

Name: \_\_\_\_\_

AP Biology  


## **Chapter 14 Active Reading Guide** **From Gene to Protein**

This is going to be a very long journey, but it is crucial to your understanding of biology. Work on this chapter a single concept at a time, and expect to spend at least 6 hours to truly master the material. To give you an idea of the depth and time required, it took over 5 hours to write this Reading Guide! You will need even longer to complete it and learn the information. Good luck, and take your time.

### ***Overview***

1. What is gene expression?

### ***Section 1***

2. What situation did Archibald Garrod suggest caused “inborn errors of metabolism”?
3. Describe one example Garrod used to illustrate his hypothesis.
4. State the hypothesis formulated by George Beadle while studying eye color mutations in *Drosophila*.
5. What strategy did Beadle and Tatum adopt to test this hypothesis?
6. Which organism did Beadle and Tatum use in their research? \_\_\_\_\_  
How did this organism’s nutritional requirements facilitate this research?

7. How were Neurospora spores treated to increase the mutation rate?
8. Cite two significant findings that resulted from the research of Beadle and Tatum.
9. What revision of detail (but not of basic principle) did this hypothesis undergo as more information was gained? Write this restatement and then highlight it. This is an important concept!

***Basic Principles of Transcription and Translation***

This section will introduce you to the processes and associated terminology in the form of an overview. Once you have the big picture, you will take a closer look in the next few concepts.

10. From the first paragraph in this section, find three ways in which RNA differs from DNA.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

11. What are the monomers of DNA and RNA? \_\_\_\_\_  
Of proteins? \_\_\_\_\_

12. Define each of these processes that are essential to the formation of a protein:  
transcription:

translation:

13. Complete the following table to summarize each process.

	Template	Product Synthesized	Location in the Eukaryotic Cell
Transcription			
Translation			

14. In eukaryotes, what is the pre-mRNA called? \_\_\_\_\_
15. Write the central dogma of molecular genetics, as proclaimed by Francis Crick, in the box below.
- 
16. How many nucleotide bases are there? \_\_\_\_\_ How many amino acids? \_\_\_\_\_
17. How many nucleotides are required to code for these 20 amino acids? \_\_\_\_\_
18. So, the language of DNA is a triplet code. How many unique triplets exist? \_\_\_\_\_
19. DNA is double-stranded, but for each protein, only one of these two strands is used to produce an mRNA transcript. What is the coding strand called? \_\_\_\_\_
20. Here is a short DNA template. Below it, assemble the complementary mRNA strand.  
3' A C G A C C A G T A A A 5'
21. How many codons are there above? \_\_\_\_\_ Label one codon.
22. Describe Nirenberg's experiment in which he identified the first codon.
23. What was the first codon–amino acid pair to be identified? \_\_\_\_\_
24. Of the 64 possible codons, how many code for amino acids? \_\_\_\_\_
25. What event is coded for by UAA, UAG, and UGA? \_\_\_\_\_
26. What is the start codon? \_\_\_\_\_
27. Why is the genetic code said to be redundant but not ambiguous?
28. Explain the concept of reading frame.

29. Now here is an important idea: DNA is DNA is DNA. By this we mean that the code is nearly universal, and because of this, jellyfish genes can be inserted into pigs, or firefly genes can make a tobacco plant glow. Enjoy a look at Figure 14.7 in your text... and no question to answer here!

## **Section 2**

30. Name the enzyme that uses the DNA template strand to transcribe a new mRNA strand.

31. Recall from Chapter 13 that DNA polymerase III adds new nucleotides to the template DNA strand to assemble each new strand of DNA. Both enzymes can assemble a new polynucleotide only in the 5' → direction. Which enzyme, DNA polymerase III or RNA polymerase, does not require a primer to begin synthesis?

