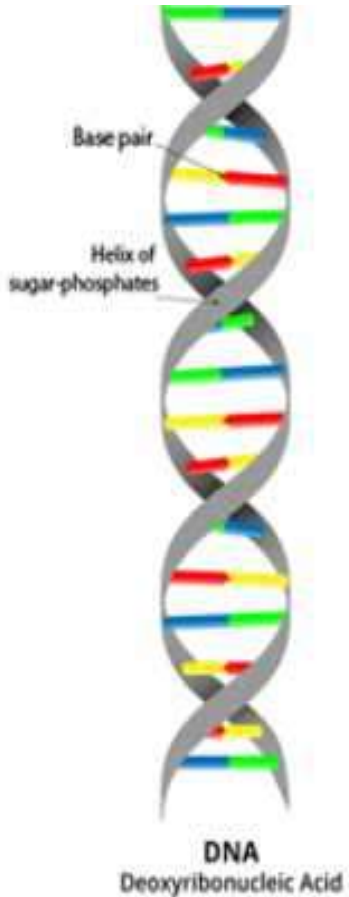gene expression ↑ → "traits"

Lesson 4- Protein Synthesis Part 1- From DNA to mRNA

Learning Objectives:
- Identify the role of the nucleus and the ribosome in protein synthesis
- Explain how DNA and RNA compare and contrast
- Synthesize a strand of mRNA from a DNA template
- Explain the role of mRNA in protein synthesis

Base pair

Helix of
sugar-phosphates

Nucleobases

DNA
Deoxyribonucleic Acid

RNA
Ribonucleic Acid

- Genes are expressed.

- Gene expression can change; gene expression can increase

- Genes code for proteins

- Proteins control your traits

- Cell express genes.

- Genes produce proteins

- Your genes increases

- Your genes changed

- The genes have many cancer cells

- There are more genes in the cancer cells
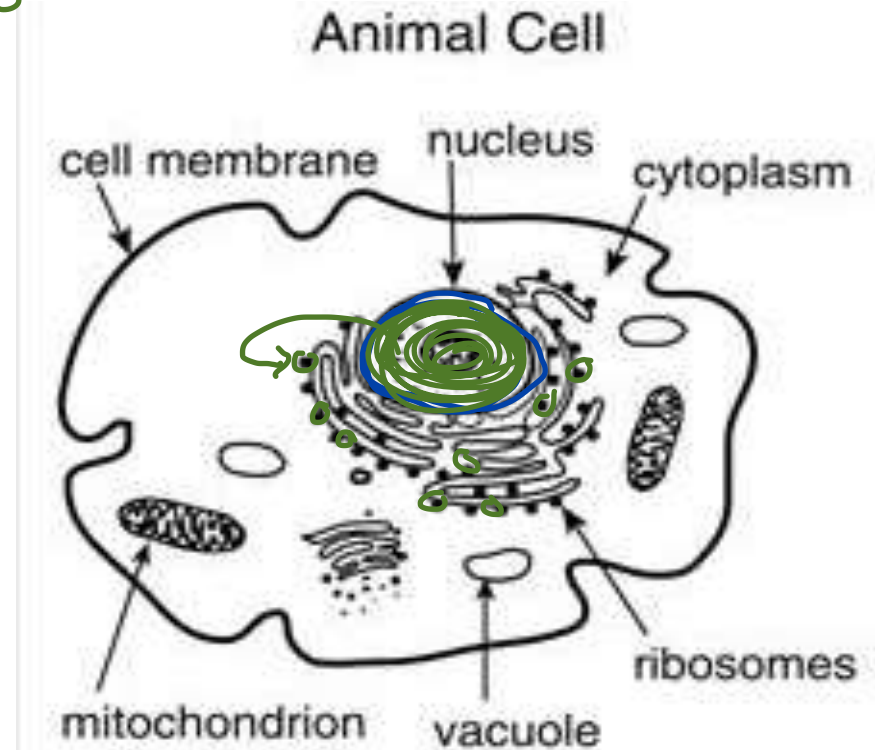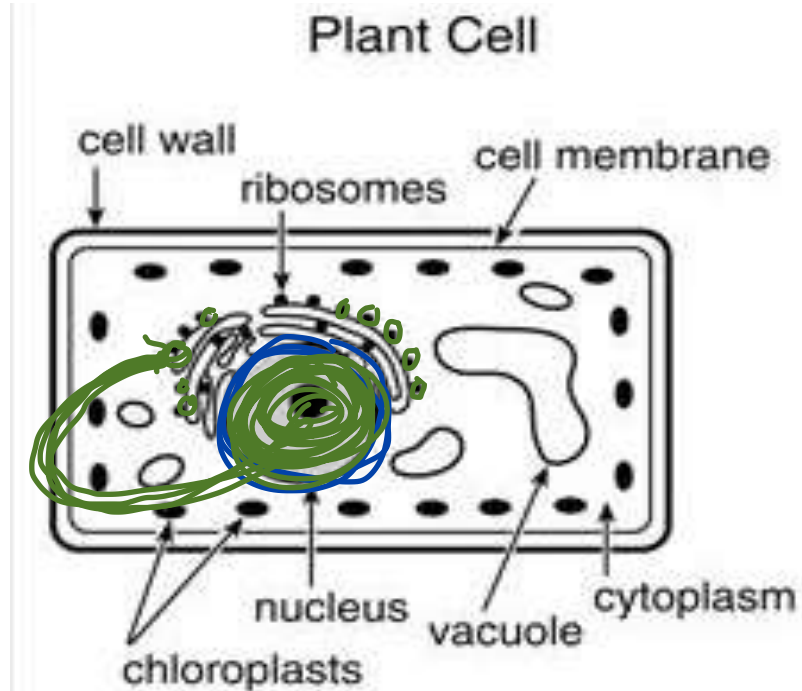
- The twins have slightly different genes

