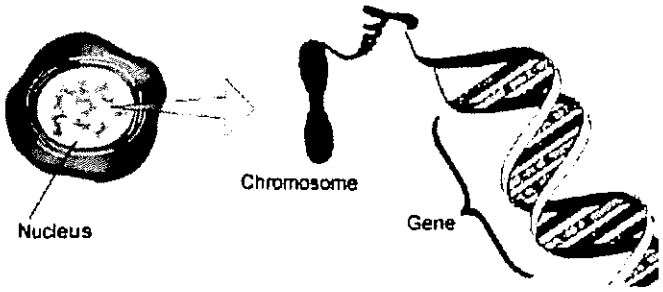
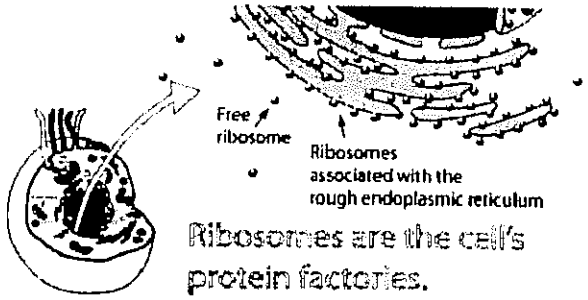
Lab #_____: Modeling Protein Synthesis

Name: _____
Hour: _____ **Date:** _____

BACKGROUND INFORMATION

The process where a cell makes proteins is called **protein synthesis**. The information that tells your cells which proteins to make originally comes from **DNA**, which is found in the cell **nucleus**. Proteins are made at the **ribosomes** in the **cytoplasm** of the cell.





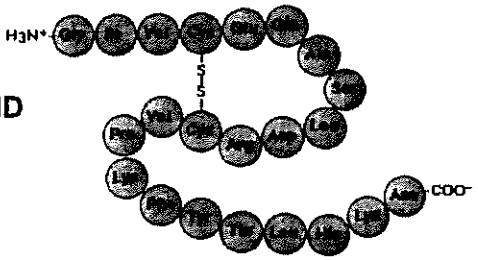
Ribosomes are the cell's protein factories.

Proteins are made up of building blocks called **amino acids**. The names of the 20 different amino acids are given in the box below. Each amino acid has a three letter abbreviation, which is simply the first three letters of the amino acid name unless otherwise noted in the box.

The full names of the 20 amino acids are: Alanine, Arginine, Asparagine (abbreviation: ASN), Aspartic Acid (or Aspartate), Cysteine, Glutamic Acid (or Glutamate), Glutamine (abbreviation: GLN), Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Tyrosine, and Valine.

A simple analogy for understanding how amino acids join to make a protein is to imagine a necklace. The protein is like the necklace and the amino acids are like the beads making up the necklace. Each protein consists of one or more amino acid chains that are twisted, folded, and coiled into a molecule with a specific 3-D shape.

AMINO ACID CHAIN



folding, etc.

PROTEIN

CHECK YOUR UNDERSTANDING : MATCH THE ITEMS BELOW!

_____ 1. cytoplasm	a. control center of the cell
_____ 2. amino acid	b. cell structure that makes protein ("protein machine")
_____ 3. ribosome	c. contains the code for making proteins
_____ 4. "Pro"	d. material that fills the inside of the cell
_____ 5. nucleus	e. process where a cell makes proteins
_____ 6. DNA	f. building block that makes up part of a protein
_____ 7. protein synthesis	g. abbreviation for the amino acid Proline

MODELING ACTIVITY DIRECTIONS

Preparing Your Models

1. Obtain a sheet of DNA, messenger RNA, and transfer RNA cut-outs and color them as follows:

   DNA = red mRNA = blue tRNA = green (color only the lower parts with the letters A, U, C, and G)

2. Cut out your models.

3. Take the two sides of the DNA model and fit them together like puzzle pieces. Fill in the letters to represent the nitrogen bases that would be found on the left side of the model

4. Obtain the "Cell Model Diagram". Place the DNA in the part of the nucleus. Place the tRNA molecules in the cytoplasm. Place the mRNA off to the side for now.

