

_____ DNA polymerase	A. made in one continuous piece
_____ DNA helicase	B. creates the daughter strands by positioning and joining new nucleotides
_____ DNA ligase	C. connects fragments on lagging strand and seals any breaks in backbone
_____ leading strand	D. term for the short segments of DNA found on the lagging strand
_____ lagging strand	E. unwinds and unzips the double-stranded DNA
_____ Okazaki fragments	F. made of pieces that need to be bound together

14. Explain why DNA replication is said to be semiconservative. _____

_____

_____

15. Put these steps of DNA replication in order from 1 – 3.

___ Fragments of the lagging strand are bonded by the enzyme DNA ligase.

___ Hydrogen bonds between paired bases are broken by enzyme DNA helicase.

___ Daughter strands form as the enzyme DNA polymerase brings in new nucleotides.

16. Make two identical strands of DNA from the original sequence below.

T G C T G A T C G A T C G A T C A G T C (parent)

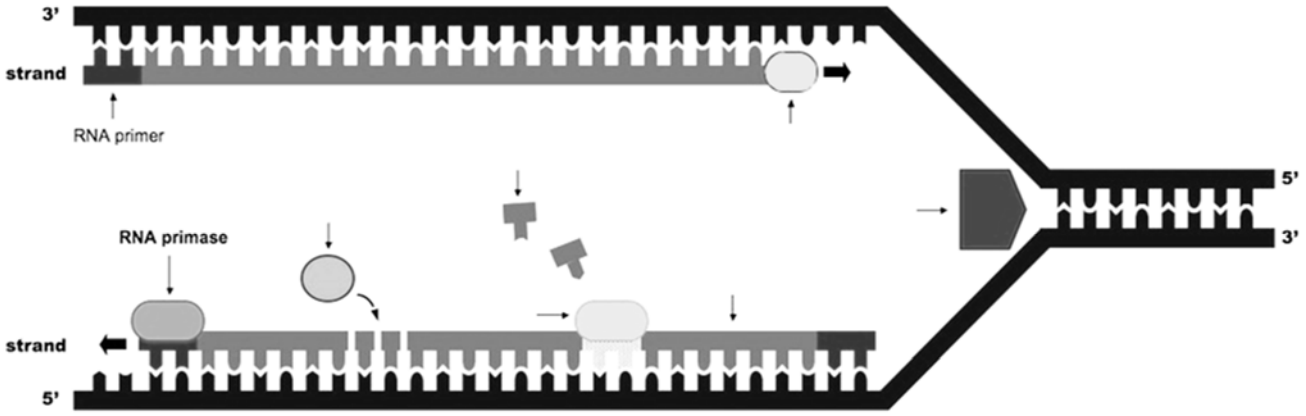
_____ (daughter)

_____ (daughter)

_____ (parent)

17. Label the diagram below with the terms:

(A) DNA helicase
(B) lagging
(C) leading
(D) DNA ligase
(E) nucleotides
(F) DNA polymerase (x2)
(G) Okazaki fragments



18. The process of using a _____[(a)] to synthesize a _____[(b)] is called _____[(c)].
19. Gene expression relies on several different forms of RNA. Briefly describe them below.
    a) **mRNA**: _____
        i. Role: _____
    b) **tRNA**: _____
        i. Role: _____
    c) **rRNA**: _____
        i. Role: _____
20. Give a simple definition for the two main processes of gene expression.
    a) **Transcription**: _____
    b) **Translation**: _____

Transcription

21. What does a "gene" code for? _____
22. Transcription begins when an enzyme _____[(a)] binds tightly to a region of the DNA called the _____[(b)]. This enzyme opens up the DNA helix to complementary base paring can occur in the same way as in DNA replication. Then, RNA polymerase inserts _____[(c)] and an _____[(d)] results.
23. Create a strand of mRNA from the DNA strand below.

    G A T C G A T C G A T C A G T C T G C (DNA)

    _____ (mRNA)
24. Describe the processing of mRNA that must occur before it can leave the nucleus. Ensure you use the terms *primary mRNA*, *mature mRNA*, *introns* and *exons*. _____

Translation

25. The sequence of bases in DNA is transcribed into mRNA, which ultimately codes for a particular sequence of _____[(a)] to form a _____[(b)].
26. Mathematically demonstrate how only 4 mRNA bases are able to code for 20 possible amino acids.
    a) If 1 base stood for an amino acid _____
    b) If 2 bases stood for an amino acid _____
    c) If 3 bases stood for an amino acid _____
        i. What is the term for a triplet of nucleotides? _____