Gene Expression in Cancer Cells and Normal Cells
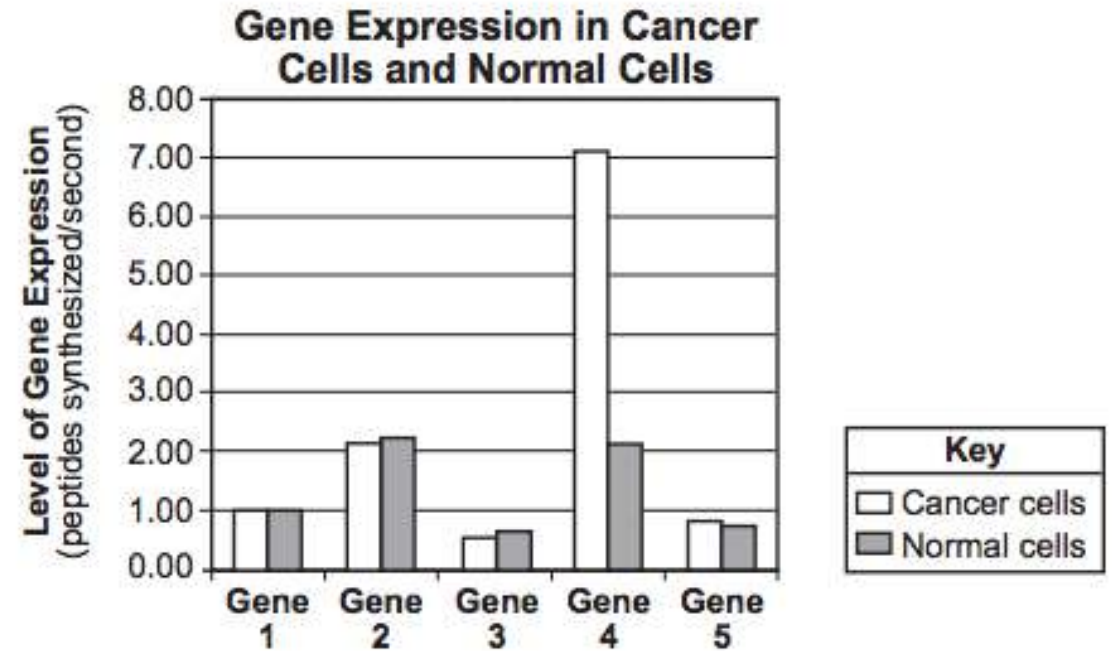
AIM: *How do the nucleus and the ribosome work together for protein synthesis?*

Ok! I get it! Genes code for proteins! And proteins control traits! But HOW does DNA code for proteins? Doesn't the ribosome make proteins? ...

