

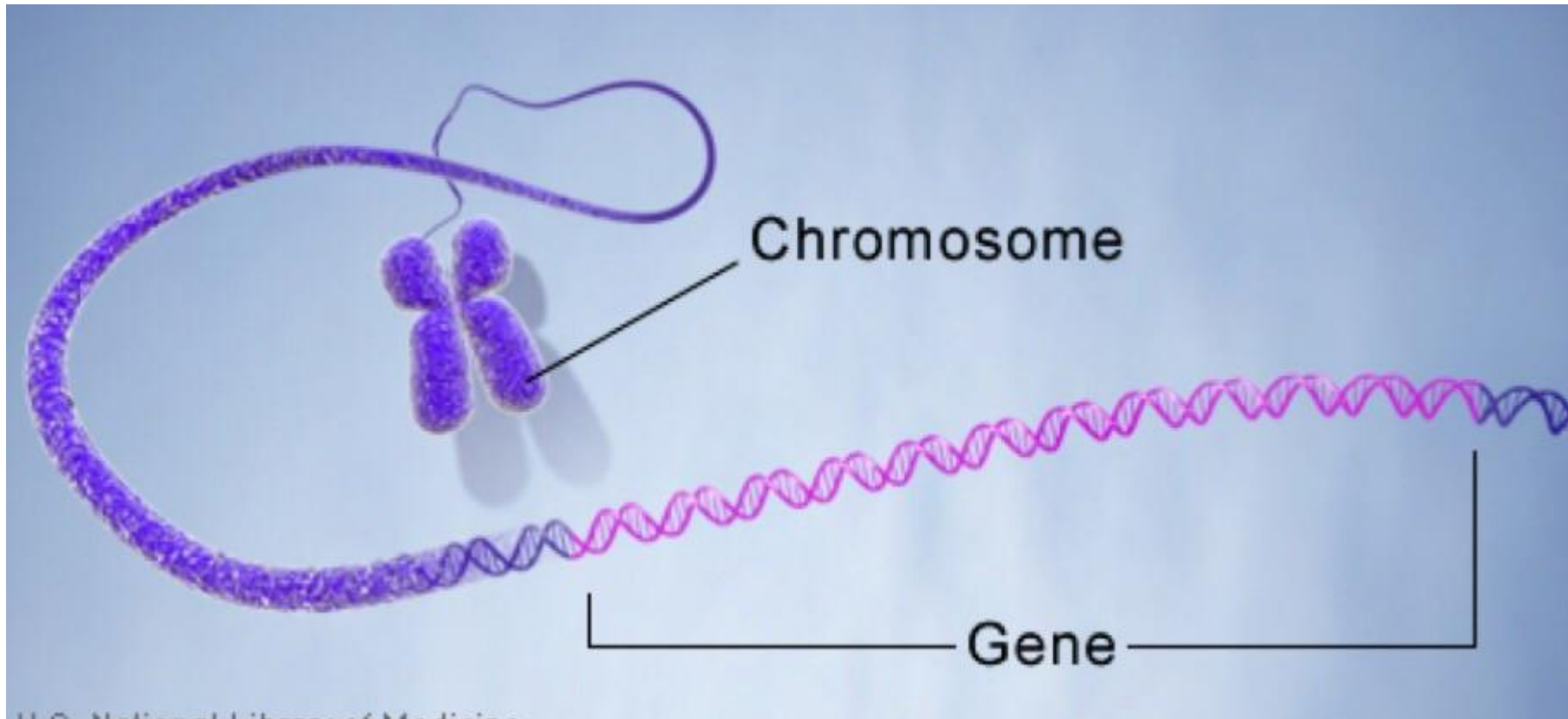
Lesson 1 - RNA

Do you remember...

- What is a gene?
- What is RNA?
- How does it differ from DNA?
- What is protein?

Gene

- Segment of DNA that codes for building a protein
- DNA code is copied into RNA form, and RNA helps the ribosomes make a protein



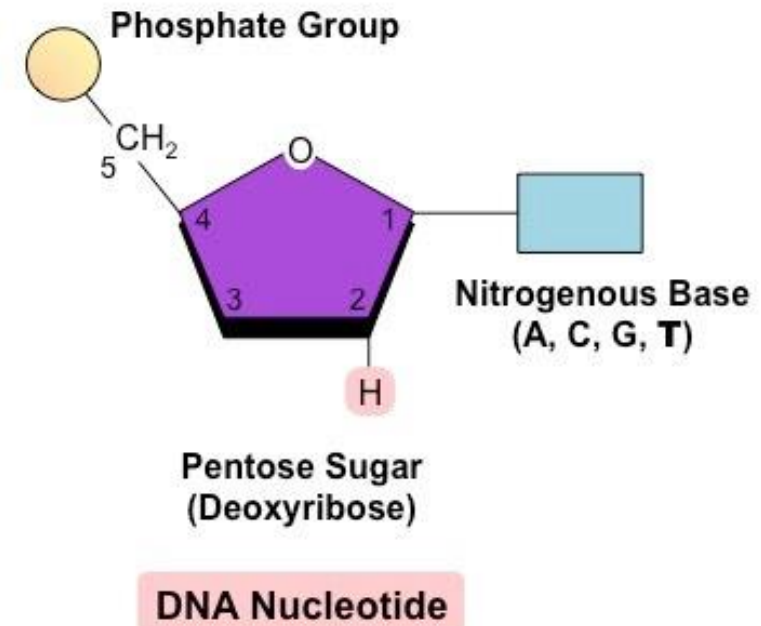
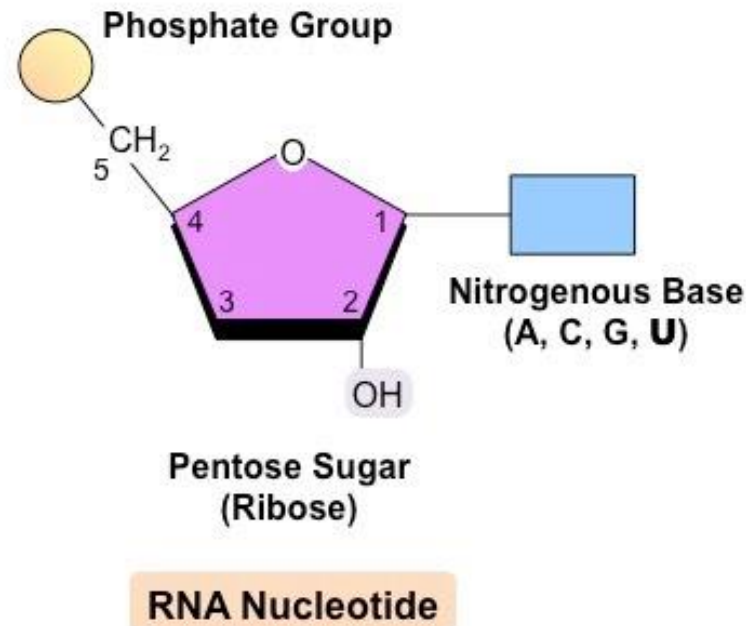
RNA

- **RNA stands for:**
 - Ribonucleic acid
- **RNA is found:**
 - In the nucleus, cytoplasm, & ribosome



RNA Structure

- Like DNA, RNA is made up of subunits called nucleotides, which are made of three parts:
 - Sugar (ribose instead of deoxyribose)
 - Phosphate
 - Nitrogen Base



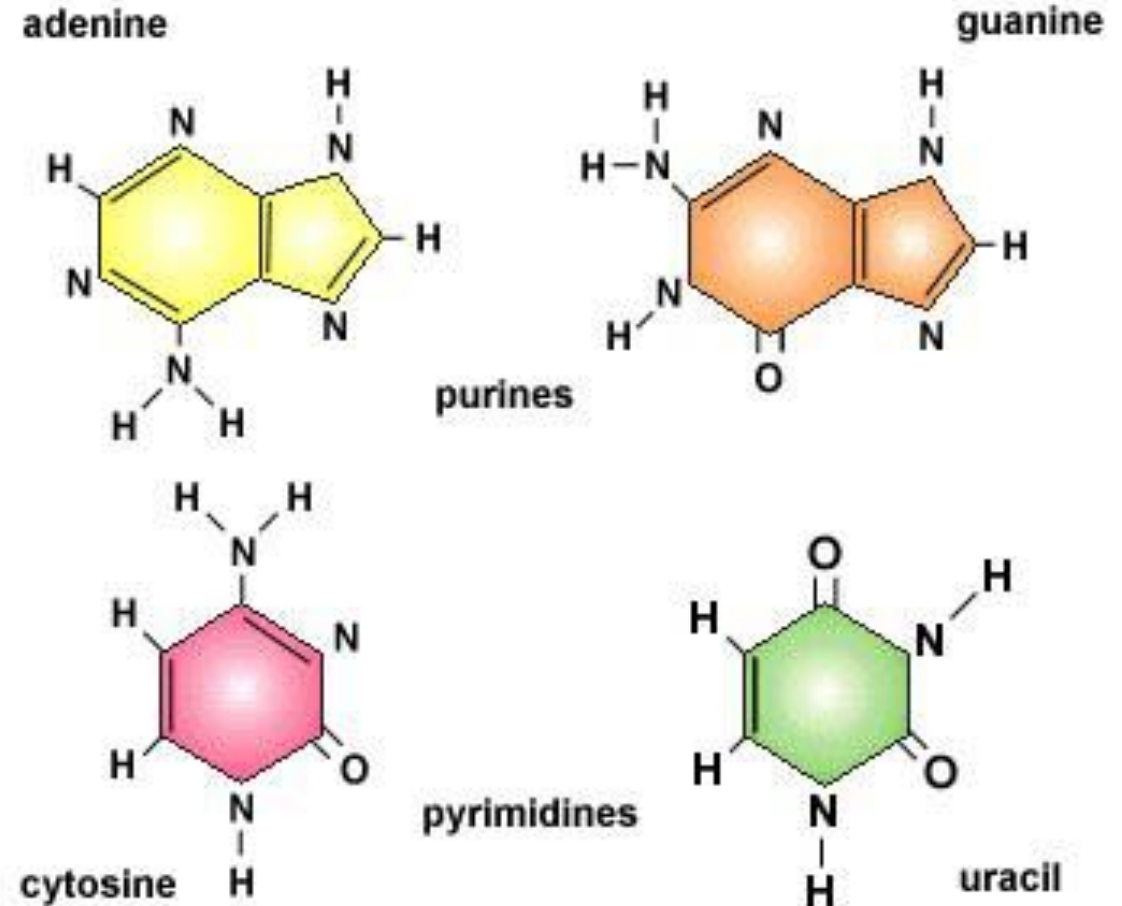
RNA's Nitrogen Bases

Purines (larger)

- Adenine (A)
- Guanine (G)

Pyrimidines (smaller)




- Cytosine (C)
- Uracil (U) instead of Thymine (T)



Pairing Rule: A with U; G with C

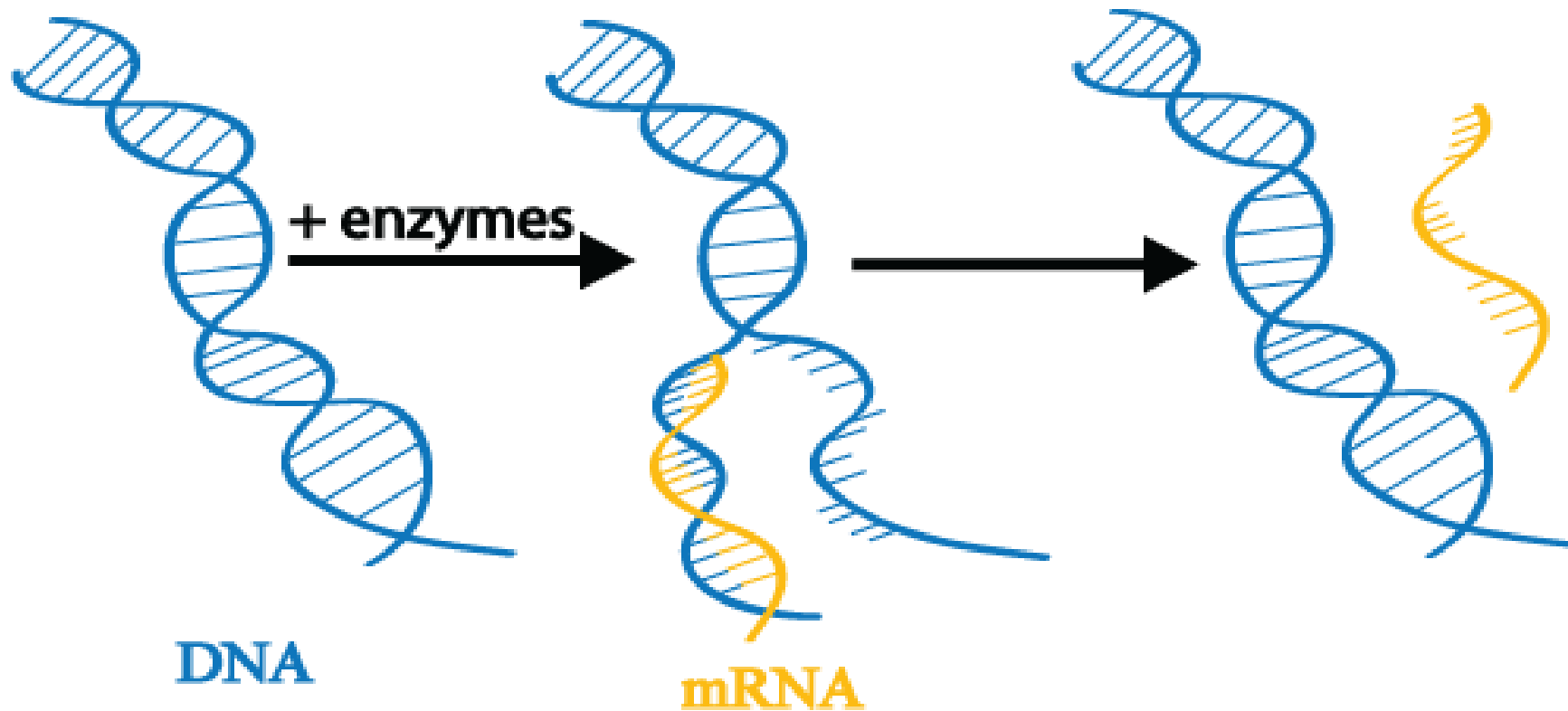
There are 3 types of RNA:

