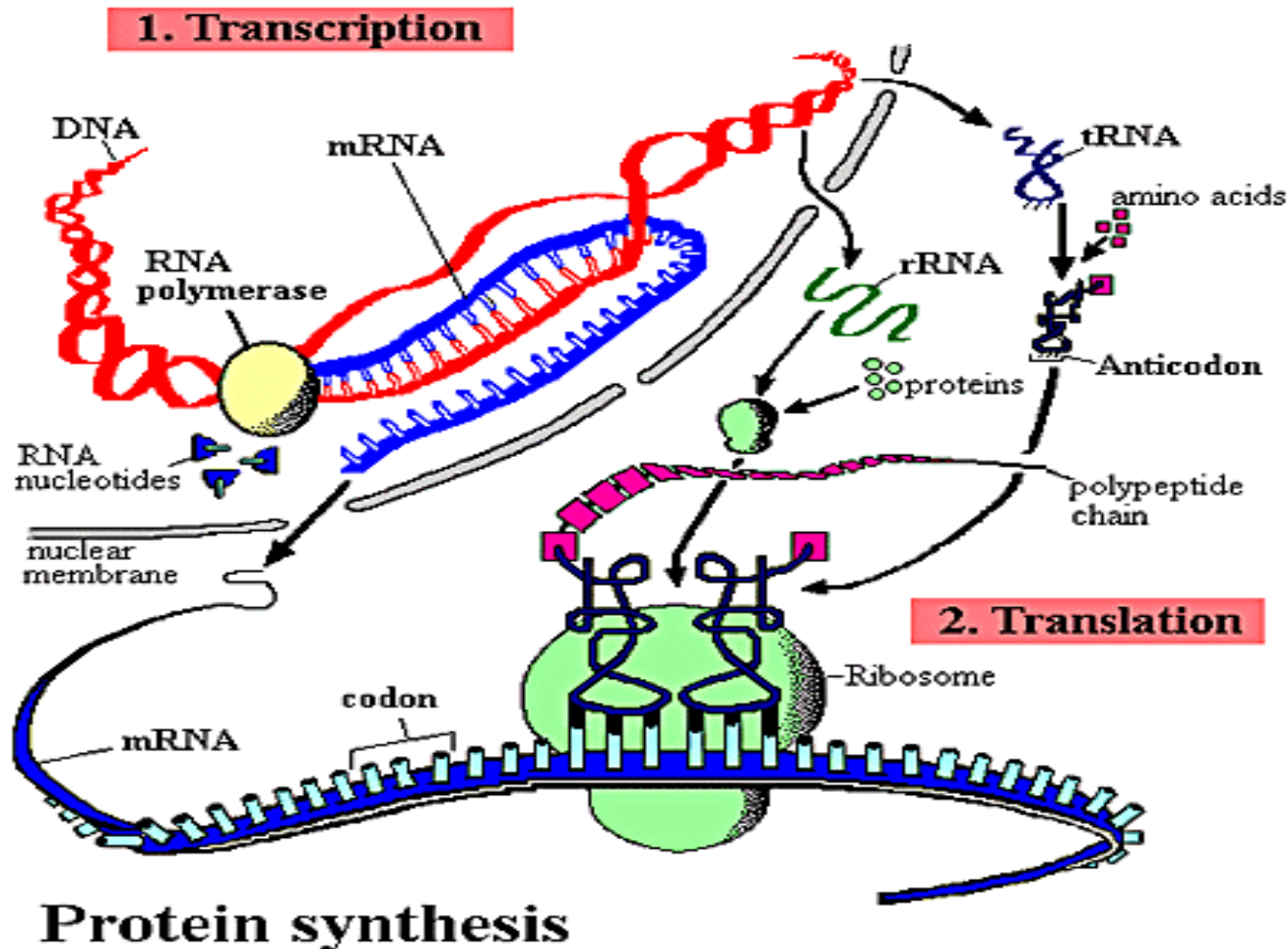


**How are animal proteins
made from DNA?**

In a process called “*Protein Synthesis*”



The Big Picture!!

Replication

DNA

Transcription

RNA

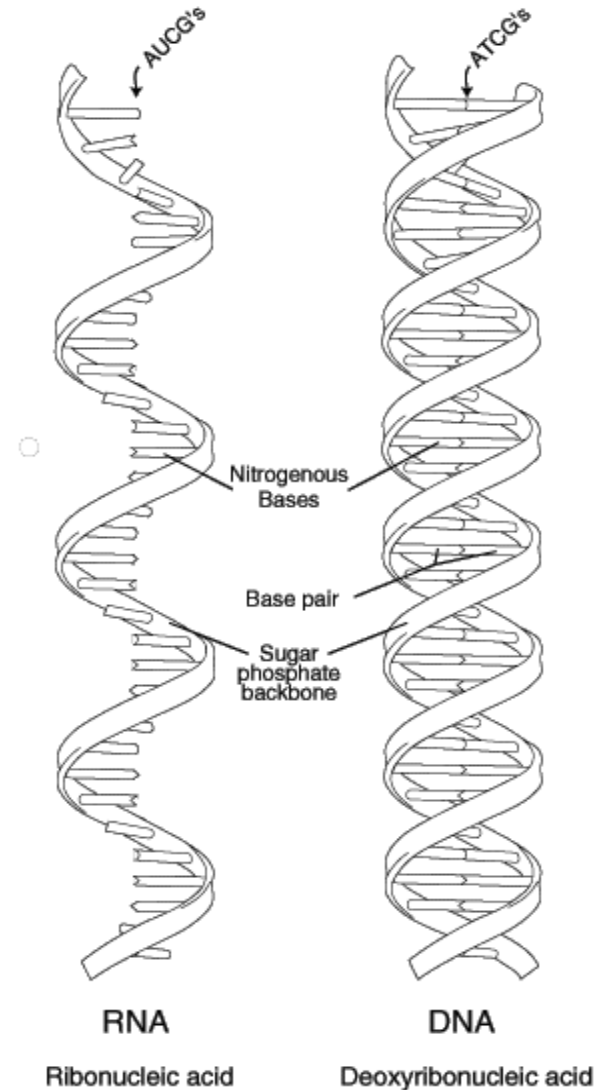
Translation

PROTEIN



What are the differences between DNA and mRNA?

