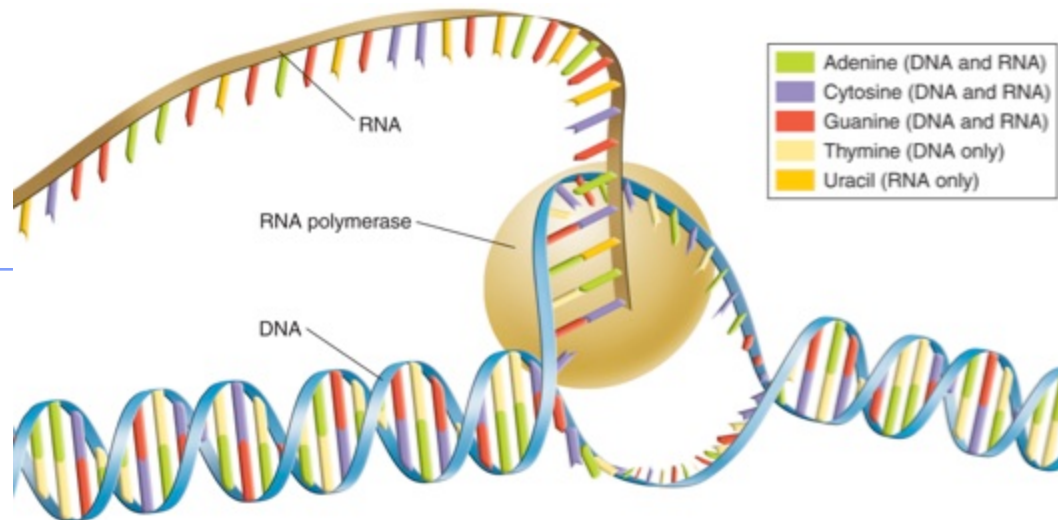


# 12.3 - RNA and Protein Synthesis



# Protein Synthesis

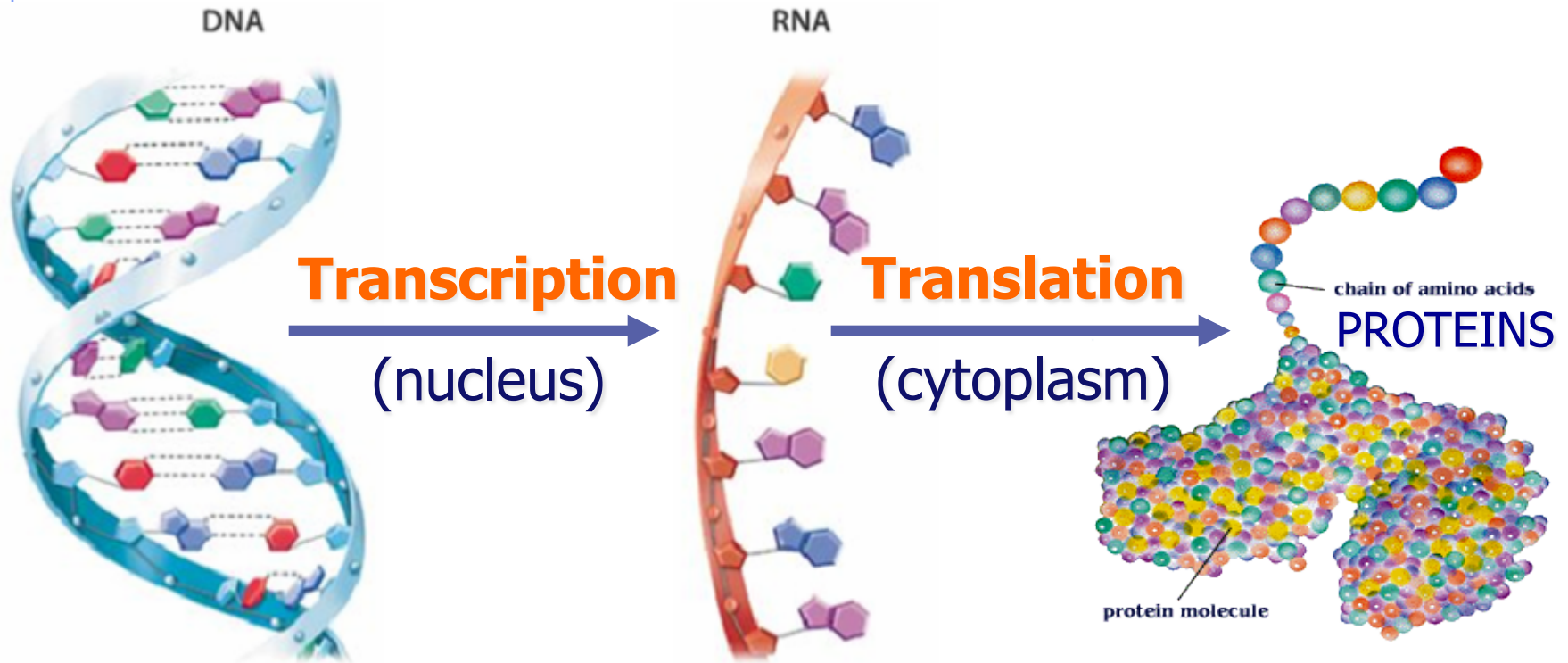


# Objectives

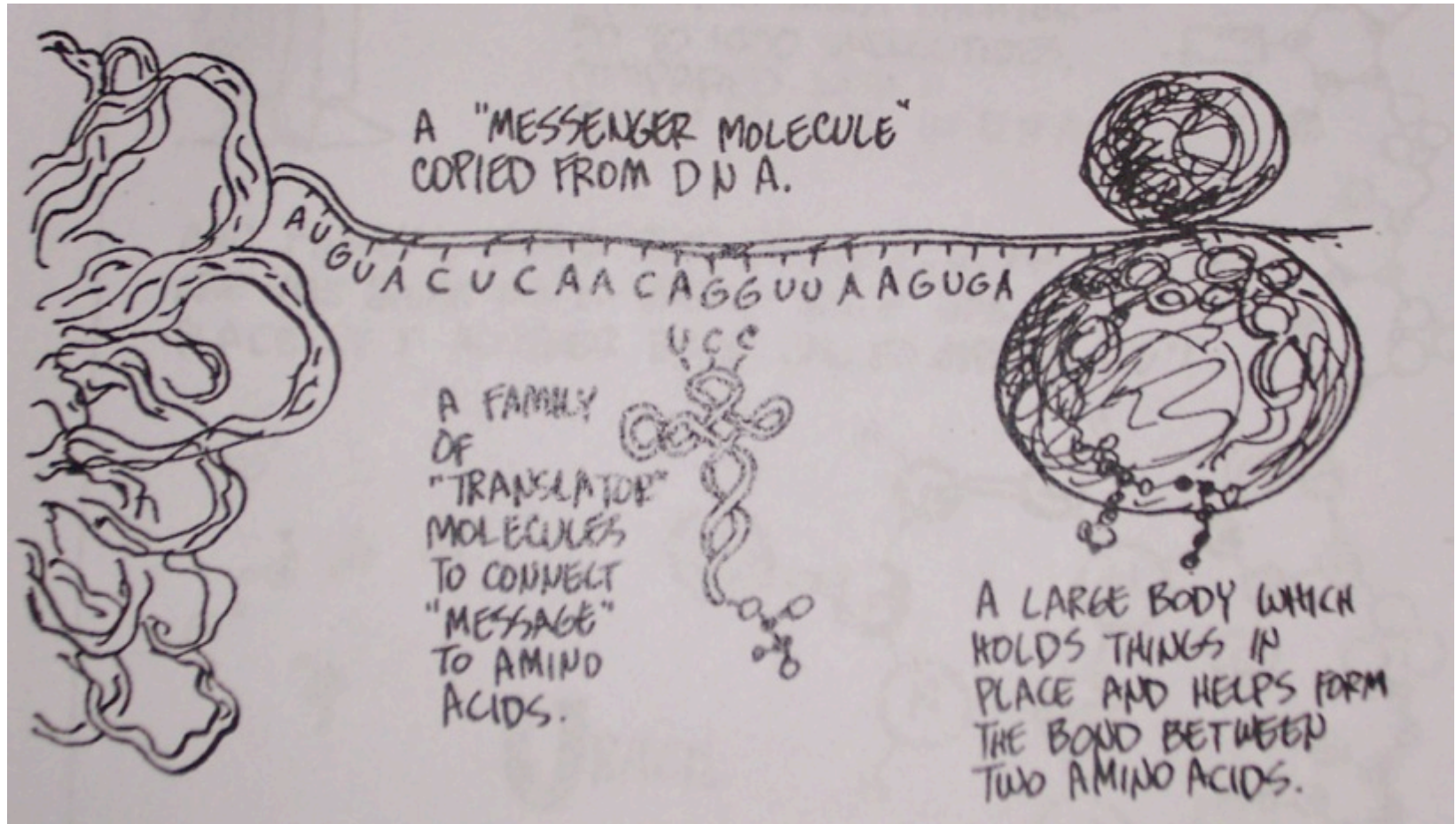
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- Distinguish **RNA** from **DNA**
- Identify the 3 types of RNA
- Summarize the steps of **transcription** and explain how RNA is edited
- Summarize the steps of **translation**

