Name ______________________________ Period _________

Regents Biology Date ______________________

LAB _____: HOW ARE PROTEINS MADE IN CELLS

"DNA gets all the glory, but proteins do all the work!"

DNA is the molecule that stores the genetic information in your cells. That information is coded in the four **bases** of DNA: C (cytosine), G (guanine), A (adenine), and T (thymine). The DNA directs the functions of the cell on a daily basis and will also be used to pass on the genetic information to the next generation. Because of its critical role in all the functions of the cell, DNA is kept protected in the nucleus of your cells.

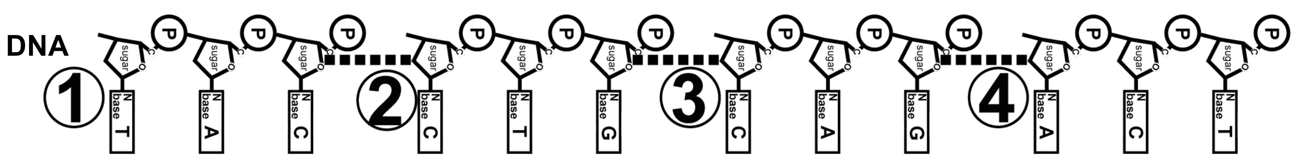
DNA is organized in sections called **genes**. Genes code for **proteins**, and it is proteins that do all the work in the cell. They function as **structural proteins** — serving as the building blocks of cells and bodies. And they function as **enzymes** — directing all the chemical reactions in living organisms.

Proteins are made in the **cytoplasm** by **ribosomes**. So the information from DNA must be transmitted from the nucleus to the cytoplasm. Each gene on the DNA is read and codes directly for a **messenger RNA** (**mRNA**) molecules. The mRNA is made by matching its complementary bases — C, G, A, and **U** (**uracil**) — to the DNA bases. The mRNA molecule then leaves the nucleus and carries the code for making the protein from the DNA gene to the ribosome in the cytoplasm.

The ribosome reads the sequence of bases on the mRNA in sets of three — the triplet **codons**. Another type of RNA — **transfer RNA** (**tRNA**) — brings the protein building blocks — **amino acids** — to the ribosome as they are needed. The ribosome bonds the amino acids together to build the protein coded for by the gene back in the nucleus.

PROCEDURE

1. Your group should obtain one sheet of paper with your four sections of DNA. Cut the strips out along straight lines and tape them together to make a long one-sided DNA molecule. Each section is numbered. Lay them out on the desk from left (#1) to right (#4). See the diagram below.

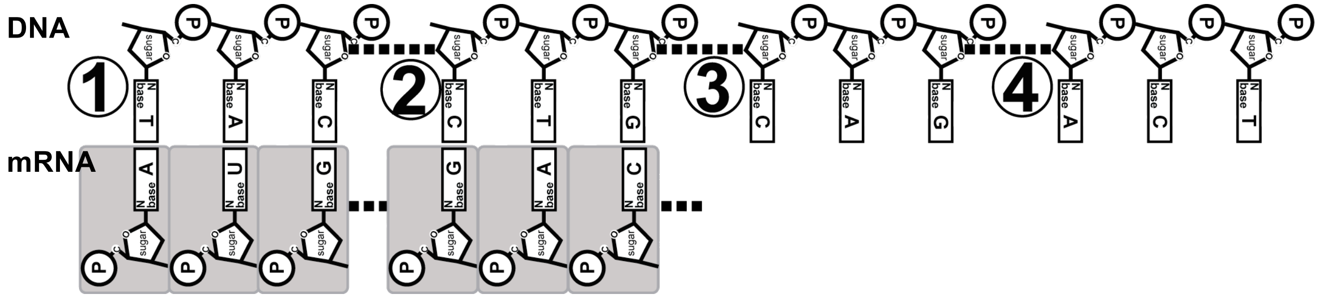


2. We are going to use this section of our DNA as a gene to make a protein the cell needs. Remember it used to be part of a double-stranded DNA molecule. But it has already been unzipped and now will be used as the template to build your mRNA, one base at a time. So first design an **RNA polymerase enzyme** to do this mRNA synthesis job.