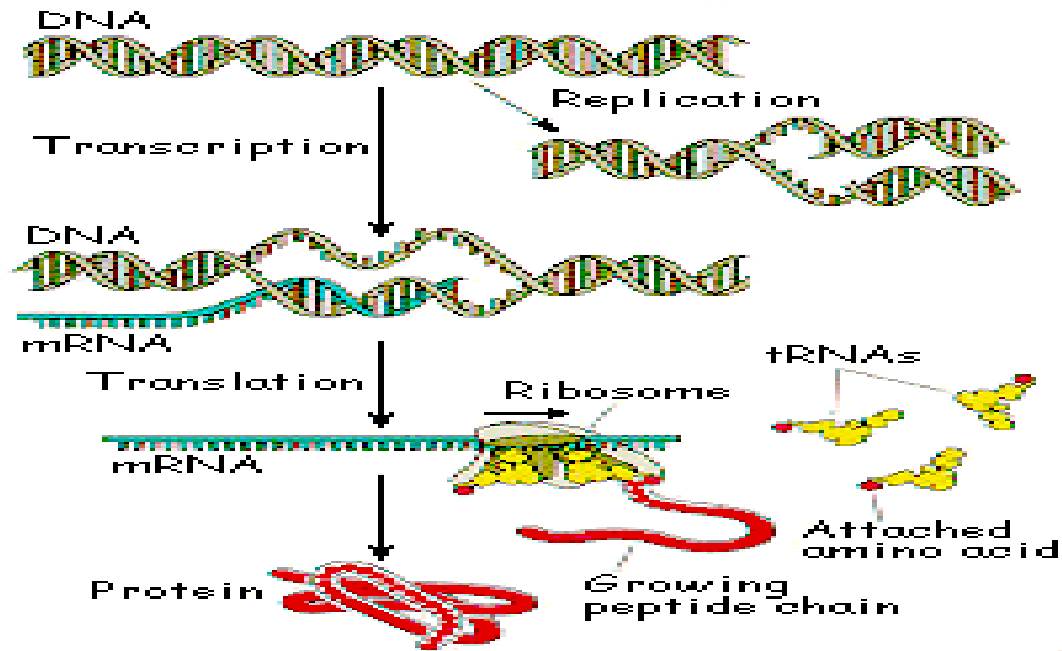
- DNA -
 - Double stranded
 - Deoxyribose sugar
- mRNA
 - Single stranded
 - Ribose sugar
 - Has uracil nucleotide in place of Thymine



There are two processes to protein synthesis!!

- Transcription DNA to mRNA (Messenger RNA). Takes place in the nucleus.
- Translation mRNA to tRNA (Transfer RNA). Takes place in the ribosomes of the cytoplasm.

Let's see these two processes up close in steps!!



What is “transcription?”

- A part of the DNA double helix within the nucleus is unzipped, cut by enzymes, and then copied onto a new single strand, called mRNA. This process is called “transcription.”
- Once the DNA is transcribed, the single strand moves from the nucleus to a ribosome in the cytoplasm of the cell. Thus the name, “messenger RNA.”

Nitrogen Bases

- You already learned that the nitrogen bases in DNA are:

Adenine – Thymine

Guanine – Cytosine

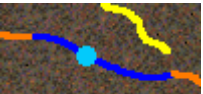
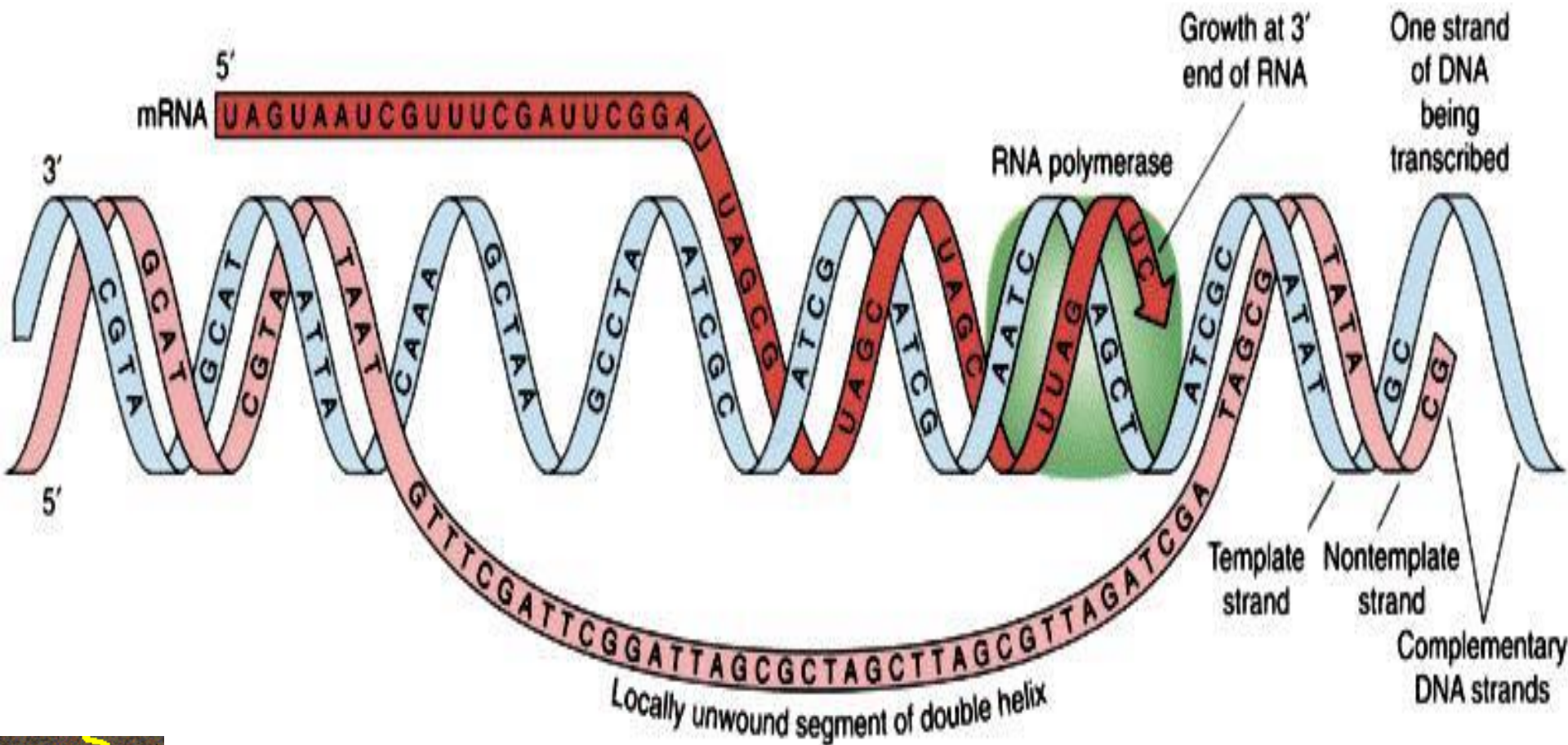
- The Nitrogen bases in RNA are similar, but rather than Thymine, RNA contains a similar base called Uracil. Thus, the base pairs are:

Adenine - Uracil

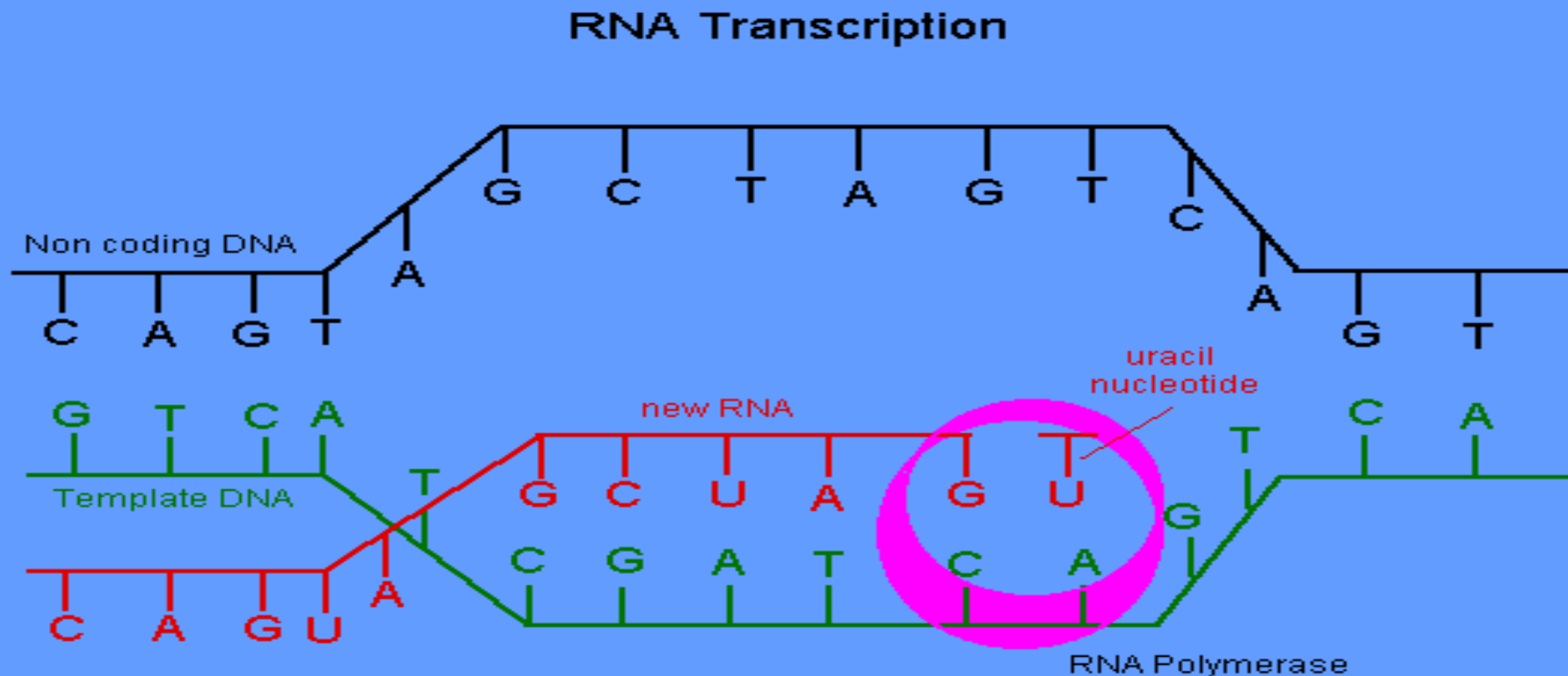
Guanine - Cytosine

Step 1 of Protein Synthesis

- DNA is copied in the process called **“Transcription”**.



- One strand of the DNA helix is used as a template to make “mRNA” (copy of the DNA section) during transcription.



C. Ophardt, c. 2003

Let's copy some DNA to mRNA!!

1. DNA strand

ATCGGCATCATT

2. MRNA strand _ _ _ _ _

_ _

3. DNA strand

ATGAAGGCGAAA

MRNA strand _ _ _ _ _

_

REMEMBER: in mRNA, Uracil replaces Thymine

Answer!!!

- DNA strand: ATCGGCATCATT
- mRNA strand: UAGCCGUAGUAA

- DNA strand: ATGAAGGCGAAA
- mRNA strand: UACUUCCGCUUU

Sample Question

- A. UUGGCCCGAUUGG
- B. TTGGCCCGATTGC
- C. AACCGGCTAACC

- Which strand is
- _____ DNA STRAND 1
- _____ DNA STRAND 2
- _____ mRNA

Answer!

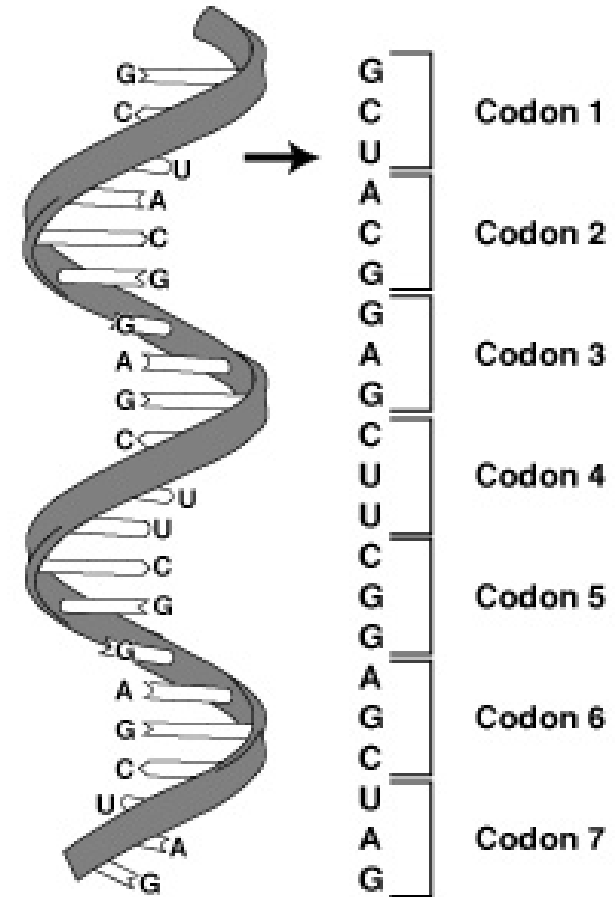
- A. UUGGCCCGAUUGG
 - B. TTGGCCCGATTGC
 - C. AACCGGCTAACC
-
- Which strand is
 - ___b or c___ DNA STRAND 1
 - ___b or c___ DNA STRAND 2
 - ___a___ mRNA

Now the message can be translated!!