# The Central Dogma

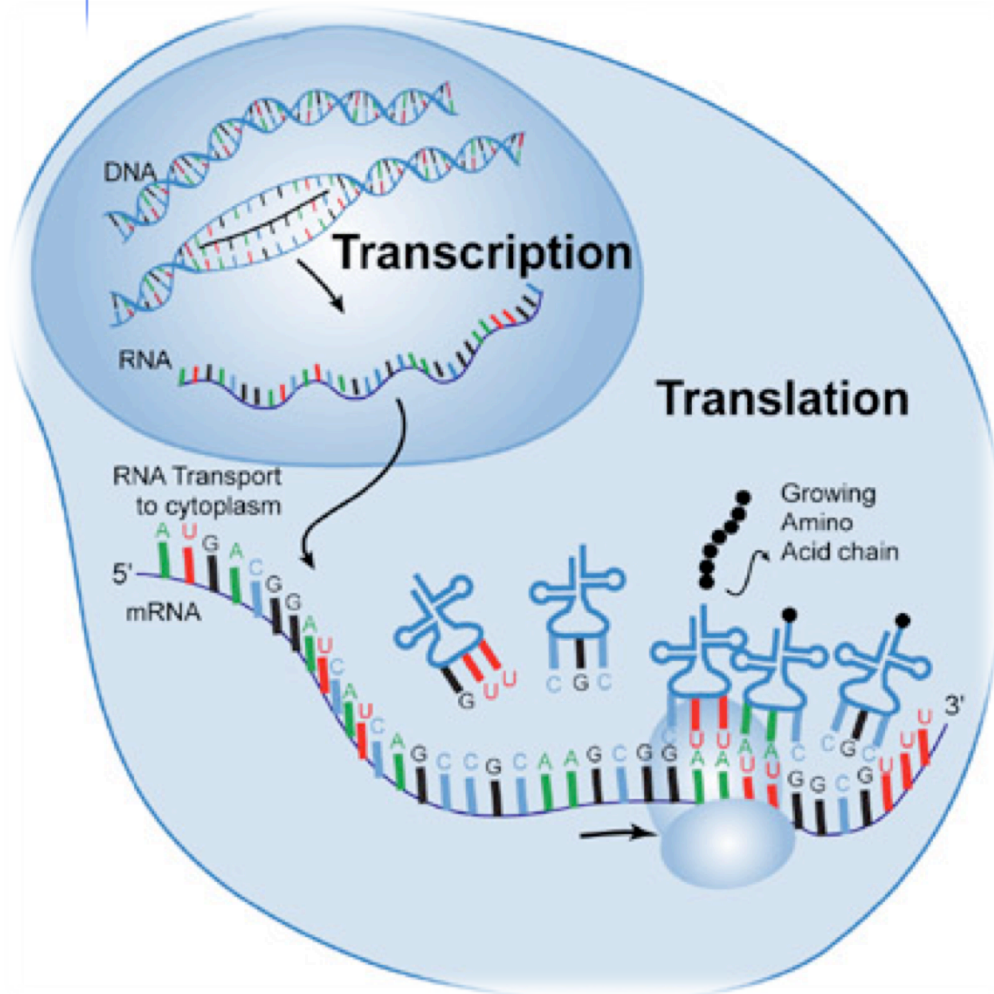


# The Central Dogma



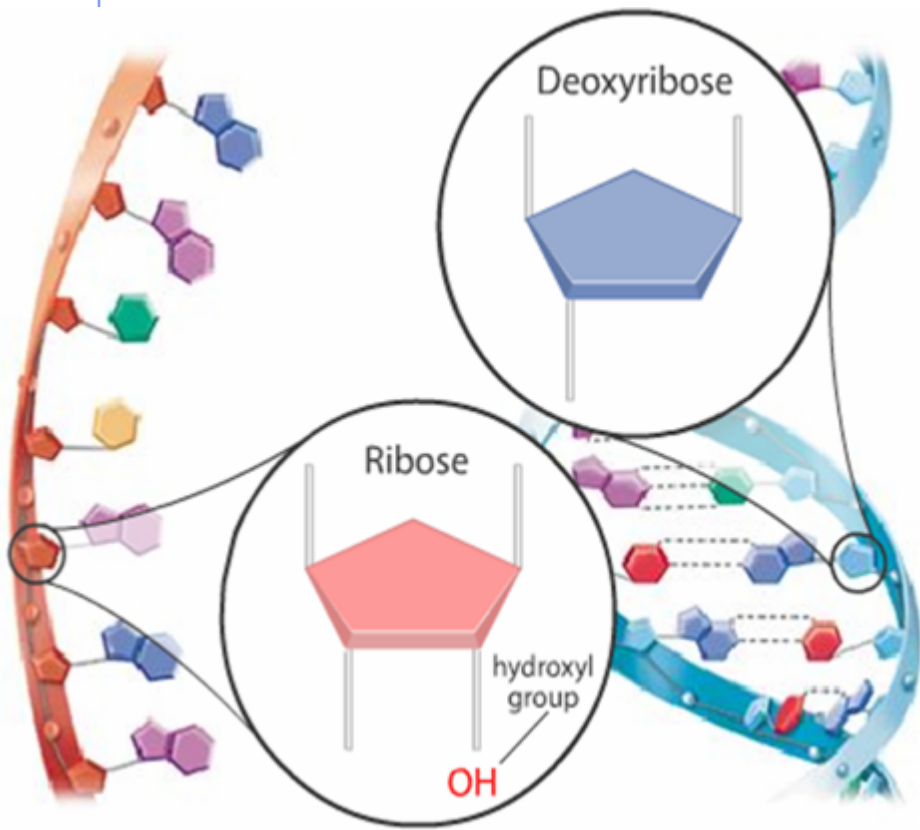


# RNA and Protein Synthesis



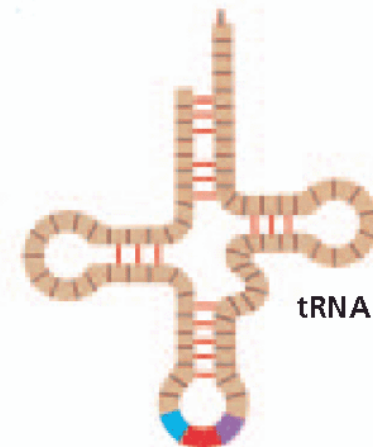
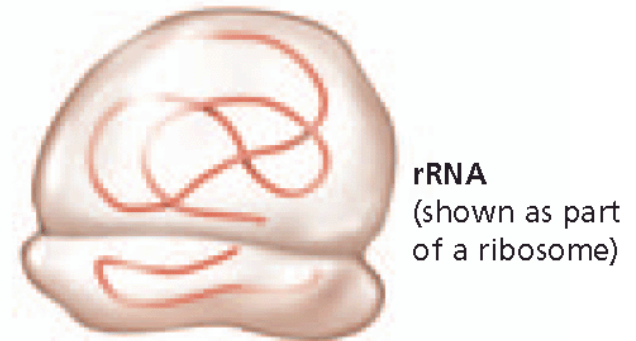
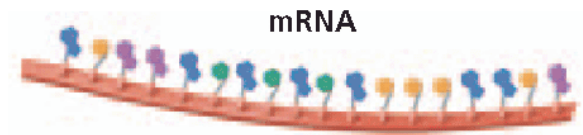
- **Traits** are determined by **proteins** that are built as coded in DNA.
- **Protein synthesis** occurs in the cytoplasm (while DNA is in the nucleus). Thus, **RNA** acts as a **go-between message**.