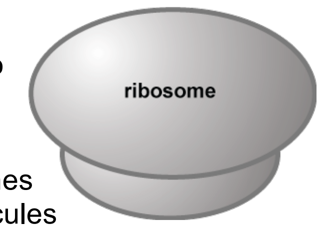
3. **TRANSCRIPTION**: You have been supplied with mRNA nucleotide bases. Build a mRNA molecule from this gene by matching the mRNA bases to your DNA template, one base at a time. Tape this mRNA molecule along its length to simulate the strong bonds that the RNA polymerase makes between the mRNA bases. This way, it will be a stable molecule and can

Name ______________________________

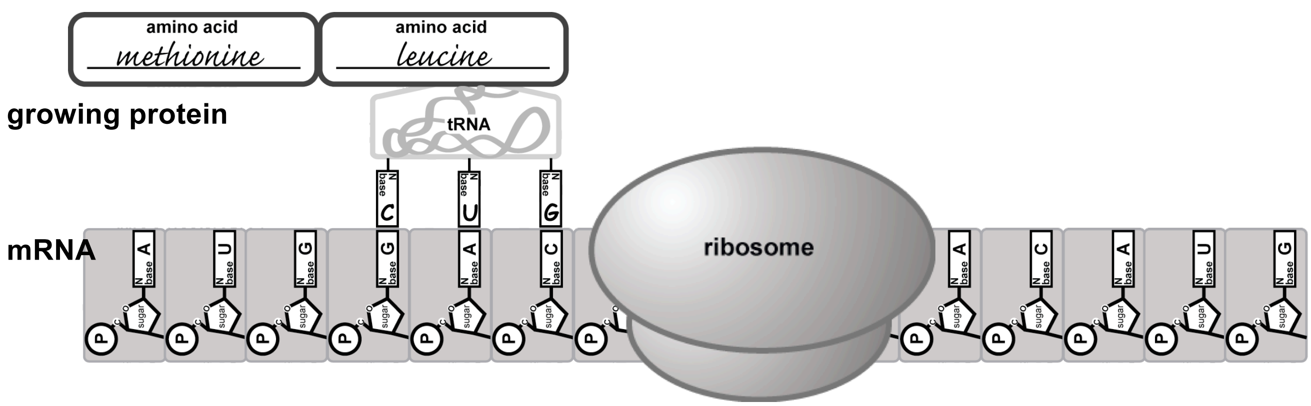
be moved off of the DNA to the ribosome for translation in the cytoplasm. Do ***not*** tape the mRNA to the DNA! Remember it has to leave the DNA in the nucleus and travel to the ribosome in the cytoplasm. Follow the diagram below.



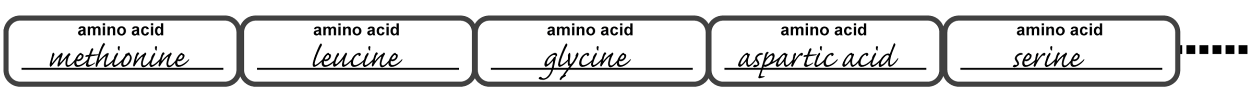
4. To be ready for the mRNA in the cytoplasm, design your own ribosome to use in your simulation.



5. **TRANSLATION**: To help the ribosome do its job, use a pencil to draw lines which divide your mRNA into 3-base codons. Now obtain tRNA molecules and fill in the complementary anticodons to match so that they bring the correct amino acid to the ribosome. Use your mRNA-codon chart to help you. Fill in the name of the amino acid that is attached to the tRNA. Start reading the mRNA at the **START** codon and end at the **STOP** codon. Follow the diagram below.



