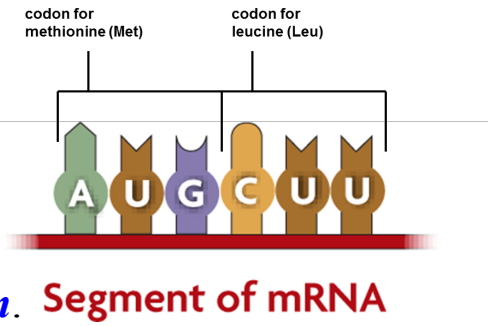
8.5 Translation

III. The Genetic Code

A. How can mRNA be translated into the sequence of amino acids that make up proteins?

-Every *three* nucleotides in mRNA specify a particular ***amino acid***. Each triplet in mRNA is called a ***codon*****.** The order of the *bases* in a codon determines which ***amino acid*** will be added to a growing protein chain. In turn, the order of amino acids will determine the structure and function of a ***protein***.



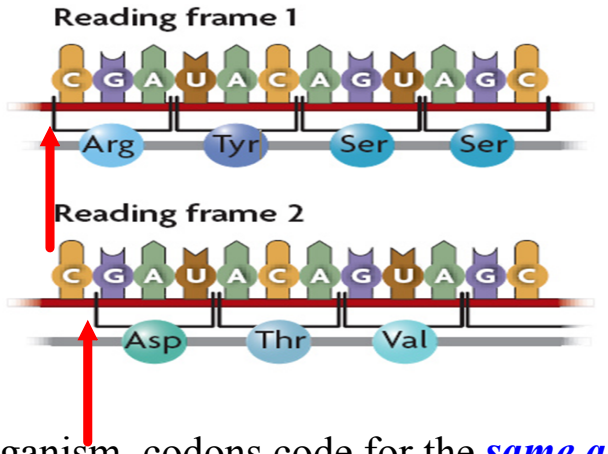
B. The genetic code is the correspondence between nucleotide triplets in DNA and the amino acids in proteins.

- Since there are 20 different kinds of amino acids, there needs to be a least ***20 triplet codes***. You would need to group the bases (A,C,U,G) in three's, which gives you ***64*** possible combinations ($4^3 = 64$). If grouped in two's, you only get 16 combinations ($4^2 = 16$).

- Some codons do not code for an amino acid, but provide ***instructions*** for starting the protein chain (***AUG or methionine***) and stopping the chain because the protein is complete (***UAA, UAG, UGA***).

- The genetic code is the same in nearly all organisms, so it is said to be ***universal***. This provides evidence that ***all life*** on Earth evolved from a ***common origin***.

- A ***change in the order*** in which codons are read, ***changes the resulting protein.***

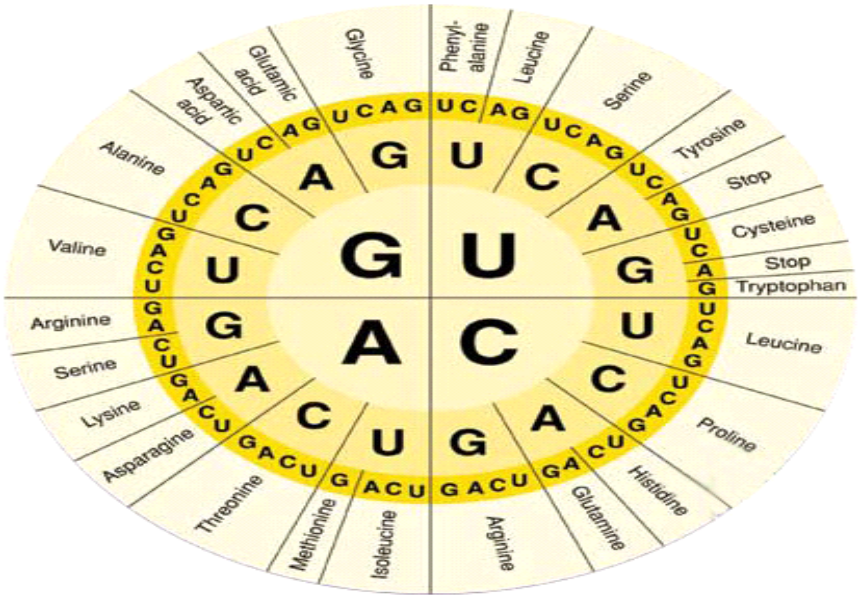


- Regardless of the organism, codons code for the ***same amino acid***.