- A single strand of mRNA was just transcribed from DNA within the nucleus and now the code will be translated to make the specific protein within a ribosome in the cytoplasm!!
- DNA strand TACATTTAGCGG
- mRNA strand AUGUAAAUCGCC

What is the structure of the mRNA code?

- Three mRNA nucleotides form a triplet code called a “codon.” Each codon sequence will then code for a tRNA with an anticodon with opposite nitrogen bases .

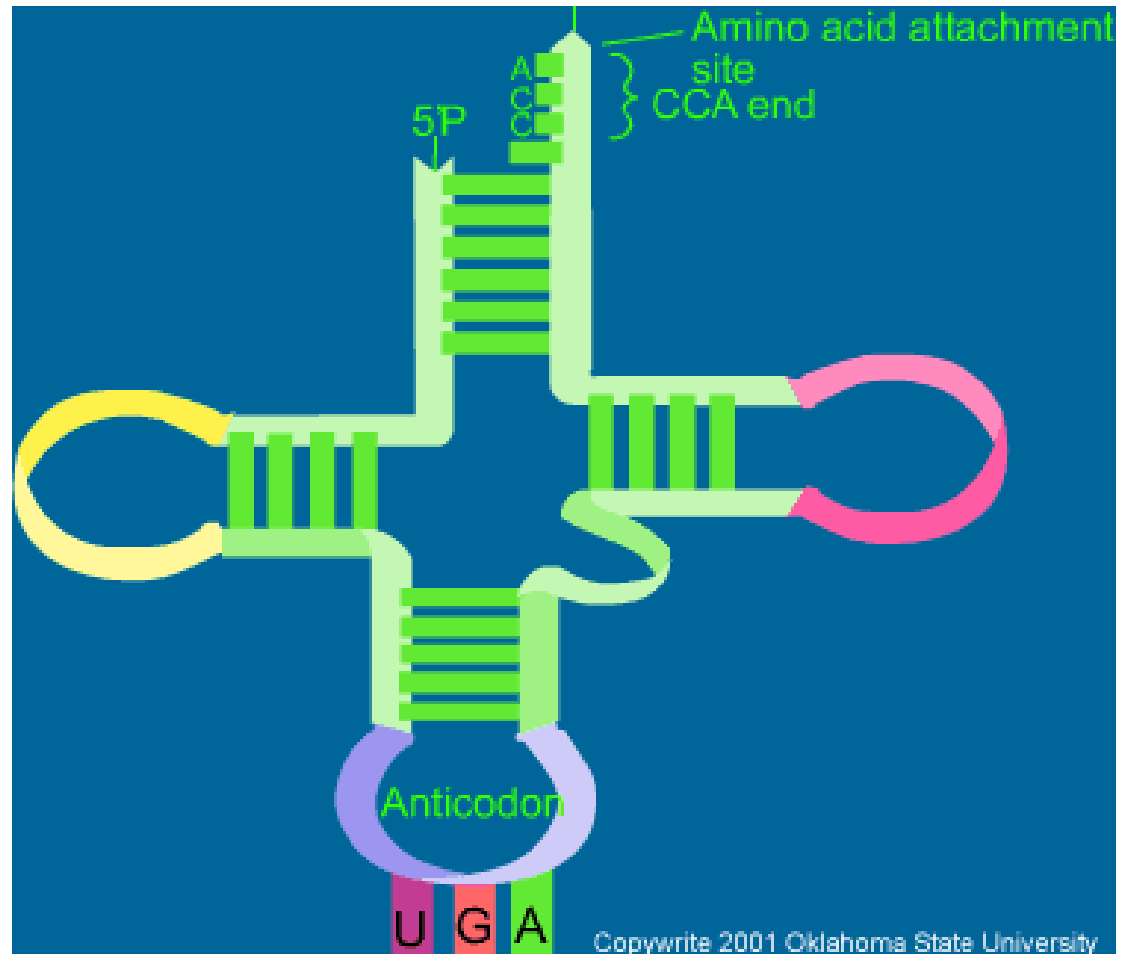


RNA

Ribonucleic acid

tRNA

- Notice UGA anticodon at bottom of the tRNA
- Notice Amino Acid at the top of the tRNA



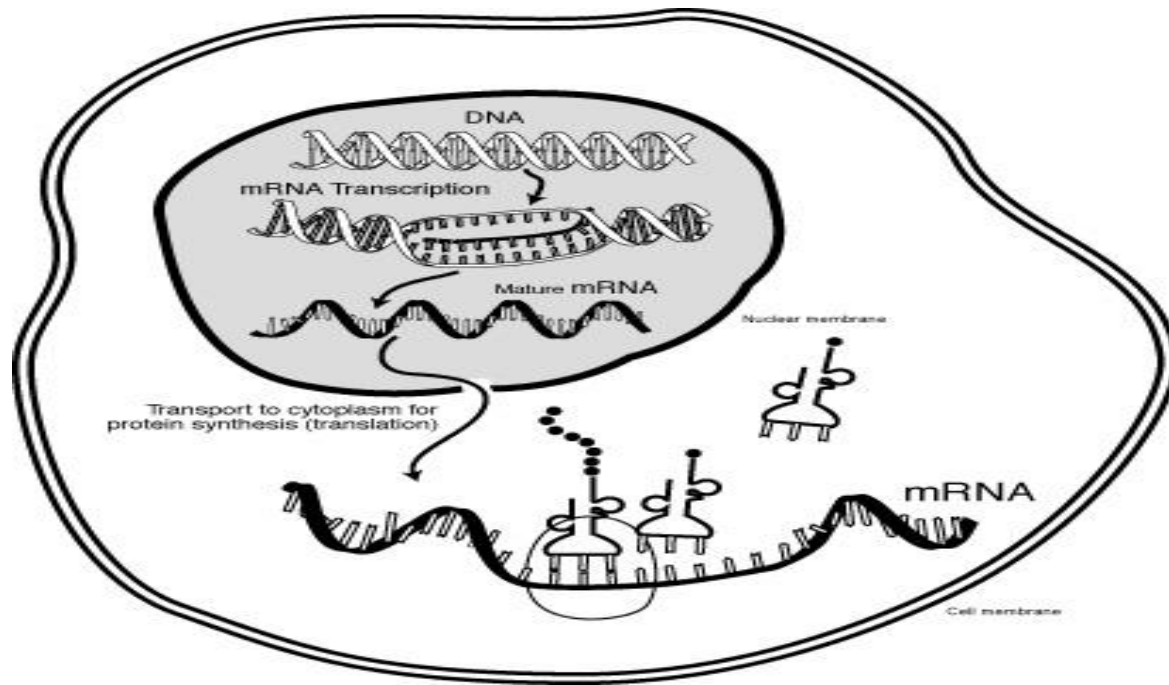
Genetic code

- There are 64 combinations using the four mRNA nucleotides AUGC to code for 20 amino acids.