- Like DNA, RNA is a nucleic acid.

# RNA vs. DNA



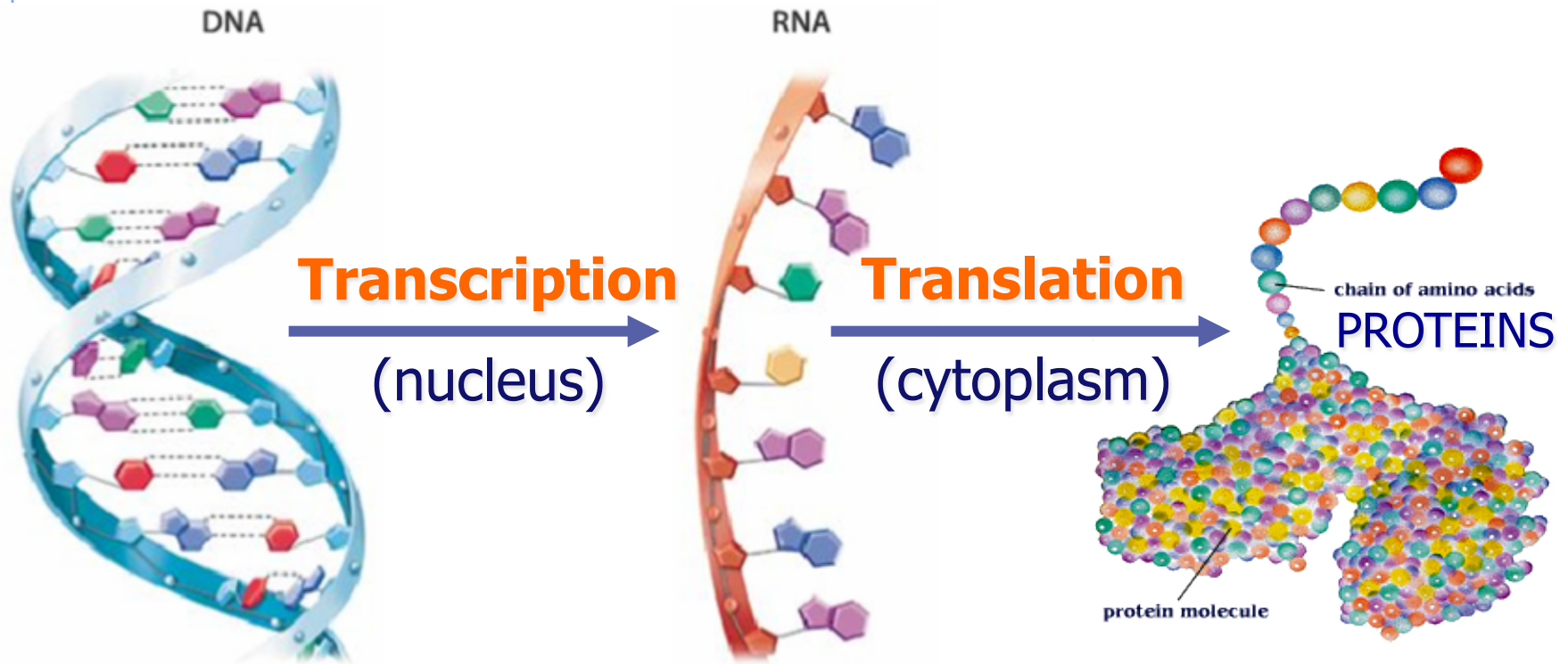
<b>RNA</b>	<b>DNA</b>
Single strand	Double strands
Ribose	Deoxyribose
Uracil (U)	Thymine (T)

- **Messenger RNA (mRNA)** delivers information from DNA to the ribosome.
- **Ribosomal RNA (rRNA)** are parts of the structure of ribosome.
- **Transfer RNA (tRNA)** carries and eventually transfers amino acids.