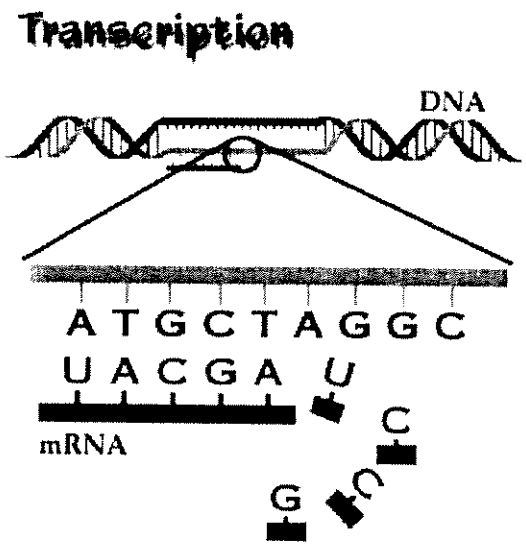
Protein Synthesis Part I: Transcription [DNA → RNA]

During the first stage of protein synthesis, which is called transcription, genetic information is copied from DNA to RNA. This stage of protein synthesis takes place inside of the nucleus of the cell. Model the process of transcription as follows:

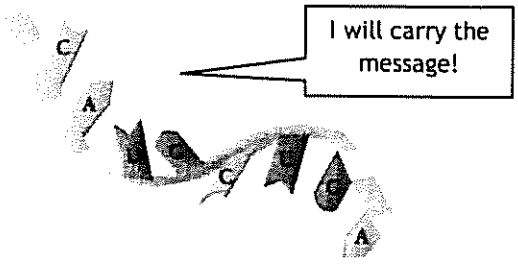
1. "Unzip" (separate) the two sides of the DNA molecule.

2. The nitrogen bases on the right side of the DNA molecule are now exposed so that the right side of the DNA molecule can serve as a template (pattern) for creating mRNA. Place the blue mRNA molecule along the right side of the DNA molecule and use the base pairing rules for RNA to determine the sequence of the nitrogen bases on the mRNA molecule. [Remember, in RNA the base uracil (U) replaces thymine (T)!] Write the sequence of bases on the mRNA molecule.

3. After the code of DNA is copied into mRNA, the mRNA molecule separates from the DNA and the DNA zips back up. To model this, move your blue mRNA sequence away from the DNA molecule and place it in another area of the nucleus. Place the DNA strand back together.



NOTE:
In order for a ribosome to know which protein to make it needs the information from DNA. However, DNA cannot leave the nucleus (it is too big to get through the nuclear pores) and ribosomes are found outside of the nucleus in the cytoplasm. This is why we need messenger RNA. It serves as a "go-between", carrying the message from DNA to a ribosome!

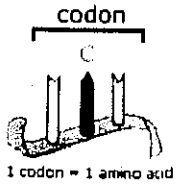


Protein Synthesis Part II: Translation [RNA → Amino Acids (Protein)]

During the second stage of protein synthesis, which is called translation, mRNA is converted to amino acids which join together to make a protein. This stage of protein synthesis takes place at a ribosome in the cytoplasm of the cell. Model the process of translation as follows:

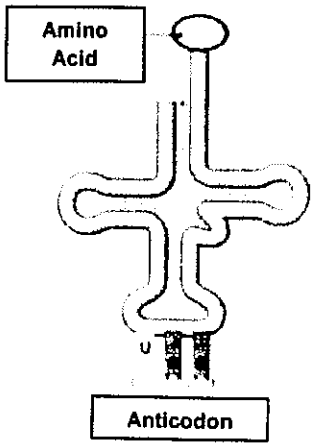
1. The mRNA leaves the nucleus through the pores (holes) in the nuclear membrane and travels through the cytoplasm to attach to a ribosome. To model this, slide your blue mRNA molecule out of the nucleus through one of the nuclear pores. Then, slide the mRNA until it is positioned over the outlined area on the ribosome.

2. Next, the ribosome moves along the mRNA molecule reading its code one mRNA **codon** (3 nucleotides) at a time. To model this, act as the mRNA and read the first 3 letters on the mRNA molecule starting with the "A" end of the mRNA.