Look at the two cell diagrams. Recall that the **nucleus** *stores the genetic material* in a cell. The **nucleus** *stores the DNA* and all of your **genes**. Just outside of the nucleus, you will find **ribosomes**. Ribosomes are *where proteins are built*.

↳ protein

- **Nucleus** = stores the instructions for building proteins → genes
- **Ribosome**= site of protein synthesis

Plant Cell

cell wall
ribosomes
cell membrane

nucleus
vacuole
cytoplasm
chloroplasts

Animal Cell

cell membrane   nucleus   cytoplasm

mitochondrion   vacuole   ribosomes
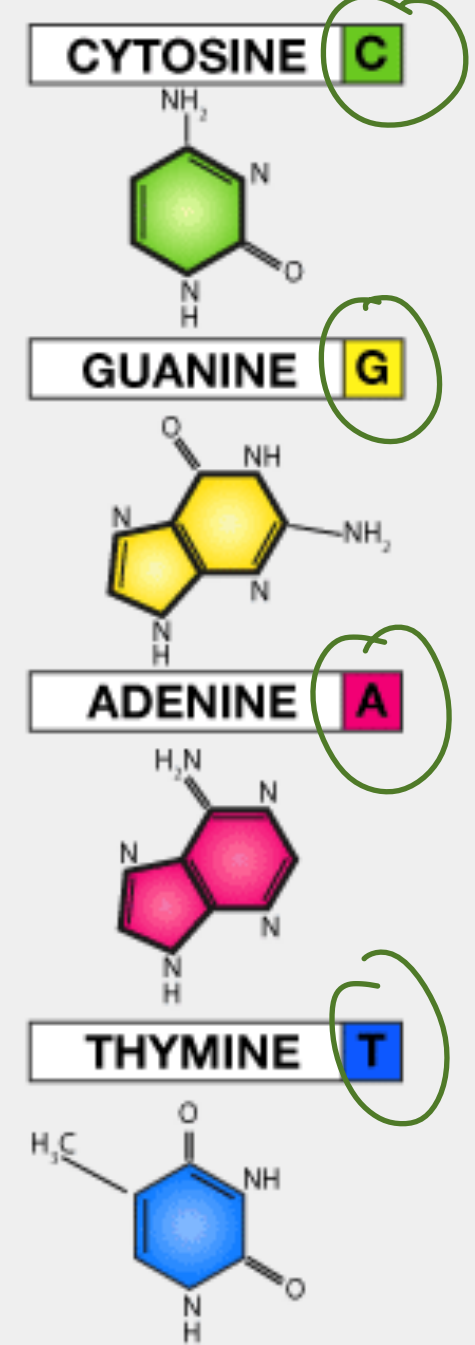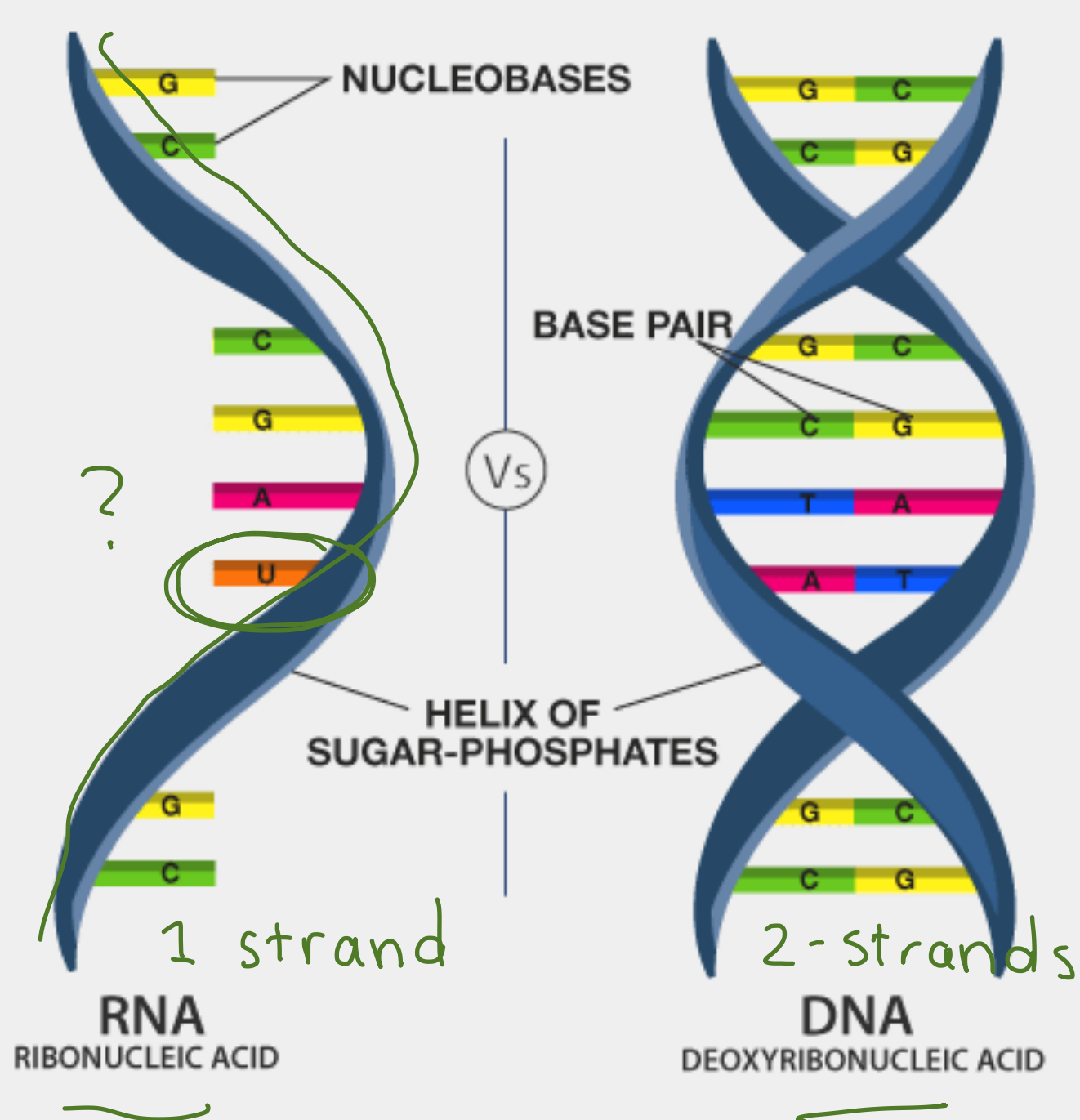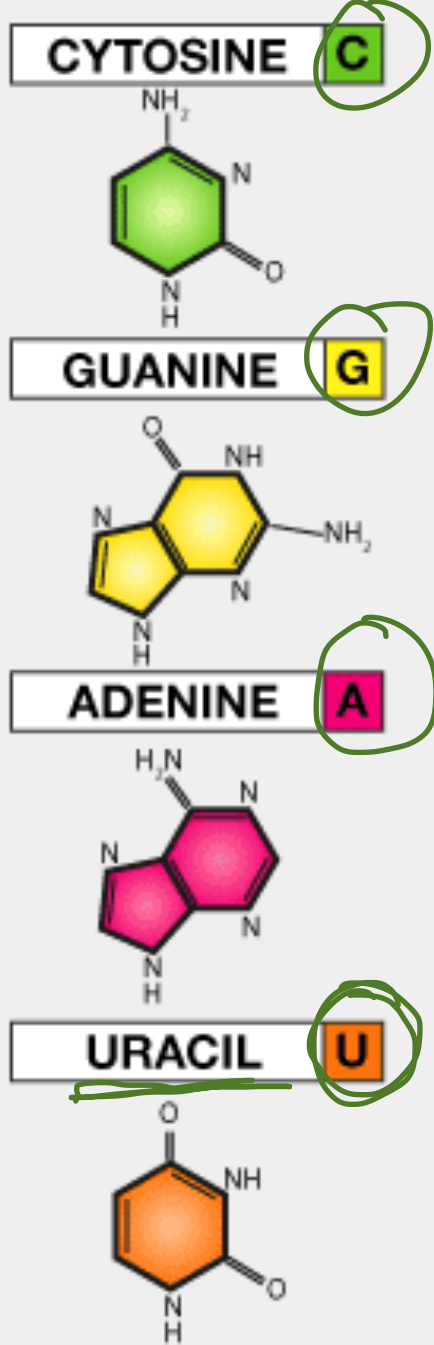
But, we have 2 problems:

- Each cell contains ONE copy of your DNA, and the DNA *never leaves the nucleus.*
- The ribosome can't even read DNA!! It reads a molecule called RNA.

DNA → RNA

Solution:

- In the nucleus, DNA is used to make a strand of **RNA**. RNA *leaves the nucleus* and goes to the ribosome. The RNA carries the information from the gene so that the ribosome knows how to make the protein. RNA is another *information molecule* similar to DNA

1 page

CYTOSINE C

GUANINE G

ADENINE A

URACIL U

NUCLEOBASES

BASE PAIR

Vs

HELIX OF
SUGAR-PHOSPHATES

?

1 strand

2-strands

RNA
RIBONUCLEIC ACID

DNA
DEOXYRIBONUCLEIC ACID

CYTOSINE C

GUANINE G

ADENINE A

THYMINE T

How is DNA used to code for RNA?

- RNA is a very similar molecule. The one difference is that RNA does **NOT** have the base "T" (thymine). Instead, it has the base "**U**" (uracil). U is so similar to T, *that it can still pair with A.*
- SO, the DNA bases are **G, C, A,** and **T**
- The RNA bases are **G, C, A,** and **U**

2 strands

When a strand of DNA is *being used to code for RNA,* we will use the following rules for base pairs:

- If the DNA template says G, the matching RNA will be a C ✓
- If the DNA template says C, the matching RNA will be a G ✓
- If the DNA template say T, the matching RNA base will be A ✓
- If the DNA template the A, **the matching RNA base will be U**
- **Look at the example below.**

"Gene" → Protein

DNA →	mRNA
G	C
C	G
A	U
T	A

DNA template: G T T A C G A T G A T C

mRNA strand: C A A U G C U A C U A G

→ Ribosome

Gene

DNA template: G T A T G T C A C

mRNA: C A U A C A G U G

Ribosome

DNA →	mRNA
G	C
C	G
A	U
T	A

DNA template: (T T A G A G A C T)

mRNA: A A U C U C U G A

Ribosome

DNA →	mRNA
G	C
C	G
A	U
T	A

When DNA is used to make RNA, we call the RNA that is being produced "**mRNA**." The **m** stands for ***messenger***. Once complete, the single strand of mRNA *leaves the nucleus* and goes to the **ribosome**. The mRNA message contains the information needed to build a specific protein.

- SO, **DNA** can act as a *template* to make *more DNA for DNA replication*.   G-C T-A
  - Use the DNA base-pair rules FOR DNA REPLICATION QUESTIONS.

- OR, **DNA** can act as a *template* to make a *strand of mRNA for protein synthesis.*
  - Use the DNA to RNA base-pair rules for PROTEIN SYNTHESIS QUESTIONS.

