AP Biology **Name:** **P:**

Chapter 14 Reading Guide: From Gene to Protein

How to use this reading guide: Look over the entire reading guide—read each question to prepare yourself for reading the chapter. Read the chapter carefully and thoroughly. Make sure to look at all of the figures and pictures and read their captions. Then…answer the questions posed below.

Overview: The Flow of Genetic Information

1. Now that you know the 3-D structure of DNA, how it replicates, and that it codes for proteins…what are the next logical questions?

2. What is the main point of this chapter?

Genes specify proteins via transcription and translation

3. Archibald Garrod was among the first to suggest a relationship between genes and phenotypes. What did Garrod postulate? Use the example of alkaptonuria to explain.

4. Beadle and Tatum conducted the "breakthrough" research that demonstrated the relationship between genes and enzymes. Read this passage and READ & STUDY figure 14.2.
    a. They used the bread mold Neurospora. Describe why Neurospora was the perfect organism for this study.

    b. Explain what Beadle and Tatum did in their experiment. Use a picture to help!

c. What were the results of their experiment?

d. What did they conclude?

5. What refinements have been made to the "one gene – one enzyme" hypothesis posed by Beadle and Tatum? Why have these refinements been made?

6. How are DNA and RNA different from each other? GIVE as many ways as you can (some aren't listed here in this section of the reading!!!)

7. It is said that "nucleic acids and proteins contain information written in two different chemical languages." What does this mean? Be specific!
    a. What does this mean about the "flow" of information from DNA to polypeptide?

8. Briefly…what is transcription?
    a. How is messenger RNA (mRNA) related to this process?

9. In brief, what is translation?
    a. How are ribosomes involved?

10. What are the EVOLUTIONARY reasons for using RNA as an intermediate in the process of protein synthesis?

11. What is the MAJOR difference about the flow of information (from gene to protein) in prokaryotes and eukaryotes?

12. What is a primary transcript? How is RNA processing related to primary transcripts?

13. Genetic information is encoded in a “triplet code”. How is it read? Give an example.

14. Explain the relationship between a gene, an mRNA transcript and the template strand.

15. Why is RNA “complementary” and not identical to the DNA?

16. What are codons? How are they read and related to amino acids?

17. The experiments that lead to “cracking the code of life” were elegant, and in some cases very simple. Explain how the codons were initially discovered.

18. What is unique about the codons: AUG, UAA, UGA, AND UAG?

19. What does the statement, “there is redundancy but no ambiguity in the genetic code,” mean?

20. What is a “reading frame?” How is it applied to a translation?

21. What does it mean that the “genetic code is nearly universal?”
    a. What does this potentially mean about evolution?

    b. Given this “universality” what have we been able to do with pieces of DNA from multiple species? WOW!!!

Transcription is the DNA-directed synthesis of RNA: a closer look

22. There are many components in the synthesis of a polypeptide. For each of the substances/items below-describe what it is (which of the four macromolecules or monomers, etc…) and what it does.
    a. RNA Polymerase II

    b. Promoter

    c. Terminator

    d. Transcription unit

    e. Transcription factors

    f. Transcription initiation complex

    g. TATA box

23. How are RNA polymerases and DNA polymerases different from each other?

24. Define the terms "upstream" and "downstream". Use them to describe location of the promoter and terminator sequences.

25. There are three stages of transcription: initiation, elongation, and termination. Read this section and STUDY figures 14.8 and 14.9.
    a. IN DETAIL, describe how initiation occurs (include a picture!)

        i. what are some of the differences between prokaryotes and eukaryotes with respect to "initiation?"

    b. What occurs in the elongation stage?

    c. How does transcription terminate?

Eukaryotic cells modify RNA after transcription

26. What modifications of the RNA transcript occur at the 5' end?

27. What modifications of the RNA transcript occur at the 3' end?

28. What functions do these modifications serve?

29. What are UTRs? Why are they important?

30. STUDY figure 14.12-RNA Splicing.
    a. What is the average length of a primary transcript? What is the length of an average-sized protein? What has to happen?

    b. There are long stretches of non-coding sequences. Are they translated? Where are they located in the transcript?

    c. What are introns? What happens to them?

    d. What are exons? What happens to them?

    e. What is a splicesome?

    f. Using a picture…explain how RNA splicing might occur.

31. What are ribozymes?

Translation is the RNA-directed synthesis of a polypeptide: a closer look

32. tRNA = Transfer RNA. What is its function?

    a. How are the tRNA molecules different from each other? Why is this important?

33. Diagram a tRNA molecule at right ⟶
    a. Where does the amino acid attach?
    b. Where is the anticodon? What is the function of the anticodon?

34. What two "recognition steps" are involved in the precise and accurate translation of a genetic message?
    a. How is aminoacyl-tRNA synthetase involved?

35. What is the "wobble hypothesis?'
    a. What does this mean about the tRNAs?
    b. How does this help explain the redundancy in the genetic code?

36. Describe the structure and function of a ribosome.
    a. Of what is it made?
    b. Where are the subunits made?
    c. Where is the ribosome assembled?
    d. Is it ALWAYS functional?
    e. Draw a schematic for a ribosome.

37. Compare the ribosomes of prokaryotes to those of eukaryotes.
    a. How are they similar?
    b. How are they different?
    c. What is significant about these differences?

38. What happens at each of the binding sites?
    a. P site

    b. A site

    c. E site

39. Describe how a ribosome catalyzes a reaction.

40. Translation also can be divided into 3 stages: initiation, elongation, and termination.
    a. Explain how initiation takes place.

    b. Describe elongation.
        i. What are elongation factors and how are they involved?
        ii. How is energy involved?

    c. How does translation terminate?

41. After protein synthesis, why do some proteins begin folding to make a functional protein?

42. Some proteins, however, require modifications. What are the post-translational modifications?

43. How are the proteins that are made on free-floating ribosomes different from those that are on bound ribosomes?

44. What determines whether a ribosome will be free in the cytosol or bound to rough ER?
    a. Include in your response the terms “signal peptide” and “signal-recognition particle”

45. How can a single mRNA copy be used to simultaneously make many copies of polypeptides?
    a. How are polyribosomes related?

46. What are the differences in the translation of proteins in prokaryotes and eukaryotes?

Point mutations can affect protein structure and function

47. Define mutations.

48. What is a point mutation?
    a. How can point mutations be passed on to offspring?
    b. How can they lead to disease?

49. What types of point mutations are there?

a. When are these mutations…
    i. Silent mutations

    ii. missense mutations

    iii. nonsense mutations

    iv. frameshift mutations

b. Which type(s) of mutation(s) cause the most severe alterations?

50. What can cause mutations?

51. What is a mutagen?
    a. What kinds of chemical mutagens are there? What do they do to cause changes in DNA?

52. What is the “final” definition of a gene? How has this definition evolved over the chapters?