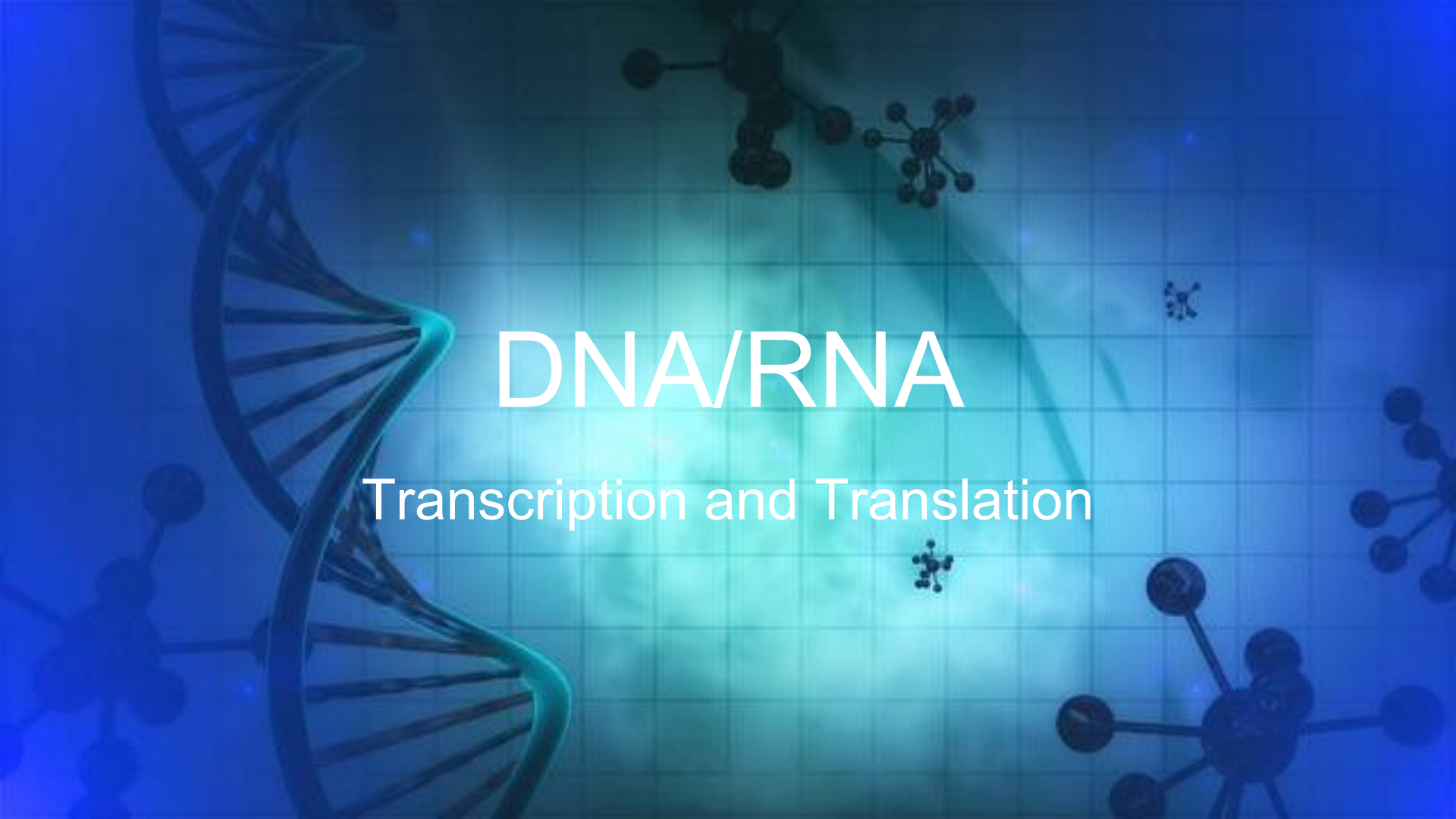

DNA/RNA
Transcription and Translation

Review……

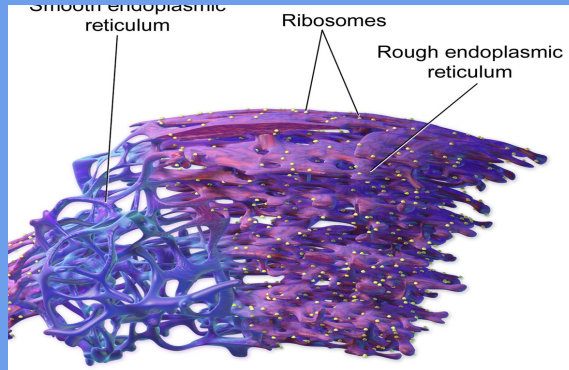
- DNA is responsible for controlling the production of proteins in the cell
- Which is essential for life

DNA → RNA → Proteins

- Chromosomes contain several thousand genes, each with directions to make one protein
- What organelle is responsible for protein production?

Where are Proteins Produced?

- RIBOSOMES!
- Ribosomes are found in two places:
  - Free Floating in the Cytoplasm
  - Attached to the Endoplasmic Reticulum(Rough ER)



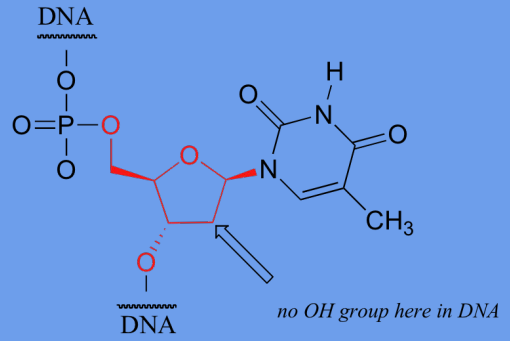
So...how does information needed to build the protein get delivered from the DNA to the ribosomes?

- With the help of RNA in a process called Protein Synthesis!

What is RNA?

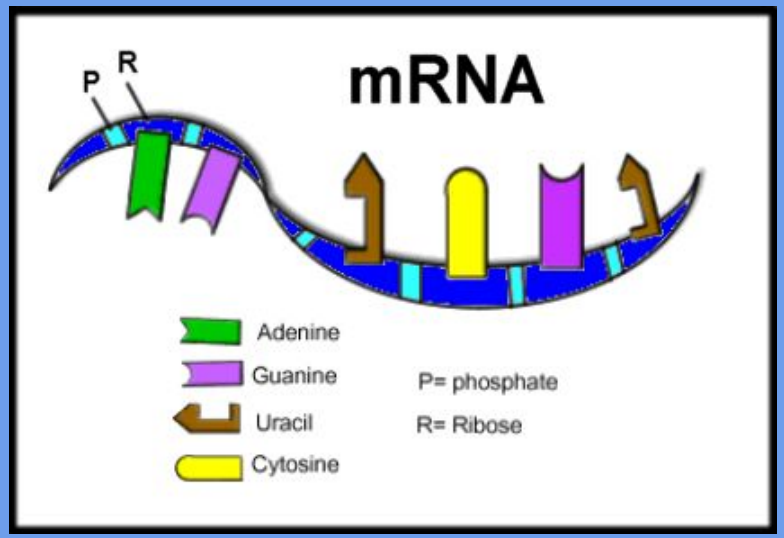
- RNA strands for Ribonucleic Acid
- One subunit of RNA is a nucleotide (just like DNA!)
  - 1 - 5 Carbon Sugar(Ribose in RNA)
  - 1 - Phosphate Group
  - 1 - Nitrogenous (N) Base
- Three types of RNA
  - mRNA - Messenger
  - rRNA - Ribosomal
  - tRNA - Transfer

ribose



mRNA

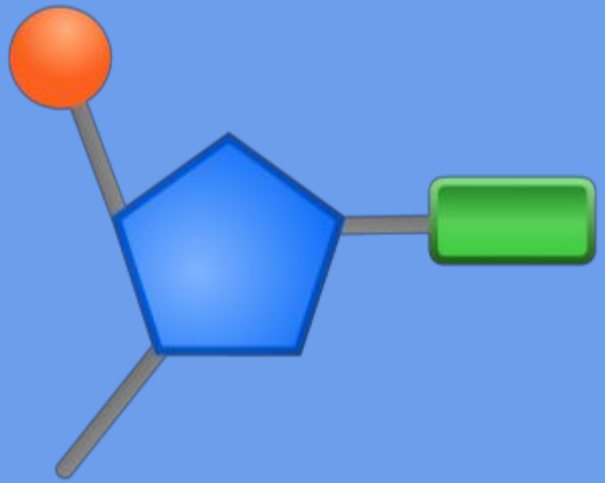
- Looking at the mRNA below, how is it different visually from DNA?
  - Single Stranded
  - Shorter and able to leave the nucleus
  - The sugar is Ribose
  - There is a different base
    - Uracil(U) takes place of the Thymine (T)

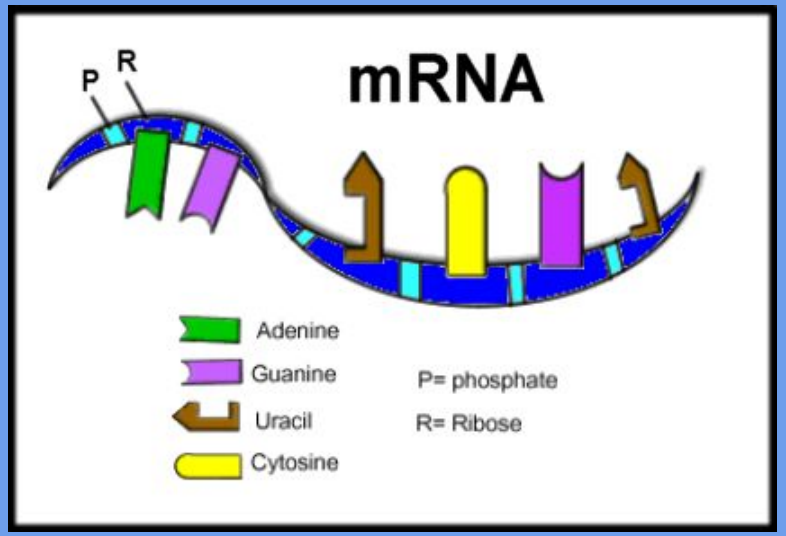


Label

Your Nucleotide: Phosphate, 5-Carbon Sugar & Nitrogen Base

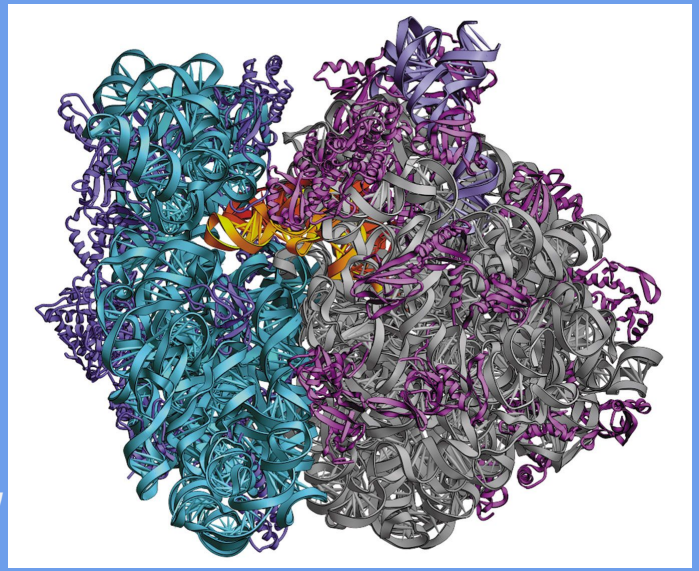
Your strand of RNA - each Nitrogen Base





What does mRNA do?

