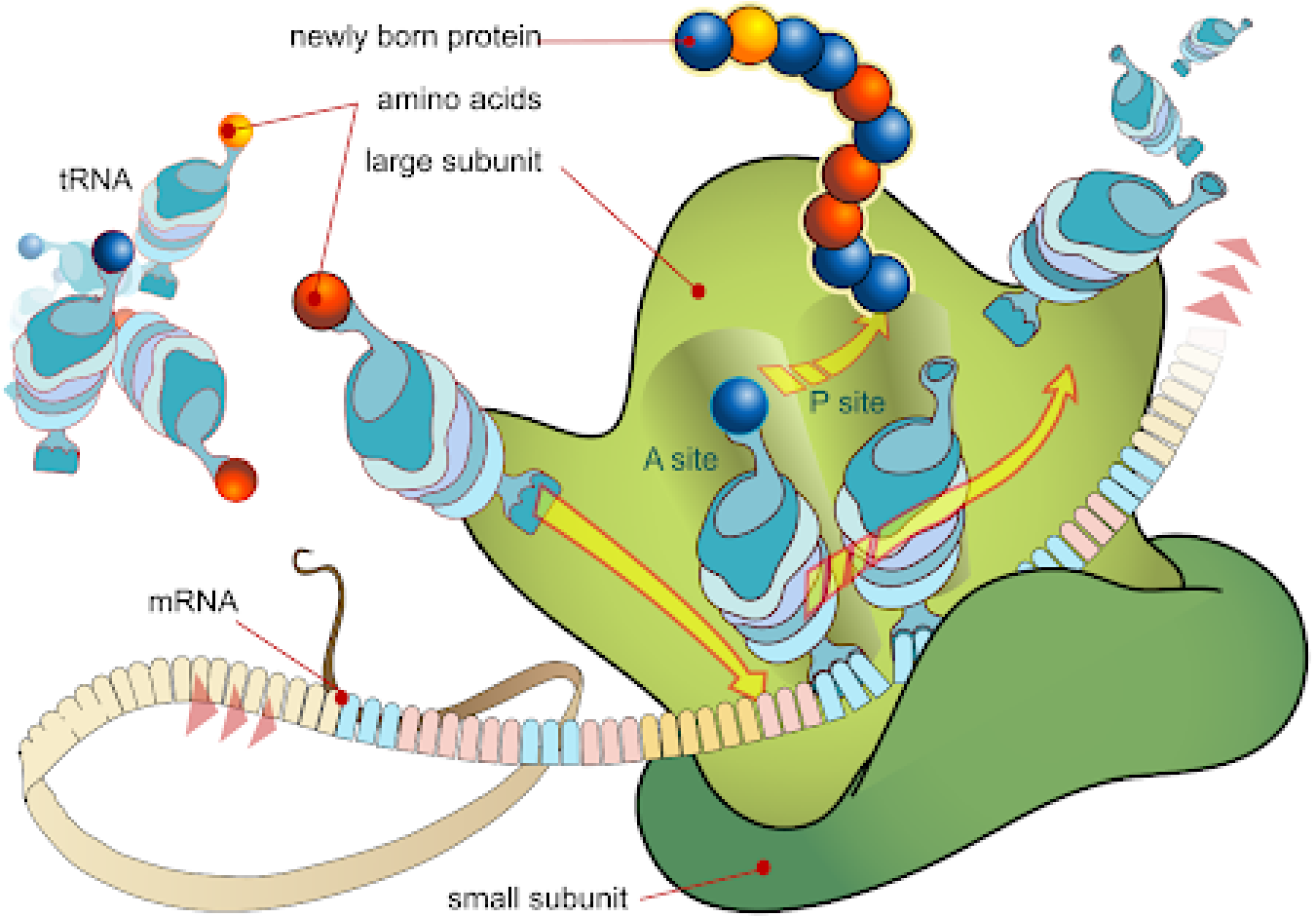
TRANSLATION:- Protein synthesis



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How do we define Translation??

- Translation is the process in which genetic message carried by mRNA from the DNA is converted in the form of a polypeptide chain having a specific sequence of Amino acid.

Key players in Translation process:-

- Ribosome
- mRNA
- t-RNA
- Enzymes
- Amino acids
- Proteins

NEED OF TRANSLATION

- As we know our body is made up of cell . And each and every cell do it's work eàch and every time. So to carry out it's work cell do so many chemical reaction. These chemical reaction called metabolism. So to carry out metabolism our body need so many enzyme . These enzymes are proteinaceous in nature.
- Ex. Trypsin, Peptidase, pepsinogen etc.
- Our cell itself made up of proteins. Intrinsic and extrinsic protein of plasma membrane are such example

Compartments for protein synthesis

- In Eukaryotes transcription occur in--Cell Nucleus
- In Eukaryotes translation occur in -- Cell Cytoplasm
- In Prokaryotes translation occur in -- Cell Nucleus
- In Prokaryotes transcription occur in - Cell Nucleus

Steps for protein synthesis:-

- Activation of Amino acid
- Charging of t-RNA
- Translation

1. Activation of Amino acid:-

- 20 type Amino acid take part in protein synthesis.
- Amino acid react 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 catalysed by a specific 'Amino acid t-RNA synthetase' enzyme.
  - There is separate'Amino acyl t-RNA synthetase' enzyme for each kind of Amino acid.