32. What is a transcription unit?

33. Figure 14.8 in your text will require a bit of study. Name the three stages of transcription and briefly describe each stage.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

34. Let's now take a closer look at initiation. Read the paragraph titled "RNA Polymerase Binding and Initiation of Transcription" carefully. List three important facts about the promoter here.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

35. Use Figure 14.9 in your text to explain the three stages of initiation.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

36. What is the TATA box? How do you think it got this name?
37. What comprises a transcription initiation complex?
38. Now it is time to put all of the elements of transcription together. Write a short essay below to describe the process by which mRNA is formed. Use these terms correctly in your essay, and highlight (or underline) each one: TATA box, gene, terminator, promoter, elongation, 5' to 3', termination, initiation RNA, polymerase RNA nucleotides, template, start point, termination signal, and transcription factors.

### **Section 3**

39. RNA processing occurs only in eukaryotic cells. The primary transcript is altered at both ends, and sections in the middle are removed.
- What happens at the 5' end?
  - What happens at the 3' end?
40. What are three important functions of the 5' cap and poly-A tail?
- \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
41. Distinguish between introns and exons. Perhaps it will help to remember this:  
Exons are expressed.

42. What are snRNPs? What two types of molecules make up a snRNP?
43. You will be introduced to a number of small RNAs in this course. What type is the RNA in a snRNP?
44. SnRNPs band together in little groups to form spliceosomes. How do spliceosomes work?
45. Study the figure and text carefully to explain how the splice sites are recognized.
46. What is a ribozyme?
47. What commonly held idea was rendered obsolete by the discovery of ribozymes?
48. What are three properties of RNA that allow it to function as an enzyme?
1. \_\_\_\_\_
  2. \_\_\_\_\_
  3. \_\_\_\_\_
49. What is the consequence of alternative splicing of identical mRNA transcripts?

50. Three types of RNA are needed for protein synthesis. Complete the chart below.

Type of RNA	Description	Function
mRNA		
tRNA		
rRNA		

51. What is an anticodon?

52. Transfer RNA has two attachment sites. What binds at each site? Sketch tRNA to indicate the two attachment sites, and note where complementary base pairing and hydrogen bonding occur to give it shape.

53. How many different aminoacyl-tRNA synthetases are there? \_\_\_\_\_

54. Scientists expected to find one aminoacyl-tRNA synthetase per codon, but far fewer have been discovered. How does wobble explain this?

55. Explain the process of a specific amino acid being joined to a tRNA. Be sure to use the words aminoacyl-tRNA synthetase, ATP, amino acid, and tRNA.

56. Describe the structure of a eukaryotic ribosome.

57. How does a prokaryotic ribosome differ from a eukaryotic ribosome? What is the medical significance of this difference?
58. Explain the functions of the A, P, and E sites on a ribosome.
59. Much like transcription, we can divide translation into three stages. List them.
60. Summarize the events of initiation. Include these components: small ribosomal subunit, large ribosomal subunit, mRNA, initiator codon, tRNA, Met, initiation complex, P site, and GTP.
61. What is always the first amino acid in the new polypeptide? \_\_\_\_\_
62. Now, summarize the events of elongation. Include these components: mRNA, A site, tRNA, codon, anticodon, ribozyme, P site, and E site.
63. What is a release factor? By what mechanism is termination accomplished?
64. What is a polyribosome?



65. What are some of the things that will result in a final-form functional protein?
66. Describe at least three types of post-translational modifications.
67. Explain how proteins are targeted for the ER.
68. Define a mutation in terms of molecular genetics.
69. Define point mutations.
70. What are frameshift mutations? Identify two mechanisms by which frameshifts may occur.
71. What is the difference between a nonsense and missense mutation?
72. How can a nucleotide-pair substitution result in a silent mutation?
73. What are the two categories of mutagens?

74. Describe the action of different types of chemical mutagens.
75. Describe two important ways in which bacterial and eukaryotic gene expression differ.
76. What is a gene? It used to be simply stated that one gene codes for one polypeptide. That definition has now been modified. Write below the broader molecular definition in use today.