Genetic Code

- DNA Replication & transcription depend upon Complimentary Base pairing but mRNA (nucleotide) & protein (amino acid) have no direct relation.
- Sequence of codon (**3 bases code)** present in mRNA give sequence of amino acid.
- Any change in DNA can change Protein**.**
- There are 64 codons, where 61 code for amino acids & rest 3 are known as stop codons, as they do not code for any amino acid.

Scientist from different field:		
George Gamow (Physicist)	Suggested (theoretically) that coding for 20 amino acids should be made up of 3 nucleotides.	Codon was a Nucleotide Triplet. $4^3 = (4\times4\times4) = 64$ codons
Har Gobind Khorana (Bio-Chemist)	Develop the chemical method in synthesizing RNA molecules with defined combination of bases (Co-polymer or Homopolymer)	Homopolymer: 5'-UUUUUUUUUUU-3' Co-polymer 5'-AUAUAUAUAUAUA-3'
Marshall W. Nirenberg (Biochemist and Geneticist)	Develop cell free system of protein synthesis that help code to be decipher (read).	UUU- (Phenylalanine) First amino acid decipher.
Severo Ochoa (Physician & Biochemist)	Discovered Severo Ochoa enzyme in 1955 that can join nucleotides in Template Free RNA Synthesis	Enzyme Isolate from bacteria Polynucleotide Phosphorylase

Salient features of Genetic Code		
Unambiguous	One Codon code for one amino acid.	Ex-GUG-only code for valine
Degenerate	Some amino acid code by more than one codon.	Ex- GAG, GAA both code for Glutamic Acid.
Universal	Code would be same from bacteria to human. Exception: mitochondrial codon, protozoans	Ex: **UGG- Tryptophan**
No Punctuation	Codon are read in mRNA in continuous fashion.	AUGUUUUUCUUCUUC
Start Codon	Initiation the process.	**AUG- (**Methionine)
Stop Codon	Terminate the process.	**UAA, UGA, UAG**

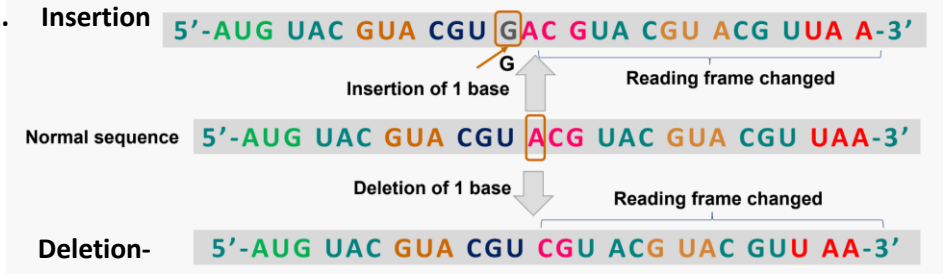
Mutations and Genetic Code

A change in the single base pair causes point mutation.

1. **Substitution** – Ex: Sickle cell anaemia- Glutamic Acid (**G**A**G**) to Valine (**G**U**G**)

Frameshift Mutation

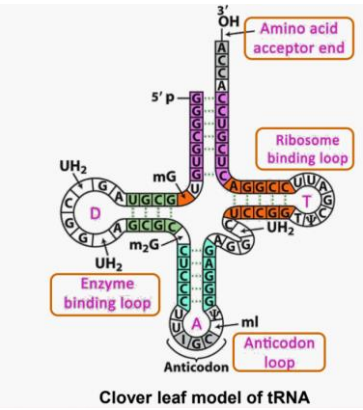
1. **Insertion**



2. **Deletion-**

tRNA- The Adapter Molecule

- Francis Crick postulated presence of an adapter molecule that can read the code to link with amino acids.
- Its secondary (2D) structure that looks like clover leaf while its 3D structure looks like inverted L.
- tRNA called sRNA (soluble RNA), was known before the genetic code was postulated.