ع) Charging of t-RNA (loading of t- RNA):-)

- ***Specific*** activated Amino acid is recognized by it's specific t-RNA.
- Now amino acid attach to the 'Amino acid attachment site' of its specific t-RNA and AMP and enzyme are separated from it.
- Amino acyl t-RNA complex is called 'Charged t-RNA'.
- Now Amino acyl t-RNA moves to ribosome for protein synthesis.

Amino acyl AMP enzyme complex +t-RNA ⟹ Amino acyl t-RNA complex+AMP +enzymes

3) Translation:

Process of Translation complete in three steps:-

a) Initiation
b) Elongation
c) Termination

First step of TRANSLATION:

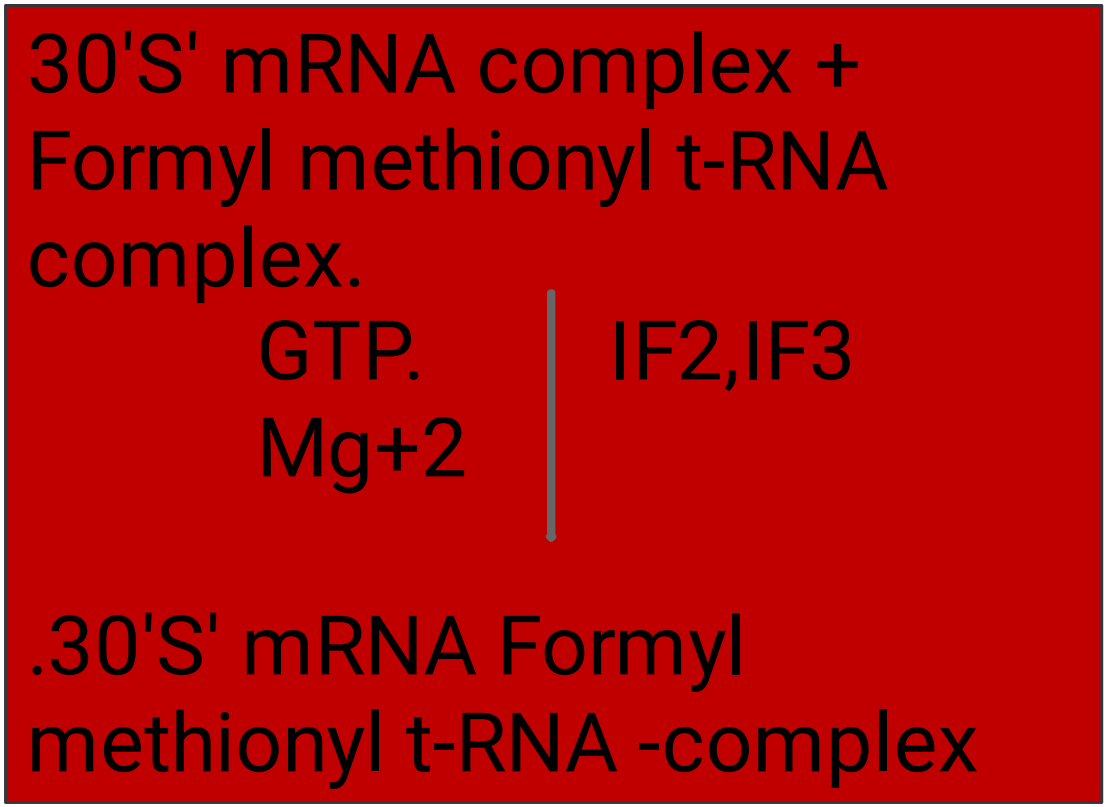
A) Initiation of polypeptide chain :-

- In this step 30 's' and 50 's' sub unit of ribosome ,GTP ,Mg**+2 ,c**harged t-RNA , m-RNA , some initiation factor are required.
- In prokaryote there are three initiation factor present-IF1, IF2 , IF3.
- In Eukaryotes more than 3 initiation factor are present. Ten initiation factor have identified- eIF1,eIF2,eIF3,eIF4A,eIF4B,eIF4C,eIF4D,eIF4F, eIF5, eIF6.
- Initiation factor are specific protein.
- GTP and initiation factor promote the initiation process.
- The both sub units of ribosome are separated with help of IF3 factors .
- In prokaryotes with the help "SD sequence " (Shine-Delgarno sequence) m - RNA recognize the smaller sub unit of ribosome. A sequence of 8 Nitogen base is present before the 4-12 nitrogen bases of initiation codon of mRNA, called "SD sequence".In smaller sub unit of ribosome a complementary sequence of "SD sequence" present on 16'S'rRNA, which is called anti shine Delgarno sequence.(ASD sequence).
- With help of 'SD' and ASD sequence" mRNA recognize the smaller sub unit of ribosome.

