

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, RNA polymerase reads and copies the DNA's nucleotide sequences in the form of a complementary messenger RNA (mRNA) 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 worksheet, 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

Red 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 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 - (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 through 3 for the remaining genes (B through F).
5. Using all the inherited traits, sketch your CHNOPS in the space provided.

Figure 1

| tRNA Anticodon | Amino Acid # |
|----------------|--------------|
| 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 2

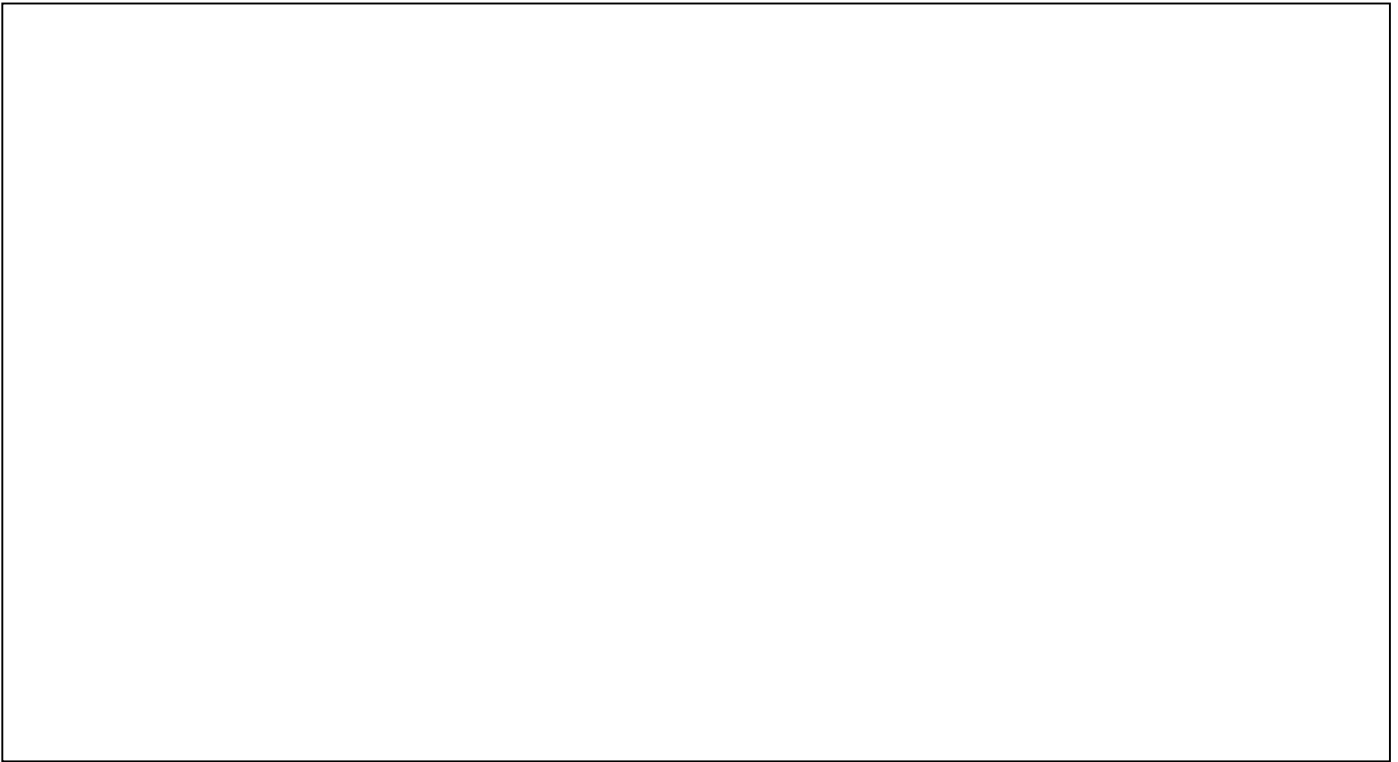
| Amino Acid Sequence | Trait |
|---------------------|-------------|
| 20-11-13 | Hairless |
| 20-12-13 | Hairy |
| 20-21-21 | Plump |
| 13-14-15 | Skinny |
| 16-2 | Four Legged |
| 12-7-8-1 | Long Nose |
| 5-7-8-1 | Short Nose |
| 9-8 | No Freckles |
| 9-4 | Freckles |
| 11-3-2 | Blue Skin |
| 11-3-3 | Red Skin |
| 6-6-10 | Male |
| 6-6-14 | Female |

Observations

Data Table

| | | |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <p>Gene A</p> <p>DNA ACC GGT TAT</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> | <p>Gene B</p> <p>DNA AGC CGA</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> | <p>Gene C</p> <p>DNA TTT AAC</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> |
| <p>Gene D</p> <p>DNA GGA CGC CGA</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> | <p>Gene E</p> <p>DNA GGG AGG AAA CCC</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> | <p>Gene F</p> <p>DNA ATC ATC CTA</p> <p>mRNA _____</p> <p>tRNA _____</p> <p>Amino Acids _____</p> <p>Trait _____</p> |

Drawing Space for the CHNOPS



Analysis and Conclusions

1. Distinguish between translation and transcription.
2. Where 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 exact amino acid sequence of a particular protein in a cell. How would you determine the DNA nucleotide sequence coded for that particular gene?
2. How could one change, or mutation, in a DNA nucleotide alter the expression of that gene?