6. As the tRNA matches the mRNA codons, cut off the amino acid from the tRNA and bond the amino acids together in a protein chain to simulate the action of the ribosome. Show your completed protein to your teacher for credit.



Teacher's Initials ____________________

7. Use your DNA, your mRNA, and your protein to answer the Summary Questions.

Name ______________________________ Regents Biology

SUMMARY QUESTIONS

1. Neatly record the sequence of the **DNA strand** that coded for the mRNA in this lab.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

2. Neatly record the sequence of the **mRNA strand** that you built from the DNA in this lab.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

3. Divide the **mRNA** sequence into its triplet **codons** and rewrite them in order below as 3-base groups.

4. Record the **amino acid** sequence that this mRNA coded for. You can use the 3 letter amino acid abbreviation.

5. Record the **tRNA anti-codons** that carried the amino acids to the ribosome.

Name ____________________________ Regents Biology

MUTATIONS

Sometimes when DNA is copied errors occur. We call these **mutations**. Sometimes mutations cause only minor changes to a gene and therefore make only minor changes in the protein produced from that gene. These types of mutations may cause only minor effects to the way an organism looks or functions — the **phenotype** of the organism. But sometimes mutations can cause great changes to the gene and therefore greatly alter the protein that is made from that gene. This will likely have great effects on the organism, since the protein will not be able to perform its normal function. This may lead to the inheritance of a genetic disease.

6. One mutation is called a **point mutation** where only one base in the gene is copied incorrectly during **DNA replication**. This would be an error of the DNA-building enzyme, **DNA polymerase**. Here is your original DNA sequence from this lab:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
T	**A**	**C**	**A**	**G**	**C**	**C**	**A**	**C**	**T**	**G**	**A**	**G**	**C**	**T**	**C**	**C**	**C**	**G**	**A**	**G**	**C**	**T**	**C**	**C**	**G**	**A**	**A**	**C**	**T**

Below, rewrite the original **DNA** sequence (from above), but let's simulate a **point mutation** at the 9th base. It was accidentally changed during DNA replication from a **C** to a **T**.

Now **transcribe** this new DNA strand into **mRNA**, and then also **translate** it into its **amino acid sequence**.

Did this change in the DNA sequence cause any significant change to the protein produced? **Explain**.

____

____

7. Now, again rewrite the original DNA sequence (from above), but let's simulate a **point mutation** to the 13th base. It was accidentally changed during DNA replication from a **G** to an **A**.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Now **transcribe** this new DNA strand into mRNA, and then **translate** it into its amino acid sequence

Did this change in the DNA sequence cause any significant change to the protein produced? **Explain**.

____

____

8. Another group of mutations is called **frameshift mutations** where at least one base is either added to or deleted from the DNA as it is copied during DNA replication. This would be an error of the DNA-building enzyme, DNA polymerase. Let's investigate the effects of these. Here is your original DNA sequence from this lab:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
T	A	C	A	G	C	C	A	C	T	G	A	G	C	T	C	C	C	G	A	G	C	T	C	C	G	A	A	C	T

Below, rewrite the original **DNA** sequence (from above), but let's simulate a frameshift mutation by **adding** an additional base between the 5th & 6th bases. The base **A** was accidentally added to the sequence of the gene.

1	2	3	4	5	add new	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Now **transcribe** this new DNA strand into **mRNA**, and then also **translate** it into its **amino acid sequence**.

1	2	3	4	5	add new	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Did this change in the DNA sequence cause any significant change to the protein produced? **Explain**.

____

____

9. Now, rewrite the **original DNA** sequence, but let's simulate a frameshift mutation by **deleting** a base at the 3rd base position.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		☒																											

Now **transcribe** this new DNA strand into mRNA, and then **translate** it into its amino acid sequence.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		☒																											

Did this change in the DNA sequence cause any significant change to the protein produced? **Explain**.

____

____