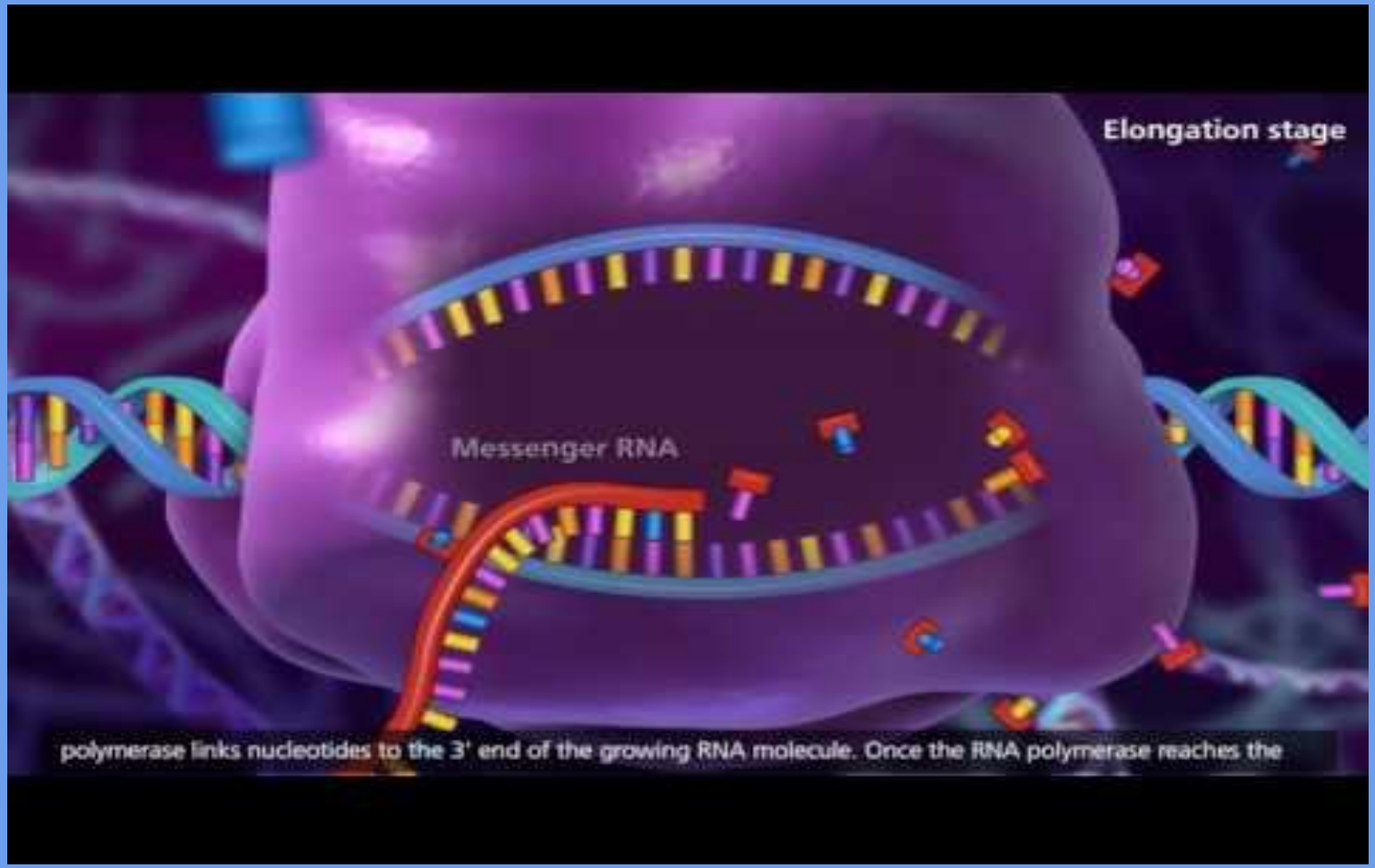
- It’s job is to take directions from one gene and transport it to a ribosome in the cytoplasm where it is translated.
  - This is so the cell can begin assembling ***amino acids***, the building blocks of proteins
  - like it’s name, it is sending messages on how to do the job
  - this is part of the process is called ***Protein Synthesis***



This is a Ribosome up close!

What is Protein Synthesis

- a two stage process
  - ***Transcription*** and ***Translation***
- During this process, a messenger molecule (mRNA) carries instructions from DNA to the ribosomes
  - DNA **cannot** leave the nucleus
  - **BUT** the mRNA can
- mRNA make it possible for the proteins to be assembled by ribosomes outside of the nucleus


Elongation stage
Messenger RNA
polymerase links nucleotides to the 3' end of the growing RNA molecule. Once the RNA polymerase reaches the

Protein Synthesis

Transcription

Transcription

- happens when DNA is turned to mRNA
- happens when proteins need to be made in the cytoplasm
- Since DNA cannot leave the nucleus, it is transcribed into RNA (DNA  RNA)
  - Transcribe: to copy (copy in the same nucleic acid language, but it only copies what is needed)

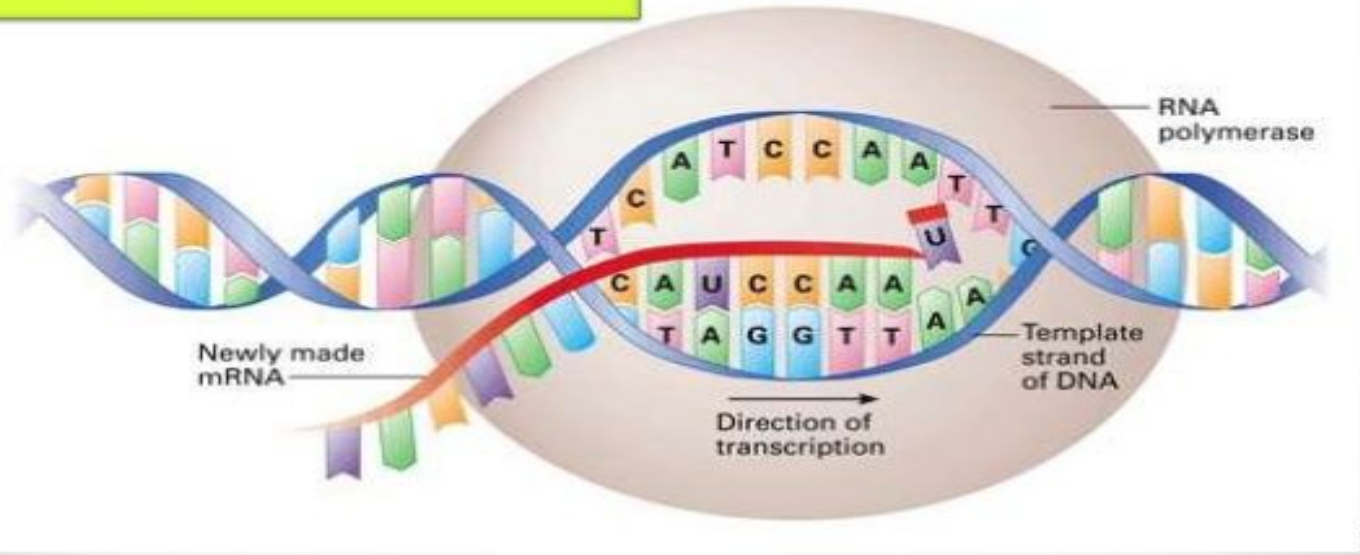
How does transcription happen?

- After an enzyme targets the portion of the DNA that should be copied (initiation), the sections of DNA (genes) will temporarily unwind to allow mRNA to transcribe (copy). This will continue until the enzyme signals to stop or end.
- mRNA leaves the nucleus, travels into the cytoplasm and attaches to a ribosome
- the ¨message¨ from the DNA can now be translated to make a protein

Transcription: DNA to RNA

- Template strand of DNA
- Newly made m RNA*
- RNA polymerase

*Pre m RNA



Transcription: DNA to mRNA

- When transcribing DNA to mRNA you must remember the following complementary pairs
  - C (in RNA) will attach to a G (in DNA)
  - G (in RNA) will attach to a C (in DNA)
  - A (in RNA) will attach to a T (in DNA)
  - U (in RNA) will attach to a A (in DNA)

Practicing Transcription:

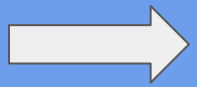
- A piece of DNA reads: T A G C A T T C C G A U
  - transcribe to mRNA: _____

- DNA reads A A G C G T A T C C C G
  - transcribe to mRNA: _____

Protein Synthesis

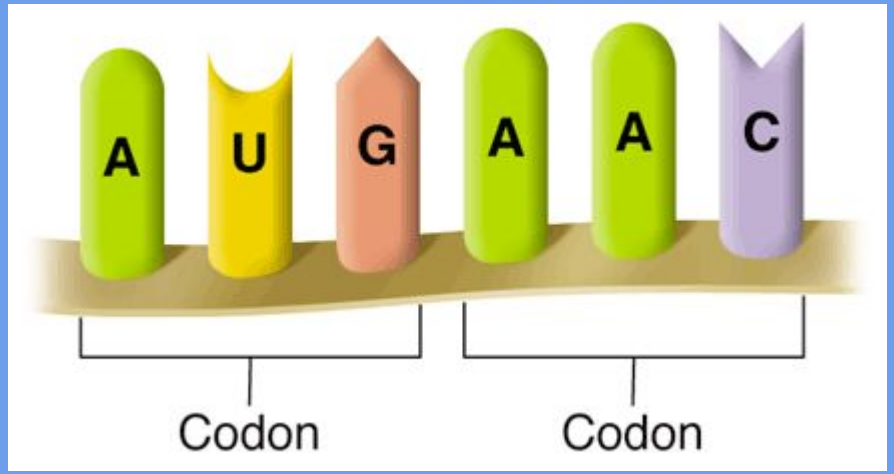
Translation

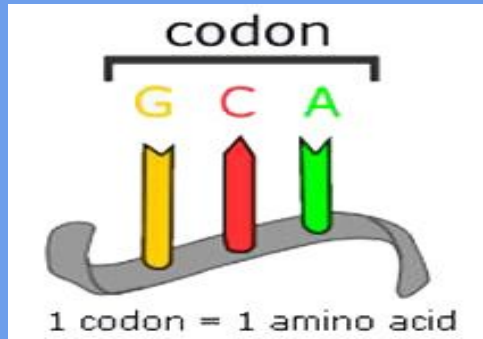
What is Translation?