# The Central Dogma



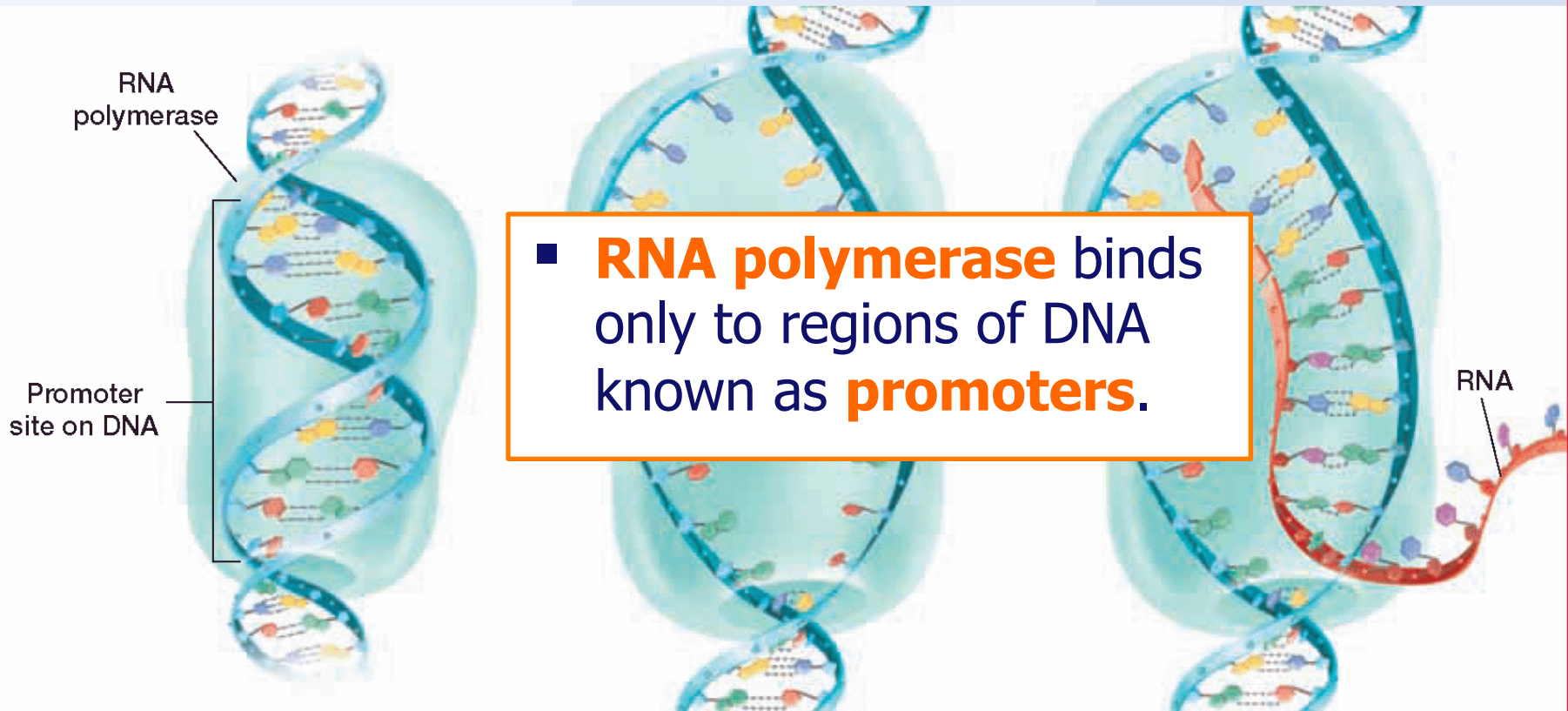
- **Transcription** – Information from DNA (a master copy) is “rewritten” into RNA (a **blueprint**).



## Transcription: Making RNA

RNA polymerase adds complementary RNA nucleotides as it reads the gene.

- 1 RNA polymerase binds to the gene's promoter.
- 2 The two DNA strands unwind and separate.
- 3 Complementary RNA nucleotides are added.





## Transcription: Making RNA

RNA polymerase adds complementary RNA nucleotides as it reads the gene.

