

Simulating Protein Synthesis

Your unique body characteristics (**traits**), such as hair color or blood type, are determined by the proteins your body produces. **Proteins** are the building blocks of life - in fact, about 45% of the human body is made of protein. These organic macromolecules perform a wide range of functions including body repair, regulation, and protection. Proteins are created by bonding groups of **amino acids** that are coded for by the nucleotide base sequences (A, T, G, C) in your DNA.

DNA is trapped in the nucleus because it is too wide to escape through the small nuclear pores in the nuclear membrane. This is a big issue for the cell, since proteins are made outside the nucleus in the cytoplasm. For this reason, a process called **transcription** occurs. DNA passes on its nucleotide base sequences, or code, to a single-stranded molecule called **mRNA** (messenger). mRNA then carries the code out to the cytoplasm to the **ribosomes**, the site where proteins are made.

When the mRNA reaches the ribosome, the code in the mRNA nucleotides are read in groups of three bases, or **codons**. Each codon signals another type of RNA, called **tRNA** (transfer), to carry a specific amino acid into the ribosome. As amino acids continue to bond to one another it forms a **polypeptide** chain that eventually results in a protein. This process is known as **translation**.

In this investigation, you will simulate protein synthesis by transcribing the DNA and translating the mRNA of the imaginary CHNOPS monster. The CHNOPS monster's cells contain only one chromosome that carries nine genes: A, B, C, D, E, F, G, H, & I each of which code for a specific trait. You will decode each gene to determine the phenotypic expression of the CHNOPS monster's DNA, and then draw the monster based on your results.

Procedure

1. *Transcribe* and record the mRNA from the DNA sequence in each gene data table.
2. Next, translation would occur resulting in the **anticodon** sequence that is complementary to the mRNA base sequence. tRNA transfers the amino acids to the ribosome.
3. Use Figure 1 to *translate* the mRNA and record amino acids sequences.
4. Use the sequence of amino acids and Figure 2 to record the inherited phenotype and trait.
5. Create your imaginary CHNOPS monster based on the results of the gene expression.
6. Complete the discussion questions on your answer sheet.



Figure 1

		Second Base				
		U	C	A	G	
U	Phe	Ser	Tyr	Cys	U	Third Base
	Phe	Ser	Tyr	Cys	C	
	Leu	Ser	stop	stop	A	
	Leu	Ser	stop	Trp	G	
C	Leu	Pro	His	Arg	U	Third Base
	Leu	Pro	His	Arg	C	
	Leu	Pro	Gin	Arg	A	
	Leu	Pro	Gin	Arg	G	
A	Ile	Thr	Asn	Ser	U	Third Base
	Ile	Thr	Asn	Ser	C	
	Ile	Thr	Lys	Arg	A	
	Met	Thr	Lys	Arg	G	
G	Val	Ala	Asp	Gly	U	Third Base
	Val	Ala	Asp	Gly	C	
	Val	Ala	Glu	Gly	A	
	Val	Ala	Glu	Gly	A	
	Val	Ala	Glu	Gly	G	

Genetic Code for Amino Acids

Figure 2

Amino Acid Sequence	Trait Phenotype
Gly – Arg – Cys	Blue Skin
Gly – Arg – Arg	Green Skin
Gly – Arg – Phe	Yellow Skin
Ile – Ile – Leu	Black Hair
Ile – Ile – Asn	Orange Hair
Phe – Lys	1 Antennae
Phe – Val	2 Antenna
Phe – Asn	3 Antenna
Pro – Pro – Tyr	6 Eyes
Pro – Tyr – Arg	4 Eyes
Pro – Tyr – Glu	1 Eye
Thr – Glu – Tyr	Nice
Thr – Gly – Tyr	Mean
Ser – Arg	2 Legs
Ser – Asn	3 Legs
Ser – Lys	4 Legs
Gly – Arg – Lys – Pro	Pink polka dots
Glu – Arg – Lys – Pro	Purple polka dots
Gly – Lys – Asn	Tail
Gly – Lys – Ile	No Tail
Asn – Thr	2 Arms
Asn – Pro	4 Arms

1Name:

Simulating Protein Synthesis

Gene Data Table

Gene A	SKIN COLOR
DNA =	CCT – GCG – AAA
mRNA =	
Amino Acids =	
Phenotype =	

Gene B	HAIR COLOR
DNA =	TAG – TAG – GAT
mRNA =	
Amino Acids =	
Phenotype =	

Gene C	ANTENNA
DNA =	AAA – TTG
mRNA =	
Amino Acids =	
Phenotype =	

Gene D	EYES
DNA =	GGG – ATA – CTC
mRNA =	
Amino Acids =	
Phenotype =	

Gene E	DEMEANOR
DNA =	TGG – CTC – ATA
mRNA =	
Amino Acids =	
Phenotype =	

Gene F	LEGS
DNA =	TCG – TTT
mRNA =	
Amino Acids =	
Phenotype =	

Gene G	POLKA DOTS
DNA =	CCA – TCC – TTT – GGG
mRNA =	
Amino Acids =	
Phenotype =	

Gene H	TAIL
DNA =	CCA – TTT – TTG
mRNA =	
Amino Acids =	
Phenotype =	

Gene I	ARMS
DNA =	TTA – TGC
mRNA =	
Amino Acids =	
Phenotype =	

1. What are proteins made up of?
2. Where are proteins made (cell organelle)?

2Name:

Simulating Protein Synthesis

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mRNA =	
Amino Acids =	
Phenotype =	

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DNA =	AAA – CAA
mRNA =	
Amino Acids =	
Phenotype =	

Gene D	EYES
DNA =	GGG – GGT – ATA
mRNA =	
Amino Acids =	
Phenotype =	

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Amino Acids =	
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Find the answers to the following questions in your notes, biology book, or the instruction sheet to this activity.

1. What are proteins made up of?
2. Where are proteins made (cell organelle)?

3. Define transcription. Where does transcription take place?
4. Which enzyme helps during transcription?
5. What is the function of mRNA?
6. What is a codon?
5. What is the base pair ruling of DNA to mRNA?
7. Define translation. Where does translation take place?
8. What is the function of tRNA?

Create your CHNOPS below