TRANSLATION

This process involves the assembly of amino acids to construct a polypeptide chain. The specific order and arrangement of these amino acids are dictated by the sequence of bases present in the messenger RNA (mRNA).

The cellular machinery responsible for protein synthesis is known as the ribosome. Comprising both structural RNAs and approximately 80 distinct proteins, the ribosome functions as a complex molecular factory. In its dormant state, the ribosome is composed of two subunits: a large subunit and a small subunit. Within the ribosome, there are designated sites for the binding of aminoacyl tRNA molecules, namely the P-site (peptidyl site) and the A-site (aminoacyl site).

Initiation of the translation process occurs when the small ribosomal subunit encounters an mRNA molecule.

The stages of the translation process include:

(1) Activation of Amino acid: Protein

- 20 types of amino acids participate in protein synthesis.
- Amino acid reacts with ATP to form "Amino acyl AMP enzyme complex", which is also known as 'Activated Amino acid'.
- Amino acid + ATP $\xrightarrow[\text{t-RNA synthetase}]{\text{Amino acyl}}$ Amino acyl AMP-enzyme complex + PP
- This reaction is catalyzed by a specific 'Amino acyl t-RNA synthetase' enzyme.
- There is a separate 'Amino acyl t-RNA synthetase' enzyme for each kind of amino acid.

(2) Charging oft-RNA (Loading of t-RNA)

Specific activated amino acid is recognised by its specific t-RNA.

Now amino acid attaches to the 'Amino acid attachment site' of its specific t-RNA and AMP and enzyme are separated from it.

Amino acyl AMP-enzyme complex + t-RNA $\rightarrow$ Amino acyl t-RNA complex + AMP+ enzyme

- Amino acyl t-RNA complex is also called 'Charged t-RNA'.
- Now Amino acyl t-RNA moves to the ribosome for protein synthesis.

(3) Translation: 3 steps

(A) Initiation of polypeptide chain.

- In this step 30s and 50s sub units of ribosome, GTP, Mg^{+2}, charged t-RNA, m-RNA and some initiation factors are required.
- In prokaryotes there are three initiation factors present- IFl, IF2, IF3.
- Initiation factors are specific protein.
- GTP and initiation factors promote the initiation process.
- In prokaryotes with the help of "S D sequence" (Shine-Delgamo sequence) m-RNA recognizes the smaller sub unit of ribosome. A sequence of 8 N_2 base is present before the 4 – 12 N_2 base of initiation codon on mRNA, called "SD sequence". In Smaller subunit of ribosome, a complementary sequence of "SD sequence" is present on 16s rRNA, which is called "Anti Shine-Dalgarno sequence" (ASD sequence)
- With the help of 'SD' and 'ASD sequence' mRNA recognizes the smaller sub unit of ribosome.
- While in eukaryotes, smaller sub unit of ribosome is recognised by "7mG cap".
- In eukaryotes, 18s rRNA of smaller sub unit has a complementary sequence of "7mG cap".

$$\text{30s sub unit + m-RNA} \xrightarrow[Mg^{+2}]{IF3} \text{30s m-RNA -complex" reacts}$$

- The "30s m-RNA – complex" reacts with 'Formyl methionyl t-RNA- complex' and 30s mRNA - formyl methionyl t-RNA - complex" is formed. This t-RNA attaches with codon part of m-RNA. A GTP molecule is required.

30s m-RNA – complex + Formyl methionyl t-RNA-complex

GTP ↓ IF2, IF3 Mg^{+2}

30s m-RNA formyl methionyl t-RNA – complex

- Now larger sub unit of ribosome (50s sub unit) joins this complex. The initiation is factor released and complete 70s ribosome is formed.
- In larger sub unit of ribosome there are three sites for t-RNA-

'P' site = Peptidyl site.

'A' site = Amino acyl site.

'E' site = Exit site

- Starting codon of m-RNA is near to 'P' site of ribosome, so t-RNA with formyl methionine amino acid first attaches to 'P' site of ribosome and next codon of m-RNA is near to 'A' site of ribosome. So next newt-RNA with new amino acid always attach at 'A' site of ribosome but in initiation step 'A' site is empty.

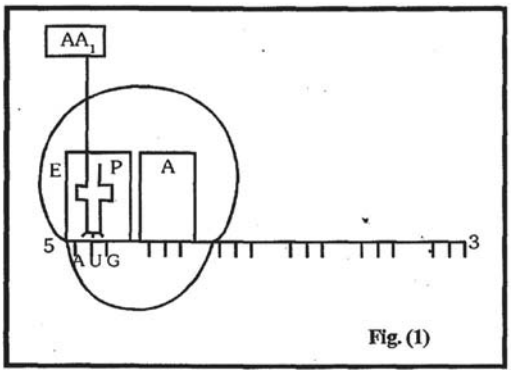

Fig. (1)

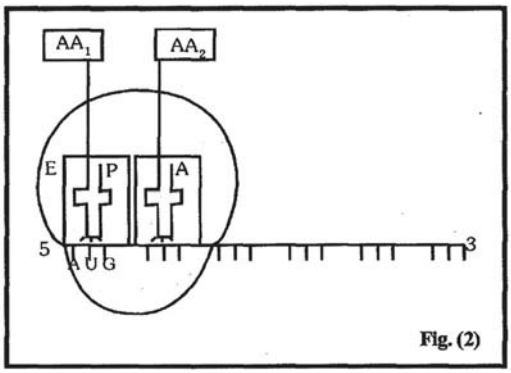

Fig. (2)

- An mRNA also have some additional sequences that are not translated and are referred as untranslated regions (UTR). The UTRs are present at both 5'end (before start codon) and at 3'end (after stop codon).
- The UTR(untranslated regions) present on mRNA are required, for efficient translation process (by recognizing the smaller subunit of ribosome by mRNA)

Some Inhibitors of Bacterial Protein Synthesis

Antibiotic	Effect
Tetracycline	Inhibits binding of amino-acyl tRNA to ribosome
Streptomycin	Inhibits initiation of translation and causes misreading
Chloramphenicol	Inhibits peptidyl transferase and so formation of peptide bonds
Erythromycin	Inhibits translocation of ribosome along mRNA
Neomycin	Inhibits interaction between tRNA and mRNA