- Messenger RNA (mRNA)
- Ribosomal RNA (rRNA)
- Transfer RNA (tRNA)

Comparison of Three Types of RNA			
Name	mRNA	rRNA	tRNA
Function	Carries genetic information from DNA in the nucleus to direct protein synthesis in the cytoplasm	Associates with protein to form the ribosome	Transports amino acids to the ribosome
Example			

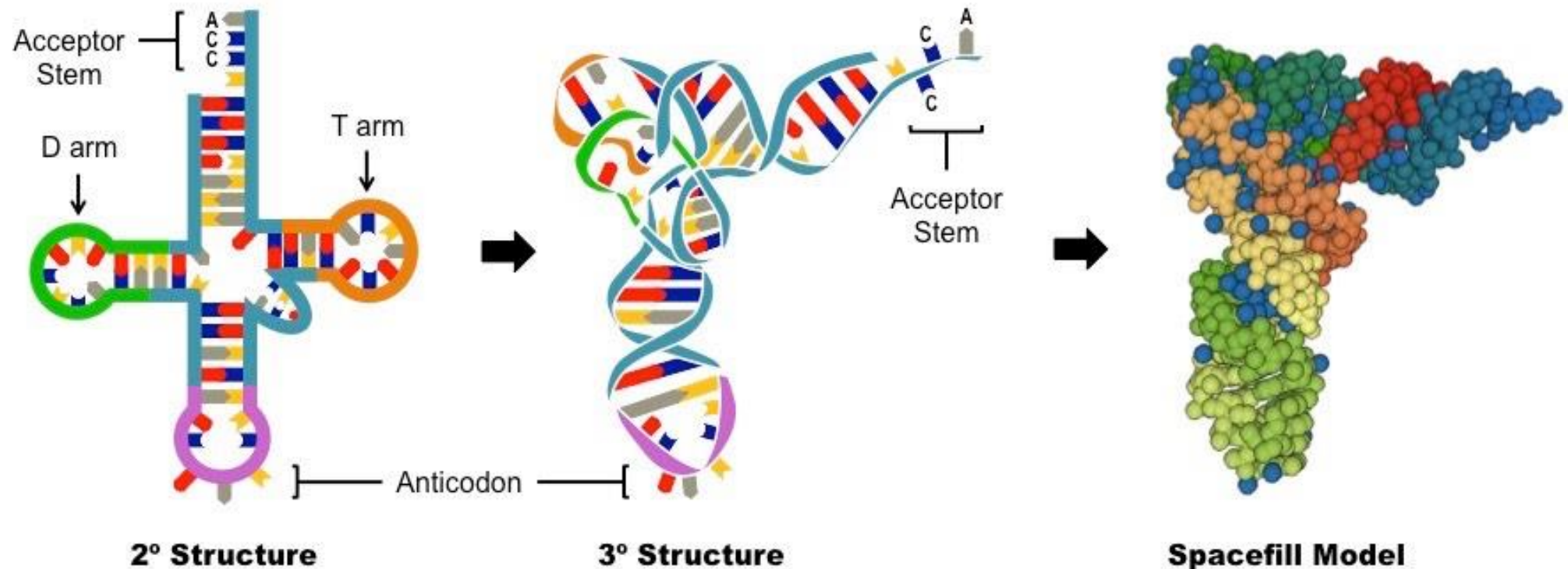
mRNA

- Messenger RNA
- Forms by copying DNA code in nucleus
- Sets of 3 bases are called codons
- Carries copied code to ribosome for protein synthesis



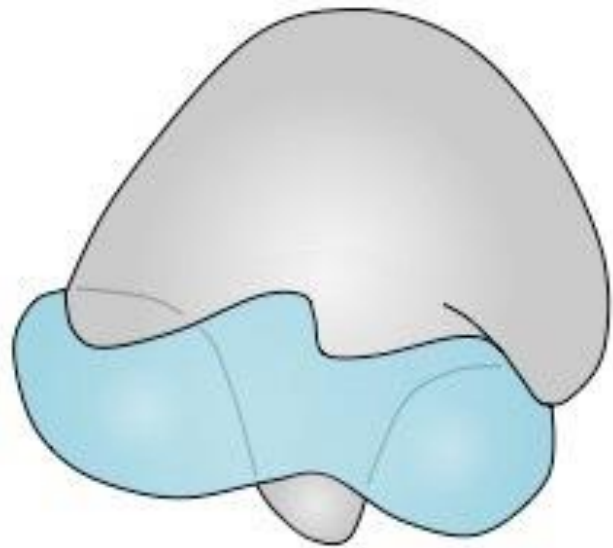
tRNA

- Transfer RNA
- Set of 3 bases called an anti-codon pairs with an mRNA codon
- Attaches to amino acids in the cytoplasm
- Brings the correct amino acid in sequence to the ribosome

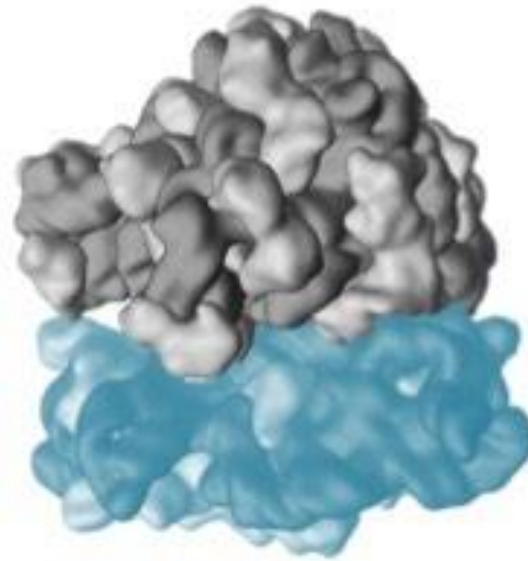


rRNA

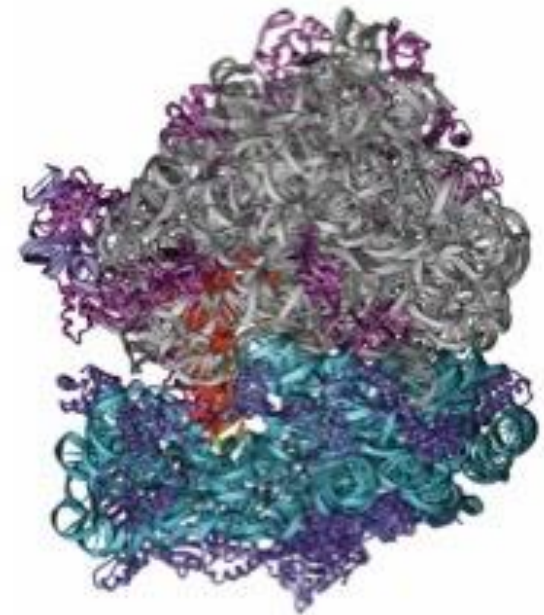
- Ribosomal RNA
- Makes up a ribosome (along with proteins)



Simplified



Modeled (3D)



Molecular

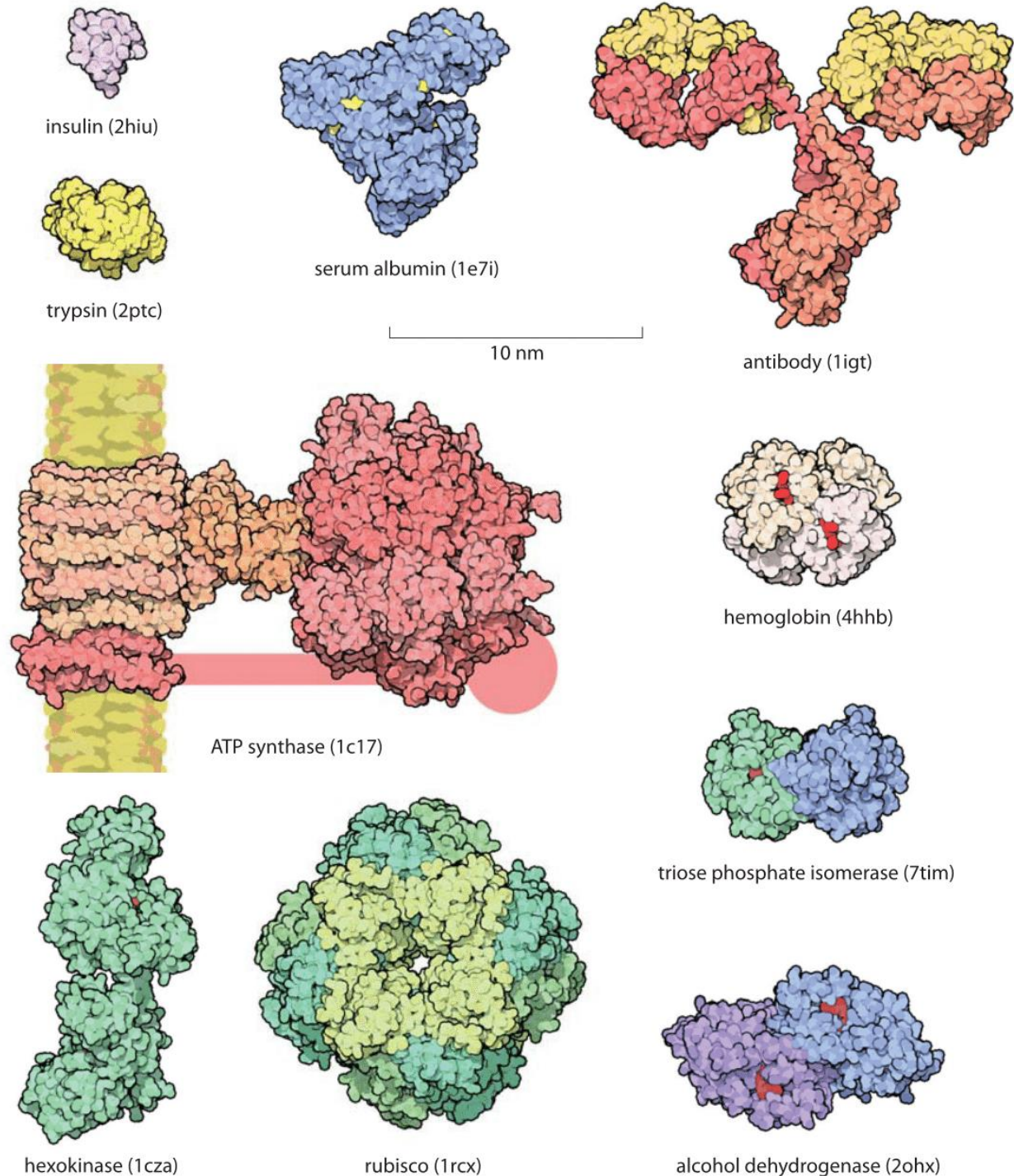
Lesson 2 – Proteins & Transcription

Do you remember...

- What is a protein made of?
- Explain the relationship between DNA and proteins.

PROTEINS

- Roles are structural and functional in all cells
- Examples:
 - Membrane transport proteins
 - Enzymes
 - Hormones
 - Antibodies
 - Hemoglobin



Let's compare to it to the English language

- Proteins are *polymers* of amino acids
- Only 20 different amino acids
- BUT there are hundreds of thousands of different proteins

How can this be?

- How many letters are in the alphabet?

a,b,c,d,...