27. Discuss why the genetic code is said to be degenerate. _____

_____

_____

_____

28. The universal nature of the genetic code suggests that it dates back to the _____[(a)] on Earth and that all living organisms have a _____[(b)].
29. Describe the structure of a tRNA molecule. _____

_____

30. On one end of a tRNA is an _____[(a)] and on the other end is an _____[(b)], a triplet set of three bases complementary to a _____[(c)].
31. Complete the table below using Figure 4.8 as reference. *A table like this will always be provided for quizzes and tests.*

Codon (mRNA)	Anticodon (tRNA)	Amino Acid
AUG		
CCU		
GAC		
CAG		
UGA		

32. Now try completing this more complex table.

DNA Sequence	Codon (mRNA)	Anticodon (tRNA)	Amino Acid
CAT			
	UGG		
		ACU	
			isoleucine
AAG			

33. _____[(a)] are small structural bodies found in the cytoplasm and on the endoplasmic reticulum where translation also occurs. Ribosomes are composed of many _____[(b)] and several _____[(c)]. In eukaryotic cells, rRNA is produced in the _____[(d)] within the nucleus. Then the rRNA joins with proteins manufactured in and imported from the _____[(e)] to form _____[(f)] ribosomal subunits, one large and one small. The subunits leave the nucleus and join together in the cytoplasm to form a ribosome just as _____[(g)] begins. A ribosome has a binding site for one _____[(h)] and three _____[(i)] molecules. These binding sites facilitate complementary base paring between tRNA _____[(j)] and mRNA _____[(k)]. As the ribosome moves down the mRNA molecule, new tRNA molecules arrive, and a _____[(l)] forms and grows longer.

34. What is the function of a **polyribosome**? _____

_____

Translation Requires Three Steps

35. Step 1: _____ : brings all the translation components together.
    i. Small _____[(a)] subunit attaches to the _____[(b)] in the vicinity of the start codon which is the triplet code _____[(c)] (methionine)
    ii. tRNA start anticodon would therefore be _____[(d)]
    iii. Large ribosomal subunit joins to the small subunit.
36. Step 2: _____ : polypeptide increases in length one amino acid at a time.
    i. _____[(a)] are linked together one at a time through formation of a _____[(b)] bond. See Figure 4.13 for a more detailed explanation.
37. Step 3: _____: ribosome separates into its two subunits, and the _____ [(a)] is released
    i. 3 possible stop codons = _____
    ii. Once the polypeptide is set free it begins to take on its _____ shape. The ribosome dissociates into its two subunits

Review of Gene Expression

38. The _____[(a)] we receive from our parents determine the _____[(a)] in our cells and these proteins are responsible for _____[(c)].
39. Visualizing the Process: create a simplified version of Figure 4.15 on page 123 to display the steps of protein synthesis below.

4.4 Gene Mutations & Cancer — pages 124 - 128

40. A **gene mutation** is a _____[(a)] in the sequence of bases in DNA. The effect on protein activity can range from _____[(b)].
41. Distinguish between a **germ-line mutation** and a **somatic mutation**. _____

_____

_____

Causes of Mutations

42. Three causes:
    a) _____
        i. Extremely rare: DNA _____ typically only makes one mistake for every _____ nucleotide pairs replicated.
    b) _____
        i. Sources of radiation such as _____, _____, and _____.
        ii. Certain organic chemicals such as _____ and _____
    c) _____ (also known as "_____")
        i. Specific DNA sequences that have the ability to move within and between chromosomes

Effects of Mutations on Protein Activity

43. Define **point mutation**: _____
_____ (also known as a **substitution mutation**).

44. Define **frameshift mutation**: _____
_____ (also known as **insertion** or **deletion mutations**).

45. Complete the tables below to demonstrate various mutations.

a) Regular protein synthesis: use a codon table to determine the sequence of amino acids

DNA	A A T	T G A	A C A	C A T	G C G	C C C
mRNA						
amino acids						

b) Change the fifth base in the original DNA from a G to a C: determine the new sequence of amino acids