- the process in which mRNA is used as a blueprint to form chains of amino acids (RNA  Protein)
  - Amino Acids linked together form a protein
  - translate - to change a sentence from one language (nucleic acid) to another (amino acid)

Codon (there are 20 different Amino Acids)

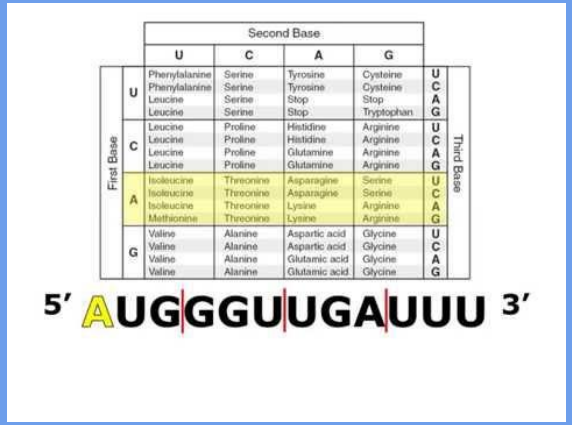
- Every 3 letters on an mRNA chain = codon
  - each codon (3 DNA letters) = 1 Amino Acid





Reading a Codon Chart

- Given the mRNA, we can read a codon chart to translate it into the amino acid it codes for
- Remember, 1 word in nucleic acid language is a codon (three nucleotides)
-



First Base	Second Base: U	Second Base: C	Second Base: A	Second Base: G	Third Base
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine	Alanine	Aspartic acid	Glycine	C
	Valine	Alanine	Glutamic acid	Glycine	A
	Valine	Alanine	Glutamic acid	Glycine	G

5′ AUGGGUUGAUUU 3′

Practice: Reading a Codon Chart

- What amino acid is coded for AUGGUCGCCCGAUAA?
  - AUG - _____
  - GUC - _____
  - GCC - _____
  - CGA - _____
  - UAA - _____

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

Practice: Reading a Codon Chart

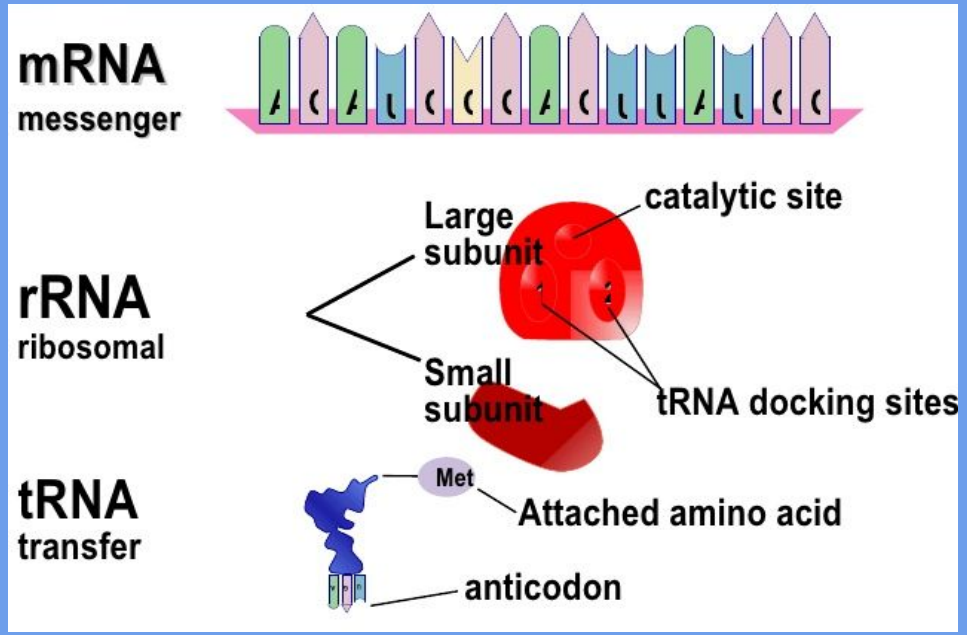
- What amino acid is coded for AUGGUCGCCCGAUAA?
  - AUG - Methionine
  - GUC - Valine
  - GCC - Alanine
  - CGA - Arginine
  - UAA - stop

Anticodon

- Region of mRNA that is a compliment to the codon

Translation

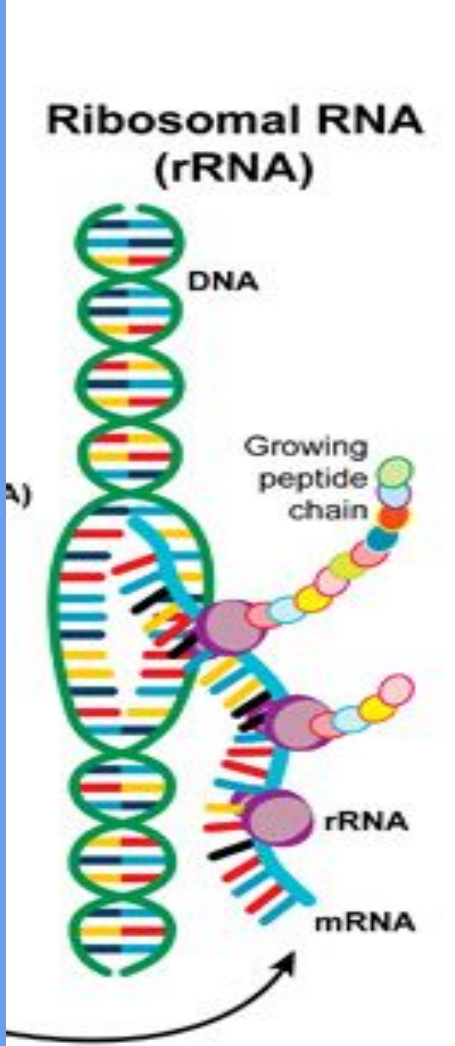
- Occurs in a ribosome in ALL cells
- This process uses all three forms of RNA (mRNA, rRNA and tRNA)
- DNA is not directly used!



Step 1 of Translation

The mRNA leaves the nucleus and lands on a ribosome

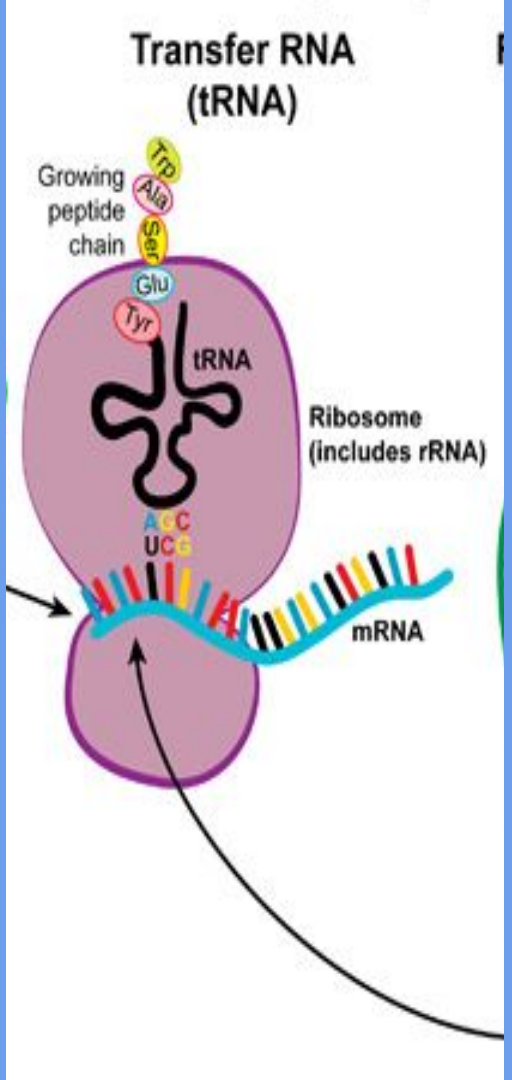
(rRNA - Ribosomal Ribonucleic Acid)