26

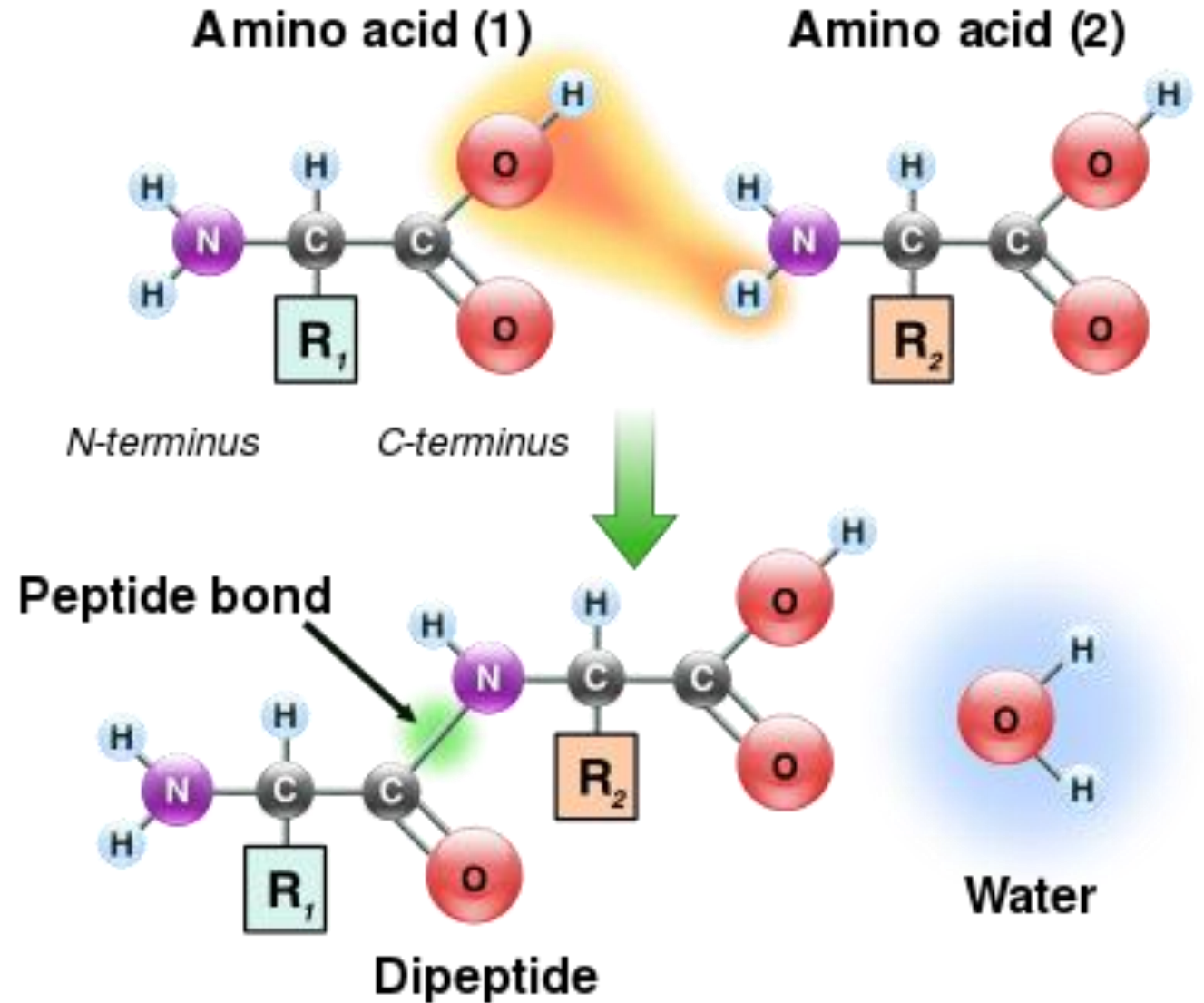
- How many words are there?

This, class, is, smart, .. **Almost infinite!**

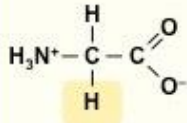
- Each word has a unique sequence of letters
- Similarly, proteins each have a unique sequence of amino acids

Proteins

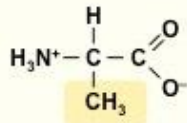
- are made up of Amino Acids (20 different kinds)
- amino acids are held together by peptide bonds to form polypeptide chains
- have a unique sequence of amino acids that determine its shape and function



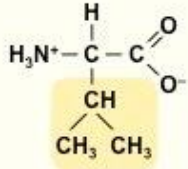
NON-POLAR



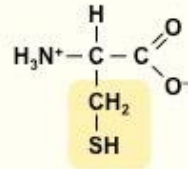
Glycine
(Gly / G)



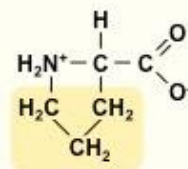
Alanine
(Ala / A)



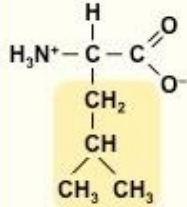
Valine
(Val / V)



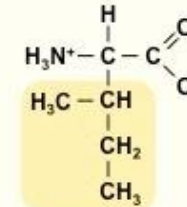
Cysteine
(Cys / C)



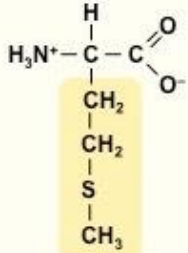
Proline
(Pro / P)



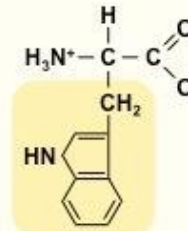
Leucine
(Leu / L)



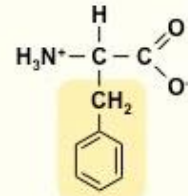
Isoleucine
(Ile / I)



Methionine
(Met / M)

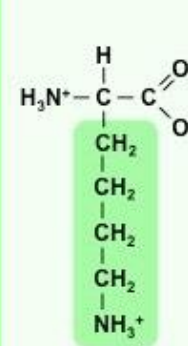


Tryptophan
(Trp / W)

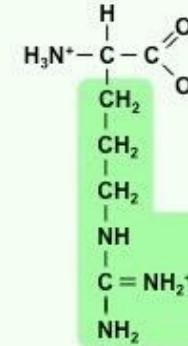


Phenylalanine
(Phe / F)

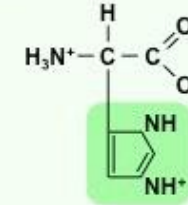
+ CHARGE



Lysine
(Lys / K)

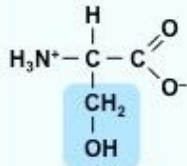


Arginine
(Arg / R)

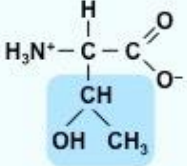


Histidine
(His / H)

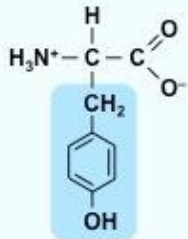
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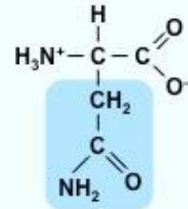
Serine
(Ser / S)



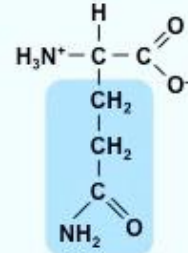
Threonine
(Thr / T)



Tyrosine
(Tyr / Y)

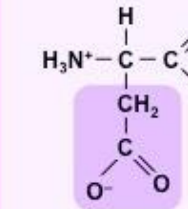


Asparagine
(Asn / N)

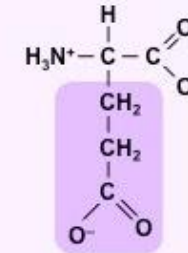


Glutamine
(Gln / Q)

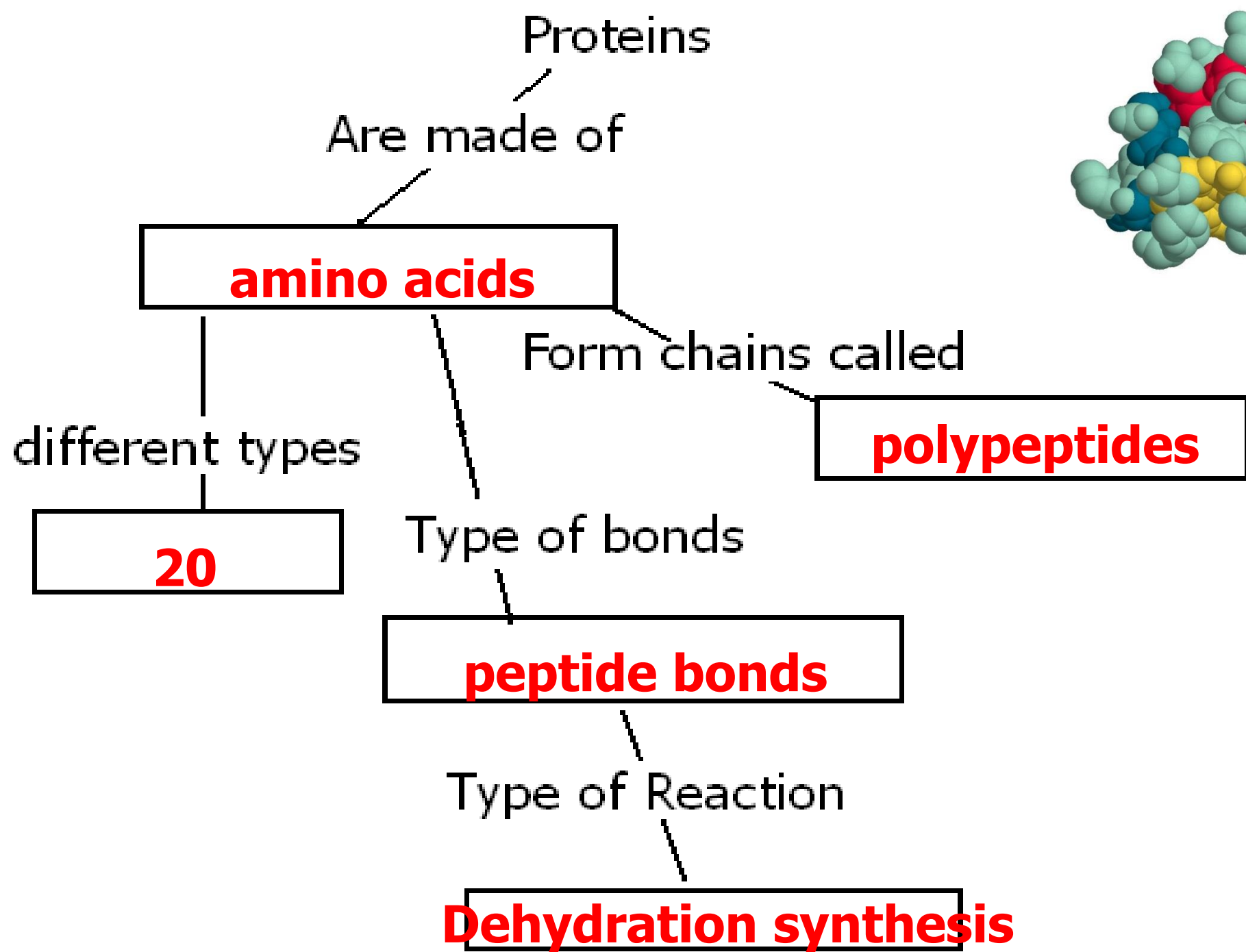
- CHARGE



Aspartic Acid
(Asp / D)

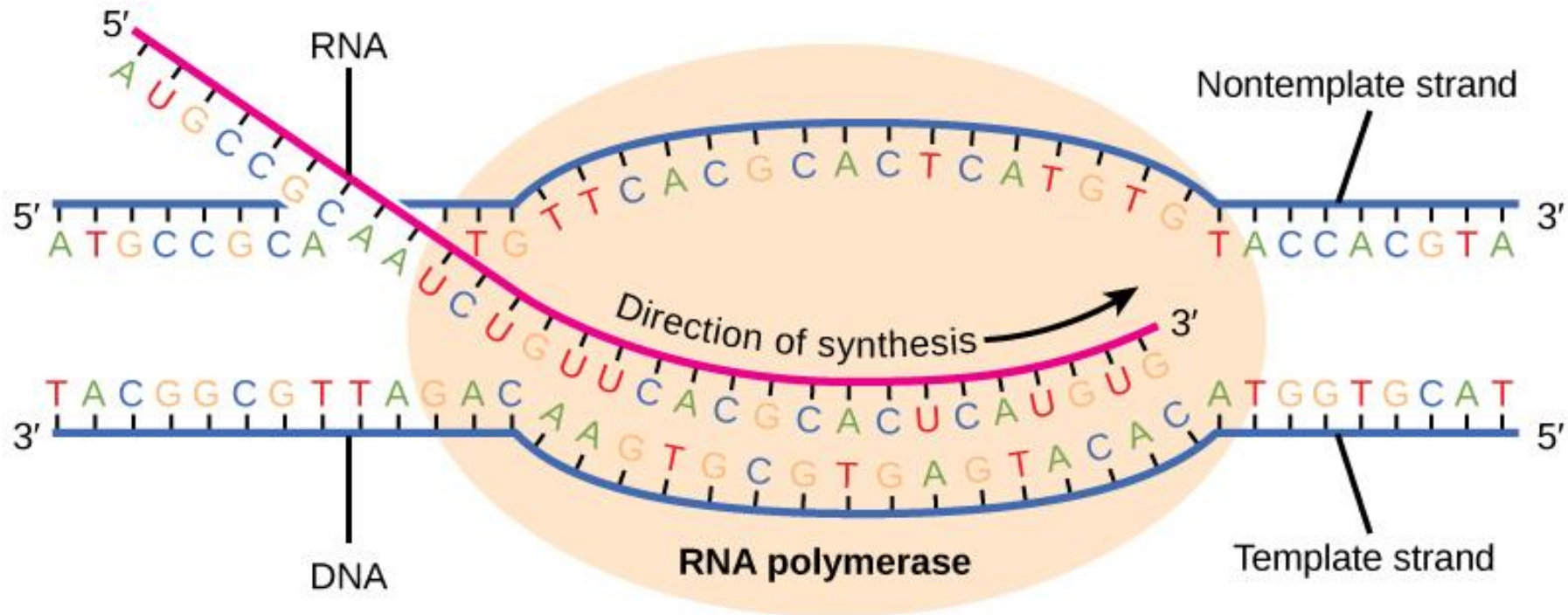


Glutamic Acid
(Glu / E)