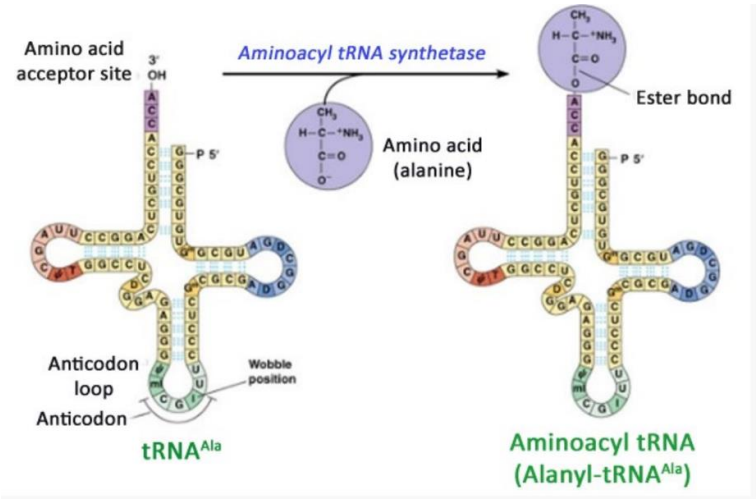
Clover leaf model of tRNA

- tRNA are specific for each amino acid.
- There are no TRNA for Stop Codon.
- ➢ **Anticodon loop:** Has bases complementary to the codon.
- ➢ **Amino Acid Acceptor end-** Amino Acids bind here.
- ➢ **Ribosome binding Loop-** Binds to Ribosome
- ➢ **Enzyme binding Loop-** Binds to Enzyme

Translation

It is the process of amino acid polymerisation to form polypeptide.
The translation process is in the 5'→3' direction always.
All three RNAs(mRNA, tRNA and rRNA) have a different role in the process of translation.
Amino Acid joint by peptide bond.
Ribosomes are a protein manufacturing factory, Ribozyme (23 sRNA in Bacteria) act as a catalyst in the formation of a peptide bond. There P site and A sites in the large subunit of a ribosome accommodate two tRNAs with amino acids close enough to form a peptide bond.

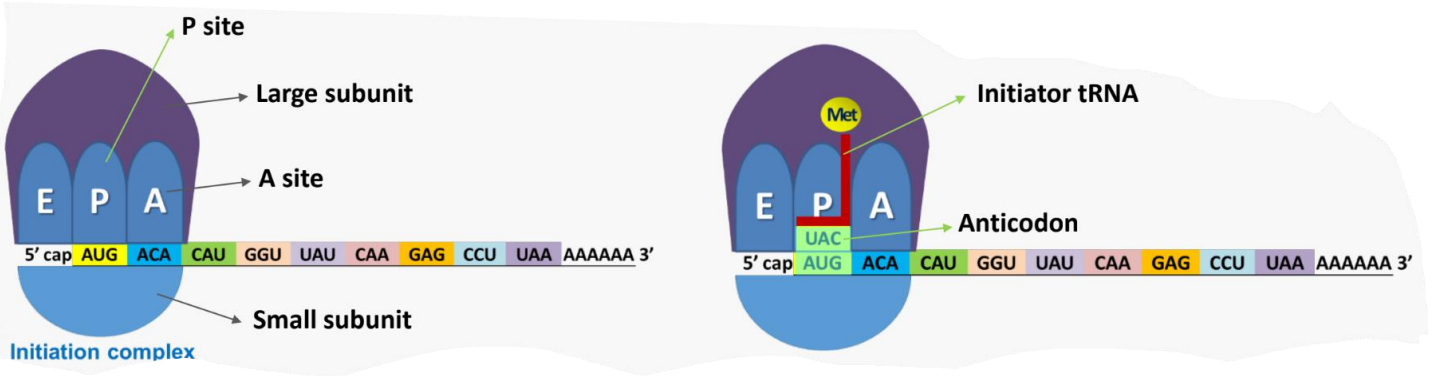
Charging of tRNA (Aminoacylation):



- Formation of peptide bond needs energy hence needs energy Amino Acids + ATP link to tRNA in presence of aminoacyl tRNA synthetase.

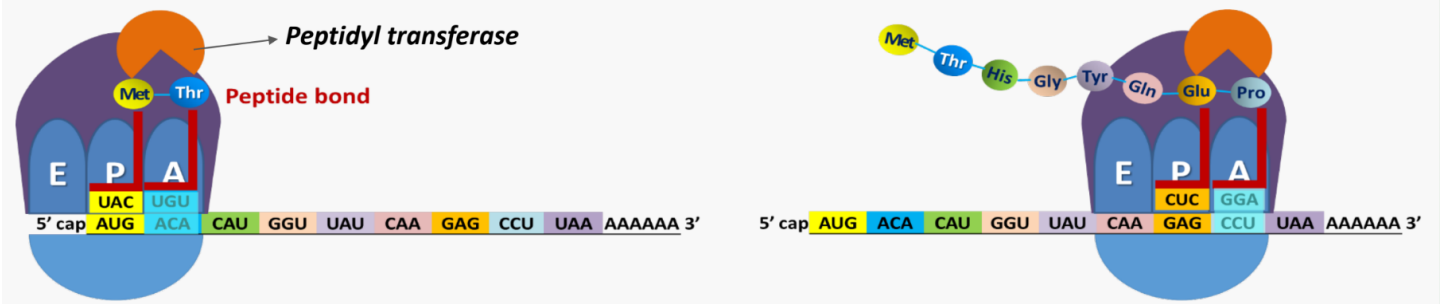
1. **Initiation:**

- Small Subunit of ribosome binds to mRNA at the start codon (AUG).
- Large subunit of ribosome binds to small subunit to form initiating complex.
- Large subunit consist of A- Site (Aminoacyl) and P-Site (Peptidyl).
- Initiator tRNA (which carries methionine) binds on P site. Its Anticodon (UAC) recognise start codon (AUG).