The genetic code matches each RNA **codon** with its amino acid or function.

First base	Second base U		Second base C		Second base A		Second base G		Third base
U	UUU	phenylalanine (Phe)	UCU	serine (Ser)	UAU	tyrosine (Tyr)	UGU	cysteine (Cys)	U
	UUC		UCC		UAC		UGC		C
	UUA	leucine (Leu)	UCA		UAA	STOP	UGA	STOP	A
	UUG		UCG		UAG	STOP	UGG	tryptophan (Trp)	G
C	CUU	leucine (Leu)	CCU	proline (Pro)	CAU	histidine (His)	CGU	arginine (Arg)	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	glutamine (Gln)	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	isoleucine (Ile)	ACU	threonine (Thr)	AAU	asparagine (Asn)	AGU	serine (Ser)	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	lysine (Lys)	AGA	arginine (Arg)	A
	AUG	methionine (Met)	ACG		AAG		AGG		G
G	GUU	valine (Val)	GCU	alanine (Ala)	GAU	aspartic acid (Asp)	GGU	glycine (Gly)	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	glutamic acid (Glu)	GGA		A
	GUG		GCG		GAG		GGG		G

1. Find the first base, C, in the left column.
2. Find the second base, A, in the top row. Find the box where these two intersect.
3. Find the third base, U, in the right column. CAU codes for histidine, abbreviated as His.

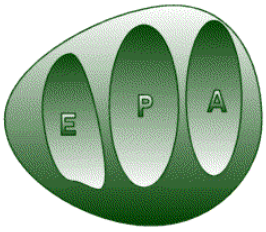


I. How RNA Makes Proteins

-Translation = ***the process by which the genetic message is deciphered***.

Steps in translation:

1. A ribosome, which is composed of ***two subunits of rRNA and protein***, attaches to a strand of mRNA in the ***cytoplasm*** of the cell.



Ribosome has three sites -
A site, P site, E site
Initiate, Elongate, Terminate

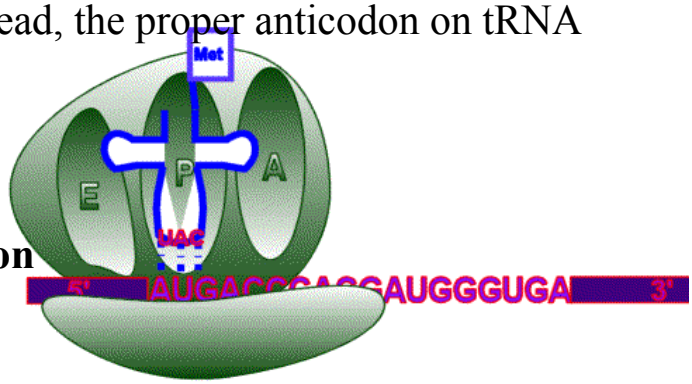
Note location of the sugar

2. Within the ribosome is another kind of RNA, ***tRNA***, which transfers in the amino acids as they are read on the mRNA.

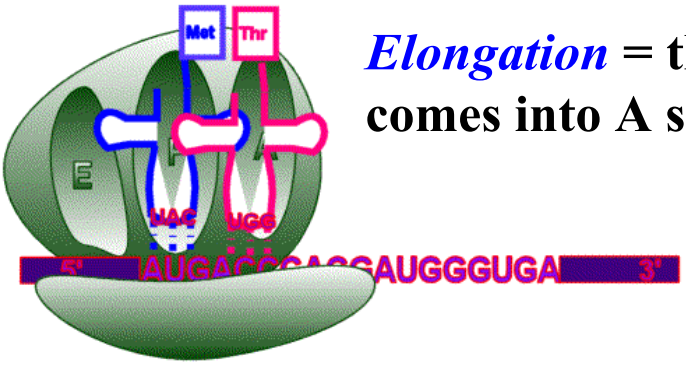
-A tRNA molecule is about ***80 nucleotides*** long, folded into a compact shape. At one end is a three-nucleotide sequence called an ***anticodon***. At the opposite end is an ***amino acid***.