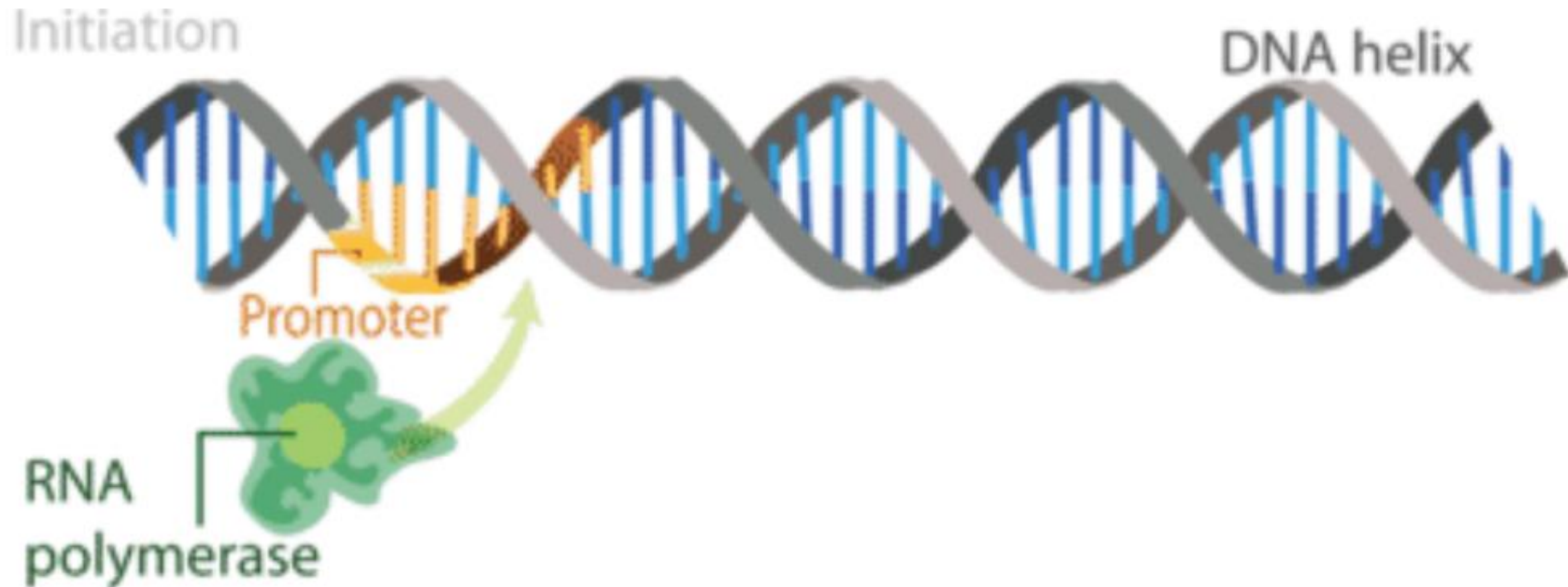
Transcription

- First step in protein synthesis, occurs in the nucleus
- Process of taking one gene (DNA) and copying its nitrogen base sequence (code) into a new mRNA strand

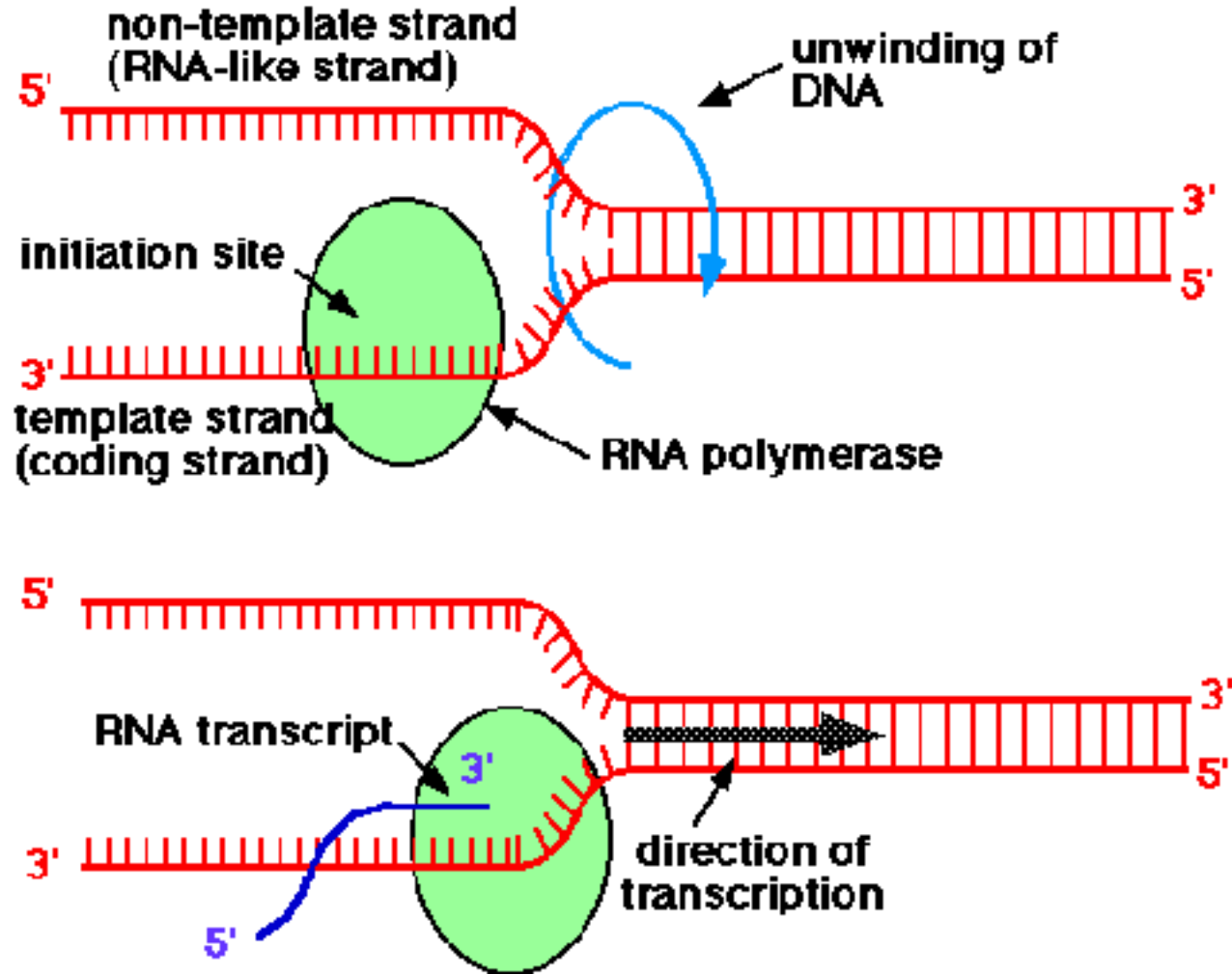


Steps to Transcription

1. Initiation - Enzyme RNA polymerase attaches to the promoter (start signal region) of a gene and unwinds the DNA



2. One strand acts as a template.



3. A mRNA copy is synthesized from the DNA template strand by RNA polymerase

Complete the transcription of the RNA sequence using the DNA template.