		Second letter				
		U	C	A	G	
U	UUU } Phe	UCU } Ser	UAU } Tyr	UGU } Cys	U	
	UUC } Phe	UCC } Ser	UAC } Tyr	UGC } Cys	C	
	UUA } Leu	UCA } Ser	UAA Stop	UGA Stop	A	
	UUG } Leu	UCG } Ser	UAG Stop	UGG Trp	G	
C	CUU } Leu	CCU } Pro	CAU } His	CGU } Arg	U	
	CUC } Leu	CCC } Pro	CAC } His	CGC } Arg	C	
	CUA } Leu	CCA } Pro	CAA } Gln	CGA } Arg	A	
	CUG } Leu	CCG } Pro	CAG } Gln	CGG } Arg	G	
A	AUU } Ile	ACU } Thr	AAU } Asn	AGU } Ser	U	
	AUC } Ile	ACC } Thr	AAC } Asn	AGC } Ser	C	
	AUA } Ile	ACA } Thr	AAA } Lys	AGA } Arg	A	
	AUG Met	ACG } Thr	AAG } Lys	AGG } Arg	G	
G	GUU } Val	GCU } Ala	GAU } Asp	GGU } Gly	U	
	GUC } Val	GCC } Ala	GAC } Asp	GGC } Gly	C	
	GUA } Val	GCA } Ala	GAA } Glu	GGA } Gly	A	
	GUG } Val	GCG } Ala	GAG } Glu	GGG } Gly	G	

Step 2 of Protein Synthesis

- mRNA is used to pair up with tRNA to code for amino acids that form a chain to make a specific protein in a process called “translation.”

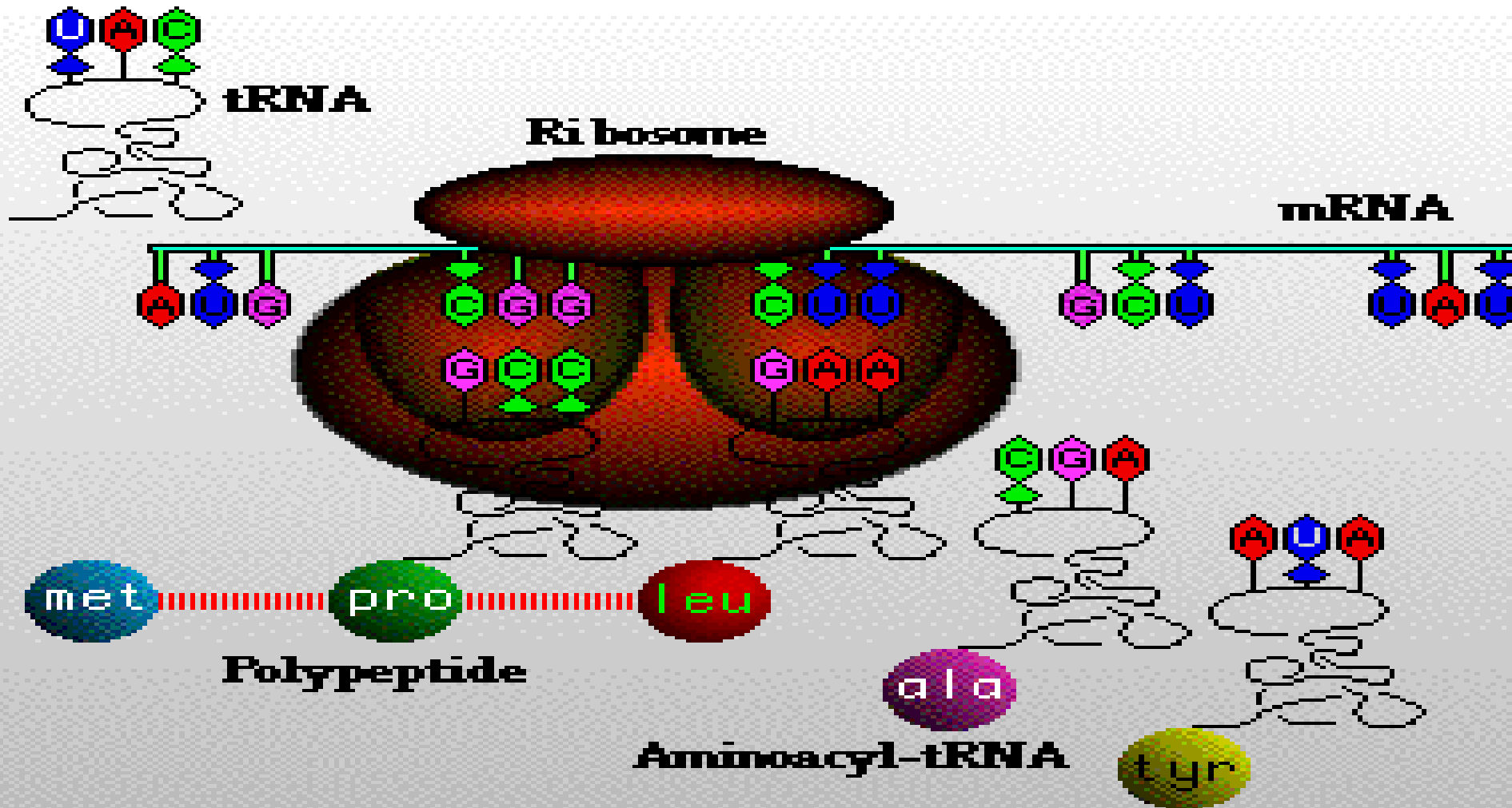


What is “translation”?

- A ribosome binds mRNA to tRNA, which is attached to specific amino acids as anticodons. Each anticodon of tRNA attaches to a codon on mRNA. An amino acid is attached to the top of a tRNA. The amino acids bond together, forming a polypeptide chain that make a specific protein.