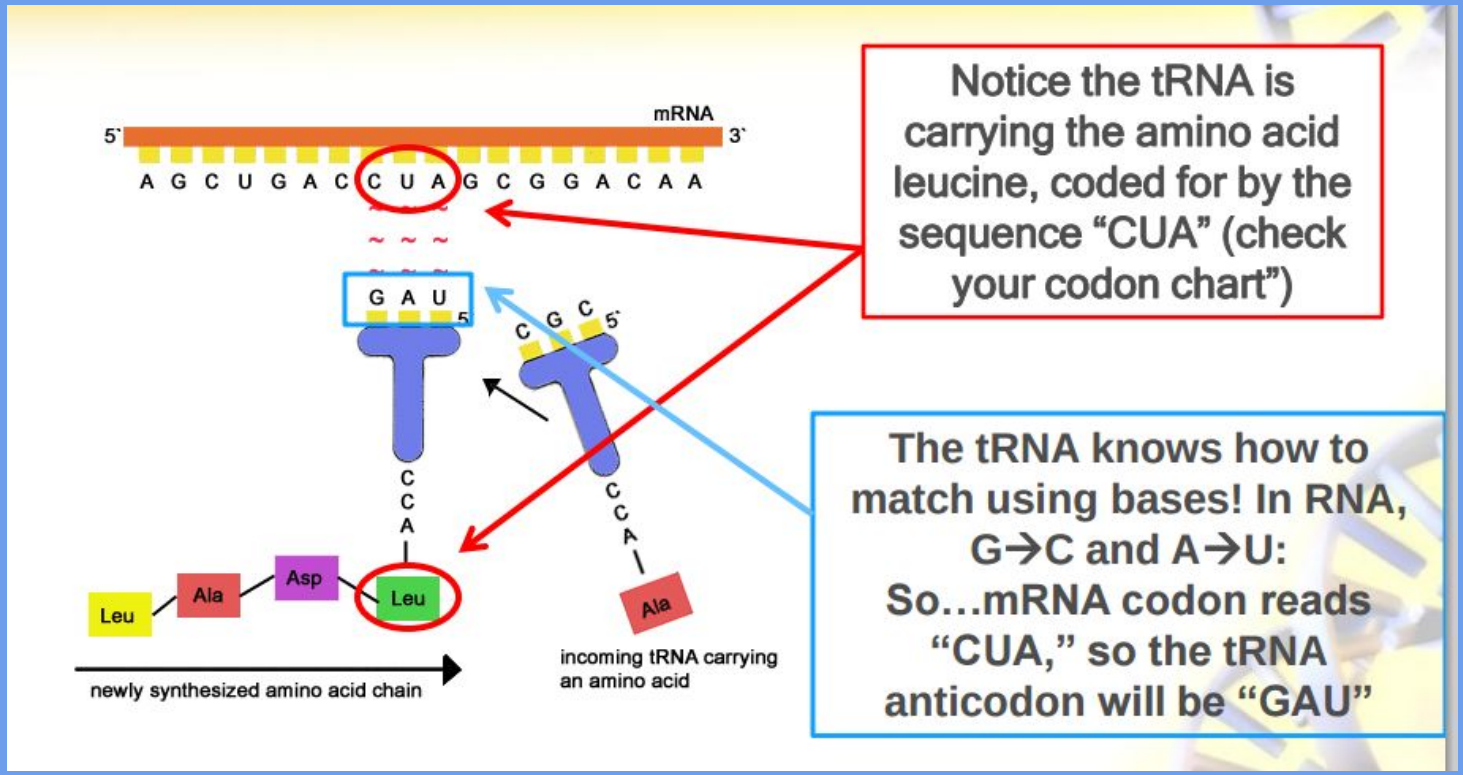
Step 2 of Translation

The tRNA (with the correct anticodon) lands on the ribose opposite a codon on the mRNA

(tRNA - Transfer Ribonucleic Acid)



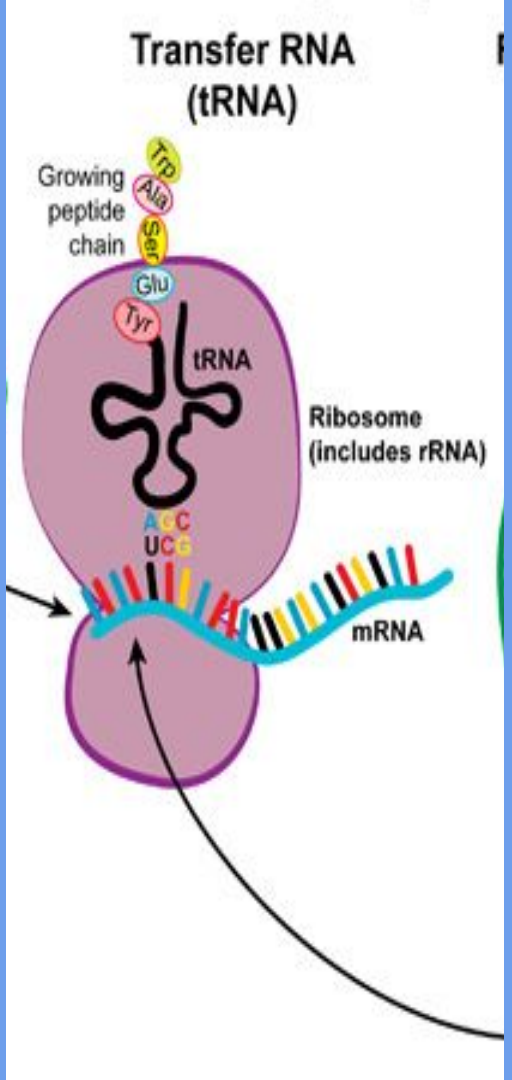
tRNA: A Closer Look



Step 3 of Translation

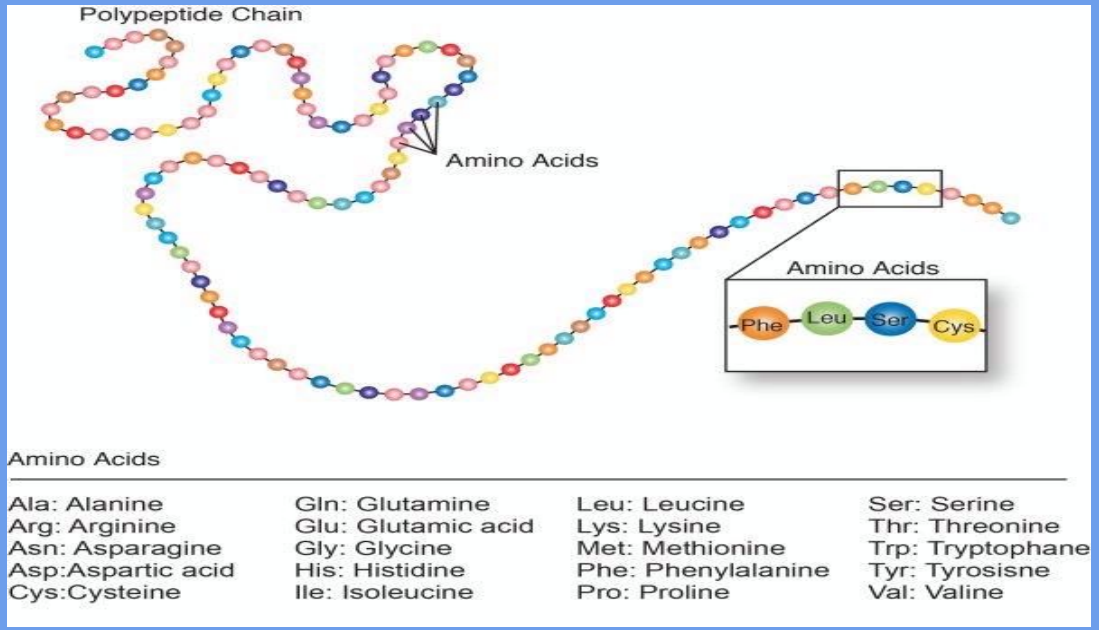
The tRNA leaves the ribosome, but the amino acid that it coded for stays on the ribosome to be read

(tRNA - Transfer Ribonucleic Acid)



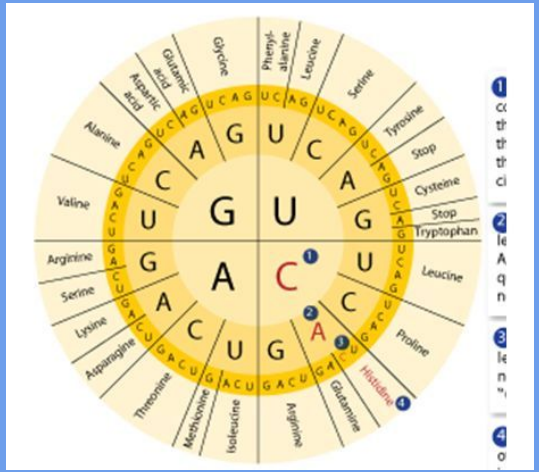
Step 4 of Translation

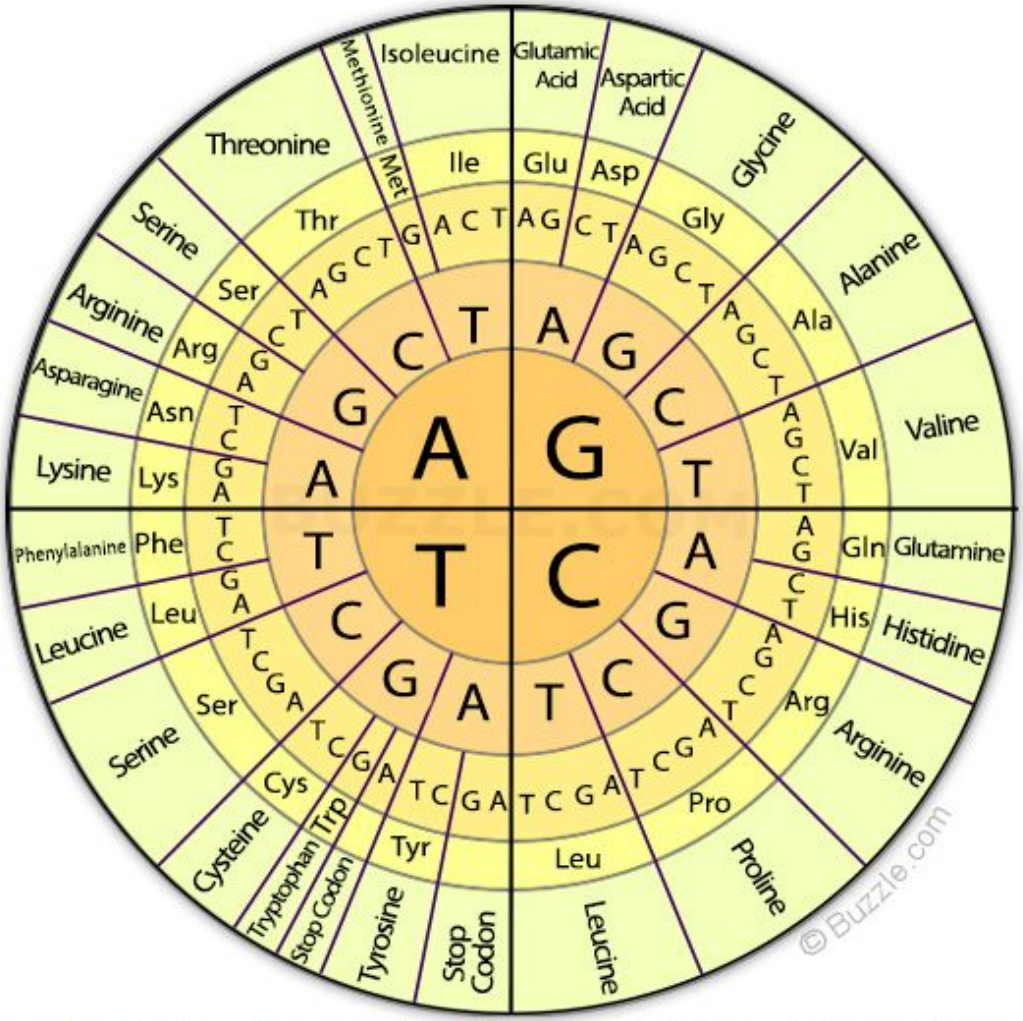
The ribosome moves to the next codon bringing in another amino acid to the growing protein (Polypeptide) chain.