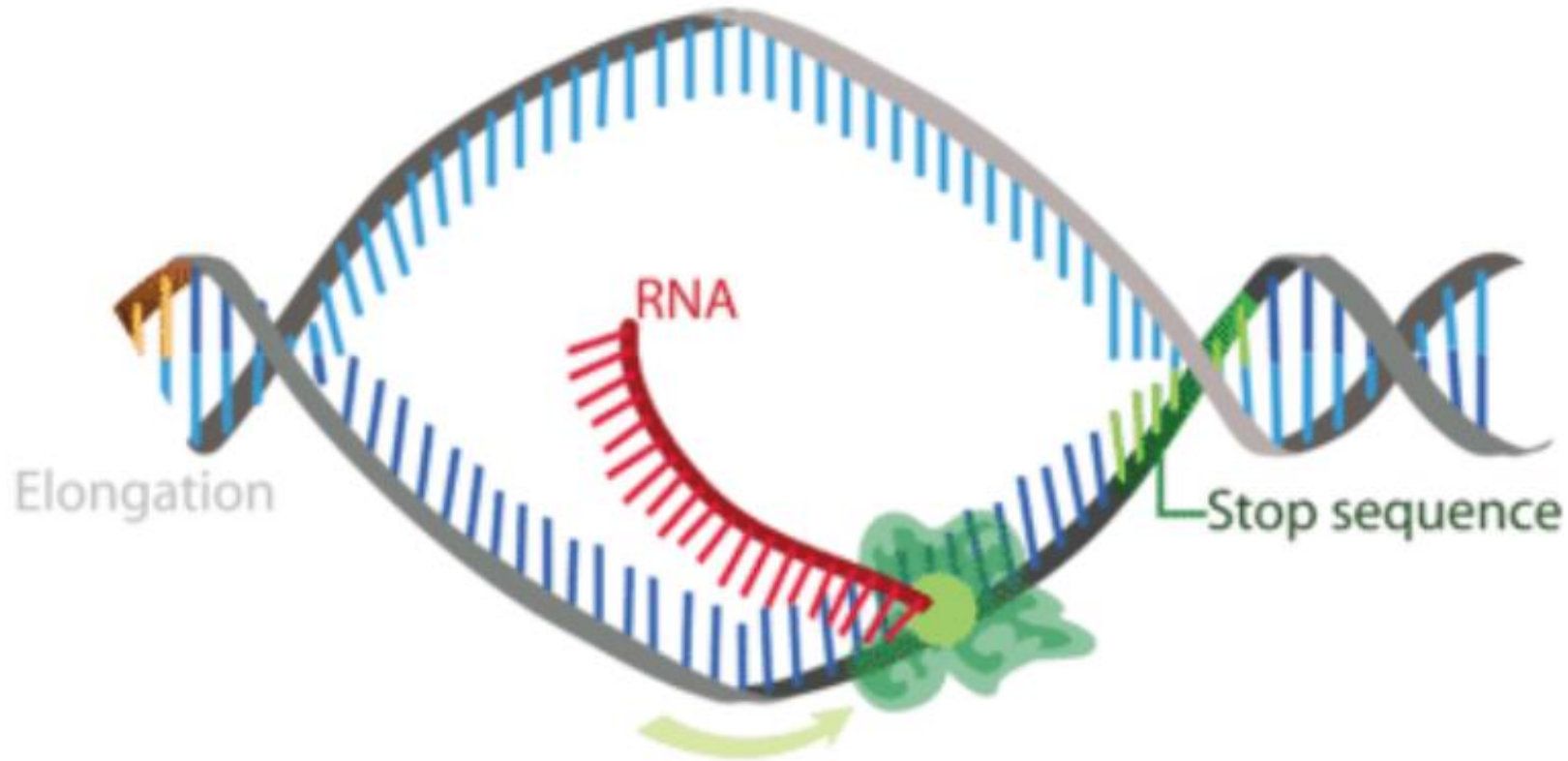
DNA Template

A	T	C	G	A	C

RNA Sequence

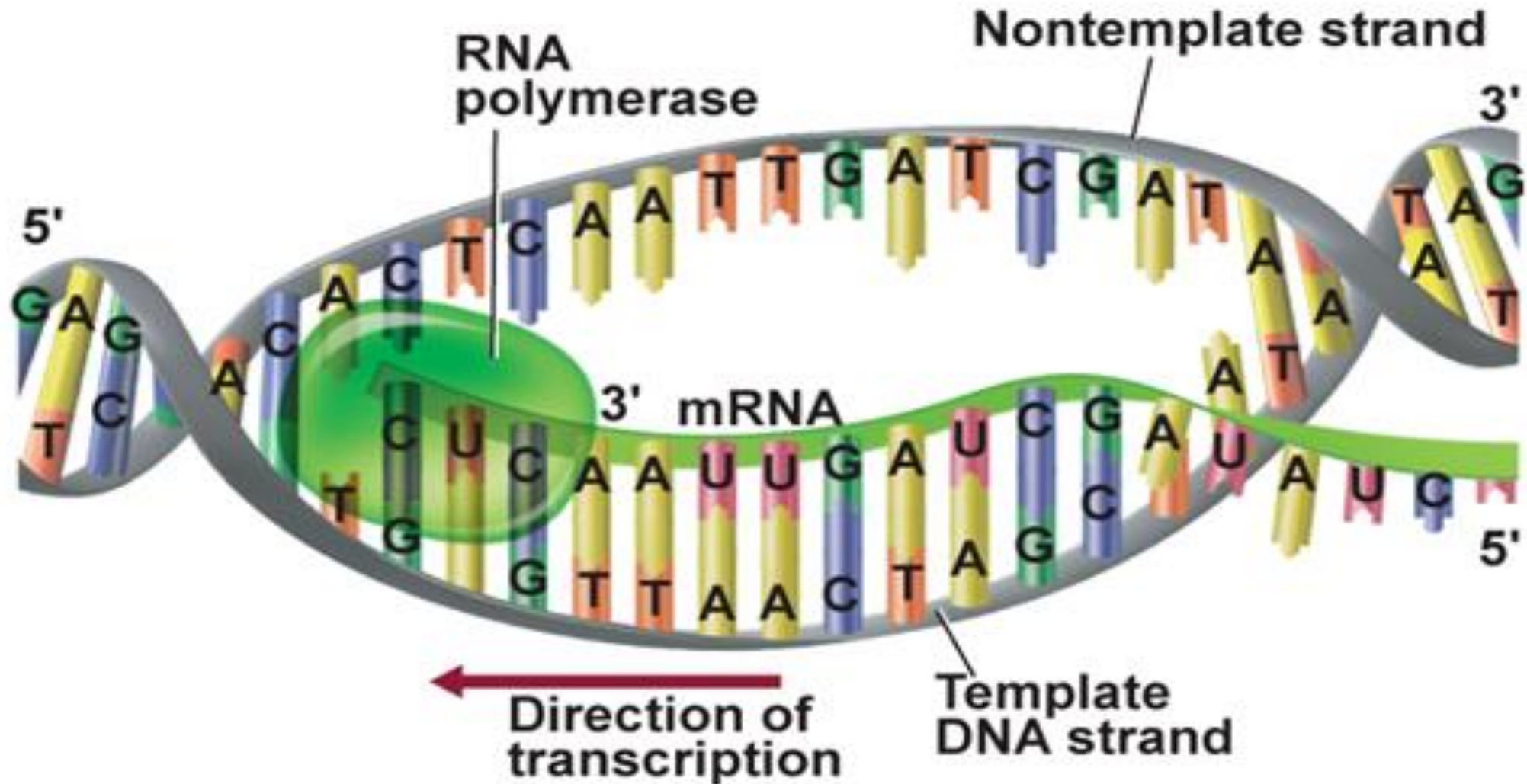
G
T
U
A
C

4. Elongation - a mRNA copy is made until it reaches the termination (stop signal) sequence



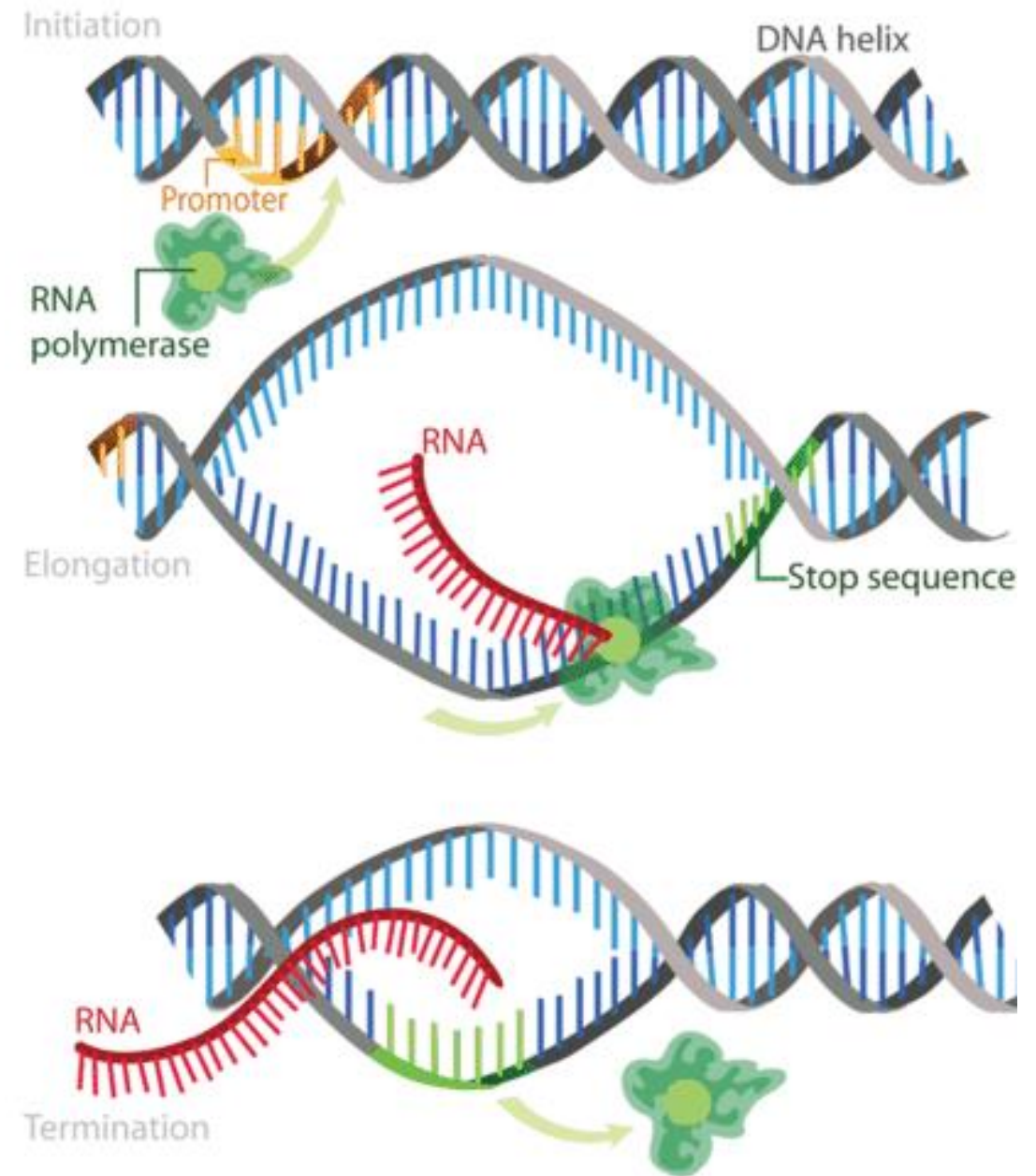
5. The two strands of DNA rejoin.

Template vs. Non Template Strand



Transcription animations

- <https://www.youtube.com/watch?v=NJxobgkPEAo>
- https://www.youtube.com/watch?v=41_Ne5mS2Is



Transcribe this DNA to mRNA

DNA: GGTCTAATCGGGCAA

mRNA: CCAGAUUAGCCCGUU

DNA: TGATCGGATCAGAC

mRNA: ACUAGCCUAGUCUG

Lesson 3 – Codon Bingo

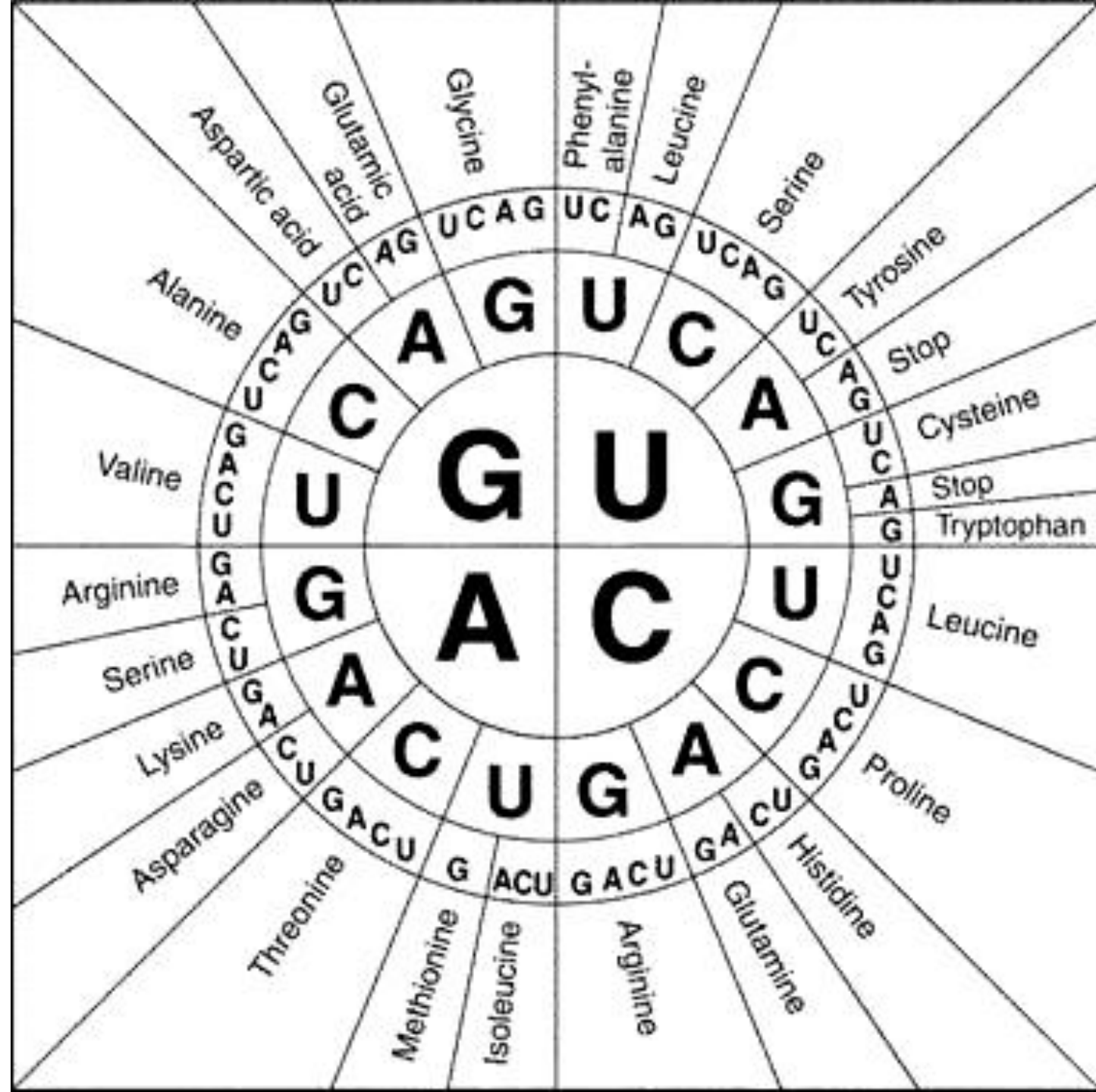
Lesson 4 – Translation

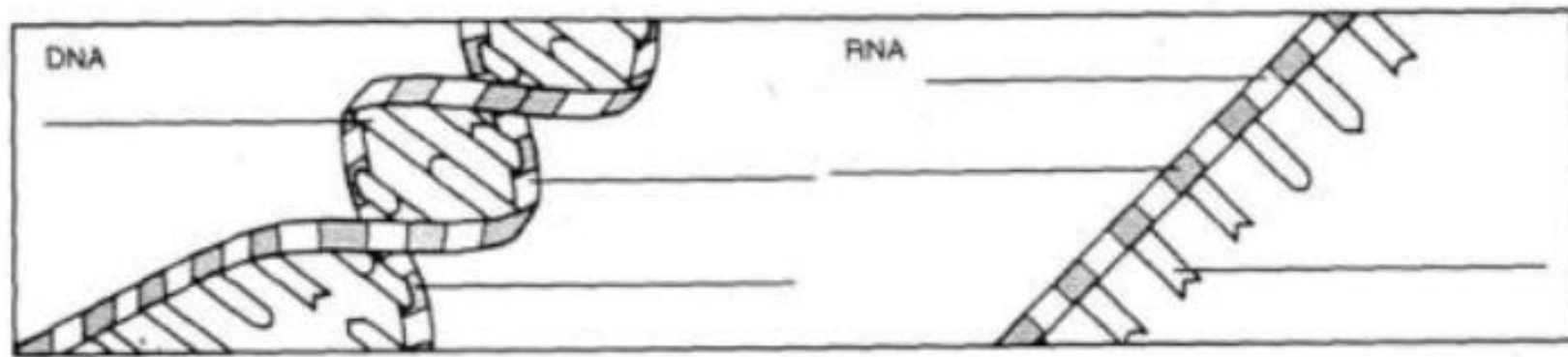
Universal Genetic Code Chart

Messenger RNA Codons and Amino Acids for Which They Code

		Second base				
		U	C	A	G	
First base	U	UUU } PHE UUC } UUA } LEU UUG }	UCU } UCC } SER UCA } UCG }	UAU } TYR UAC } UAA } STOP UAG }	UGU } CYS UGC } UGA } STOP UGG } TRP	U C A G
	C	CUU } LEU CUC } CUA } CUG }	CCU } CCC } PRO CCA } CCG }	CAU } HIS CAC } CAA } GLN CAG }	CGU } CGC } ARG CGA } CGG }	U C A G
	A	AUU } ILE AUC } AUA } AUG } MET or START	ACU } ACC } THR ACA } ACG }	AAU } ASN AAC } AAA } LYS AAG }	AGU } SER AGC } AGA } ARG AGG }	U C A G
	G	GUU } VAL GUC } GUA } GUG }	GCU } GCC } ALA GCA } GCG }	GAU } ASP GAC } GAA } GLU GAG }	GGU } GGC } GLY GGA } GGG }	U C A G

mRNA codon wheel





Name	Sugar	Bases	Number of Nucleotide Strands
DNA			
RNA			

1. The two DNA strands twist around each other. This is called a _____.
2. The repeating units of _____ and _____ make the backbone of DNA and RNA.
3. In a DNA molecule, the nitrogen bases of one strand attach to the nitrogen bases of the other. This is called _____. The bases are held together by bonds of _____.
4. A strand of DNA contains the following bases: ATCGACT. What will be the bases on the complementary DNA strand? _____ On the complementary RNA strand? _____
5. Part of the DNA molecule shown above is starting to unwind. What two cellular activities could this be the start of? _____

TRANSCRIPTION

1. The following phrases describes what happens during the process of **transcription**; they are not in correct order. What would be the correct order of events?

