Name _____ Class _____ Date _____

Simulating Protein Synthesis

Pre-Lab Discussion

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 tRNAs 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 into 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 fictitious organisms 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.

Problem

How can the traits on a particular chromosome be determined? How can these traits determine the characteristics of an organism?

Materials *(per student)*

Blue pencil
Orange pencil

Procedure

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 lin 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 - (hyphen) 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 i 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.

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

Figure 1

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	blue skin
11-3-3	orange skin
6-6-10	male
6-6-14	female

Figure 2

Observations

Data Table

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** _____

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Analysis and Conclusions

1. Distinguish between translation and transcription. _____

2. What is the specific site for transcription and translation in the cell?

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

Critical Thinking and Application

1. Suppose you knew the makeup of specific proteins in a cell. How would you determine the particular DNA code that coded for them? _____

2. How could one change in a DNA nucleotide alter the formation of the translated protein? (An example would be the difference between normal and sickle-cell hemoglobin.)

Going Further

Create two additional traits for your CHNOPS and give their initial DNA sequence, mRNA codon, and tRNA anticodon. Include the resulting amino acid sequence.