Amino Acid Chain

- Will start with the “START codon” - AUG
- tRNA will continue to add amino acids until it reaches a “STOP codon”
  - (UAA, UAG, UGA)
- Reaching the stop protein, means a complete protein has been built
- The protein un-attaches from the ribosome

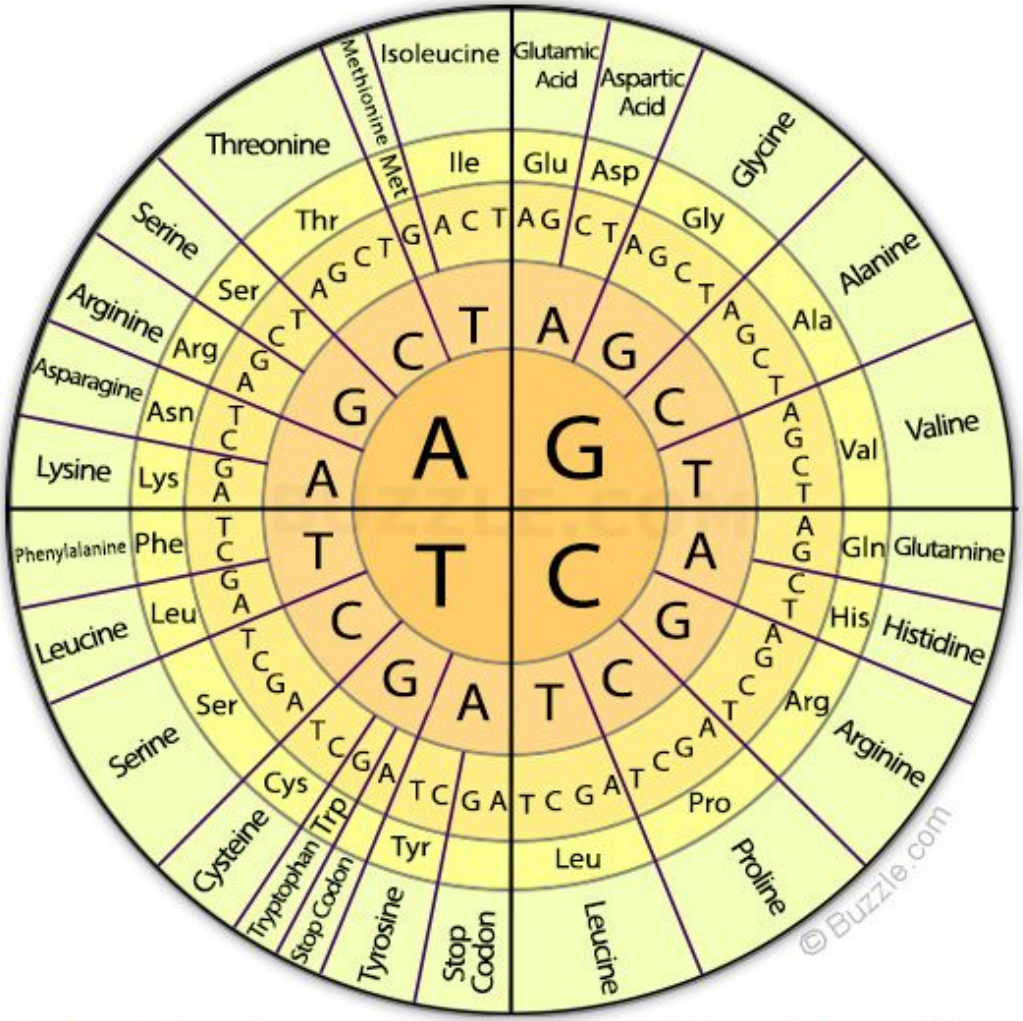




To decode the codon, move from the center circle towards the periphery.

Code the Following Amino Acids:

1. TGC - _____
2. CCG - _____
3. ACG - _____



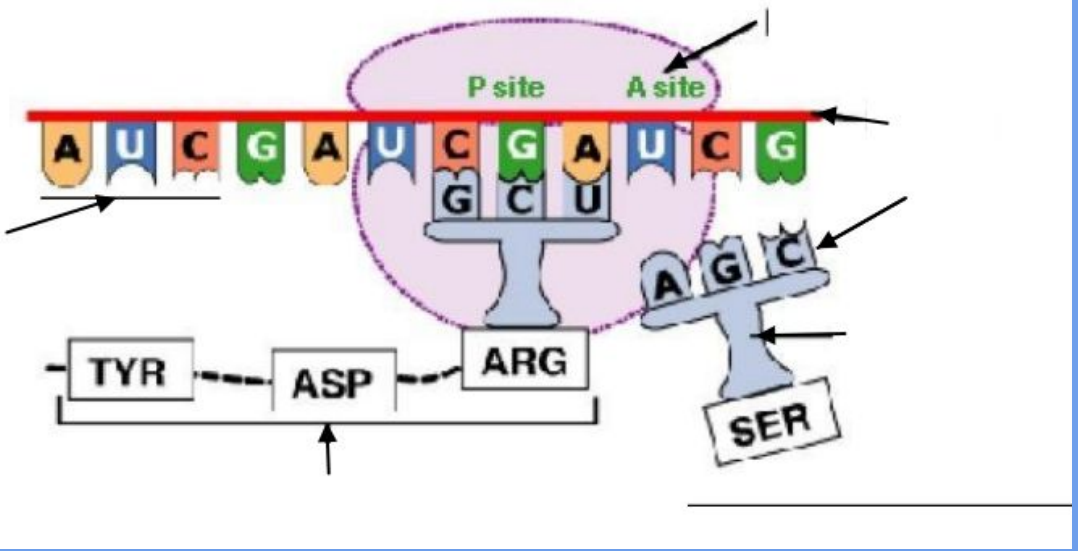
To decode the codon, move from the center circle towards the periphery.

Code the Following Amino Acids:

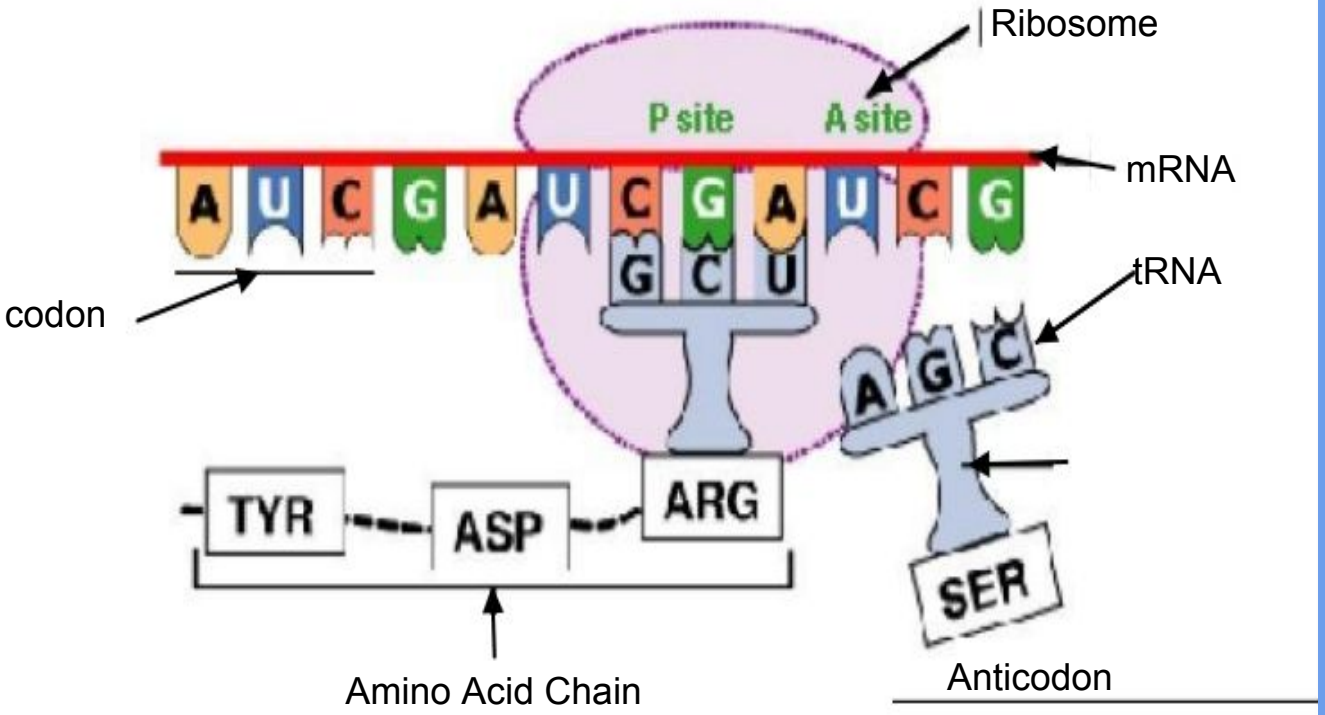
1. TGC - Cysteine
2. CCG - Proline
3. ACG - Threonine

Label the diagram of translation

a) ribosome
b) mRNA
c) tRNA
d) codon
e) anticodon
f) amino acid chain



a) ribosome
b) mRNA
c) tRNA
d) codon
e) anticodon
f) amino acid chain



Let's Practice

- Given the strand of DNA below, what would it´s ***complementary DNA*** strand read?
  - ATC

- Now, transcribe the DNA to mRNA
- What amino acid does the codon code for? (use the codon chart)

- What would the anticodon on the tRNA read?

Let's Practice

- Given the strand of DNA below, what would it´s ***complementary*** DNA strand read?
  - ATC - TAG

- Now, transcribe the DNA to mRNA - AUC
- What amino acid does the codon code for? (use the codon chart) - isoleucine

- What would the anticodon on the tRNA read? - UAG

One more time

- Given the strand of DNA below, what would it´s ***complementary*** DNA strand read?
  - TGA

- Now, transcribe the DNA to mRNA
- What amino acid does the codon code for? (use the codon chart)

- What would the anticodon on the tRNA read?