(use letters, as in the example: B \longrightarrow D \longrightarrow F etc.)

- A. mRNA separates from DNA.
 - B. Hydrogen bonds reform between the 2 strands of the DNA molecule.
 - C. RNA nucleotides match up to complementary nucleotides on the DNA.
 - D. The hydrogen bonds of the DNA molecule break.
 - E. mRNA moves into the cytoplasm.
 - F. A portion of the DNA molecule unzips.
-

2. Where in the cell does transcription occur? _____

3. What nucleic acids are involved in the process of transcription? _____

4. What is the importance of transcription?

5. In transcription, how come the whole DNA molecule is not copied into mRNA?

6. How does one gene differ structurally from another?

7. Because one gene differs from another, what molecules in the cell will also differ?

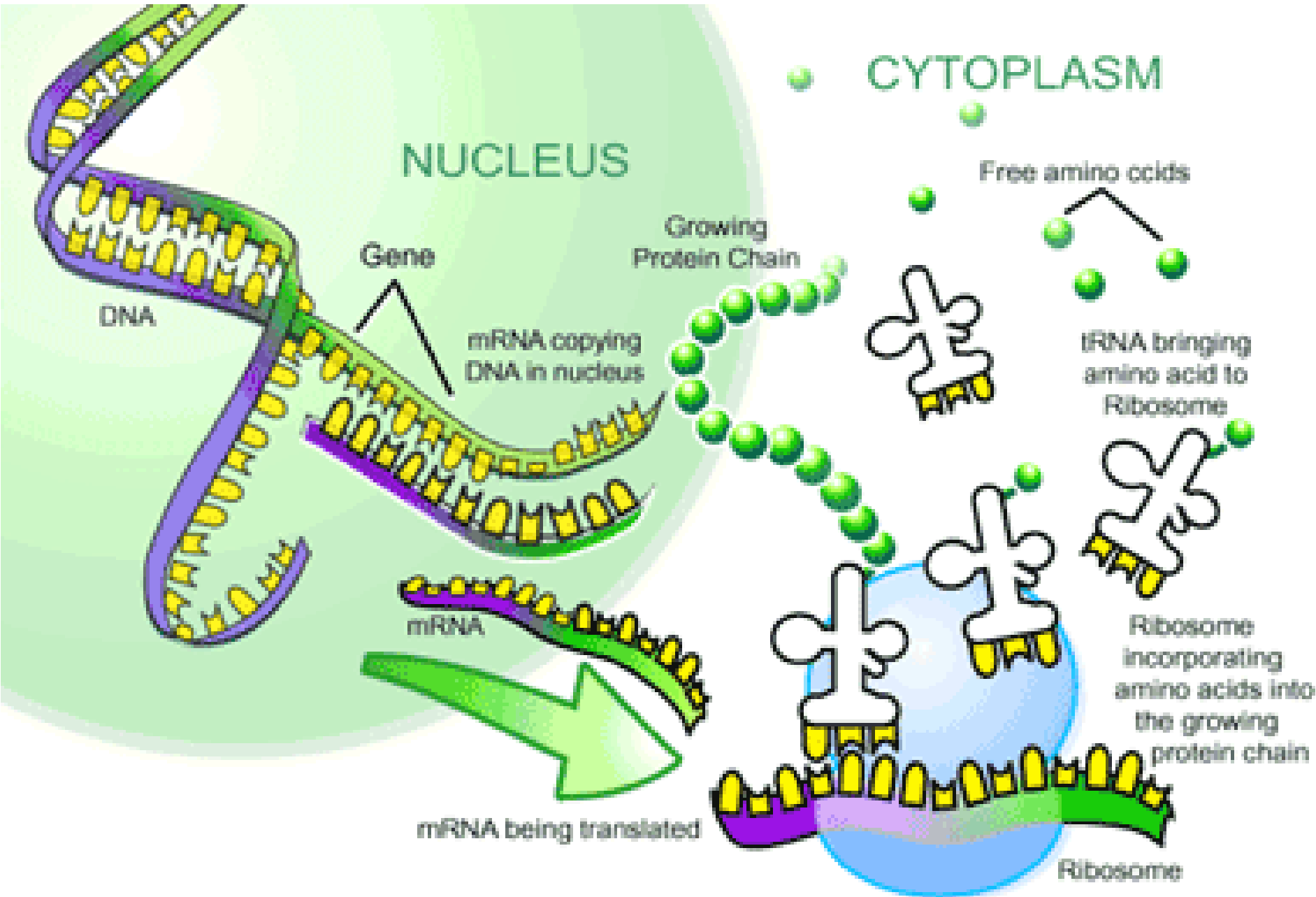
Think- Pair- Share

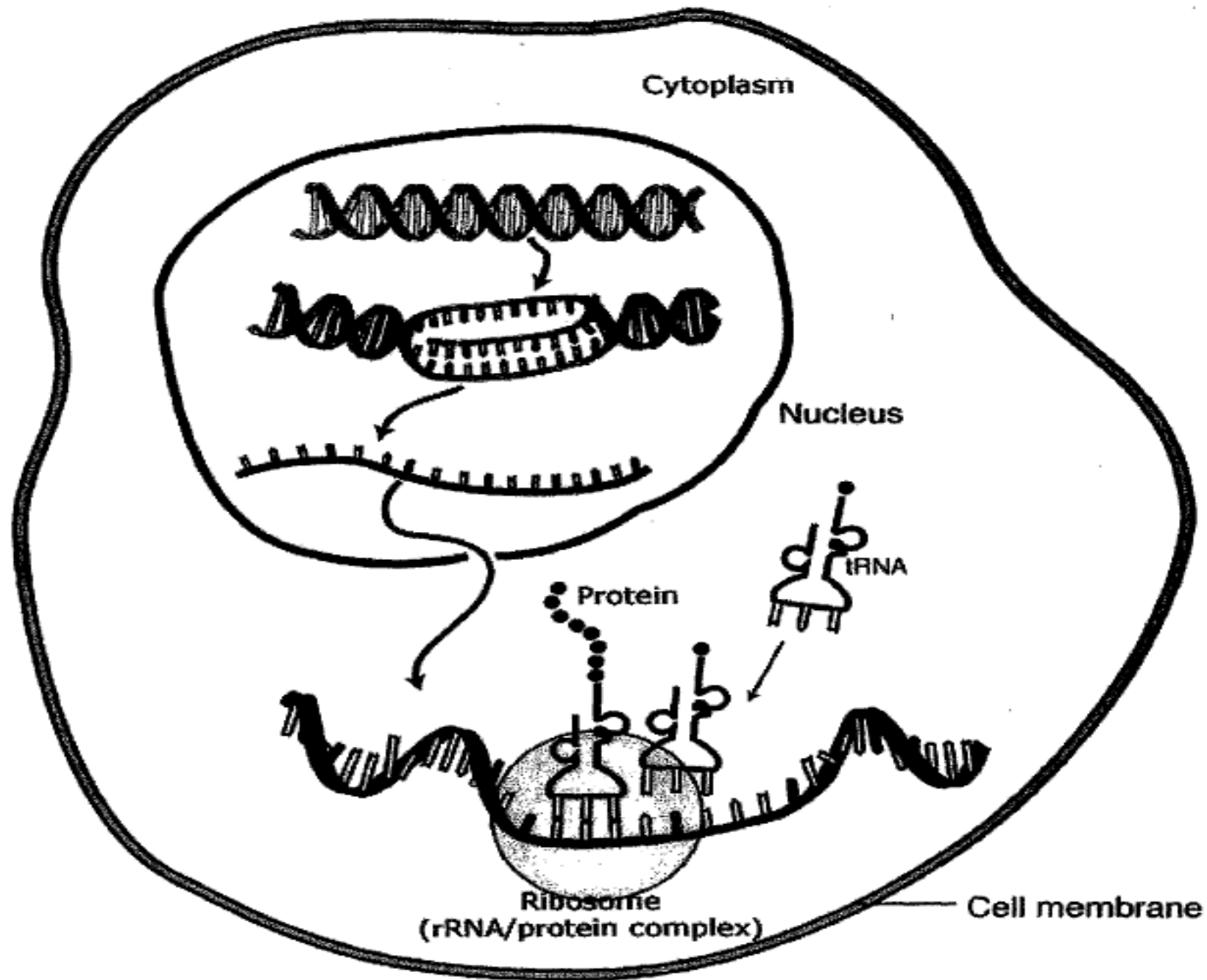
- 1. Where in the cell does transcription occur?
- 2. What nucleic acids are involved in the process of transcription?
- 3. What is the importance of transcription?
- 4. In transcription, how come the whole DNA molecule is not copied into mRNA?
- 5. How does one gene differ structurally from another?
- 6. Because one gene differs from another, what molecules in the cell will also be different?

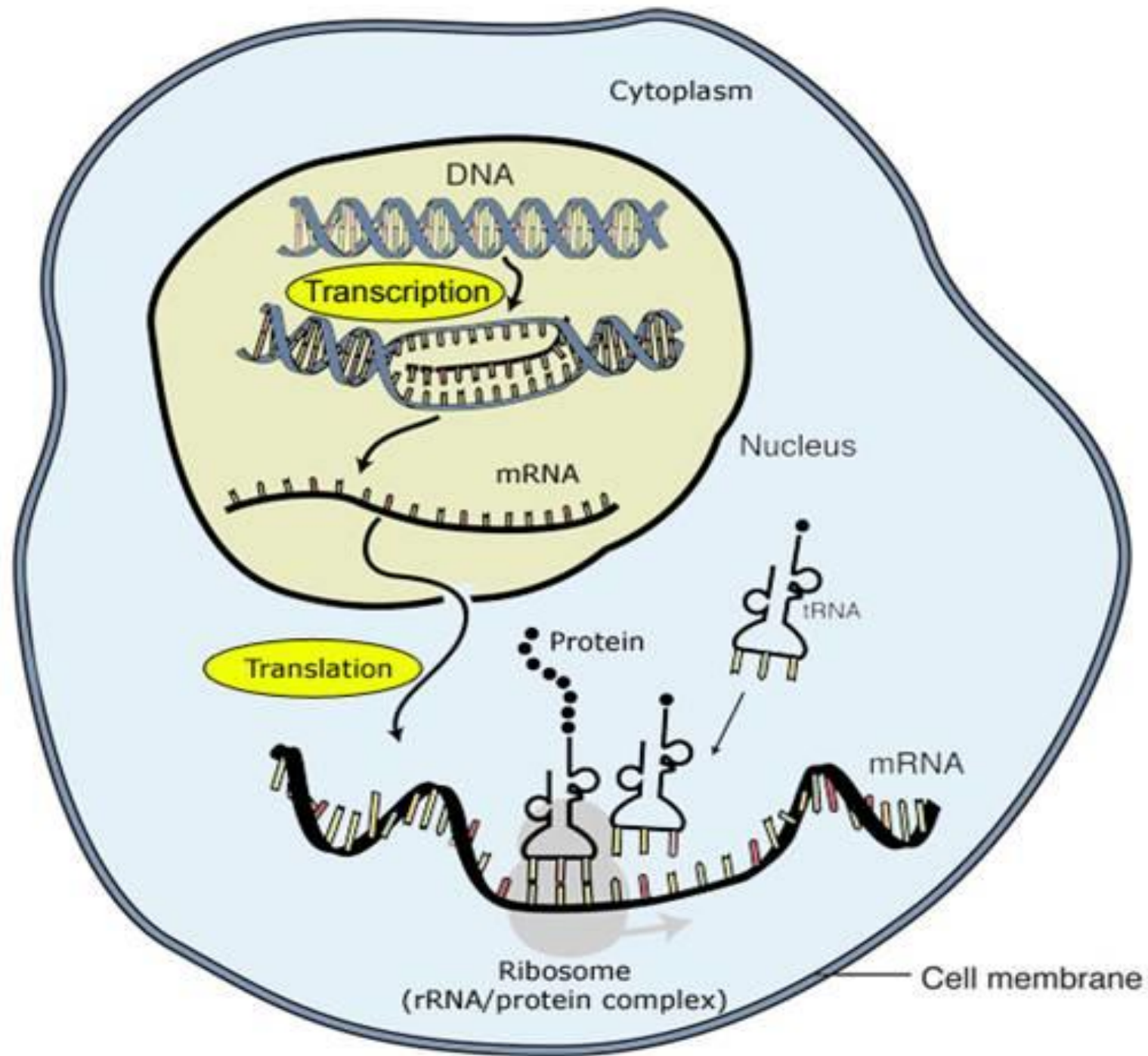
Translation

- Production of proteins from mRNA
- mRNA goes to the ribosomes which produce proteins