ATGACGGATCAGCCGCAAGCGGAATTGGCGACATAA
UACUGCCUAGUCGGCGUU

mRNA Transcript
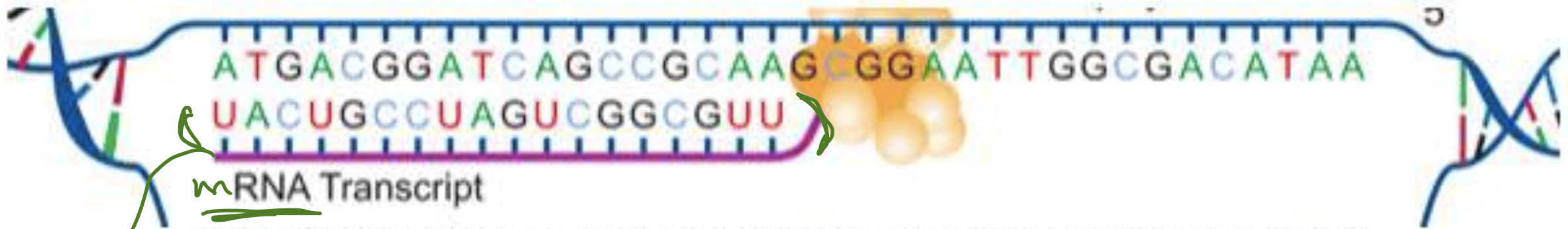
^ This pic shows a sequence of DNA being used to code for a strand of mRNA

DNA → mRNA

U C G A G U

A DNA molecule with the base sequence A-G-C-T-C-A was used as a template for the synthesis of a messenger RNA molecule. Which base sequence correctly represents the corresponding portion of this RNA molecule?

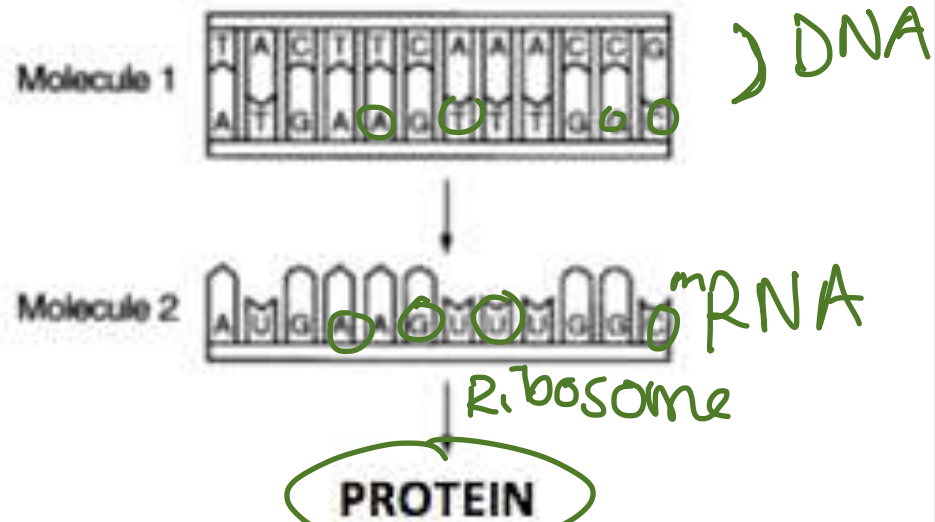a) T-C-A-G-C-A   *b) U-C-G-A-G-U   c) A-G-C-U-C-A   d) A-T-G-A-C-T
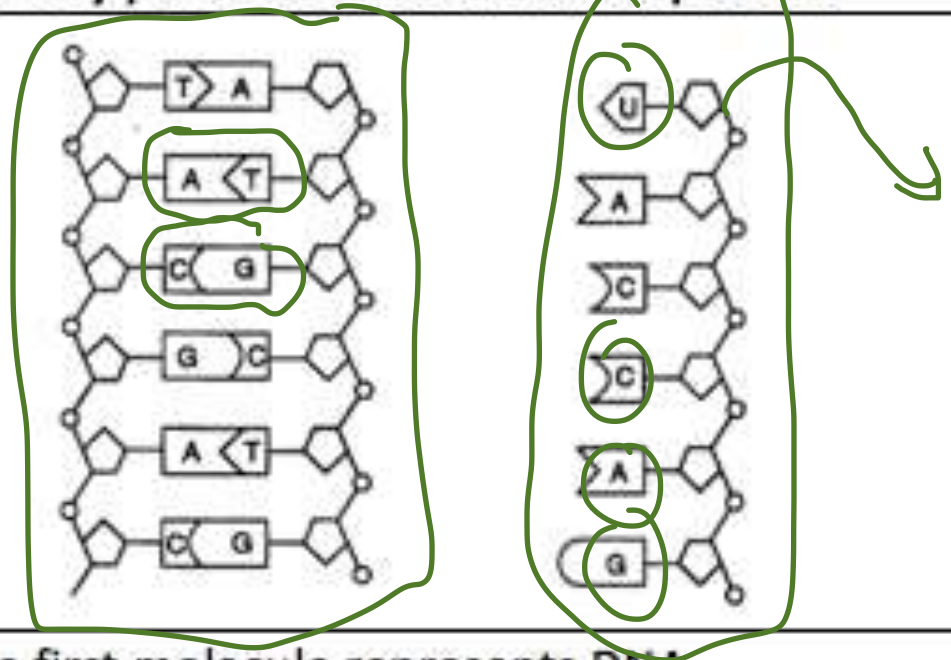
DNA → DNA