DNA						
mRNA						
amino acids						

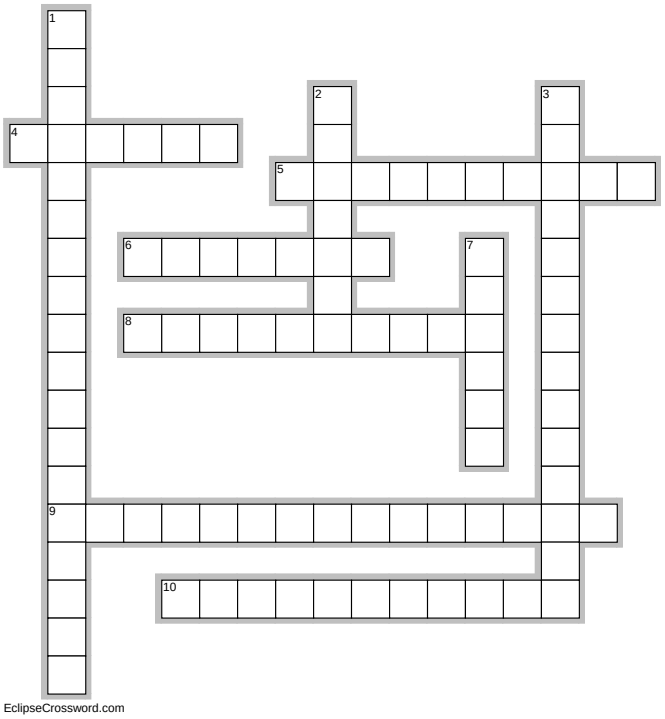
c) Add a G to the original DNA strand after the third base: determine the new sequence of amino acids

DNA						
mRNA						
amino acids						

46. Based on question #45, which type of mutation is likely more harmful and why? _____
_____
_____

4.5 DNA Cloning pages 128 - 131

47. Read through the section, then complete the crossword.



Across

4. The complete genetic makeup of an organism.
5. A _____ chain reaction (PCR) can create billions of copies of a segment of DNA in a test tube in a matter of hours.
6. One common vector used to make rDNA is a bacterial _____.
8. Organisms with foreign DNA or genes inserted into them are called _____ organisms.
9. During a process called gel _____, an electrical current is used to force DNA through a porous gel.
10. _____ DNA (rDNA) contains DNA from two or more different sources.

Down

1. Cloning genes and using them to alter the genome of viruses and cells (2 words).
2. Production of identical copies an organism.
3. A pattern of distinctive DNA bands (2 words).
7. Term for a piece of DNA that researchers can manipulate and add foreign DNA to.

4.6 Biotechnology Products and Gene Therapy pages 131 - 134

48. Transgenic organisms (bacteria, plants, and animals) are often called _____ _____ (GMOs) and the products they produce are called _____ products.
49. Name several uses for…
    a) Transgenic bacteria
        i. create products such as _____
        ii. protect plants from _____
        iii. aid in environmental cleanup by _____
    b) Transgenic plants
        i. dual purpose plants such as the _____
        ii. create plants that are resistant to _____ and _____
        iii. to increase crop _____
        iv. engineered to produce human proteins such as _____
    c) Transgenic animals
        i. many types of animal eggs have acquired the gene for _____ to make larger fishes, cows, pigs, rabbits and sheep
        ii. _____, the use of transgenic farm animals to produce pharmaceuticals
        iii. Genes that code for _____ and _____ proteins that will appear in the animal's milk.
        iv. Studying a gene's function by _____ a gene and can be used to test _____ for the treatment of the disease.

4.7 Genomics, Proteomics, and Bioinformatics pages 134 - 137

50. Define **genomics**: _____

_____

Sequencing the Genome

51. Describe the "Human Genome Project" and its importance, or benefit, to humanity. _____

_____

_____

_____

_____

_____

_____

Chapter 4 Review Questions pages 148 - 153

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____*
15. _____
16. _____*
17. _____
18. _____*
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
32. _____
34. _____
36. _____
37. _____
38. _____
39. _____
42. _____

* key is wrong for the above questions

43. _____

44. (a) _____ (b) _____ (c) _____ (d) _____ (e) _____
(f) _____ (g) _____ (h) _____ (i) _____ (j) _____

45. Complete the table

	DNA	RNA
Subunit		
Sugar		
Nitrogenous bases		
# of strands		
Base pairings		
Process that produces this nucleic acid		

46. _____

47. _____

48. _____

49. _____

50. (a)_____(b)_____

(c)_____(d)_____

51. _____

52. _____

53. _____

54. _____

55. (amino acids) _____

( ) _____

( ) _____

_____

56. _____

57. _____

_____

58. _____

_____

59. _____

_____

60. _____

_____

61. _____

62. _____

65. Complete the table

DNA	GCA	ATG	TCA	GTT
mRNA				
tRNA				
Amino acid				

66. _____

_____

67. _____

68. _____

69. _____

72. Complete the table

Species W: amino acids				
Species Z: mRNA sequence				

74. _____

76. _____

79. _____

_____

80. _____

_____

81. _____

_____

84. _____

86. _____

_____

Mark the review questions using the answer key on pages 530 - 532