-As the codon on mRNA is read, the proper anticodon on tRNA ***matches*** to it.

Initiation = **Ribosome + mRNA + tRNA come together at AUG start codon**

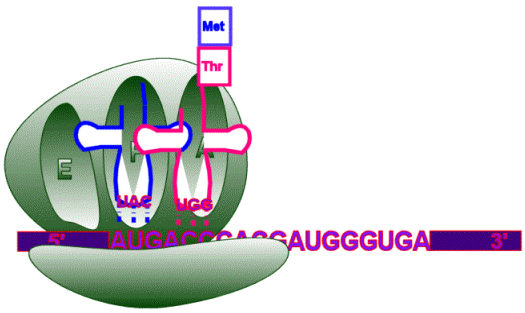


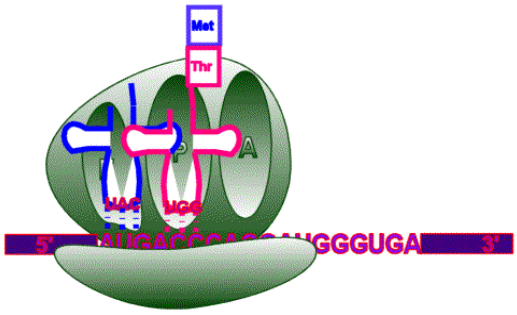
3. The anticodon ***binds*** to the codon, thus bringing in the proper amino acid.
4. The amino acid detaches from the *tRNA* molecule and attaches to the growing ***protein*** chain within the ribosome. A ***peptide*** bond is formed with the amino acid next to it. The empty tRNA molecule then ***leaves*** the ribosome to pick up another amino acid.



Elongation **= tRNA with anticodon comes into A site**

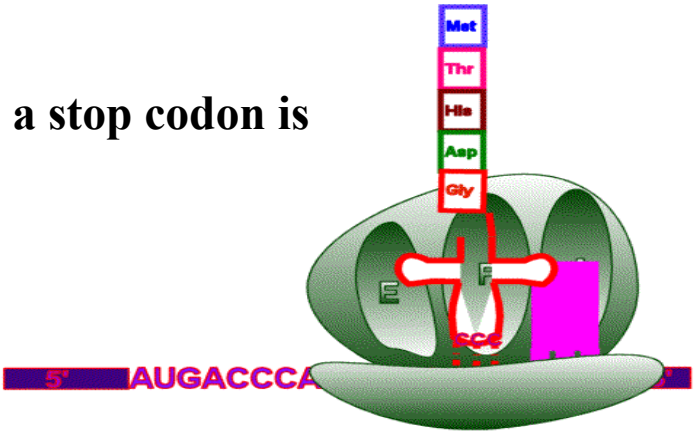
Translocation **- system ratchets down so that the tRNA formerly in the A site is now in the P site**