T C G A T

If one strand of DNA molecule has the base sequence A-G-C-T-A, the complementary strand of DNA would have the base sequence

a) A-G-C-T-A   b) U-C-G-A-T   c) U-C-G-A-U   d) T-C-G-A-T

Here are some important pictures to analyze! Please look at every picture and read each caption!!!

Handwritten annotations: DNA, mRNA, Ribosome, PROTEIN

- **Molecule 1** represents DNA. I can tell because its double-stranded, and I see the 4 DNA bases (G, C, A, and T).
- **Molecule 2** represents mRNA. I can tell because it is single-stranded, and I see the 4 RNA bases (G, C, A, and U)

- The first molecule represents DNA.
- The second molecule represents a strand of RNA.
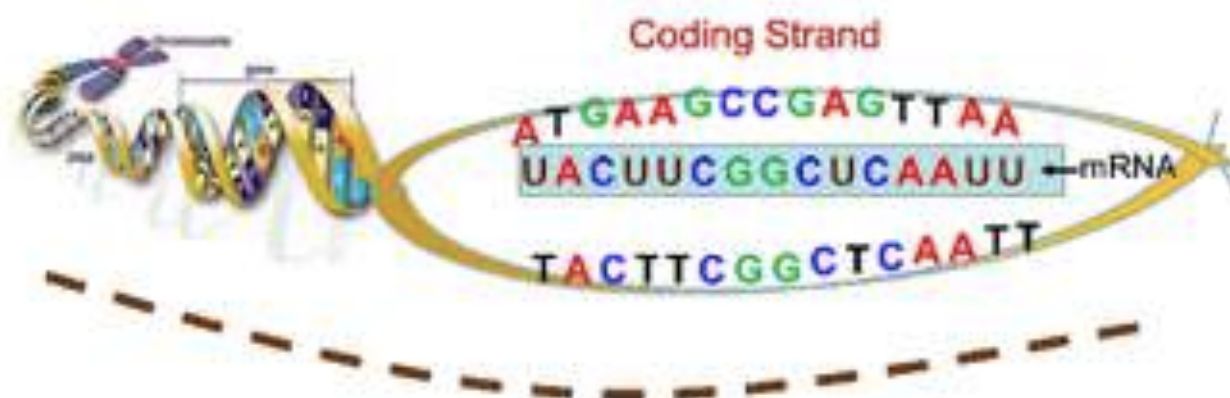- DNA can be used to code for RNA.
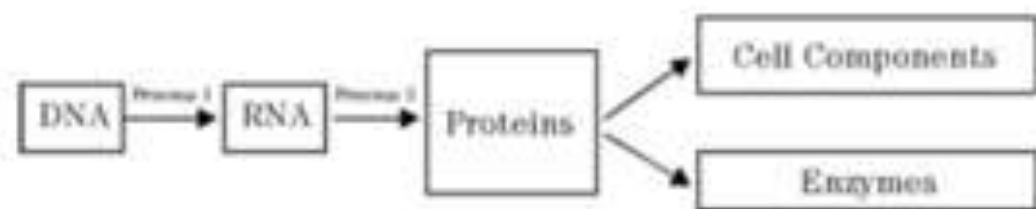
DNA → RNA → Proteins → Cell Components / Enzymes	DNA → RNA → Protein → Trait
• This shows me that *DNA can be used to make RNA*. This process happens in the **nucleus**. • *mRNA* then goes to the **ribosome**. The mRNA is *read by the ribosome to build proteins*. • **Proteins** in the body can become various parts of cells, enzymes, or other things.	