**1** RNA polymerase binds to the gene's promoter.

**2** The two DNA strands unwind and separate.

**3** Complementary RNA nucleotides are added.







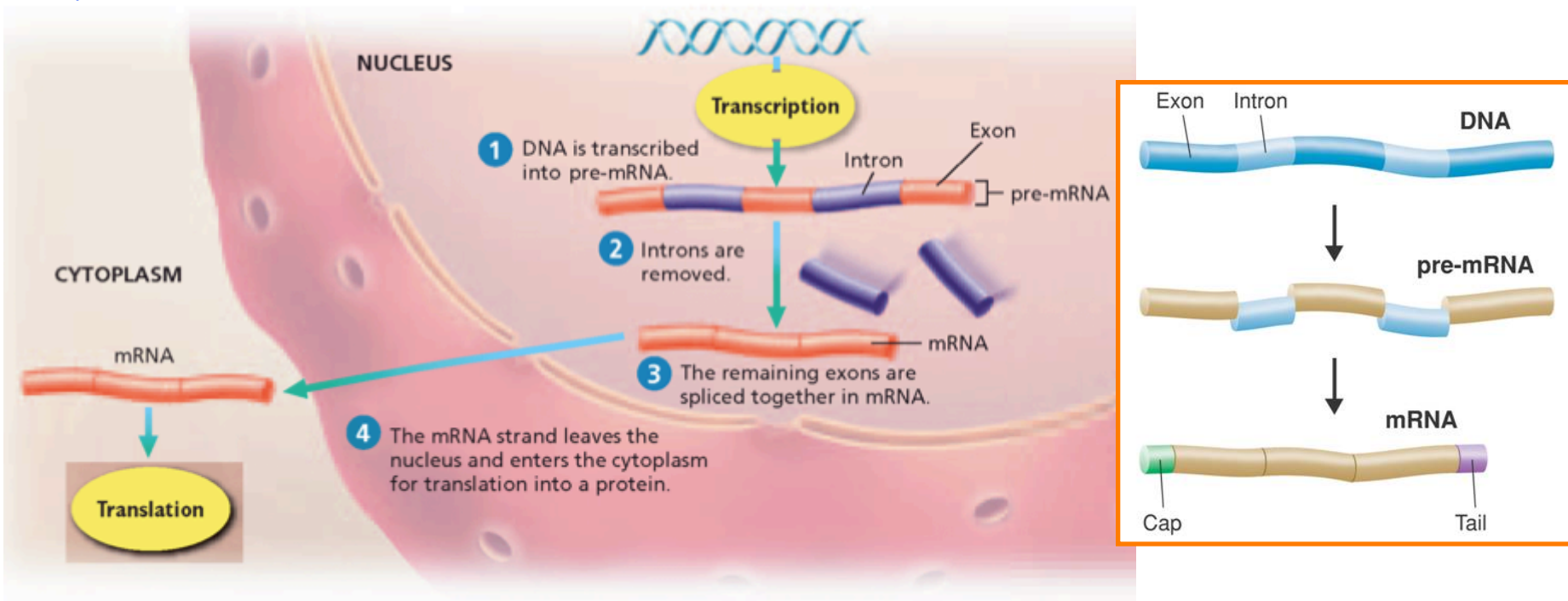
## Transcription: Making RNA

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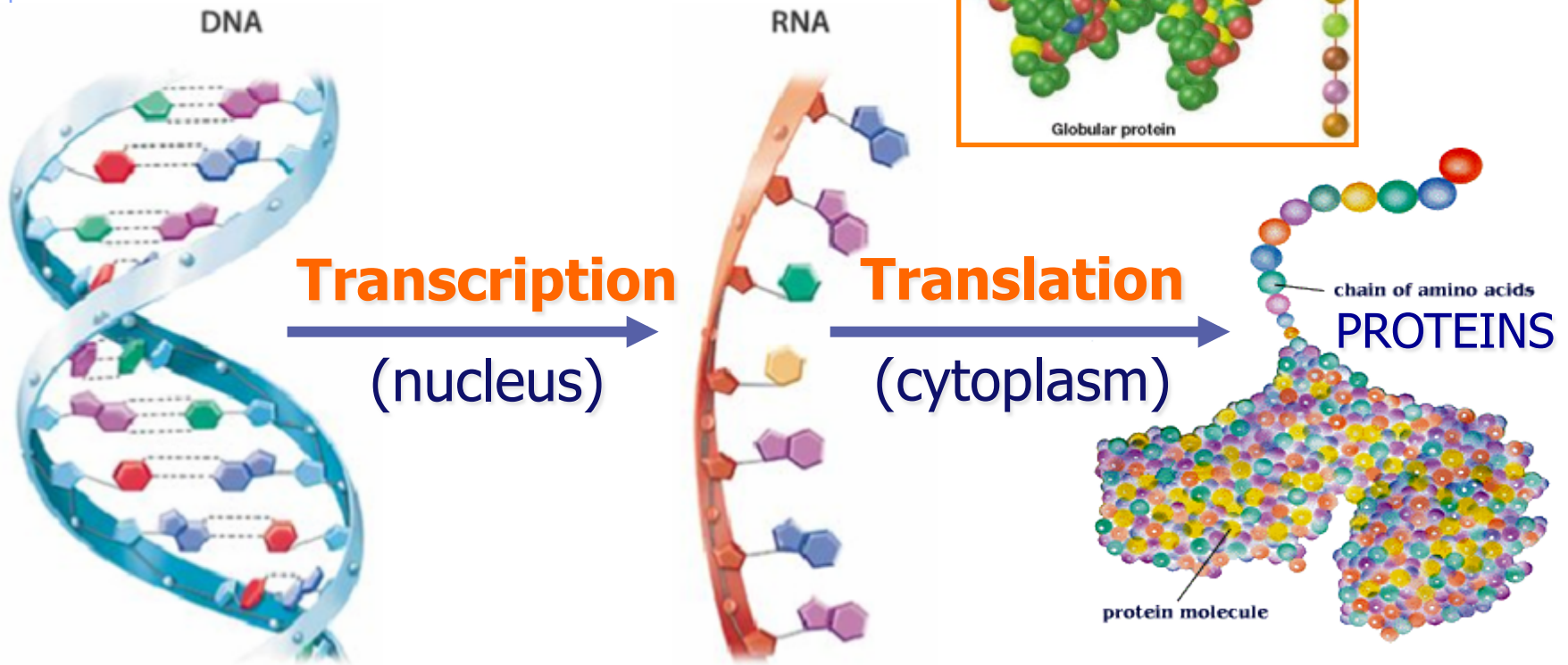
# RNA Editing



- **Introns** – DNA sequences *NOT* involved in coding for proteins
- **Exons** – sequences that code for proteins (i.e., “expressed”)



# The Central Dogma



- **Translation** – Information from RNA is “translated” into proteins.

# How are Proteins Important?

## Structural Proteins

Hair (keratin)

Fingernails (keratin)

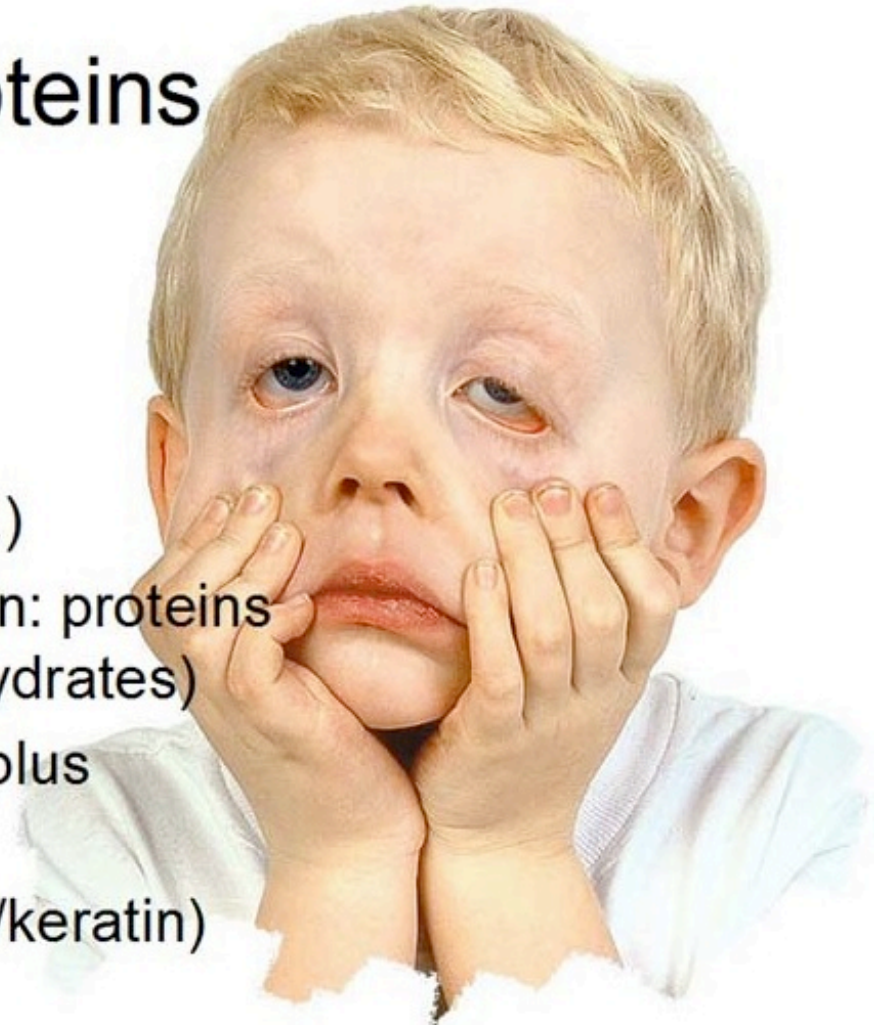
Skin (collagen)

