Translation Questions

Analysis Questions:

1. Explain why a cell needs both mRNA and tRNA in order to synthesize a protein. First, explain their functions.

2. How do tRNA and mRNA work together to result in the right amino acids in the right sequence as a polypeptide is synthesized?

3. a) Why it makes sense to use the word translation to describe this part of protein synthesis.

b) Explain why it would not make sense to use the word translation to describe mRNA synthesis (transcription).

Extension Activity:
How the Gene for Sickle Cell Hemoglobin Results in Sickle Cell Anemia

Different versions of the same gene are called different **alleles**. These different alleles share the same general sequence of nucleotides, but they differ in at least one nucleotide in the sequence.

Different alleles can result in different characteristics as follows:

differences in the nucleotide sequence in the gene
result in differences in the nucleotide sequence in mRNA
result in differences in the amino acid sequence in the protein
result in differences in the structure and function of the protein
result in differences in a person's characteristics.

For example, if a person has an allele that codes for a normal version of an enzyme to make melanin, this person will have normal skin and hair pigmentation. In contrast, if a person's alleles code for a defective version of this enzyme, this person's cells will not be able to make melanin, so this person will have albinism.

In this section, you will learn about another example: normal vs. sickle cell hemoglobin.

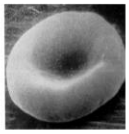
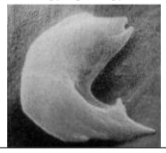
You will work to understand how differences between the normal and sickle cell hemoglobin alleles result in different hemoglobin proteins. Then you will learn how the differences between the normal and sickle cell hemoglobin proteins can result in good health or sickle cell anemia.

1. In the table below, compare the DNA for the *Beginning of the Normal Hemoglobin Gene* vs. the *Beginning of the Sickle Cell Hemoglobin Gene*. What is the only difference?

*Beginning of **Normal** Hemoglobin **Gene***	**CACGTAGACTGAGGACTC**					
Transcription produces:	codon 1	codon 2	codon 3	codon 4	codon 5	codon 6
*Beginning of **Normal** Hemoglobin **mRNA***						
Translation produces:	amino acid 1	amino acid 2	amino acid 3	amino acid 4	amino acid 5	amino acid 6
*Beginning of **Normal** Hemoglobin **Protein***						
*Beginning of **Sickle Cell** Hemoglobin **Gene***	**CACGTAGACTGAGGACAC**					
Transcription produces:	codon 1	codon 2	Codon 3	codon 4	codon 5	codon 6
*Beginning of **Sickle Cell** Hemoglobin **mRNA***						
Translation produces:	amino acid 1	amino acid 2	Amino acid 3	amino acid 4	amino acid 5	amino acid 6
*Beginning of **Sickle Cell** Hemoglobin **Protein***						

2. Complete the table below.
3. What is the difference in the **amino acid sequence** of the hemoglobin molecules synthesized by translating the sickle cell vs. normal hemoglobin mRNA molecules?

Each complete hemoglobin protein has more than 100 amino acids. Sickle cell hemoglobin and normal hemoglobin differ in only a single amino acid. This difference in a single amino acid results in the very different properties of sickle cell hemoglobin, compared to normal hemoglobin.
If a person inherits **two copies** of the sickle cell hemoglobin gene and produces **only sickle cell hemoglobin**, then the sickle cell hemoglobin molecules tend to clump together in long rods. When the sickle cell hemoglobin molecules clump together in long rods, these rods can change the shape of the red blood cells from their normal disk shape to a sickle shape. Sickle-shaped red blood cells can block the blood flow in the tiny capillaries, causing pain and damage to body organs. In addition, sickle-shaped red blood cells do not last nearly enough red blood cells, causing anemia.

Genotype	→	Protein	→	Phenotype
SS (2 alleles for normal hemoglobin)	→	Normal hemoglobin in red blood cells  NORMAL HEMOGLOBIN	→	Disk-shaped red blood cells → normal health 
ss (2 alleles for sickle cell hemoglobin)	→	Sickle cell hemoglobin can clump in rods in red blood cells  CLUMPED HEMOGLOBIN	→	Some red blood cells are sickle-shaped → pain, damage to body organs, anemia 

4. On the chart indicate which arrows represent transcription + translation.

In summary, the sickle cell allele results in production of the sickle cell hemoglobin protein, which results in the health problems observed in sickle cell anemia. This is a dramatic example of the importance of the nucleotide sequence in a gene, which determines the amino acid sequence in a protein, which in turn influences the characteristics of an individual.

Protein Synthesis Review Questions

1. How does DNA determine whether you develop sickle cell anemia?

2. Why does a cell need to carry out transcription before translation?

3. To summarize what you have learned, explain how a gene directs the synthesis of a protein. Include in your explanation the words amino acid, anti-codon, codon, cytoplasm, DNA, mRNA, nucleotide, nucleus, protein, ribosome, RNA polymerase, tRNA, transcription, and translation.

4. Considering that we are all made up of the same 4 nucleotides in our DNA, the same 4 nucleotides in our RNA, and the same 20 amino acids in our proteins, why are we so different from each other?