PROTEIN SYNTHESIS SIMULATION

Background: DNA carries the information for the synthesis of all proteins in an organism. Protein molecules are large and complex, composed of 1000's of amino acids. All the proteins are made of combinations of only 20 different amnion acids. In each kind of protein, the amino acids are linked in a definite sequence, much like letters link to form words. If the letters are rearranged the word is different. So too would a rearrangement of the amino acids change a protein. This is particularly important to the cell because enzymes, which control all chemical reactions in the cell, are proteins. If the amino acids sequence in an enzyme is changed then the enzyme will cease to function and that important reaction will not happen in the cell. That is often a fatal turn of events.

The sequence of amino acids in a protein (enzyme) is determined by the sequence of nucleotides in the DNA molecule in the cell's nucleus. In the first step of protein synthesis, the nucleotide base sequence of the DNA is TRANSCRIBED into a long single strand of mRNA. The mRNA moves out of the nucleus and attached to a ribosome where the protein will be assembled. Every three bases in the mRNA are called CODONS. These codons match up with anti-codons in the tRNA in a particular sequence. The tRNA molecules bring specific amino acids to the ribosome where they will be linked in order to make a specific protein (enzyme). This process of assembling the amino acids in a specific order based on the codon sequence is called TRANSLATION. Therefore, the information chain is DNA, mRNA, tRNA, Amino acid sequence.

Objectives: In this activity you will: (1) Follow the steps of protein synthesis. (2)Translate the genetic code for a specific amino acid chain. (3) Use paper models to simulate protein synthesis.

Procedure: During transcription, the DNA double helix unwinds and "unzips." The two strands separate as the hydrogen bonds between the bases break. Then, free nucleotides in the nucleus move into the open positions along the exposed DNA strand. The mRNA base order is determined by the base sequence in the DNA strand to which they are transcribed. The bases in the newly formed mRNA are complementary to the bases in the DNA segment on which it is formed. Thus, "A" in DNA pairs with "U" in RNA, "T" in DNA pairs with "A" in RNA, "G" in DNA pairs with "C" in RNA, and "C" in DNA pairs with "G" in RNA. After the single stranded mRNA is formed it moves out of the nucleus to the cytoplasm.

1. One strand of DNA has the base sequence: **CGA-TTG-GCA-GTC-ATT. Determine the sequence of bases in the complementary strand of mRNA that would form next to this DNA strand**. Use the answer chart provided for all your answers.

The information carried on the mRNA is in a code – the GENETIC CODE. A group of three bases on the mRNA form a codon. Each codon specifies one of the 20 amino acids, except for three codons that are stop, or termination, codons. There are 64 codons in the genetic code.

2. Use the codon chart you received in class to read the codons below. **Find the name of the amino acid and write it in the space provided. If the letters code for more than one amino acid, separate them with dashes**:
   a. UUA b. GAG c. UAU-CUA d. AUC-UUG e. AAG-AGU-UCG
   f. AAA-UUU-GGG g. CCA-GCU-AGA-GGG-UGG-CUG-UCA

3. Molecules of tRNA are formed in the nucleus and move to the cytoplasm. These molecules bring the 20 different amino acids to the mRNA at the ribosome to assemble the protein. The tRNA molecule has two ends. One end can carry only one kind of amino acid. The opposite end has a three-base segment called the anti-codon. These anti-codons are complimentary to the codon bases on the mRNA. During protein synthesis the ribosome moves along the mRNA as each tRNA brings its amino acid into sequence. During this time peptide bonds form between the amino acids forming a polypeptide chain, which is a protein. This amino acid chain will continue to grow till a stop codon is encountered. **Determine the anti-codon for each codon below:**
   a. GGU b. CGC c. AUG d. UCG e. AAA f. CUG

4. Complete only if directed to do so:
   a. Cut out the tRNA models with amino acids attached found in the attached page. Cut out the mRNA strands and tape them together in order, so that a single long mRNA stand is formed.
   b. Starting at the left of the mRNA strand, find a tRNA molecule with an anti-codon complementary to the first mRNA codon. With tape, attach the tRNA to the mRNA strand, anti-codon to codon.
   c. For the next codon, find another tRNA with the complementary anti-codon. Tape the next tRNA in place to the mRNA. Also, use a small piece of tape between the two amino acids to represent a