2. **Elongation:**

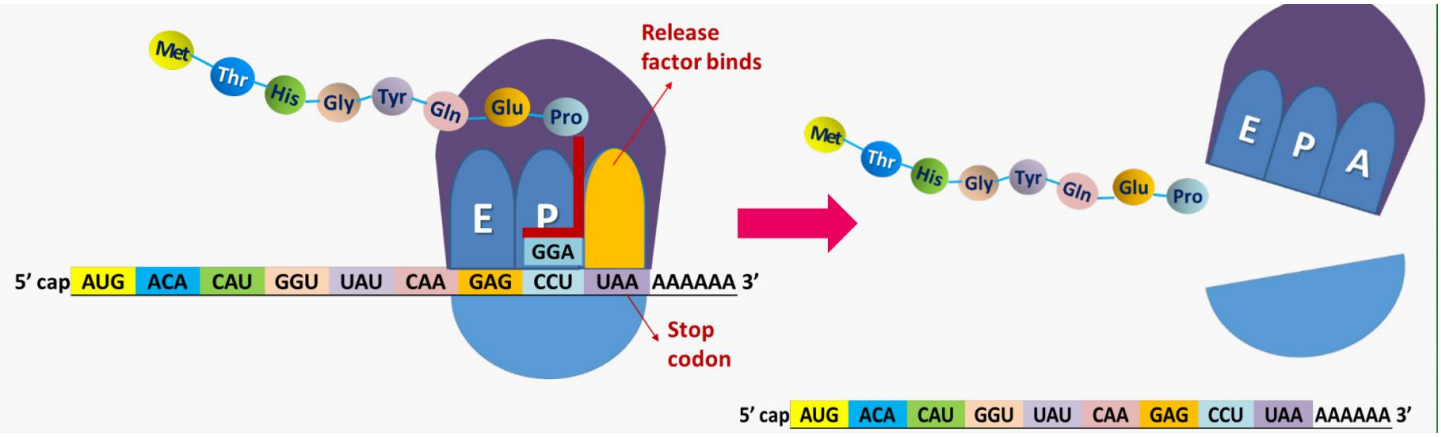
- Second onwards tRNA binds to A site. Its anticodon binds to second codon on mRNA and forms peptide bond between amino acid with the help of **peptidyl transferase**.



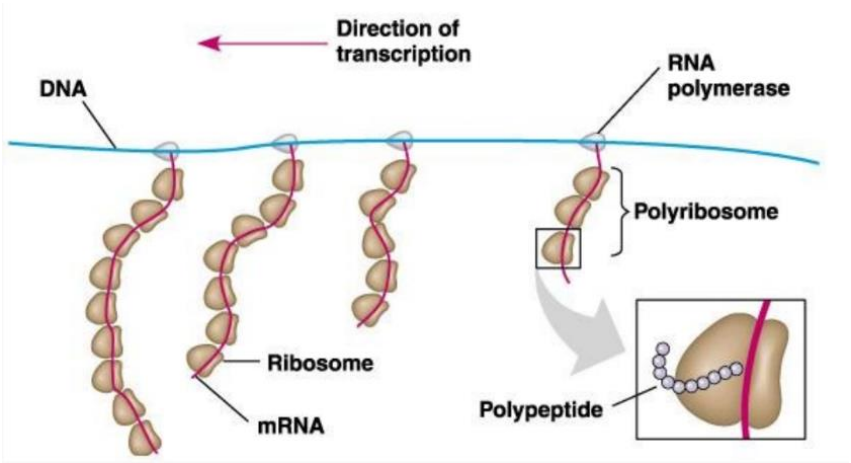
- First amino acid from P site exit from E site and next tRNA from A site moves to P site along with mRNA and the process is called translocation.
- Ribosomes moves from codon to codon.

3. Termination:

- No tRNA binds to Stop codon as the do not code for any amino acid.
- When Release factor binds to stop codon, the translation terminates releasing chain of amino acids
- Ribosome dissociates



Polyribosome (polysome): Group of ribosomes associated with a single mRNA for translation.



UTR- Untranslated region on mRNA. Present on both 5' and 3' ends.