Muscles (myosin, etc.)

Cartilage (glycoprotein: proteins attached to carbohydrates)

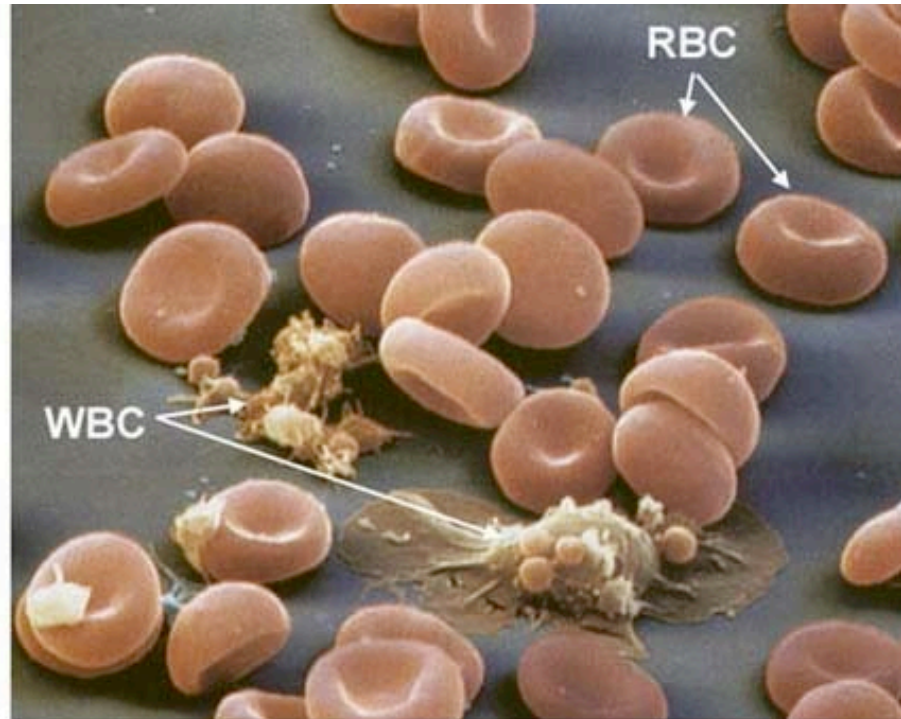
Ligaments (collagen plus glycoproteins)

Eye cornea (collagen/keratin)



## Chemical Proteins

- In red blood cells (RBC), the protein, hemoglobin, carries the oxygen.



- The white blood cells (WBC) create specialized proteins called antibodies that can neutralize toxic substances in the blood. White blood cells also create hydrogen peroxide to kill bacteria.



# Translation

BIO  
graphic

## Translation: Assembling Proteins

Amino acids are assembled from information encoded in mRNA.

1 The ribosomal subunits, the mRNA, and the tRNA carrying methionine bind together.

2 The tRNA carrying the amino acid specified by the codon in the A site arrives.

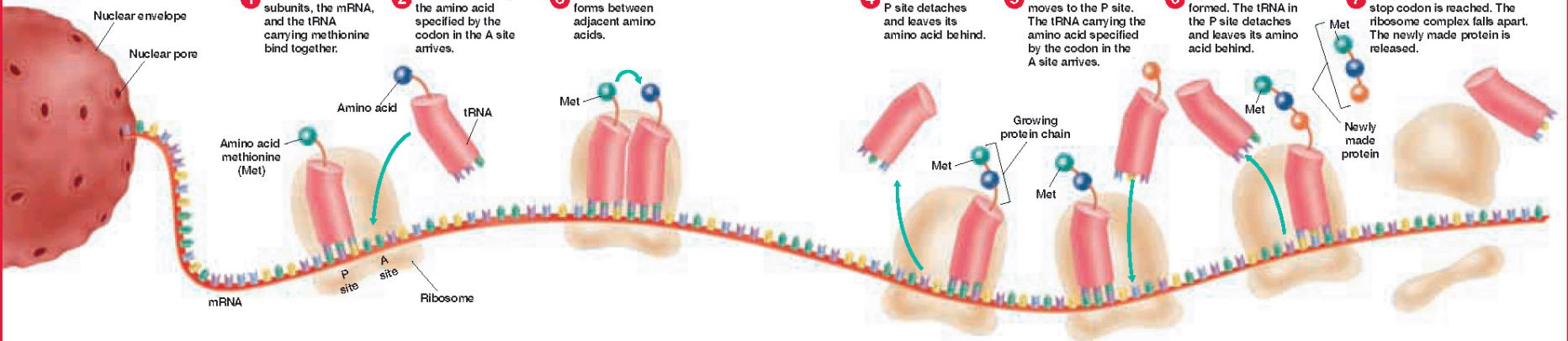
3 A peptide bond forms between adjacent amino acids.

