Biology 12 Name: _____

Cell Biology Per: ___ Date: _____

Understanding Protein Synthesis

Background

The DNA in genes codes for the amino acids that make up the proteins necessary to carry out life functions. The code for each amino acid consists of three nucleotides, called a codon. A gene consists of a sequence of all the codons for the amino acids that make up a specific protein. Since DNA cannot leave the nucleus, the first part of protein synthesis is the synthesis of a single-stranded molecule, mRNA, that can carry the genetic information to the cytoplasm. The synthesis of mRNA is called **transcription** and is carried out by enzymes such as RNA polymerase.

Transcription normally copies only one strand of DNA into mRNA. The two strands of DNA are complementary, not identical, thus only one strand carries the correct code (gene). Transcription is a three-step process: initiation, elongation, and termination. **Initiation** begins when RNA polymerase binds to a promoter region on the gene and forces the double strands of DNA apart. During **elongation**, RNA polymerase moves along the template strand in the 3' to 5' direction, and uses free RNA nucleotides in the nucleus to synthesize a single strand of mRNA that is complementary to the DNA of the template strand.

The same base-pairing rules as in DNA replication apply, except that adenine in DNA is paired with uracil in mRNA> When the RNA polymerase reaches the **termination** signal (a series of DNA bases signalling "the end"), the newly made mRNA completely detaches from the DNA and the RNA polymerase. The RNA polymerase leaves the template strand and the two DNA strands rejoin. The mRNA then leaves the nucleus through pores in the nuclear envelope, carrying the DNA code to the cytoplasm.

In the second part of protein synthesis, called **translation**, the protein coded for in DNA is actually made. The mRNA carries the code from the DNA in the nucleus to the actual site of protein synthesis, a ribosome in the cytoplasm of the cell. The genetic code is read in sets of three consecutive bases, called codons. Each codon specifies a particular amino acid. There are 20 different amino acids and a single amino acid may be specified by several different codons. The table in your textbook lists the codons of mRNA aligned with the amino acids the code for. Translation of the mRNA always begins at the "start" codon (AUG – methionine) and ends with one of the "stop" codons (UAA, UAG, or UGA).

Three types of RNA cooperate in protein synthesis. The **mRNA** carries the genetic code from DNA to the cytoplasm. Each **tRNA** carries an anticodon (3 bases complementary to the codon) and takes the amino acid through the cytoplasm to the ribosome where it is incorporated into a protein. The **rRNA** is a component of both the large and small subunits of the ribosome, and plats an important part in recognizing mRNA and in catalyzing the formation of peptide bonds between the amino acids in a protein.

When translation is not occurring, each ribosome is separated into a small subunit and a large subunit. In the first part of translation, the small subunit of the ribosome binds to a "start" tRNA (UAC), which has the anticodon for the "start" mRNA (AUG) and carries the amino acid methionine. The small subunit binds to an mRNA and moves along it in the 5' to 3' direction until it finds the start codon (AUG). The start tRNA anticodon UAC pairs with the start codon AUG of the mRNA. The large ribosomal subunit binds to the small subunit, and the start tRNA-methionine complex simultaneously binds to the P site of the large subunit. Initiation is complete; the ribosome is fully assembled and read to begin translation.

Questions

Using the above background knowledge and the information from your textbook, answer the following.

1. Write the sequence of RNA nucleotides for a strand of DNA with the base sequence TACCGA.

2. Why is mRNA needed?

3. What ultimately determines the order of the amino acids in the polypeptide chain?

4. How many nucleotides make up a codon, what does it code for, and where is it found?

5. How many nucleotides make up an anticodon, and where is it found?

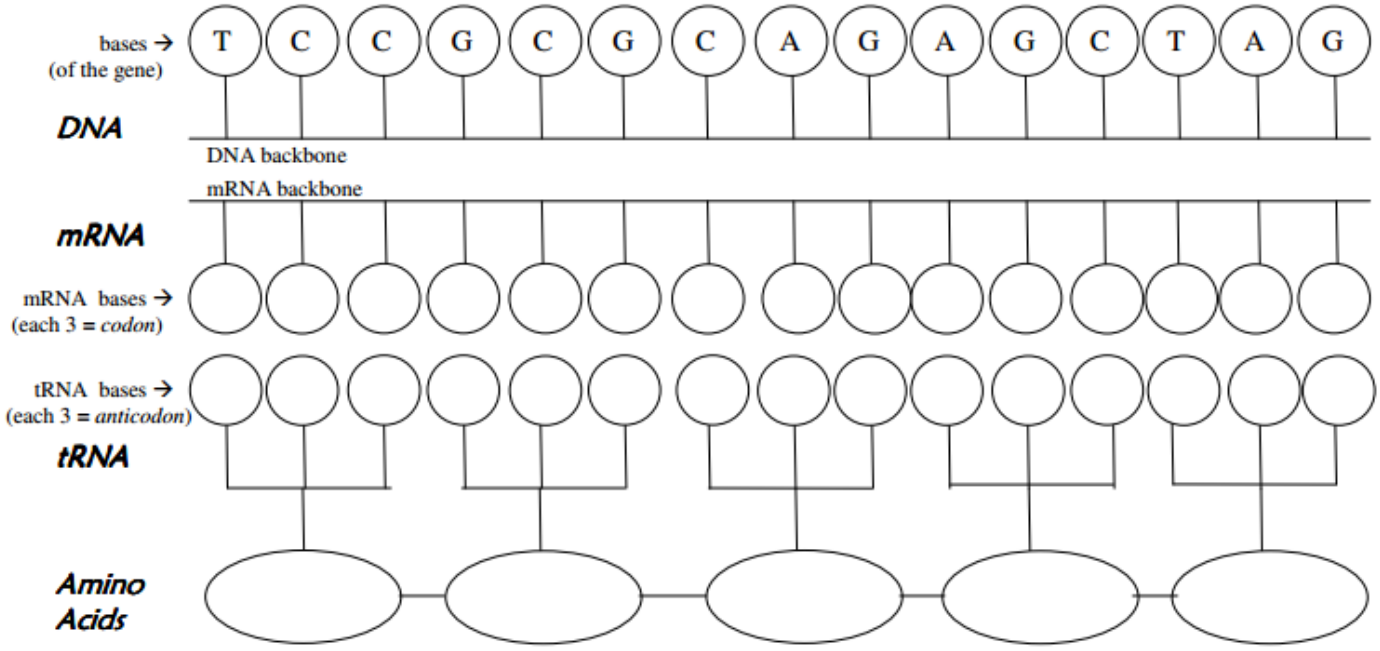
6. What are the three main types of RNA? Briefly describe their functions.