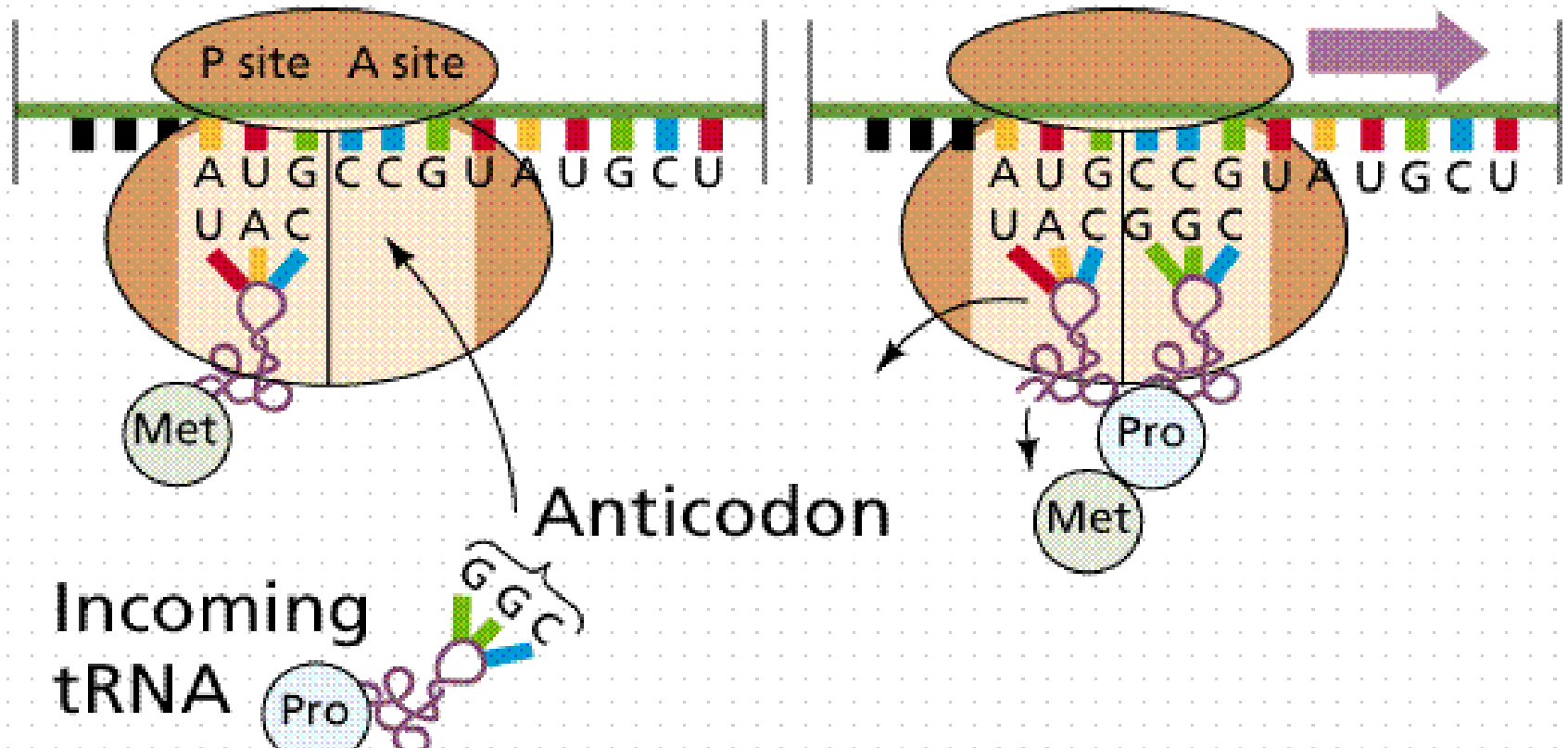
Where does translation take place?

- In ribosomes in the cell's cytoplasm

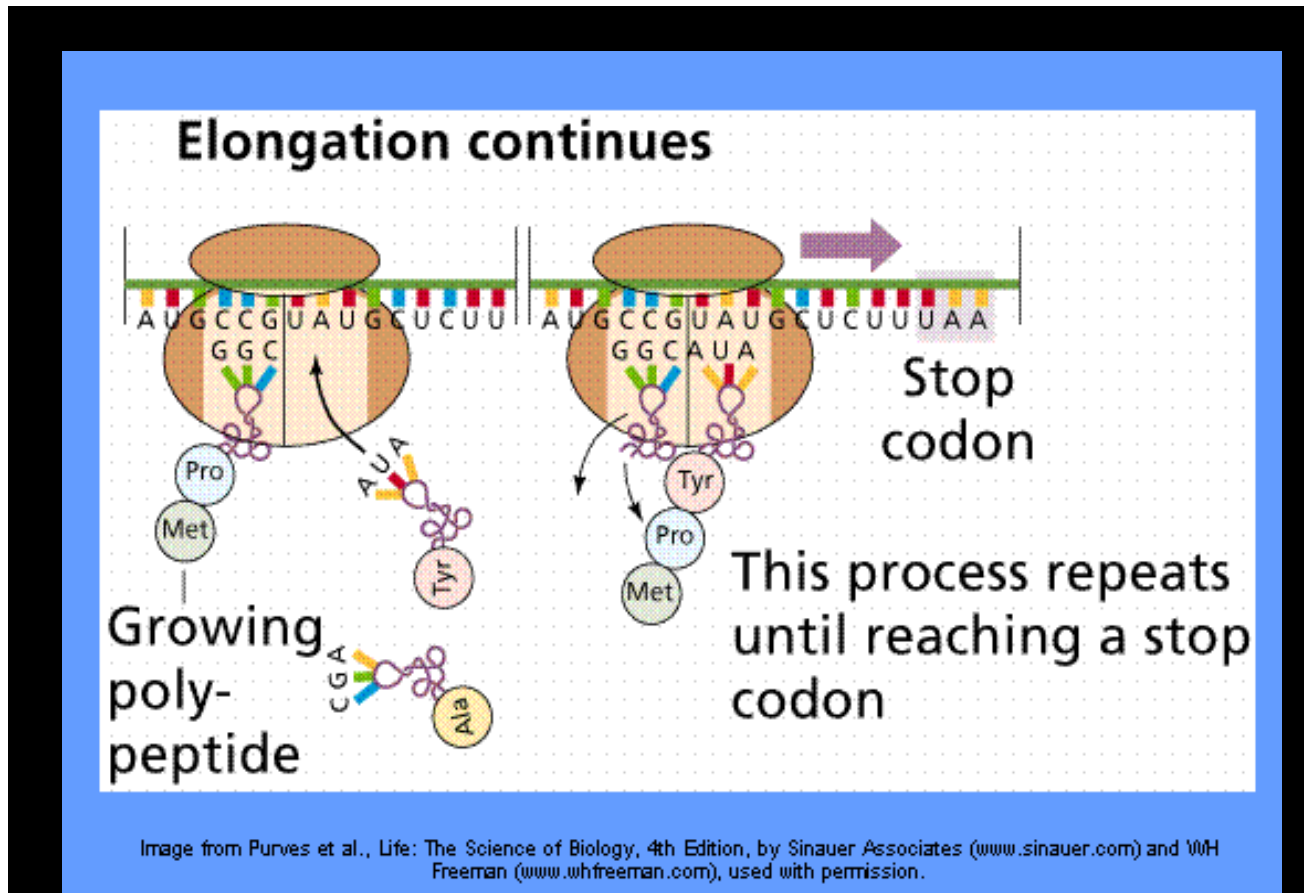


tRNA anticodon (UAC) binds mRNA at the START codon (AUG) to begin the translation message