4 The tRNA in the P site detaches and leaves its amino acid behind.

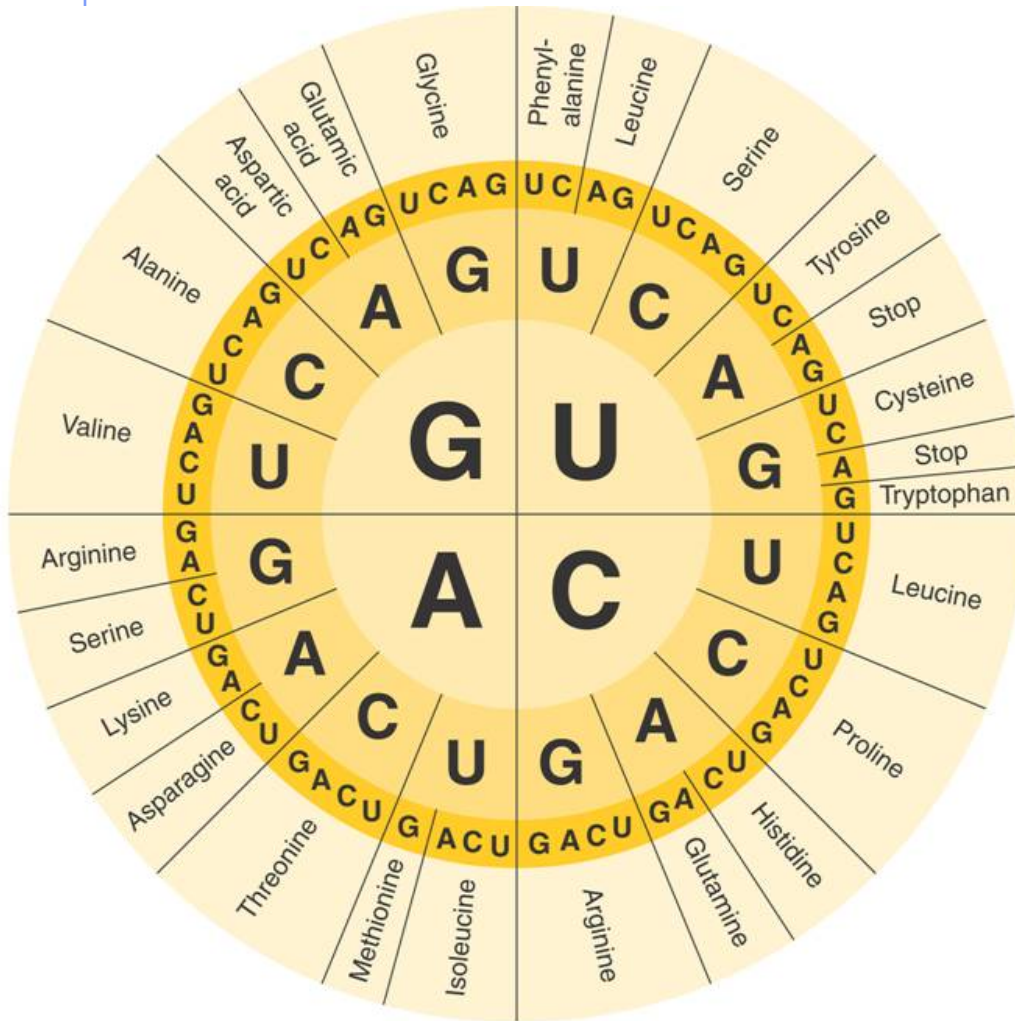
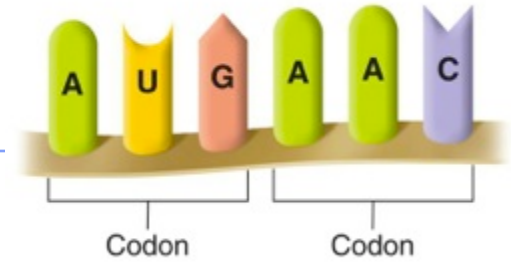
5 The tRNA in the A site moves to the P site. The tRNA carrying the amino acid specified by the codon in the A site arrives.

6 A peptide bond is formed. The tRNA in the P site detaches and leaves its amino acid behind.

7 The process is repeated until a stop codon is reached. The ribosome complex falls apart. The newly made protein is released.

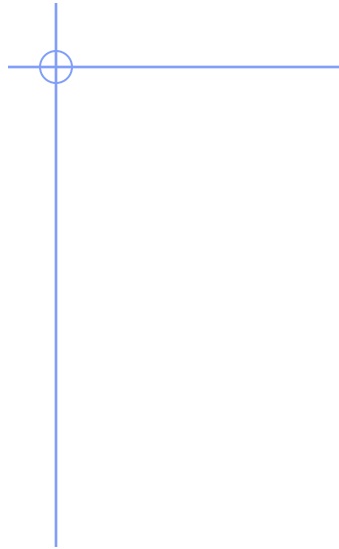


# The Genetic Code



- The bases must be read in **groups of three bases** called **codons**.
- 4 possibilities for each base of a codon, the total number of mRNA codons is \_\_\_\_\_.
- Each **codon** specifies a particular **amino acid** to be added to the polypeptide chain.

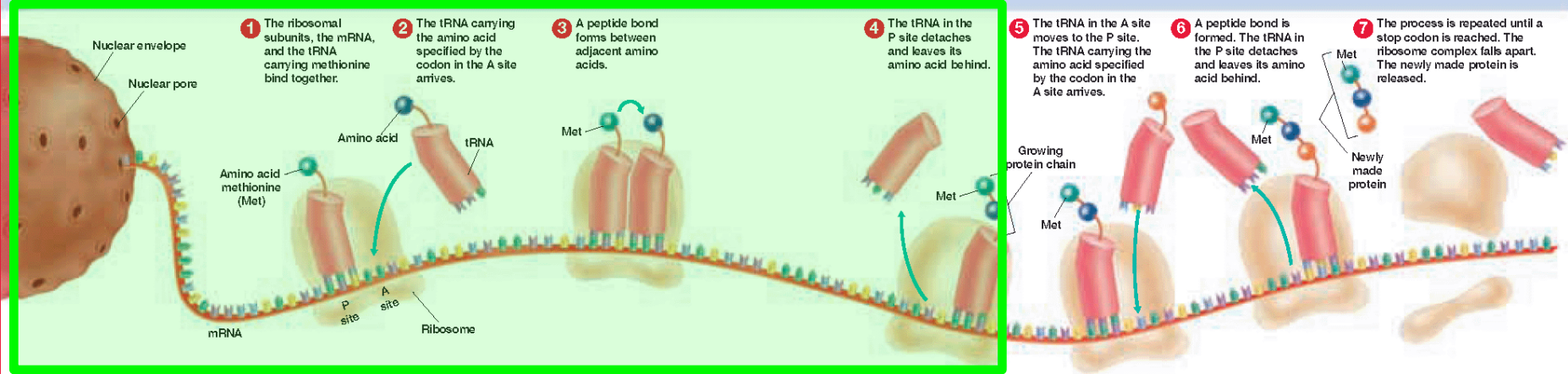




		Second base					
		U	C	A	G		
First base (5' end)	U	UUU	UCU UCC UCA UCG	UAU	UGU UGC UGA UGG	U	
		UUC		UAC		C	
		UUA		UAA Stop		A	
		UUG		UAG Stop		G	
	C	CUU	CCU CCC CCA CCG	CAU	CGU CGC CGA CGG	U	
		CUC		CAC		C	
		CUA		CAA		A	
		CUG		CAG		G	
	A	AUU	ACU ACC ACA ACG	AAU	AGU AGC AGA AGG	U	
		AUC		AAC		C	
		AUA		AAA		A	
		AUG Met or start		AAG		G	
G	GUU	GCU GCC GCA GCG	GAU	GGU GGC GGA GGG	U		
	GUC		GAC		C		
	GUA		GAA		A		
	GUG		GAG		G		

