From Gene to Protein
Chapter 17

1. Protein synthesis occurs in two stages: transcription and translation. State the location and the purpose of each.

2. Describe the relationship between a DNA triplet and a codon.

3. A segment in the middle of an mRNA has the sequence 5'-AGAGAACCGCGA-3'. Translate this sequence, assuming it is downstream of the start codon.

4. Explain how the universal nature of the genetic code provides evidence of evolution.

5. The template strand of a gene contains the sequence 3'-TTCAGTCGT-5'. Imagine that the nontemplate sequence was transcribed instead of the template sequence. Draw the mRNA sequence and translate it (Be sure to pay attention to the 5' and 3' ends.) Predict how well the protein synthesized from the nontemplate strand would function.

6. Compare the use of a template strand during transcription and replication.

7. a) Describe a promoter. State whether you would expect to find a promoter at the upstream or downstream end of a transcription unit.

   b) Describe how RNA polymerase is able to start transcribing a gene at the right place on the DNA in a prokaryotic cell and in a eukaryotic cell.

   c) Imagine radiation is used to cause a substitution mutation in the TATA box of a gene's promoter. Describe the expected result on the transcription of the gene.

8. Imagine that groups of cells are treated with two different chemicals. One removes the 5' cap from mRNAs while the other prevents the addition of a poly A tail. Describe the effect on each group of cells.

9. Humans have about 20,000 genes coding for proteins, yet human cells are able to make between 75,000-100,000 different proteins. Explain how RNA splicing makes this possible.

10. Imagine you've recorded your favorite show on your PVR and are sitting down to watch it. Describe how RNA splicing is similar. Identify what are analogous to introns.

11. As introns are not translated into protein, they seem wasteful and you might predict that natural selection would eliminate them. Explain why this has not happened.

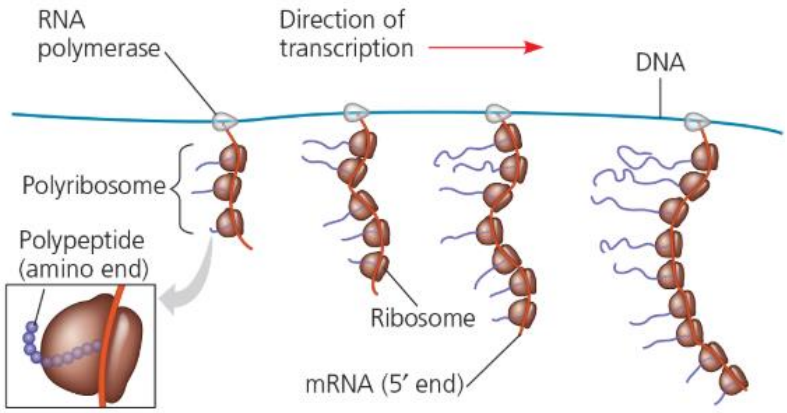
12. Describe the features of a tRNA that allow the molecule to ensure that the correct amino acid is added to a growing polypeptide.

13. Consider the tRNA with the anticodon 3'-AAG-5'. identify the codon it would bind to, as well as the amino acid that it would carry.

14. a) Describe how a polypeptide to be secreted reaches the endomembrane system.

    b) If a protein is to be secreted from a cell, describe what would happen to it after its synthesis were

complete.



15. In prokaryotes, which lack a nucleus, transcription and translation are not temporally (or spatially) separated. In the diagram above, identify which of the mRNA molecules started being transcribed first. On that mRNA, identify which ribosome started translating the mRNA first.

16. Draw a tRNA with the anticodon 3'-CGU-5'. Identify the two different codons it could bind to. Identify the amino acid that would be added to the polypeptide in each case.

17. In eukaryotic cells, mRNAs have been found to have a circular shape with proteins holding one end of the mRNA near the other. Explain how this might increase translation efficiency.

18. Describe how a point mutation can result in the wrong amino acid being added to a polypeptide.

19. a) Identify the cause of a frameshift mutation.

    b) Explain why frameshift mutations are especially harmful.

20. Individuals heterozygous for the sickle-cell allele are generally healthy but can show some symptoms when blood oxygen is low. Explain this in terms of gene expression.

21. The template strand of a gene includes the sequence 3'-TACTTGTCCGATATC-5'. It is mutated to 3'-TACTTGTCCAATATC-5'. For both the wild-type and mutant sequences, write the resulting mRNA and the amino acid sequence encoded. Describe the effect of the mutation on the amino acid sequence.

22. Knowing the genetic code is universal, a molecular biologist inserts the human β-globin gene into bacterial cells with the intention of having the cells express it and produce functional β-globin protein. Instead, the protein is non-functional and contains many more amino acids than the protein produced by human cells. Propose an explanation for this observation.