CHNOPS Lab

Constructing a Model of 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 eight genes (A, B, C, D, E, F, G and H), each of which is responsible for a certain trait.

PROCEDURE

1. To determine the trait for Gene A of your CHNOPS, **first you must transcribe the DNA into mRNA**.
2. Then, you must write the nucleotides of tRNA that are complementary to mRNA.
3. Use the chart in Figure 1 to find the corresponding amino acid sequence. *Remember to use the mRNA sequence and not the tRNA sequence in this chart!*
4. Using figure 2, find the trait that matches the amino acid sequence. To save space, you may abbreviate each amino acid. Record this information in the appropriate place.
5. Repeat steps 1 through 4 for the remaining genes (B through F).
6. Create two additional traits for your CHNOPS and give their initial DNA sequence, mRNA codon, tRNA anticodon, and the amino acid sequence. Start with a trait listed in Figure 2 and work backwards to fill in the information for Genes G and H.
7. Using all the inherited traits, sketch your CHNOPS in the space provided.

Figure 1

First Base	*Second Base*				*Third Base*
	U	**C**	**A**	**G**	
U	Phenylalanine	Serine	Tyrosine	Cysteine	**U**
	Phenylalanine	Serine	Tyrosine	Cysteine	**C**
	Leucine	Serine	Stop	Stop	**A**
	Leucine	Serine	Stop	Tryptophan	**G**
C	Leucine	Proline	Histidine	Arginine	**U**
	Leucine	Proline	Histidine	Arginine	**C**
	Leucine	Proline	Glutamine	Arginine	**A**
	Leucine	Proline	Glutamine	Arginine	**G**
A	Isoleucine	Threonine	Asparagine	Serine	**U**
	Isoleucine	Threonine	Asparagine	Serine	**C**
	Isoleucine	Threonine	Lysine	Arginine	**A**
	Methionine (start)	Threonine	Lysine	Arginine	**G**
G	Valine	Alanine	Aspartate	Glycine	**U**
	Valine	Alanine	Aspartate	Glycine	**C**
	Valine	Alanine	Glutamate	Glycine	**A**
	Valine	Alanine	Glutamate	Glycine	**G**

Figure 2

Amino Acid Sequence	**Trait**
Tyrosine – Alanine – Tyrosine	Hairless
Lysine – Leucine	Hairy
Proline – Alanine – Alanine	Plump
Histidine – Arginine	Skinny
Tryptophan – Proline – Isoleucine	Four-legged
Threonine – Serine – Serine	Two-legged
Tyrosine – Glutamate - Aspartate	Long nose
Lysine – Arginine – Serine – Leucine	Short nose
Valine – Isoleucine	No freckles
Serine – Alanine	Freckles
Proline – Serine – Phenylalanine - Glycine	Blue skin
Proline – Serine – Glycine	Orange skin
Methionine – Tryptophan – Stop	Short legs
Cysteine – Methionine – Alanine	Long legs
Methionine – Phenylalanine – Valine	Long tail
Valine – Glycine – Cysteine	Short tail
Asparagine – Threonine – Methionine	Spots
Cysteine – Aspartate - Stop	Stripes

CHNOPS A

Gene A	Gene B	Gene C
DNA A C C G G T T A T **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** A G C C G A **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** T T T A A C **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene D	**Gene E**	**Gene F**
DNA G G A C G C C G A **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** GGG AGG AAA CCC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** A T G C T C C T A **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene G	**Gene H**	
DNA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	** Draw your CHNOPS on a blank sheet of paper. Use color. Label each gene with its letter.

CHNOPS B

Gene A	**Gene B**	**Gene C**
DNA ACC GGT TAT **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** CAG TAG **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** TTT AAC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene D	**Gene E**	**Gene F**
DNA GGA CGC CGA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** GGT AGA CCA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** TTT GCC TCG AAC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene G	**Gene H**	
DNA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	** Draw your CHNOPS on a blank sheet of paper. Use color. Label each gene with its letter.

CHNOPS C

Gene A	**Gene B**	**Gene C**
DNA ACC GGT TAT **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** CAT TAT **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** ATA CGC ATA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene D	**Gene E**	**Gene F**
DNA GTA TCC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** GGT AGG AAA CCC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** ATG CTT CTA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene G	**Gene H**	
DNA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	** Draw your CHNOPS on a blank sheet of paper. Use color. Label each gene with its letter.

CHNOPS D

Gene A	**Gene B**	**Gene C**
DNA TGT AGA AGC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** AGC CGC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** ATA CGG ATG **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene D	**Gene E**	**Gene F**
DNA GTG TCC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** GGG AGA CCC **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** TTT TCT AGA GAA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____
Gene G	**Gene H**	
DNA **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	**DNA** **mRNA** _____ **tRNA** _____ **Amino Acid Sequence** _____ **Trait** _____	** Draw your CHNOPS on a blank sheet of paper. Use color. Label each gene with its letter.

ANALYZE AND CONCLUDE

1. Compare and contrast translation and transcription.

Transcription	Both	Translation

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

3. What is the specific site for translation in the cell? _____

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

5. How could one change in a DNA nucleotide alter the formation of the translated protein? For example, if we changed or removed the nucleotide in **bold** from the following DNA strand, how would that affect the formation of the protein? Explain (step by step).

DNA: T A C **T** C A A T T C A C G C T