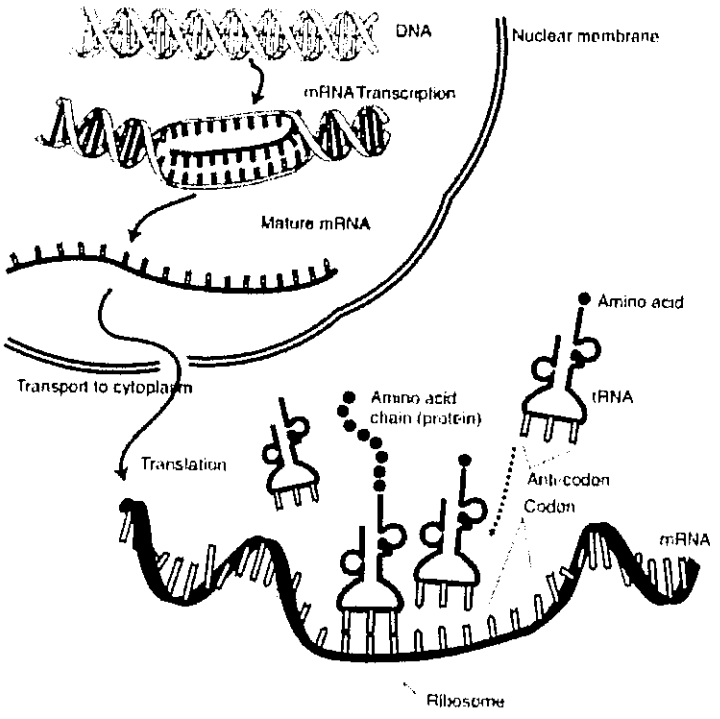
   Record the codon that you just read here: _____

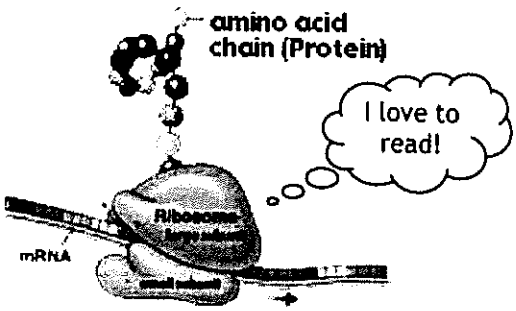
3. As the code is read, tRNA molecules transport amino acids that are found freely floating in the cytoplasm to the ribosome to be chained together to make a protein. The **anticodons** on the bottom of the tRNA molecules pair with the complementary codons of mRNA. To model this, find the tRNA that fits together with the first mRNA codon that you read and place them together. Then, use the base pairing rules for RNA to determine the sequence of nitrogen bases on the tRNA anticodon using the mRNA codon. Write the sequence of bases on the tRNA anticodons.



4. Repeat the process above to pair the remaining mRNA codons with their corresponding tRNA anticodons and determine the base sequences of the tRNA anticodons.

5. After they drop off their amino acids, tRNA molecules are released back into the cytoplasm to pick up other amino acids as shown below. The process of adding amino acids continues until a complete protein chain is formed. (You will not be modeling this step, but it's good to know!)





6. Call your teacher over to check the positions of the DNA, mRNA, and tRNA models on your "Cell Model Diagram". Once your model has been checked, glue your models into position.

Teacher signature here indicates that the model has been checked: _____

LABELING

Label the items listed below on the "Cell Model Diagram":

DNA	fluid inside cell	place where transcription (DNA → mRNA) occurs
mRNA	control center of cell	place where translation (RNA → amino acids) occurs
tRNA	nuclear pore	protein (amino acid chain)
DNA codon	mRNA codon	
tRNA anticodon	amino acid	

QUESTIONS

1. What is the process where a cell makes proteins called? _____
2. What are the building blocks that make up proteins called? _____
3. How many different types of amino acids are there? _____
4. Protein synthesis happens in 2 major stages. Name the two major stages of protein synthesis.
   _____
5. Name the stage of protein synthesis where DNA is copied into RNA. _____
6. Name the stage of protein synthesis where RNA is converted to amino acids, which join to make a protein. _____
7. Where in a cell does the process of transcription occur? _____
8. Where in a cell does the process of translation occur? _____
9. The information that tells a cell which proteins to make originally comes from DNA. Where is DNA found in a cell? _____
10. During transcription, DNA is copied into RNA. Determine the sequence of the mRNA segment that would be made from the following DNA segment:

    A G C C T T A G C → _____

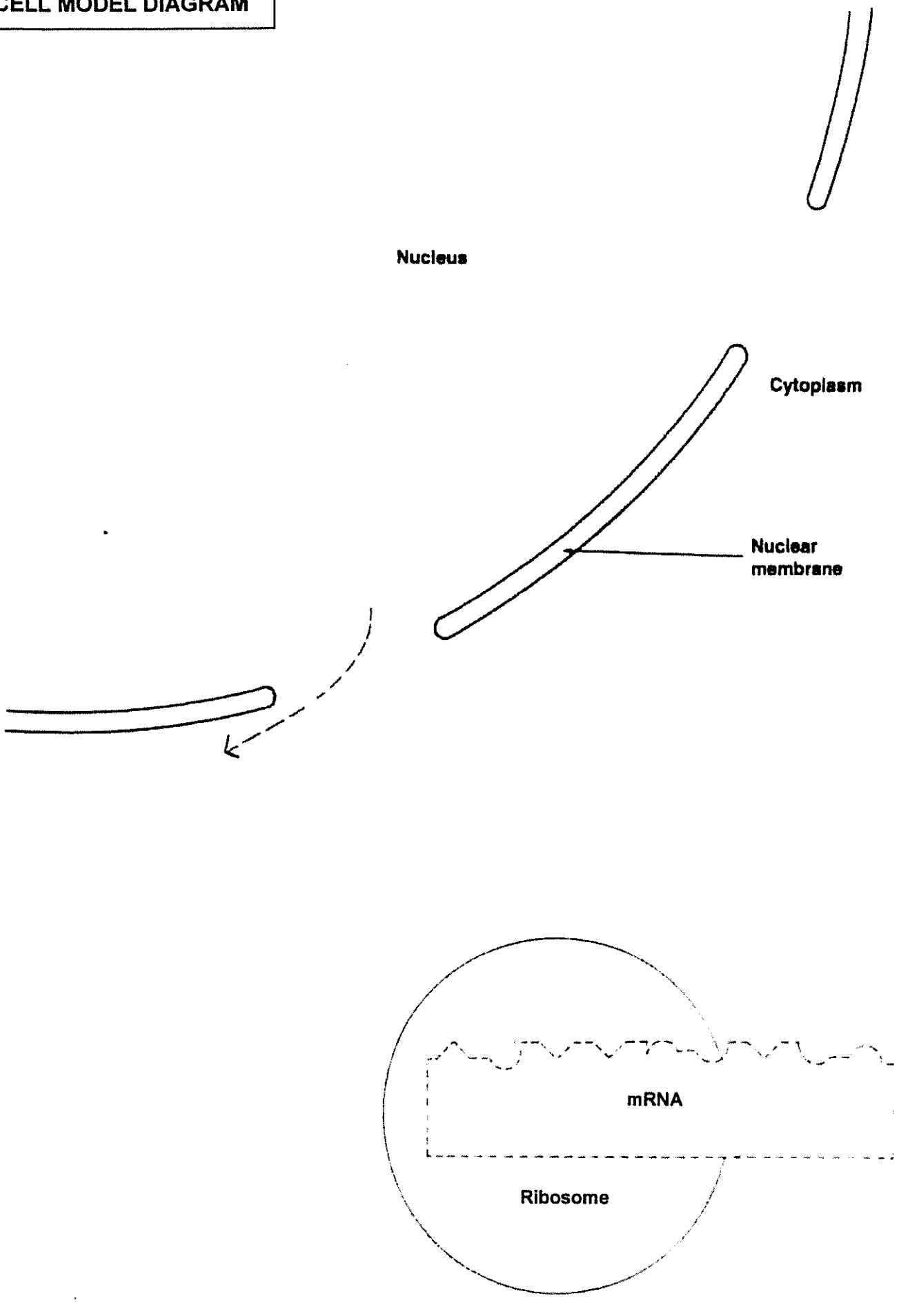
11. During translation, mRNA is converted into amino acids. Determine the sequence of amino acids coded for by the mRNA shown below.