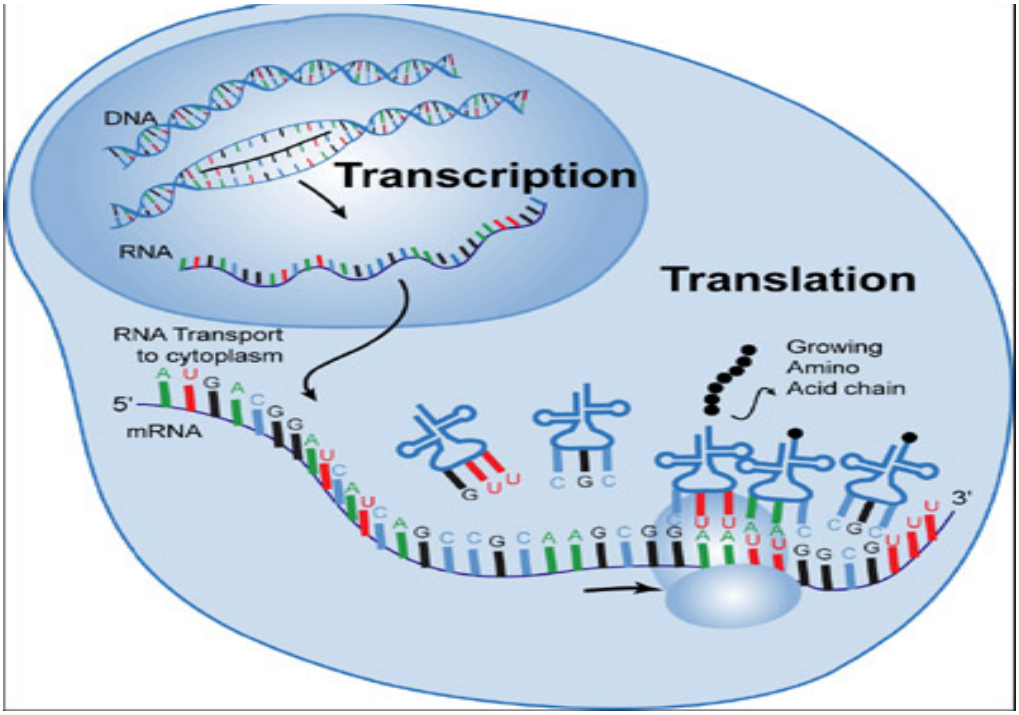


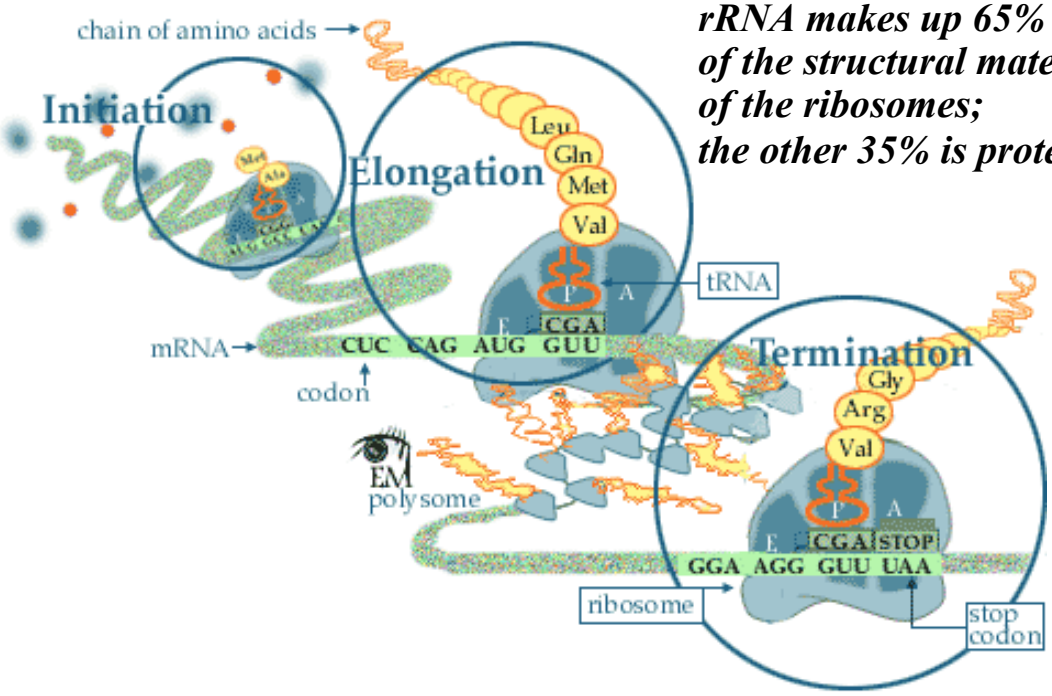


5. The ribosome moves along the ***mRNA*** strand to read the next ***codon***, and the whole process happens again.
6. At some point in the **mRNA** strand the ***"stop"*** codon occurs and the components of the ribosome ***separate and disengage*** the **mRNA**. The protein is then ***released*** into the cell. The **mRNA** returns to the nucleus, ***disassembles*** and begins again in the transcription process.

Termination **= when a stop codon is encountered**







rRNA makes up 65% of the structural material of the ribosomes; the other 35% is protein.