One more time

- Given the strand of DNA below, what would it´s ***complementary*** DNA strand read?
  - TGA - ACT

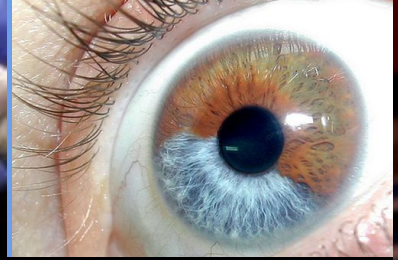
- Now, transcribe the DNA to mRNA - UGA
- What amino acid does the codon code for? (use the codon chart) STOP - causing translation to stop

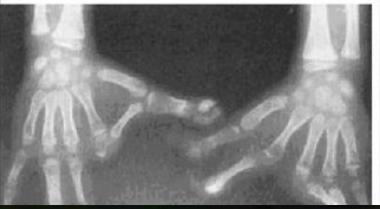
- What would the anticodon on the tRNA read? ACU


Mutations
Changes to DNA


a

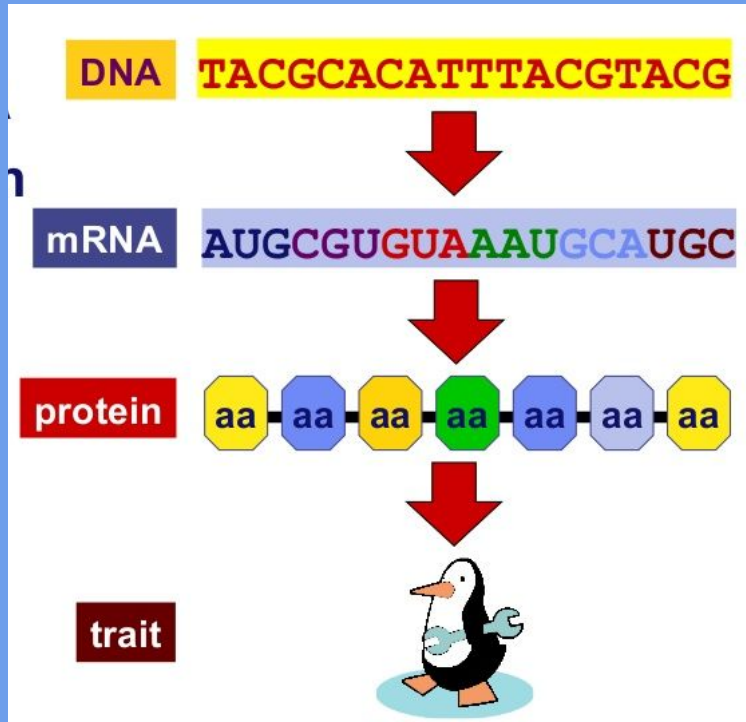

b





Mutations

- Any changes to the DNA Sequence
  - Changes to the DNA
  - Changes to the mRNA
  - may change the protein
  - may change the trait

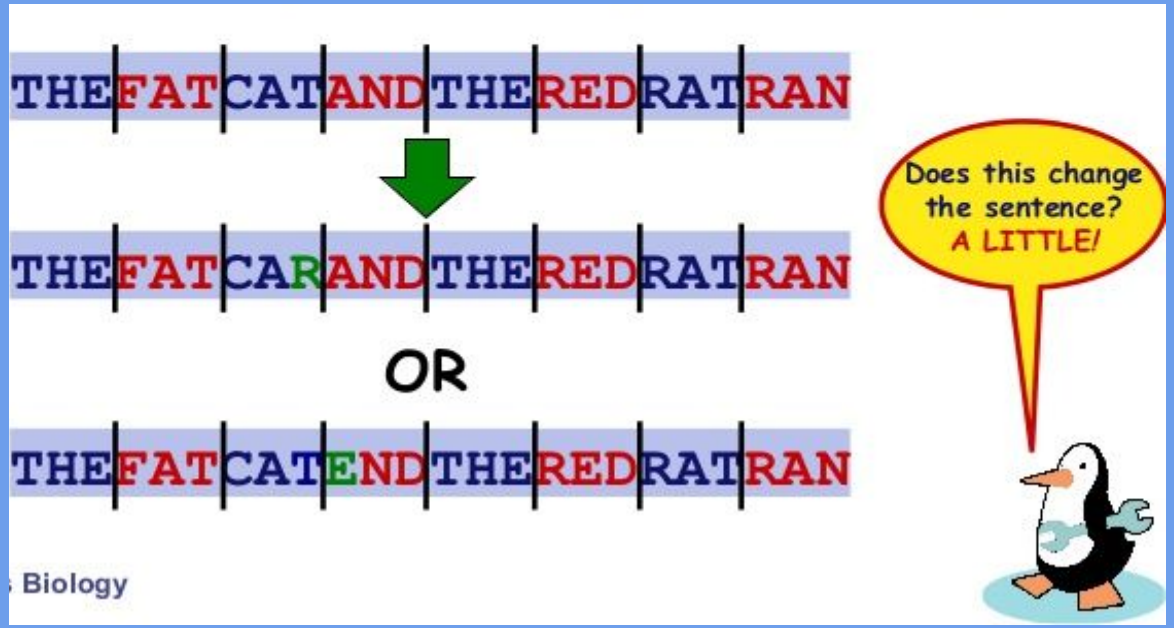


Types of Mutations

- Changes to the letters (A,C,T,G bases) in the DNA
  - *point mutation*
    - change to ONE letter (base) in the DNA
    - may (or may not) cause change the protein
  - *frameshift mutation*
    - addition of a new letter (base) in the DNA sequence
    - deletion of a letter (base) in the DNA
    - both shift the DNA and change how the codons are read
    - big changes to protein!

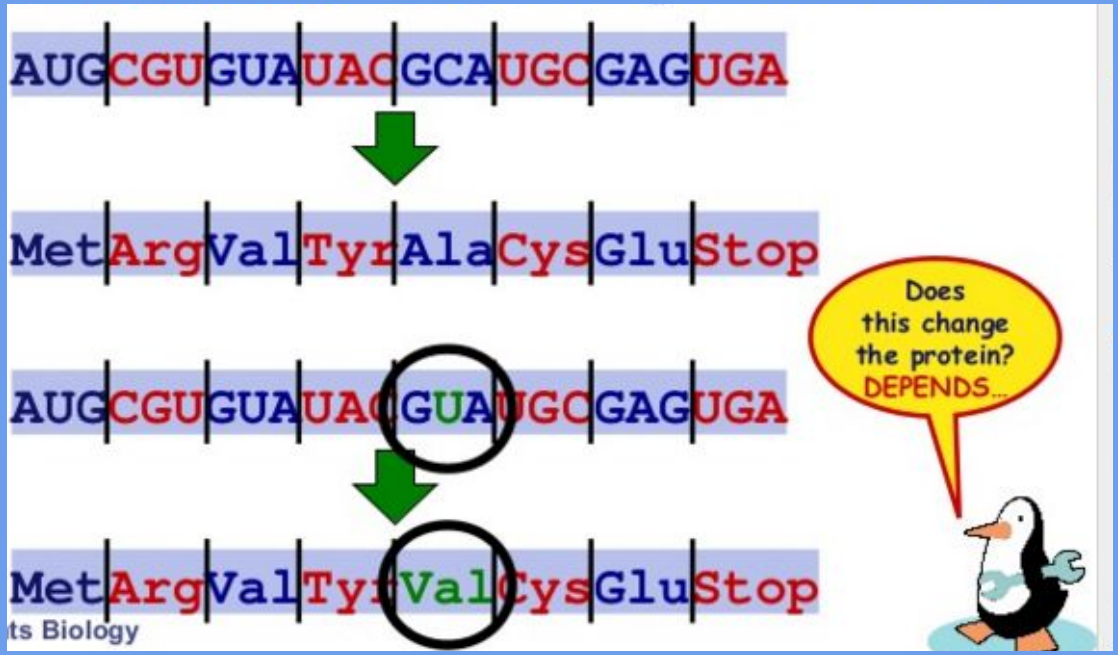
Point Mutations

- One base change, can change the meaning of the whole protein



Point Mutations

- Missense Mutation - changes the amino acid

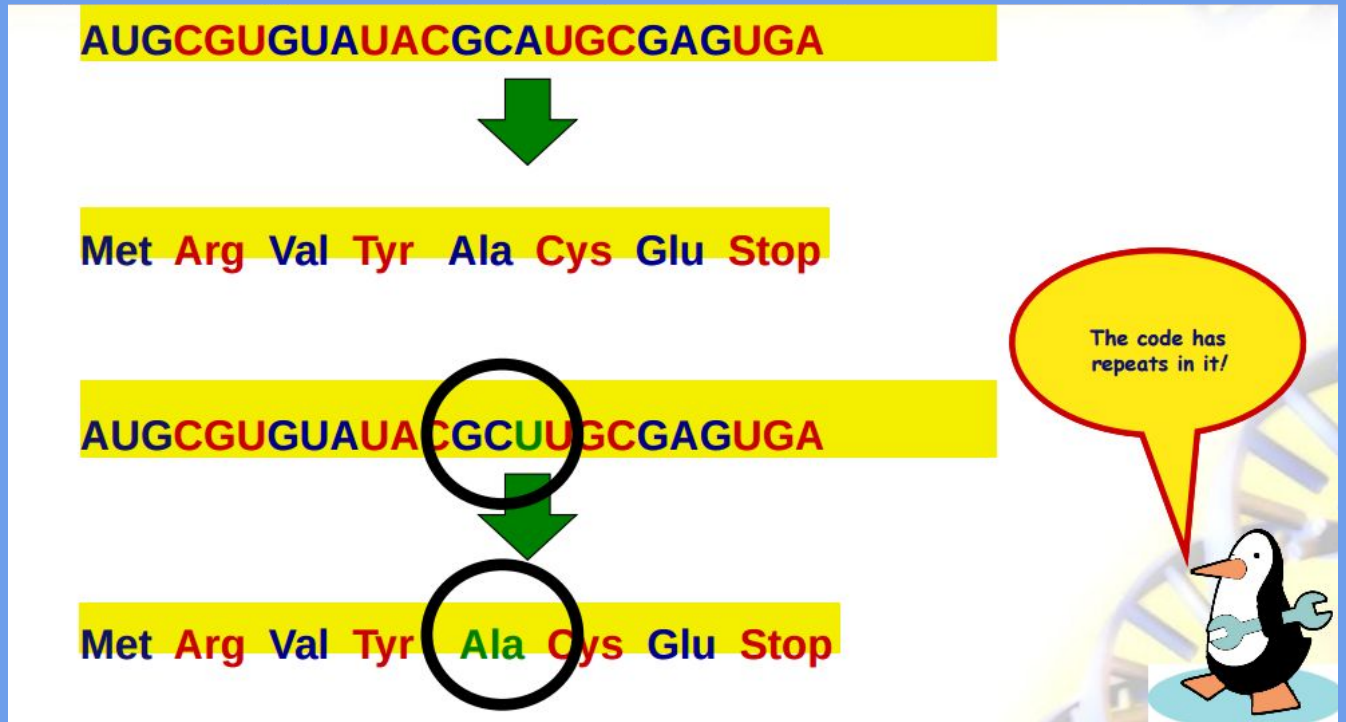


Sickle Cell Anemia: ex. missense mutation

- Hemoglobin protein in the red blood cells
  - strikes 1 out of 400 African Americans
    - side effects: limited activity, painful & may die young