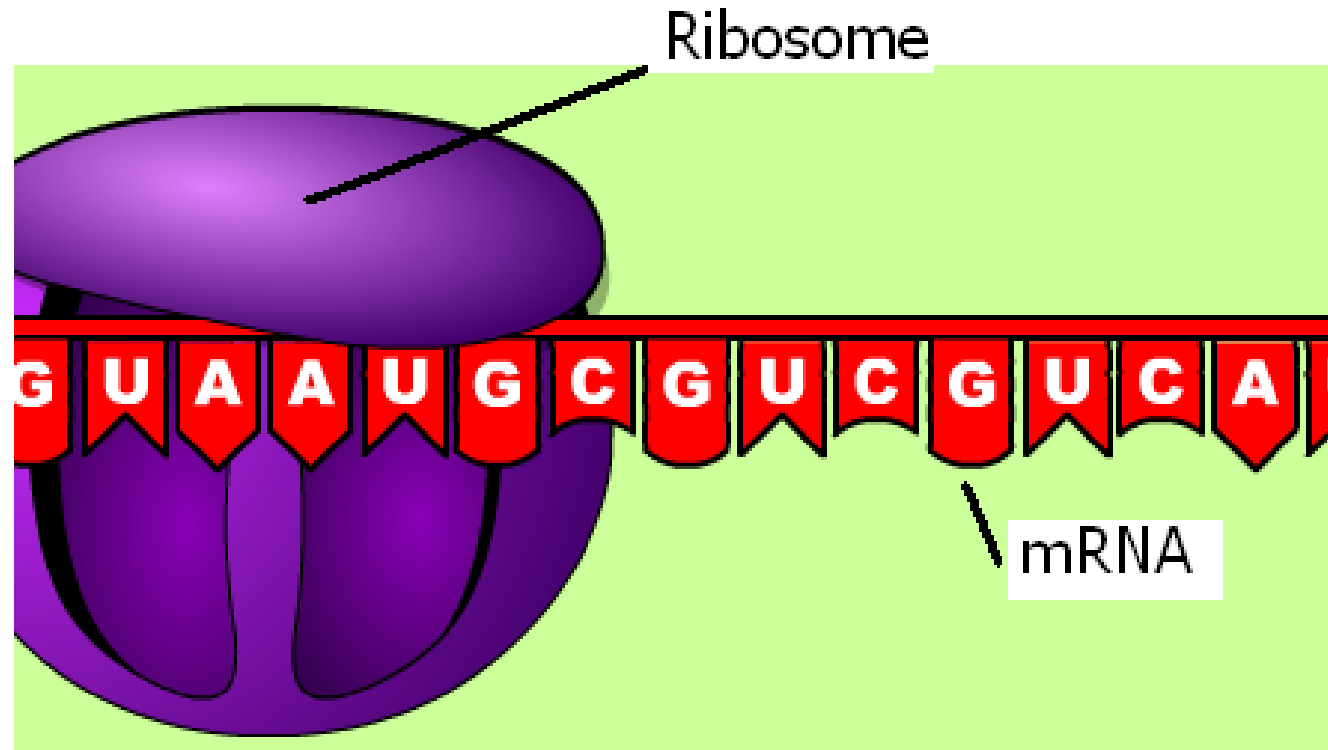






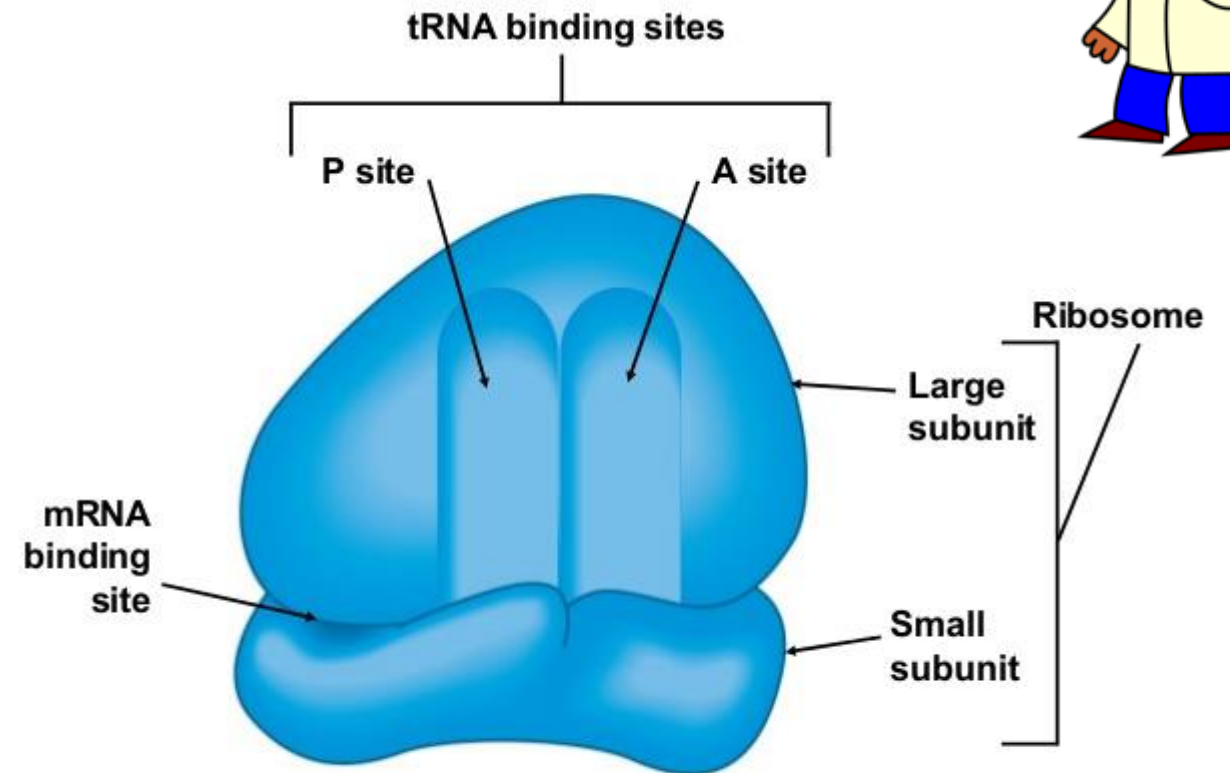
Steps of Translation

- 1. mRNA leaves the nucleus
- 2. mRNA binds to ribosome



Ribosome structure

- Two subunits to the ribosome (large & small)
- 2 binding sites:
 - P site- holds growing peptide chain
 - A site- holds the next amino acid to be added



(a) A simplified diagram of a ribosome

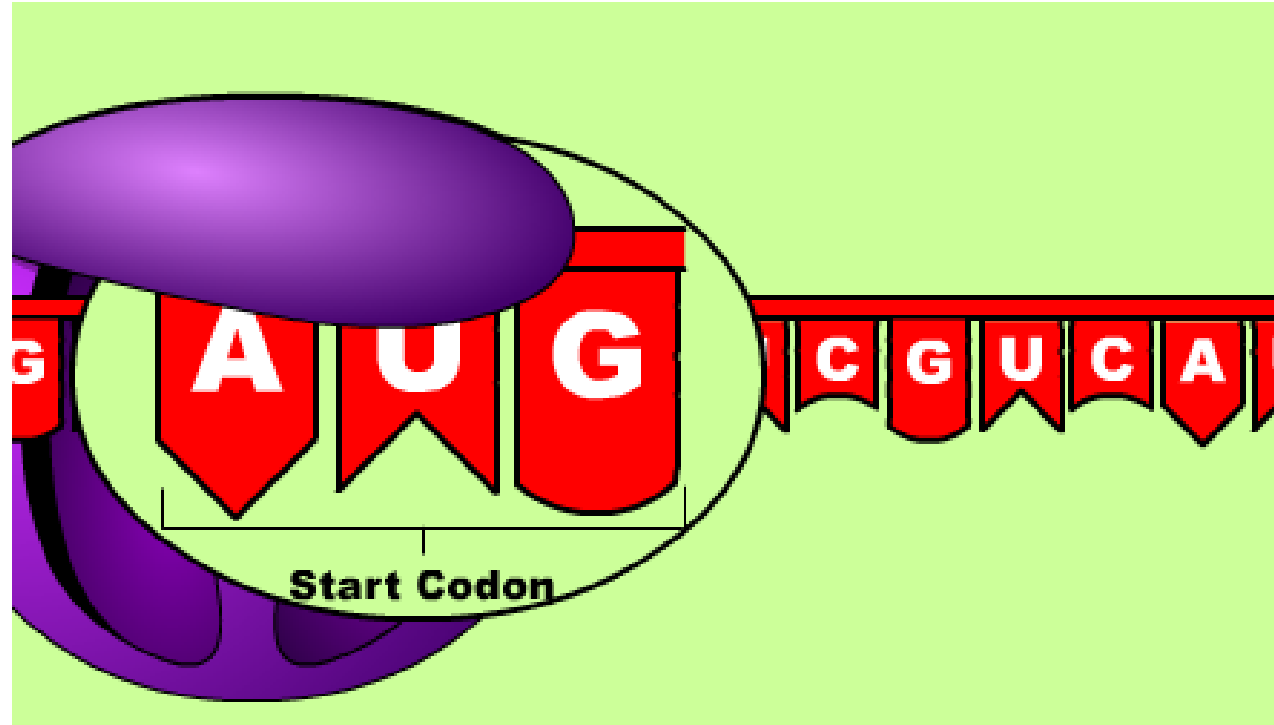
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Figure 10.16a



Steps to Translation (Cont.)

- 3. Ribosome looks for the start **Codon** (AUG)
 - **Codon**: group of 3 nucleotides on the mRNA that specifies one amino acid (64 different codons)

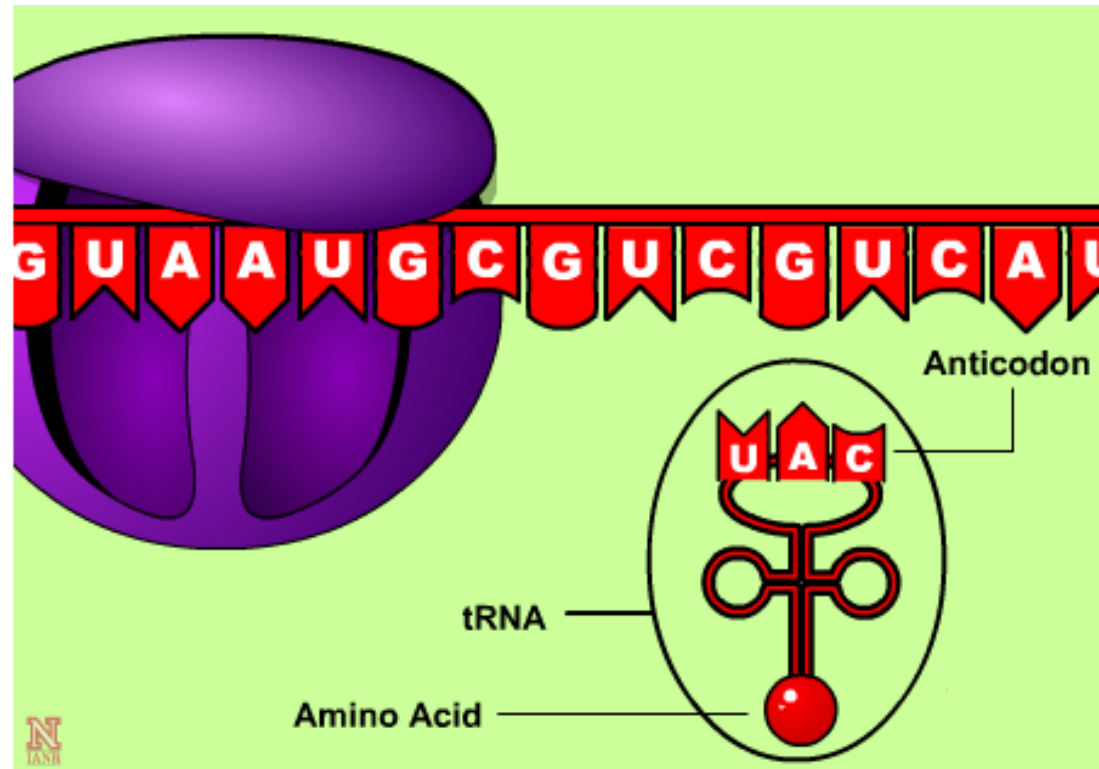


Steps to Translation (Cont.)

