Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Simulating Protein Synthesis

**Purpose**

The purpose of this exercise is to investigate how the traits on a particular chromosome are determined, and how these traits determine characteristics of an organism.[[1]](#endnote-1)

**Background**

Genes are the units that determine inherited characteristics, such as hair color and blood type. Genes are lengths of DNA molecules that determine the structure of polypeptides (the building blocks of proteins) that our cells make. The sequence of nucleotides in DNA determines the sequence of amino acids in polypeptides, and thus the structure of proteins.

In a process called *transcription*, which takes place in the nucleus of the cell, messenger RNA (mRNA) reads and copies the DNA’s nucleotide sequences in the form of a complementary RNA molecule. Then the mRNA carries this information in the form of a code to the ribosomes, where protein synthesis takes place. The code, in DNA or mRNA, specifies the order in which the amino acids are joined together to form a polypeptide. The code words in mRNA, however, are not directly recognized by the corresponding amino acids. Another type of RNA called transfer RNA (tRNA) is needed to bring the mRNA and amino acids together. As the code carried by mRNA is “read” on a ribosome, the proper tRNA’s arrive in turn and give up the amino acids they carry to the growing polypeptide chain. The process by which the information from DNA is transferred in to the language of proteins is known as *translation*.

In this investigation, you will simulate the mechanism of protein synthesis and thereby determine the traits inherited by a fictitious organism called CHNOPS. CHNOPS, whose cells contain only one chromosome, are members of the kingdom Animalia. A CHNOPS chromosome is made up of six genes (A, B, C, D, E, and F), each of which is responsible for a certain trait.

**Procedure:**

**Materials**

1. Colored Pencil #1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Colored Pencil #2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Sequence of Steps**

1. To determine the trait for Gene A of your CHNOPS, fill in the information in the box labeled Gene A in the Data Table. Notice the sequence of nucleotides in DNA. On the line provided, write the sequence of nucleotides of mRNA that are complementary to DNA. Then, on the line provided, write the sequence of nucleotides of tRNA that are complementary to mRNA.
2. In order to determine the sequence of amino acids, match each tRNA triplet with the specific amino acid in Figure 1. Using a – (dash) to separate each amino acid number, record this information in the appropriate place in the Data Table.
3. Using Figure 2, find the trait that matches the amino acid sequence. Record this information in the appropriate place in the Data Table.
4. Repeat steps 1 through 3 for the remaining genes (B through F).
5. Using all the inherited traits, sketch your CHNOPS in the space provided.

Figure 1 Figure 2

|  |  |
| --- | --- |
| **tRNA Triplet** | **Amino Acid Number** |
| ACC | 20 |
| AGC | 16 |
| CGA | 2 |
| AAC | 4 |
| CGC | 3 |
| GGG | 5 |
| AGG | 7 |
| AAA | 8 |
| UUU | 9 |
| GGU | 12 |
| UAU | 13 |
| CCC | 1 |
| AUC | 6 |
| CUA | 10 |
| GGA | 11 |

|  |  |
| --- | --- |
| **Amino Acid Sequence** | **Trait** |
| 20-11-13 | Hairless |
| 20-12-13 | Hairy |
| 20-21-21 | Plump |
| 13-14-15 | Skinny |
| 16-2 | Four-legged |
| 12-7-8-1 | Long nose |
| 5-7-8-1 | Short nose |
| 9-8 | No freckles |
| 9-4 | Freckles |
| 11-3-2 | (Color #1) skin |
| 11-3-3 | (Color #2) skin |
| 6-6-10 | Male |
| 6-6-14 | Female |

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**Data & Results**

|  |  |  |
| --- | --- | --- |
| **Gene A**  **DNA** ACC GGT TAT  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** | **Gene B**  **DNA** AGC CGA  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** | **Gene C**  **DNA** TTT AAC  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** |
| **Gene D**  **DNA** GGA CGC CGA  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** | **Gene E**  **DNA** GGG AGG AAA CCC  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** | **Gene F**  **DNA** ATC ATC CTA  **mRNA**  **tRNA**  **Amino acid sequence:**    **Trait** |

Now draw the best representation of your CHNOPS in the box below. Make sure you pay attention to the traits of your CHNOPS that you determined from the DNA!!

Analysis & Conclusions

1. What are the differences between translation and transcription?

1. What are the specific sites for transcription and translation in the cell?

1. How many tRNA nucleotides form an anticodon that will attach to the mRNA codon?

1. What information do you need to have to show how transcription works? (What must be given to you in a problem?)

1. What information do you need to have to show how translation works? (What must be given to you in a problem?)

1. (2008).Simulating Protein Synthesis. *Atwater High School Agriculture Department*. [↑](#endnote-ref-1)