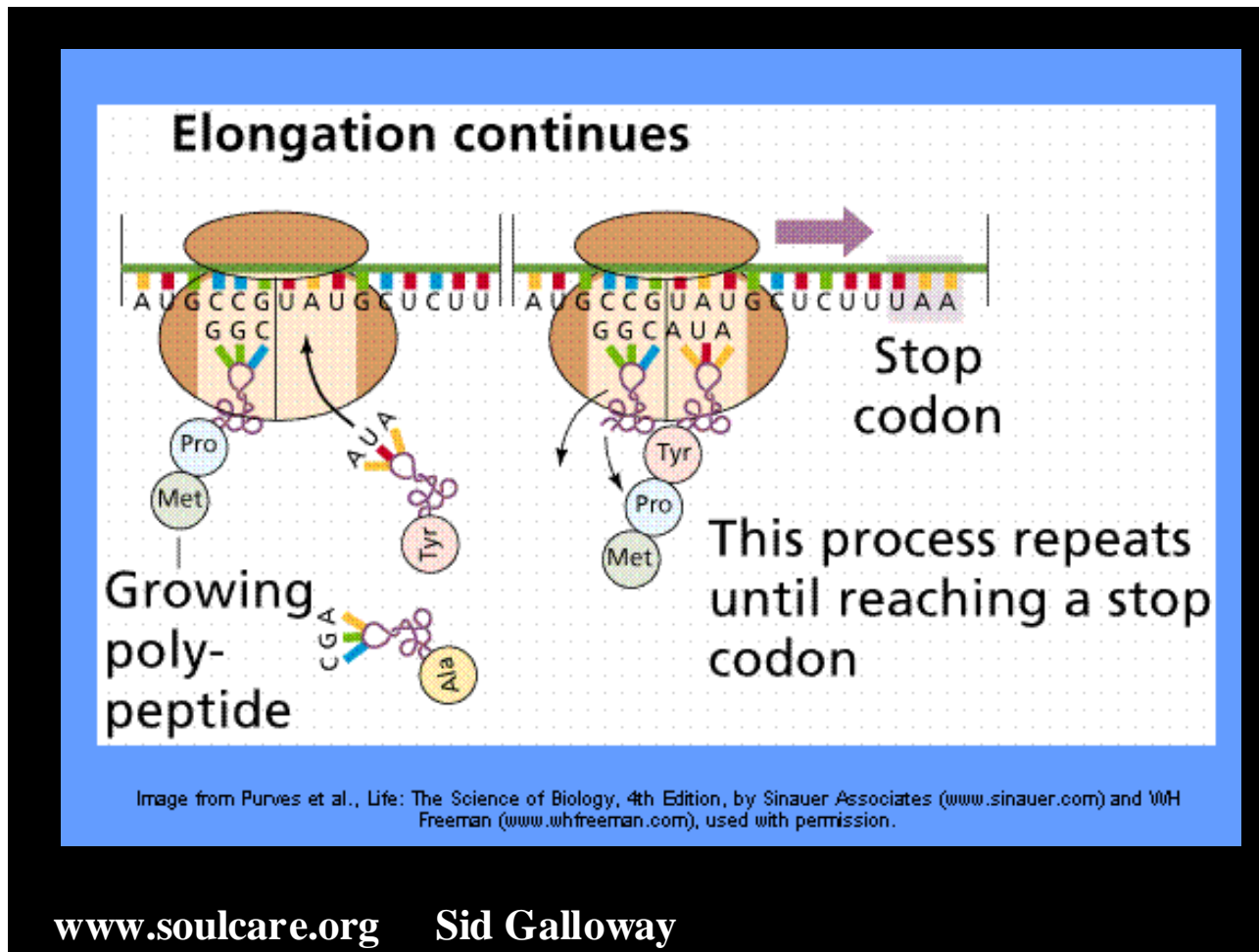
Elongation (translation)



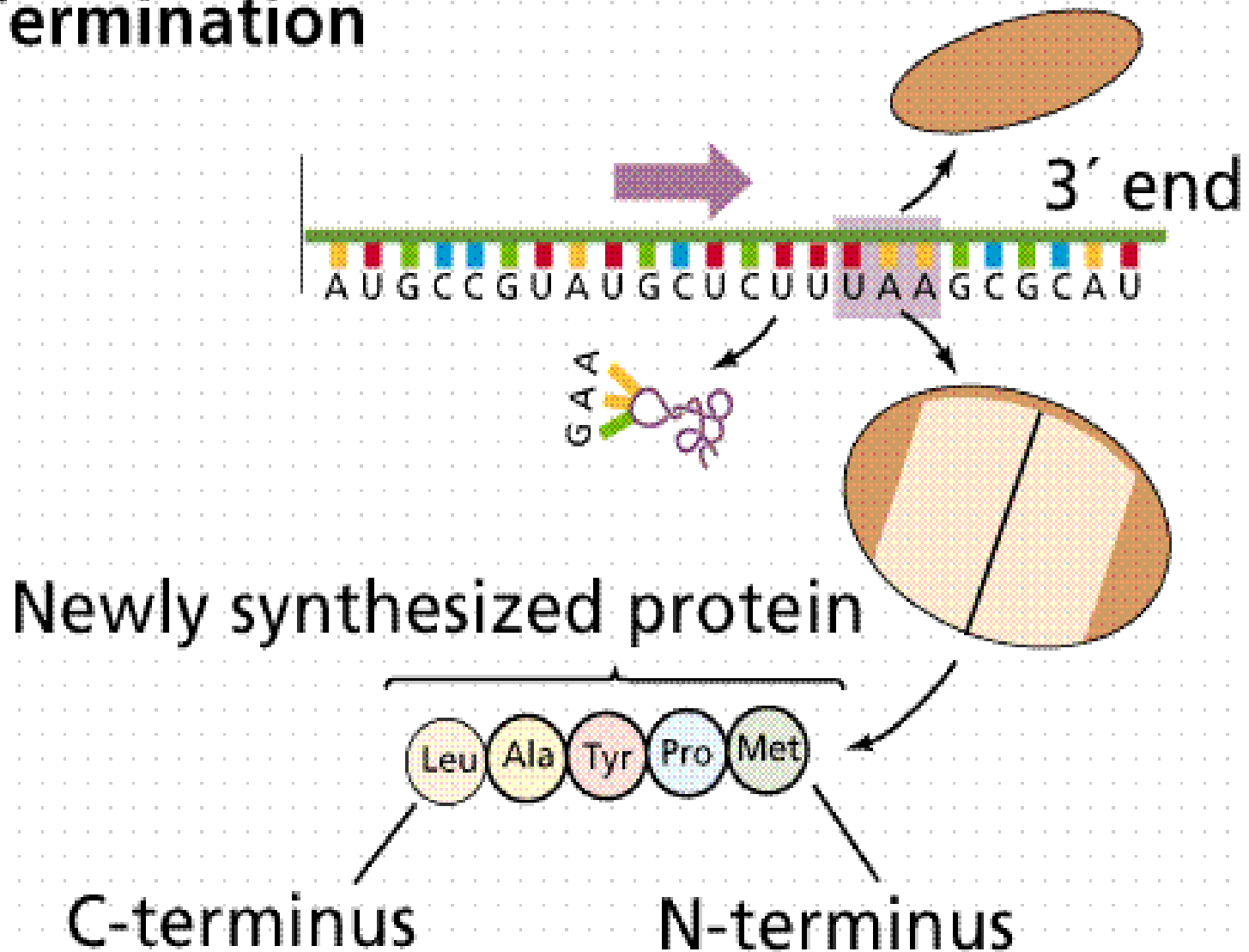
Each tRNA carries a specific amino acid. The amino acids bind together to make a polypeptide chain to make specific proteins.