## Translation: Assembling Proteins

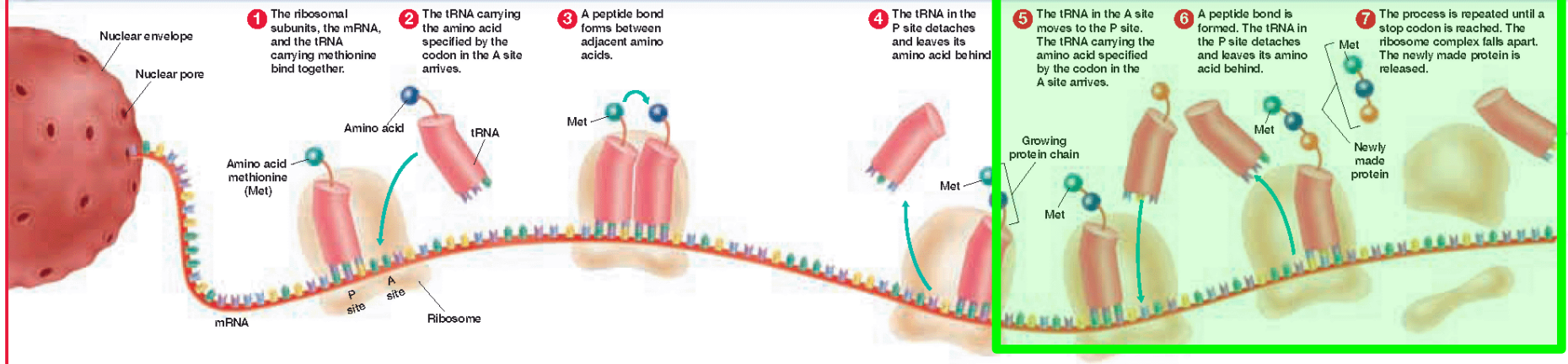
Amino acids are assembled from information encoded in mRNA.



- mRNA “start” codon **AUG** starts protein synthesis; tRNA with **methionine** is at P site.
- A tRNA with the specified amino acid binds to the A site.
- **Peptide bond** links the 2 amino acids.
- tRNA in P site departs, leaving its amino acid behind.

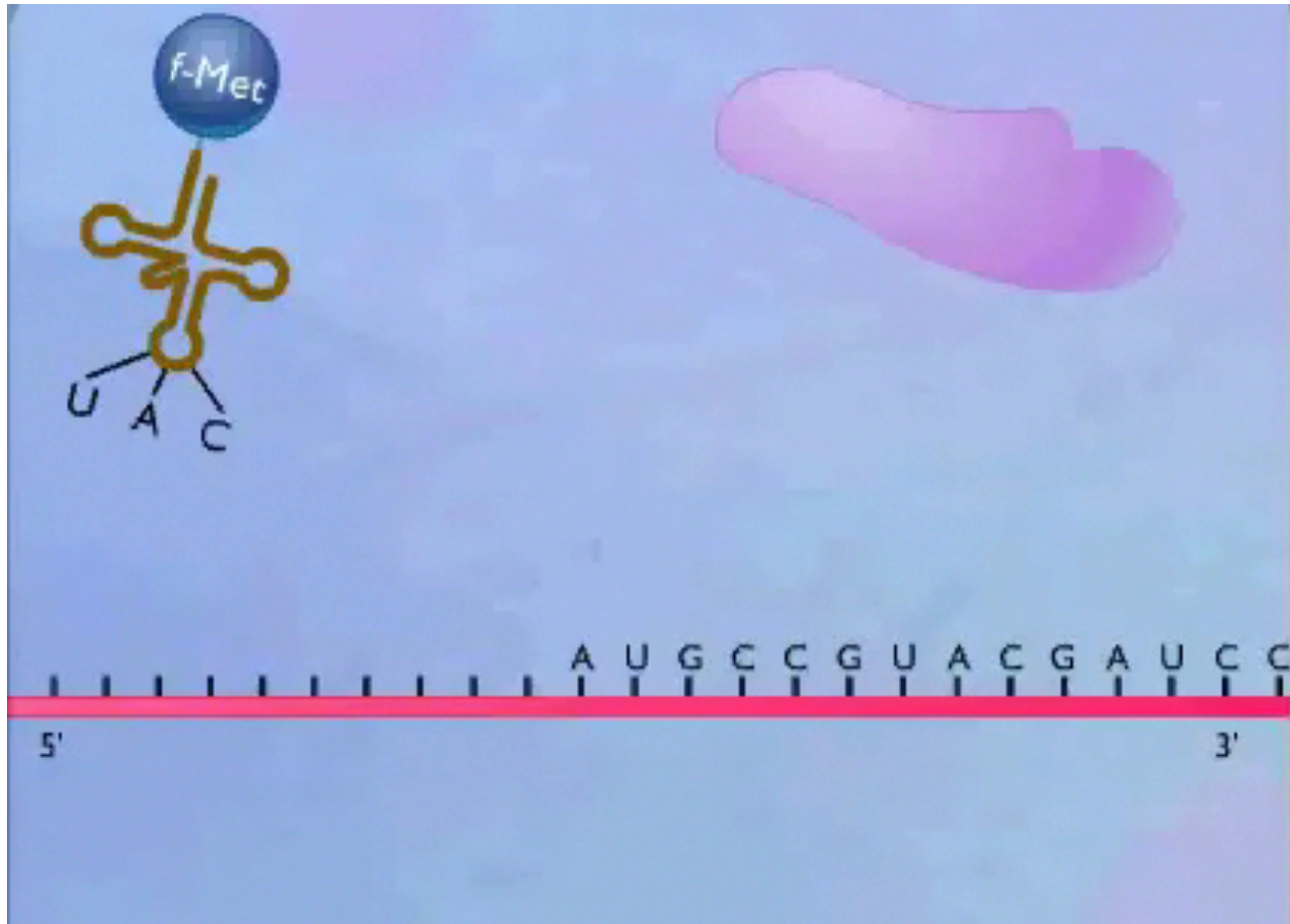
## Translation: Assembling Proteins

Amino acids are assembled from information encoded in mRNA.



- tRNA (with protein chain) moves over to P site. Another tRNA arrives with specified amino acid.
- tRNA in P site departs.
- Things keep on going until a **stop codon** (UAG, UAA, or UGA) is reached. Synthesis stops. Protein is released into the cell.

# Translation Animation



Translation Animation  
<http://www.youtube.com/watch?v=Ikq9AcBcohA>