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

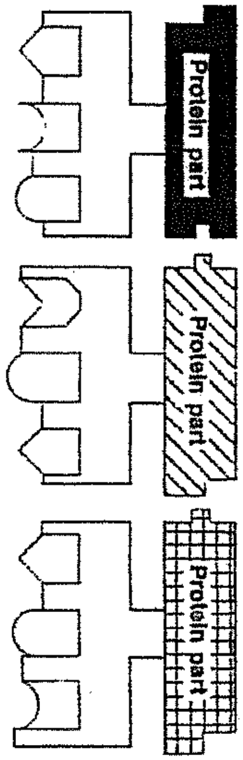
    _____

12. Which molecule carries amino acids to the ribosome? _____
13. A combination of three DNA nucleotides is called a(n) _____.
14. A combination of three mRNA nucleotides is called a(n) _____.
15. A combination of three tRNA nucleotides is called a(n) _____.

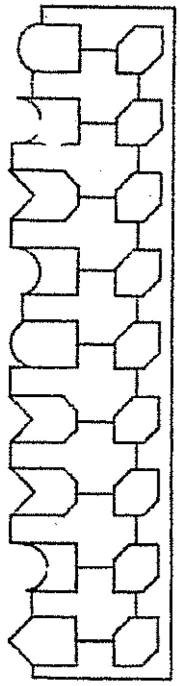
CELL MODEL DIAGRAM



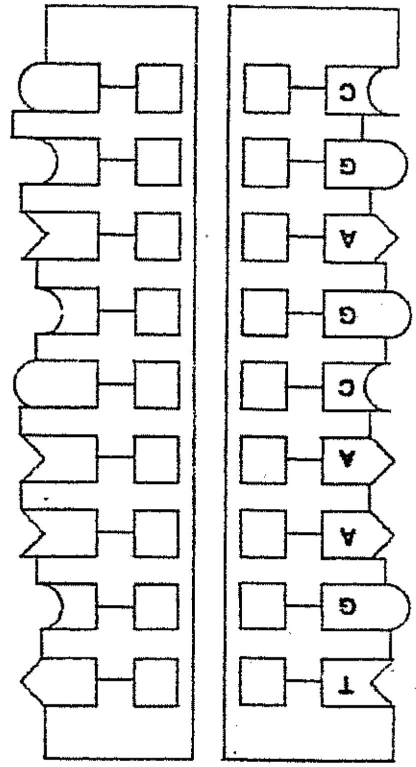
tRNA (green)

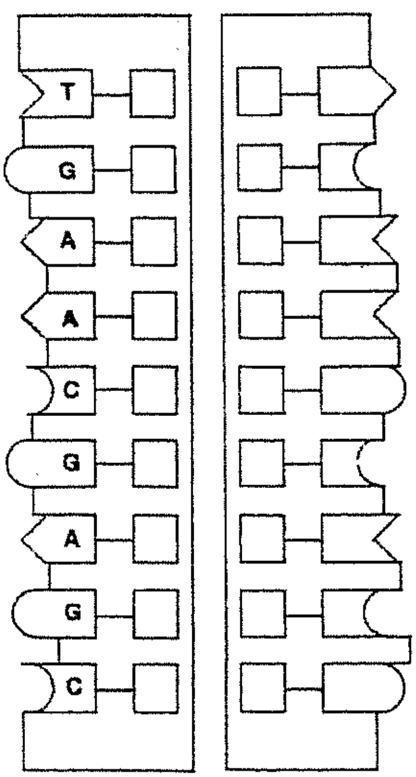


mRNA (blue)

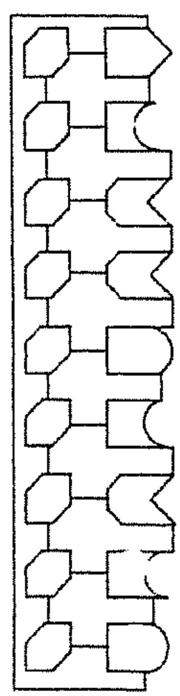


DNA (red)

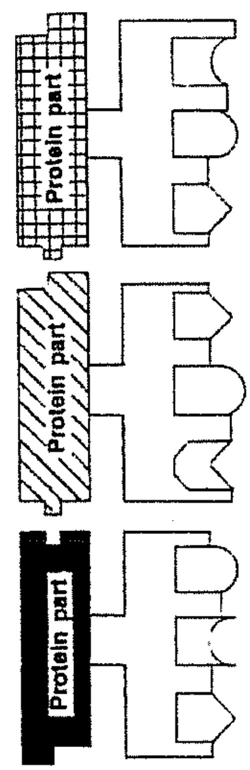




DNA (red)



mRNA (blue)



tRNA (green)