- At the end (stop codon), a release enzyme binds to a stop codon in the sequence. This stops translation, releasing the completed chain of protein.



Termination



Complete the following code!!

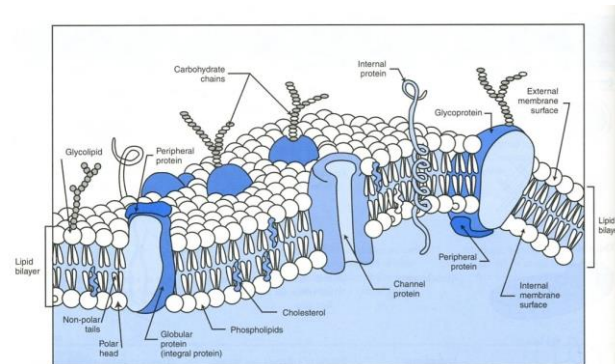
- DNA AT _ CGG _ _ _ TGG
- DNA TAC _ _ _ CGT ACC
- mRNA _ _ _ _ _ _ _ _ _ _
- tRNA _ _ C G _ _ _ _ _ _ _ _
- A.A _____ =Protein
 - (Use the table to find the correct amino acid)

Complete the following code!!

- DNA ATG CGG GCA TGG
- DNA TAC GCC CGT ACC
- mRNA AUG CGG GCA UGG
- tRNA UAC GCC CGU ACC
- A.A TRY ALA ARG THR = Protein
 - (Use the table to find the correct amino acid)

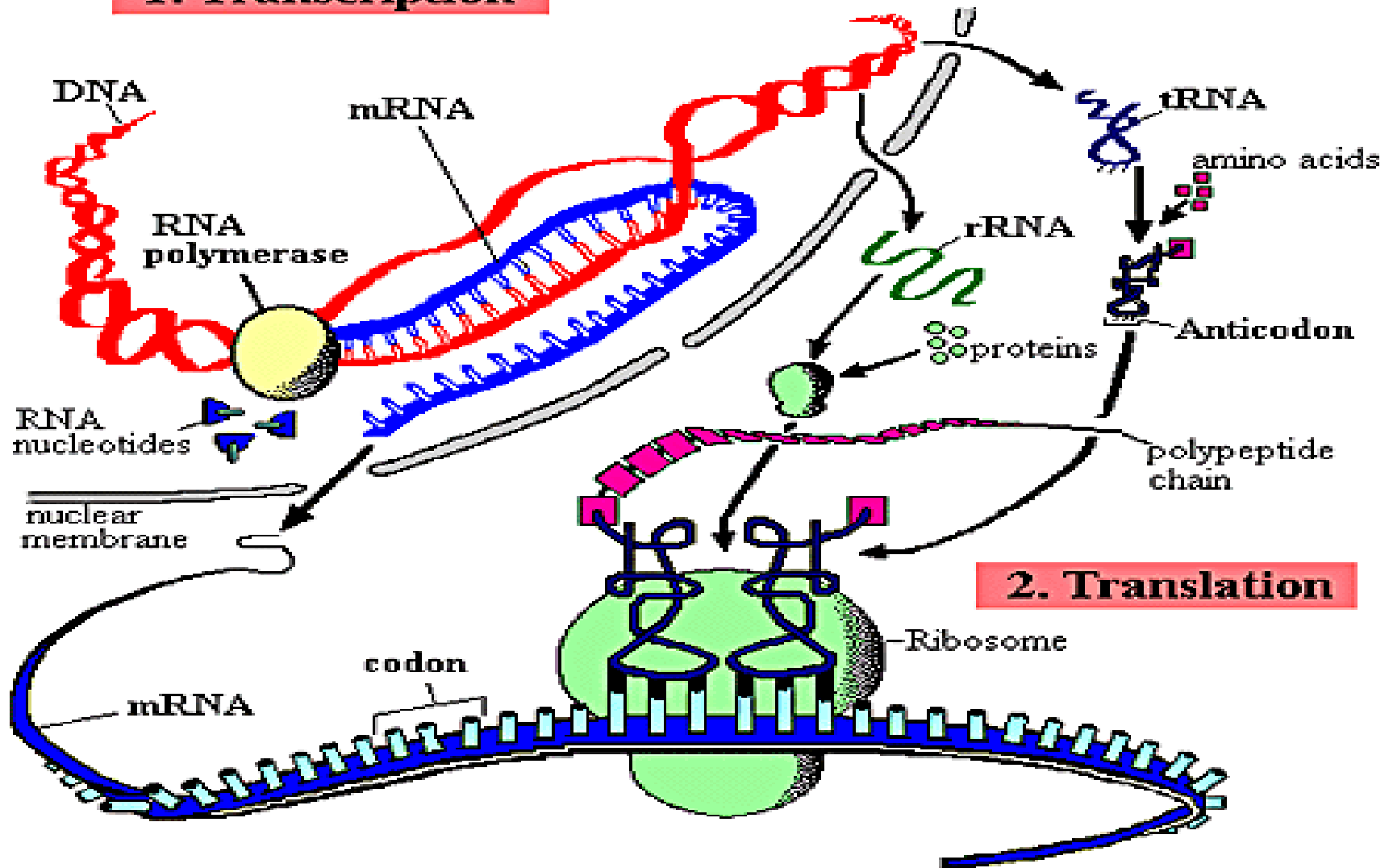
How is this new animal protein used?

- It may be used for:
- Structure
muscle, bone, hair
- Cell membranes
- Chemicals
special enzymes



Big Picture in Action

1. Transcription



2. Translation

Protein synthesis