7. What is the significance of the AUG codon and the UAA, UAG and UGA codons?

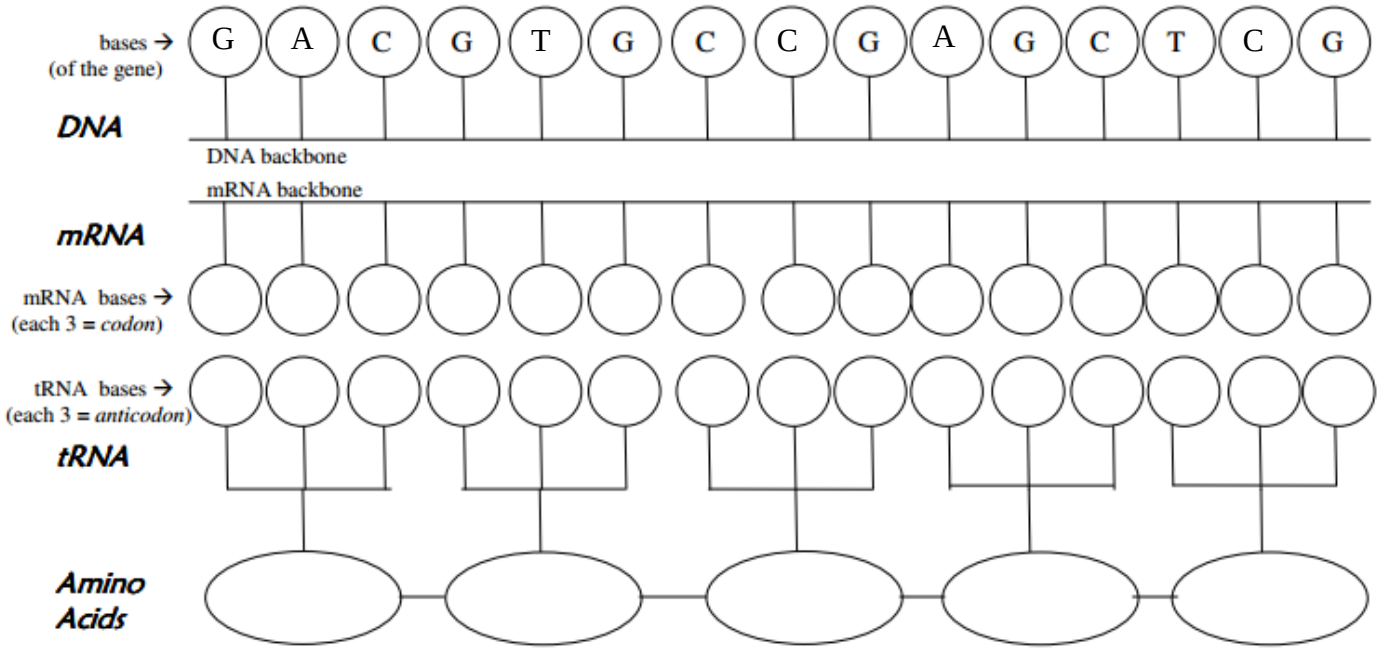
8. If the mRNA codons are AUG, GGU, and CAG, what tRNA anticodons would attach?

9. What amino acids would be attached to the tRNA in the last question?

GENE 1


bases →
(of the gene)
T C C G C G C A G A G C T A G
DNA
DNA backbone
mRNA backbone
mRNA
mRNA bases →
(each 3 = codon)
tRNA bases →
(each 3 = anticodon)
tRNA
Amino
Acids

GENE 2


bases →
(of the gene)
G A C G T G C C G A G C T C G
DNA
DNA backbone
mRNA backbone
mRNA
mRNA bases →
(each 3 = codon)
tRNA bases →
(each 3 = anticodon)
tRNA
Amino
Acids