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 sequences 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. They process by which the information from DNA is transferred into the language of proteins is known as **translation.**

In this lab, you will simulate the mechanisms of protein synthesis and thereby determine the traits inherited by fictitious organisms called CHNOPS. CHNOPS, whose cells only contain one chromosome, are members of the kingdom Animalia. A CHNOPS chromosome is made up of nine genes (A, B, C, D, E, F, G, H, and I), 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

Colored pencils

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 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 mRNA 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 in the appropriate place in the data table.
4. Repeat steps 1-3 for the remaining genes (B through I).
5. Using all the inherited traits, sketch your CHNOPS on a separate sheet of paper.

Figure 1

mRNA	Amino Acid Number
UGG	20
UCG	16
GCU	2
UUG	4
GCG	3
CCC	5
UCC	7
UUU	8
AAA	9
CCA	12
AUA	13
GGG	1
UAG	6
GAU	10
CCU	11

Figure 2

Amino Acid Sequence	Trait	Amino Acid Sequence	Trait
20-11-13	Hairless	10-4-12	Feet
20-12-13	Hairy	10-4-13	Hooves
20-1-1	Plump	4-9-9	Two Eyes
13-10-16	Skinny	4-9-8	One Eye
16-2	Four-legged	16-1-7	Pointy Ears
12-7-8-1	Long Nose	16-2-7	Round Ears
5-7-8-1	Short Nose	9-1	Scales
9-8	No Freckles	11-6-5-7	Antennae
9-4	Freckles	8-2-13	Wings
11-3-2	Blue Skin	5-5-9-1	Tail
11-3-3	Orange Skin	1-1-3	Eye Brows
6-6-10	Male	2-2-8-6	Eye Lashes
6-6-13	Female	2-8-9-10	Lips
6-4-12	Horns	6-4-13	Mole

Observations

Gene A DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA GGA CGC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA GGT AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA TAT CTA AGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA GGG GGG TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

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_____
_____
_____

Observations

Gene A DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA GGA CGC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA GGT AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA TAT CTA AGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA ATC ATC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA CGA CGA AAA ATC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA GGA ATC GGG AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA GGA CGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA CGA AAA TTT CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA AGC CCC AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA AAA CGA TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA ACC CCC CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA GGT AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

_____
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Observations

Gene A DNA ATC ATC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA GGG GGG TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA TAT CTA AGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA GGA ATC GGG AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA AAC TTT TTT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA CCC CCC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA GGA CGC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA ATC AAC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA ACC CCC CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA GGG AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA AGC CGA AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA CGA CGA AAA ATC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA ATC ATC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA GGA CGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA AAA CGA TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA GGA ATC GGG AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA ATC AAC GGT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA GGA CGC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA GGG GGG TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA GGT AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA ACC CCC CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA CGA AAA TTT CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA AAA CGA TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA AGC CCC AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA ATC AAC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA AAA CGA TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA AGC CGA AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA GGA CGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA TAT CTA AGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA GGG AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA ATC ATC CTA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA ATC AAC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA CGA CGA AAA ATC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA CCC CCC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA TAT CTA AGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA GGA ATC GGG AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA AAC TTT AAA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

1. Distinguish between translation and transcription.

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

Observations

Gene A DNA ATC ATC TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene B DNA GGG GGG TTT CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene C DNA AGC CGA mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene D DNA GGG AGG AAA CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene E DNA ACC CCC CCC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene F DNA ACC GGT TAT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____
Gene G DNA AGC CCC AGG mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene H DNA AAC TTT TTT mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____	Gene I DNA CCC CCC CGC mRNA _____ tRNA _____ Amino Acid Sequence _____ Trait _____

Analysis and Conclusion

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-celled hemoglobin.)

Going Further

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