• **DNA** can be used to code for **mRNA**. This takes place in the **nucleus**. • **RNA** is used by the **ribosome** to build **proteins**. • **Proteins** give rise to various **traits**.
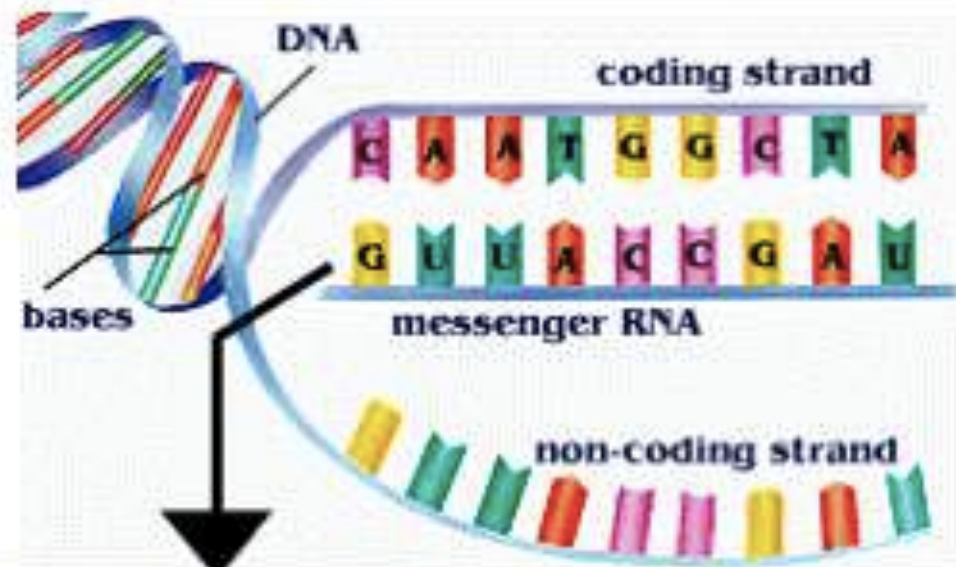
This picture shows how one strand of my DNA is used to make the strand of messenger mRNA.	Here is another picture that shows how a sequence of DNA can be used to make a strand of mRNA to send to the ribosome.

Lesson 4- Protein Synthesis Part 1- From DNA to mRNA

Base pair

Helix of sugar-phosphates

DNA
Deoxyribonucleic Acid

Nucleobases

RNA
Ribonucleic Acid

Learning Objectives:

- Identify the role of the <u>nucleus</u> and the <u>ribosome</u> in <u>protein</u> synthesis

  store info to build protein
  — store genes

  Ribosome- build the protein

- Explain how <u>DNA</u> and <u>RNA</u> compare and contrast

  2 strands
  G C A T

  1 strand
  G C A U

- Synthesize a strand of mRNA from a DNA template

  T T G G A A T G
  A A C C U U A C

- Explain the role of <u>mRNA</u> in protein synthesis.

  message w/ the instruction to build a protein that goes from the nucleus to the ribosome