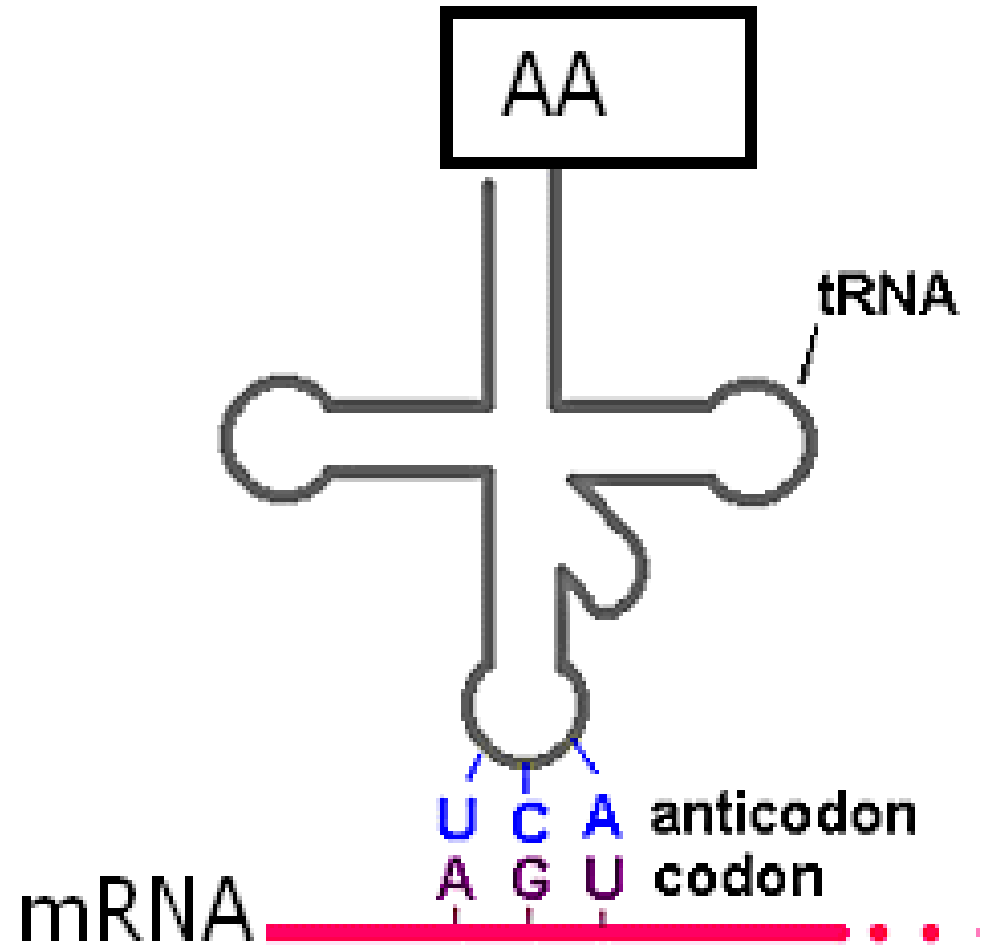
- 4. Amino acids are attached to a tRNA molecule and are brought over to the mRNA.
- 5. This tRNA has an **anticodon** that matches the codon on the mRNA strand

Anticodon:

Group of 3 unpaired nucleotides on a tRNA strand. (binds to mRNA codon)

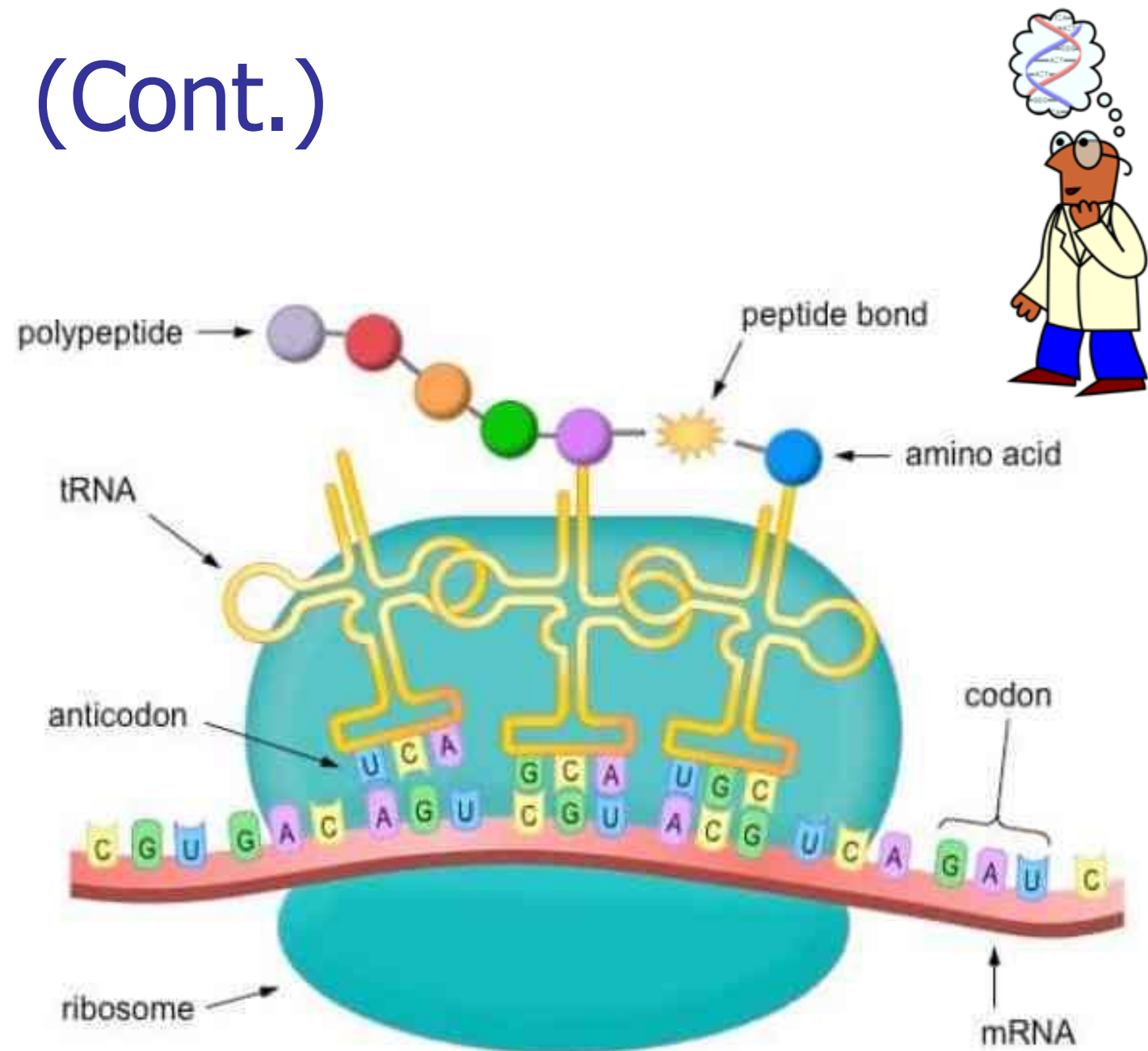


tRNA



Steps to Translation (Cont.)

- 6. tRNA binds to the mRNA sequence and adds an amino acid
- 7. tRNA leaves and amino acids bond together through a peptide bond



Think – Pair - Share

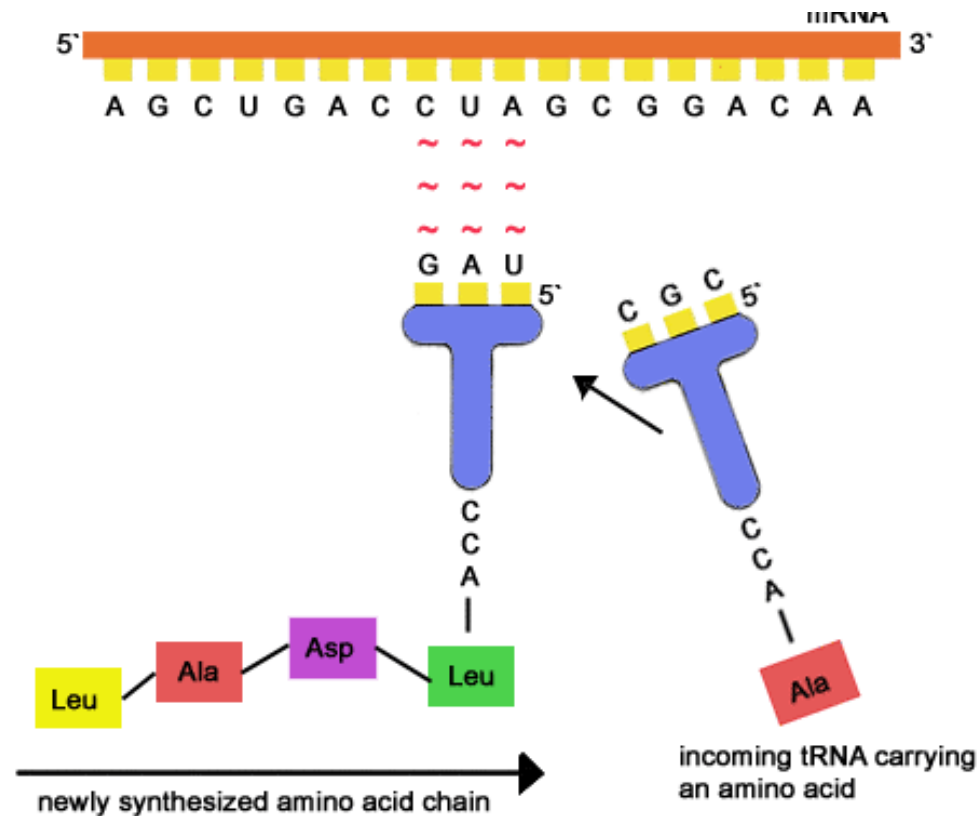
- Use a codon chart or mRNA wheel to find the amino acid sequence for the following mRNA sequence (*translation*)

mRNA: AUG CGA CGA AUU UAA

Amino acid sequence:

Steps to Translation (Cont.)

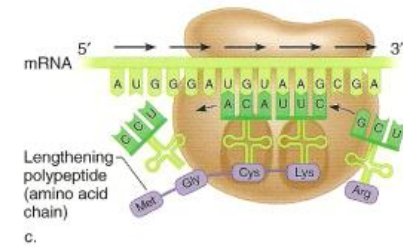
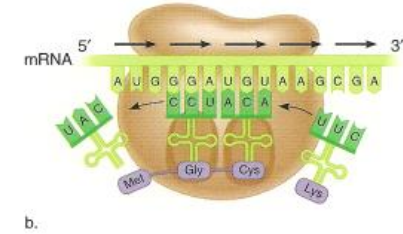
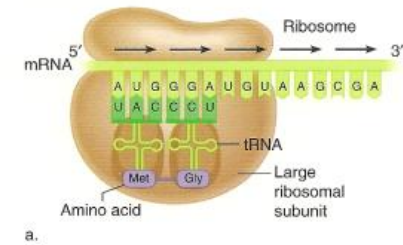
- 8. The mRNA sequence continues until a stop codon is reached.
- 9. The amino acids disconnect from the mRNA sequence and a protein is formed.



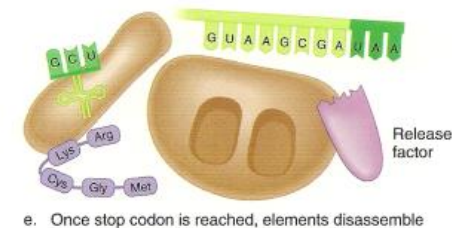
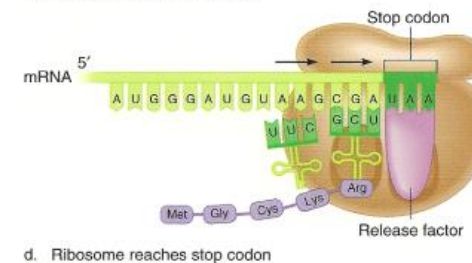
Translation Animations

- http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a3.html
- <http://www.stolaf.edu/people/giannini/flashanimation/molgenetics/translation.swf>

TRANSLATION ELONGATION



TRANSLATION TERMINATION



Making Proteins

Transcription

Translation

Produces

mRNA

Happens
in the...

nucleus

Happens
in the...

ribosome

Produces

proteins

Are made of
smaller units called

amino acids

Leaves the nucleus
and goes to the...

ribosome

Try this

- Do transcription on this DNA sequence:
CGTACGCTCCCTAGACTA

Do Translation- Remember to start the right place!

Try this

- Do transcription on this DNA sequence:

TTTTATACTGAGGGTTAACTCGT

Do Translation- Remember to start the right place!

Try this

- Take the following amino acid sequence, do reverse transcription and translation (find RNA and DNA).
- **Methionine, Arginine, Alanine, Serine, Tryptophan, Tyrosine, Leucine, Valine, stop**
- What do you notice about your DNA sequences?



DNA Webquest Links: Part 2 – RNA, Transcription, Translation

Page 4

RNA

<http://www.dnaftb.org/21/>

Page 5

Transcription (DNA → RNA)

<http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf>

DNAi website

<http://www.dnai.org/a/index.html>

Translation (mRNA → protein)

<http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf>

DNAi website

<http://www.dnai.org/a/index.html>