Overview

1. What is gene expression?

Concept 14.1 Genes specify proteins via transcription and translation

Basic Principles of Transcription and Translation

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

3. What are the monomers of DNA and RNA? Of proteins?

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

   transcription

   translation

5. Complete the following table to summarize each process.

<table>
<thead>
<tr>
<th>Process</th>
<th>Template</th>
<th>Product Synthesized</th>
<th>Location in Eukaryotic Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transcription</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Translation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. In eukaryotes, what is the pre-mRNA called?

7. Write the central dogma of molecular genetics, as proclaimed by Francis Crick.

8. How many nucleotide bases are there? _______________ How many amino acids? __________

9. How many nucleotides are required to code for these 20 amino acids? ______________

10. So, the language of DNA is a triplet code. How many unique triplets exist? ______________

11. 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?

12. Here is a short DNA template. Below it, assemble the complementary mRNA strand.

   3'ACGACCAAATA5'
13. How many codons are there above? ________ Label one codon.

14. Of the 64 possible codons, how many code for amino acids? _________________________

15. What event is coded for by UAA, UAG and UGA? ________________________________

16. What is the start codon? ____________________________________________________

17. Explain the concept of reading frame.

**Concept 14.2 Transcription is the DNA-directed synthesis of RNA: A closer look**

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

19. Use Figure 14.8 it to label the following elements on the figure below: promoter, RNA polymerase, transcription unit, DNA template, nontemplate DNA, and RNA transcript. Then, to the right of the figure, name the three stages of transcription and briefly describe each stage.

![Diagram of transcription]

20. 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) 

21. Use Figure 14.9 in your text to label the following elements of the figure below: TATA box, RNA polymerase II, transcription factors, template DNA strand, start point, 5’ and 3’, and mRNA transcript. To the right of the figure, explain the three stages of initiation that are shown.
22. What is the TATA box? How do you think it got this name?

23. What comprises a transcription initiation complex?

**Concept 14.3 Eukaryotic cells modify RNA after transcription**

24. RNA processing occurs only in eukaryotic cells. The primary transcript is altered at both ends, and sections in the middle are removed.
   a. What happens at the 5' end?
   b. What happens at the 3' end?

25. What are three important functions of the 5' cap and poly-A tail?

26. Distinguish between introns and exons. Perhaps it will help to remember this: *Exons are expressed.*

27. On the figure below, label: pre-mRNA, 5' cap, poly-A tail, introns, and exons.

28. What is a ribozyme?
Concept 14.4 Translation is the RNA-directed synthesis of a polypeptide: A closer look

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

<table>
<thead>
<tr>
<th>Type of RNA</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>mRNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tRNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rRNA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

30. What is an anticodon?

31. How does a prokaryotic ribosome differ from a eukaryotic ribosome? What is the medical significance of this difference?

32. On this figure, label the large subunit, small subunit, A, P, and E sites, mRNA binding site. To the right of the figure, explain the functions of the A, P, and E sites.

33. Much like transcription, we can divide translation into three stages. List them.

34. Identify the start codon. Explain the significance of the start codon.

35. Identify the three stop codons. Explain the significance of stop codons.

36. What is always the first amino acid in the new polypeptide?

37. What are some of the things that will result in a final-form functional protein?
38. Finally, use this summary figure to put together all that you have learned in this chapter.