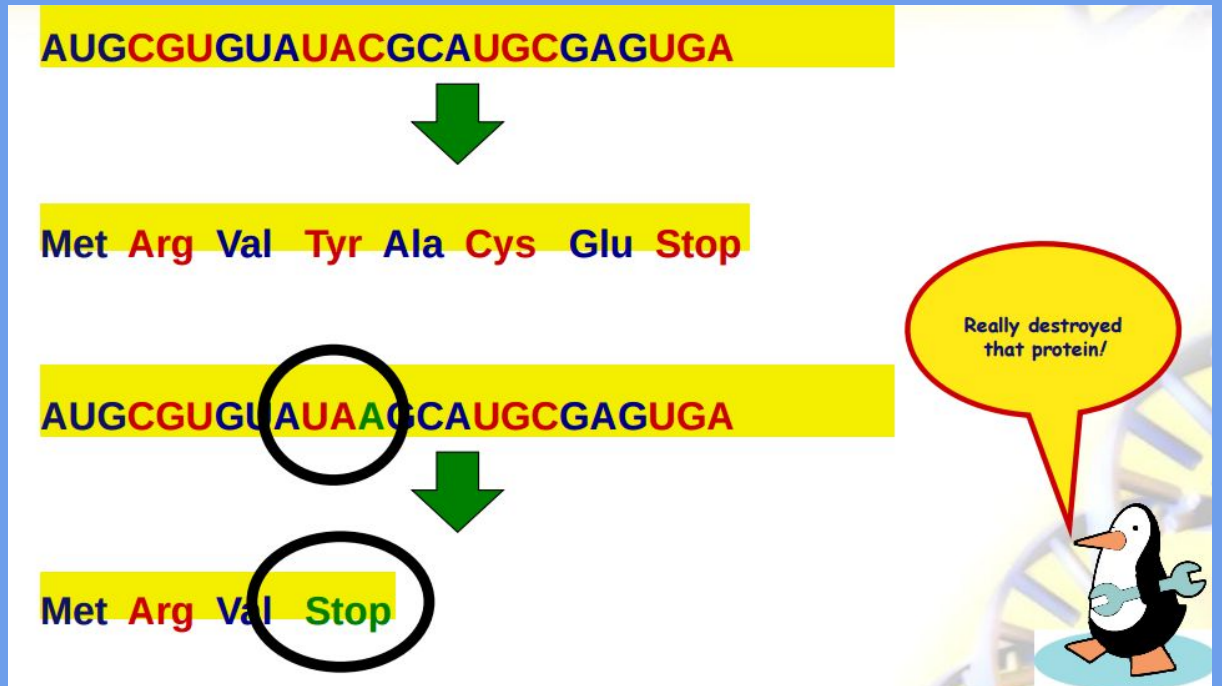
Silent Mutations

- no change to the protein



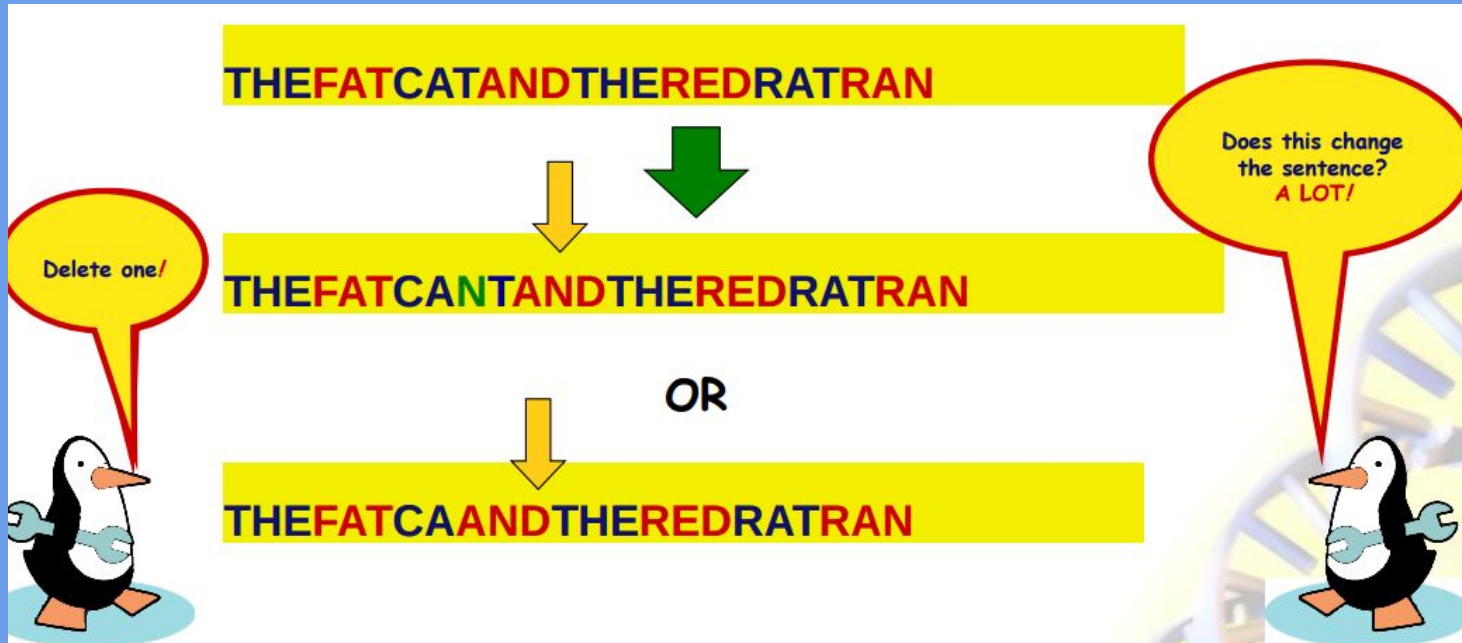
Nonsense Mutations

- changes protein to STOP



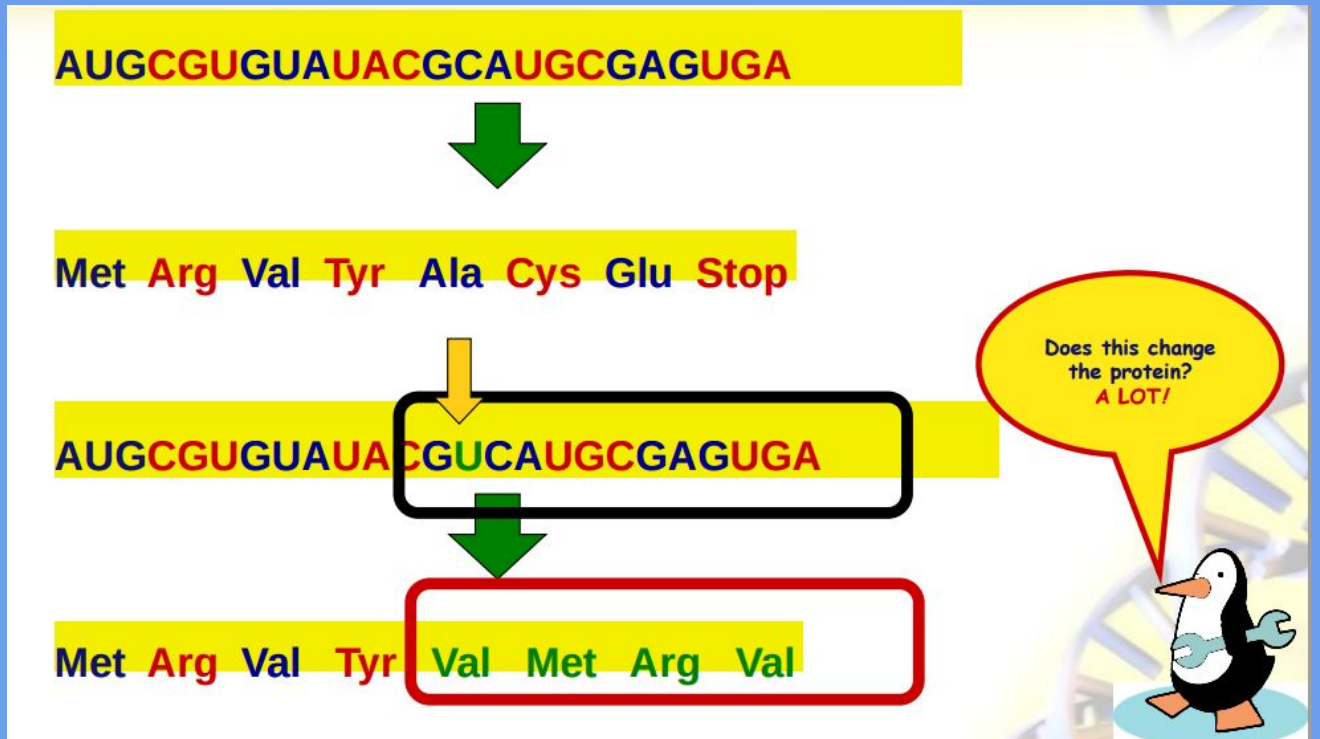
Frameshift Mutations

- Add or Delete one or more base - changes the whole meaning of the protein



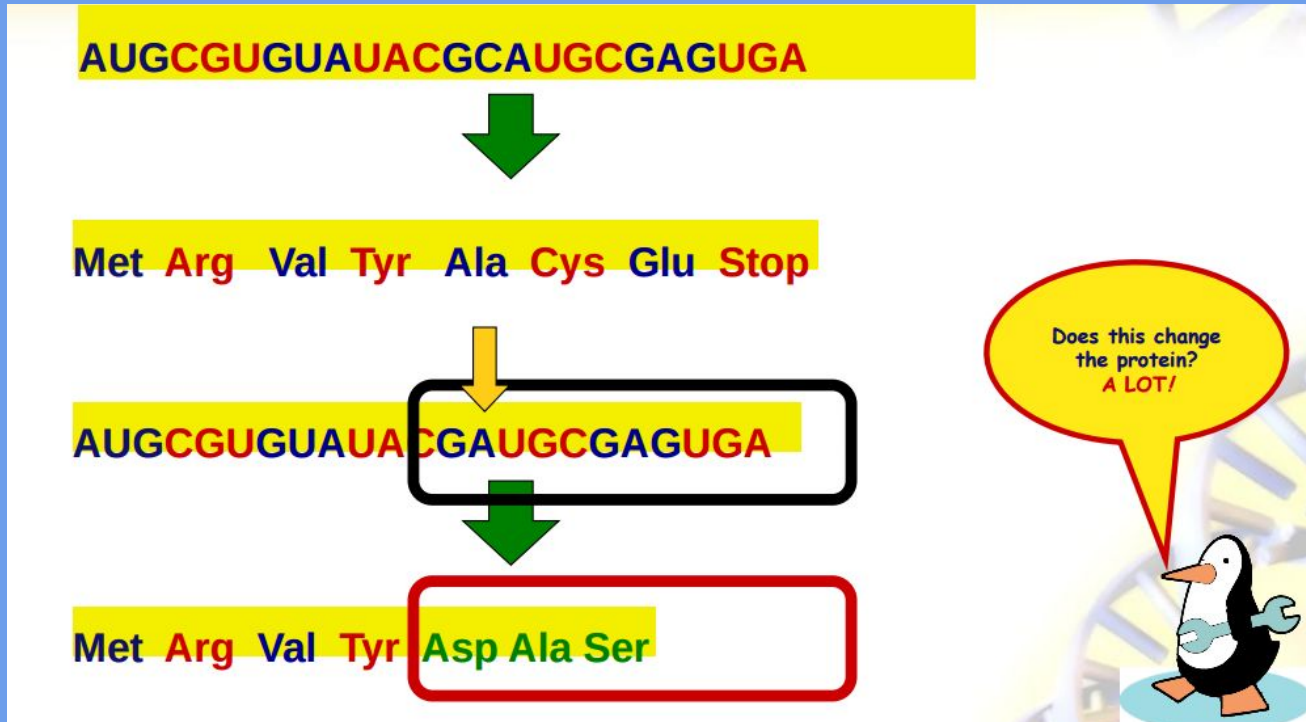
Addition

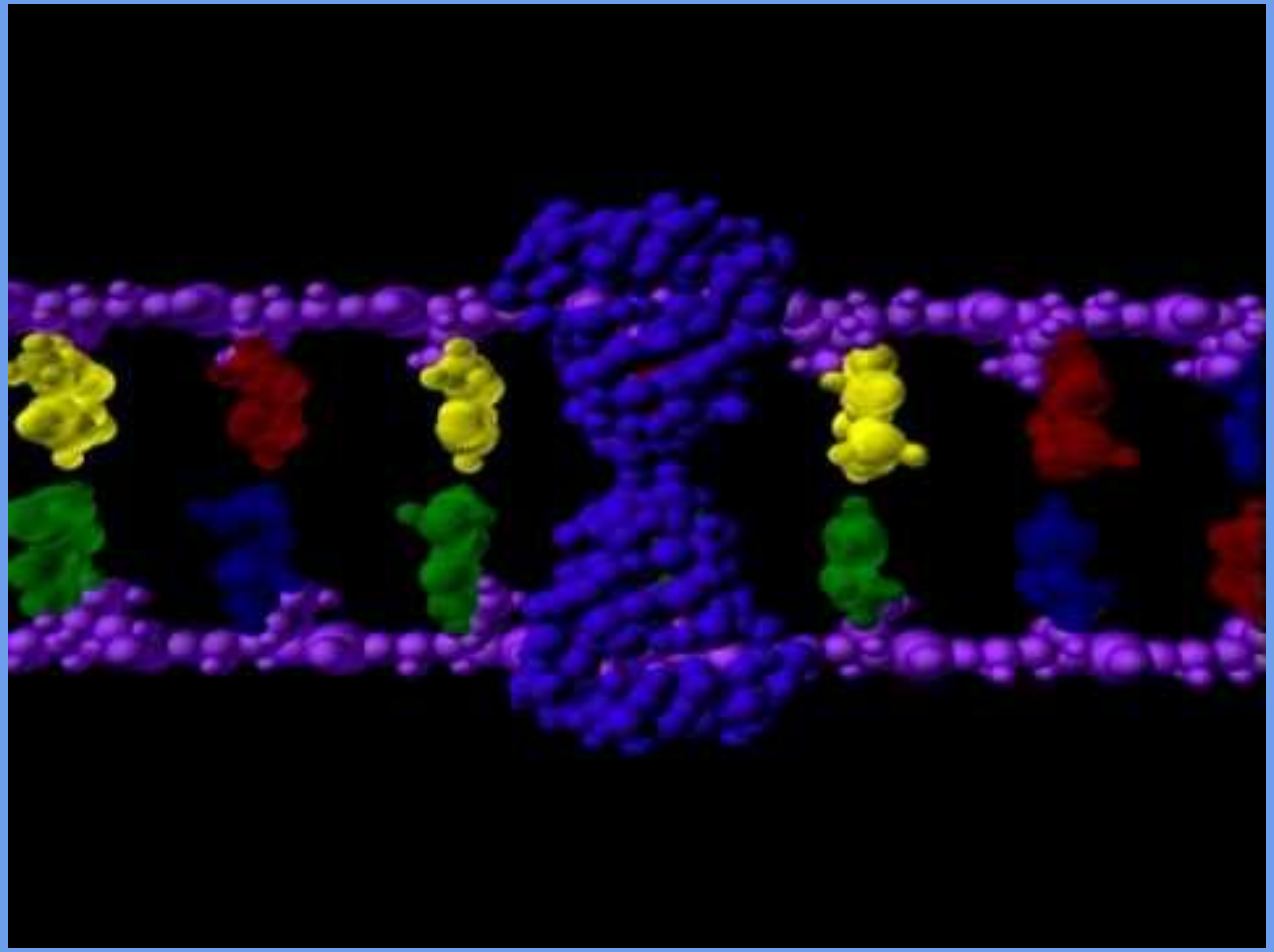
- add one or more base(s)



Deletion

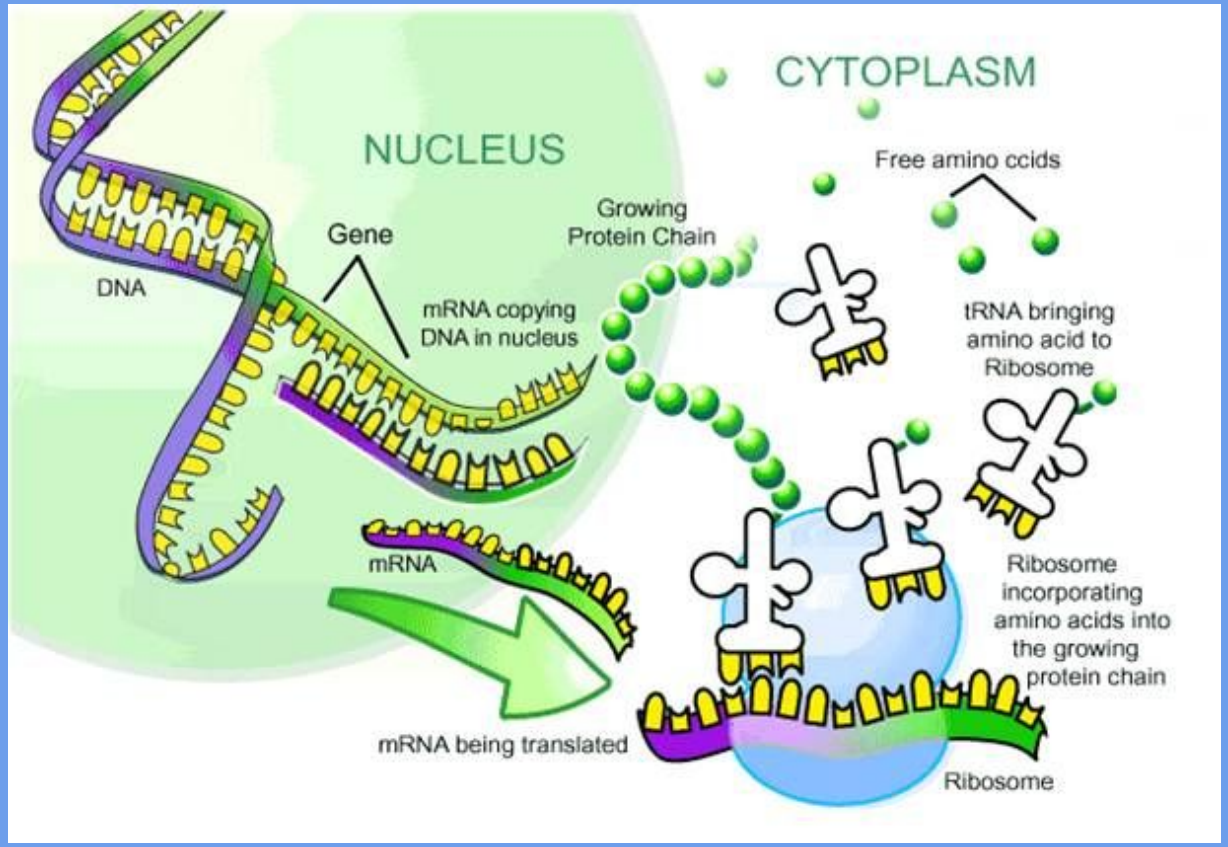
- lose one or more base(s)





Remember

- mRNA - gives you your Amino Acid sequence
- Protein Synthesis - translation and transcription
- DNA - has 4 bases - ATCG
- RNA - has 4 bases - AUCG
- 3 bases = 1 codon = 1 amino acid


CYTOPLASM
NUCLEUS
Free amino ccids
Growing
Protein Chain
Gene
DNA
mRNA copying
DNA in nucleus
tRNA bringing
amino acid to
Ribosome
mRNA
Ribosome
incorporating
amino acids into
the growing
protein chain
mRNA being translated
Ribosome

Circular mRNA Codon Chart:

There are 20 different Amino Acids