- While in Eukaryotes , smaller sub unit of ribosome is recognized by "7mG cap".
- In Eukaryotes, 18 'S' rRNA of smaller Sub unit has a complementary sequence of 7mG cap".

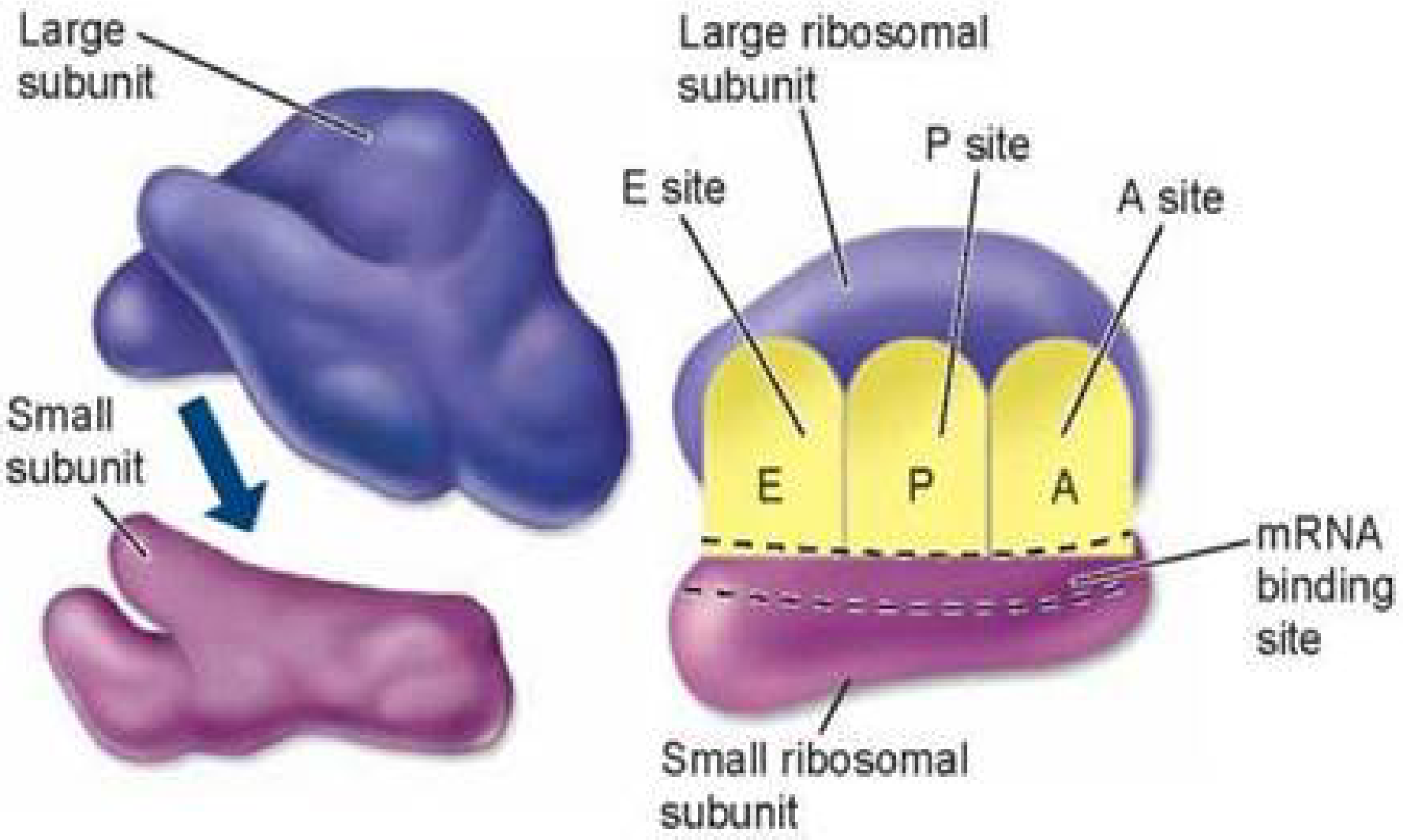
$$\text{30 'S' sub unit+ mRNA.} \xrightarrow[Mg+2]{IF3} \text{30'S' m-RNAcomplex}$$

- This 30'S' m-RNA-complex" reacts with 'Formyl methionyl t-RNA complex ' and " 30' S' mRNA- Formyl methionyl t-RNA -complex" is formed. This t-RNA attach with codon part of mRNA . A GTP molecule is required.



- Now larger sub unit of ribosome (50's' sub unit) joins the complex . The initiation factor released and forms complete 70'S' ribosome is formed.

- In larger sub unit there are three sites for t-RNA-
- 'P' site - peptidyl site
- 'A'site - amino acyl site
- 'E' site - Exit site
- Starting condon of m-RNA is near to 'P' site of ribosome, so t-RNA with Formyl methionine amino acid first attach to 'P' site of ribosome and next codon of m-RNA is near to 'A' site of ribosome but in initiation step' A' site is empty.

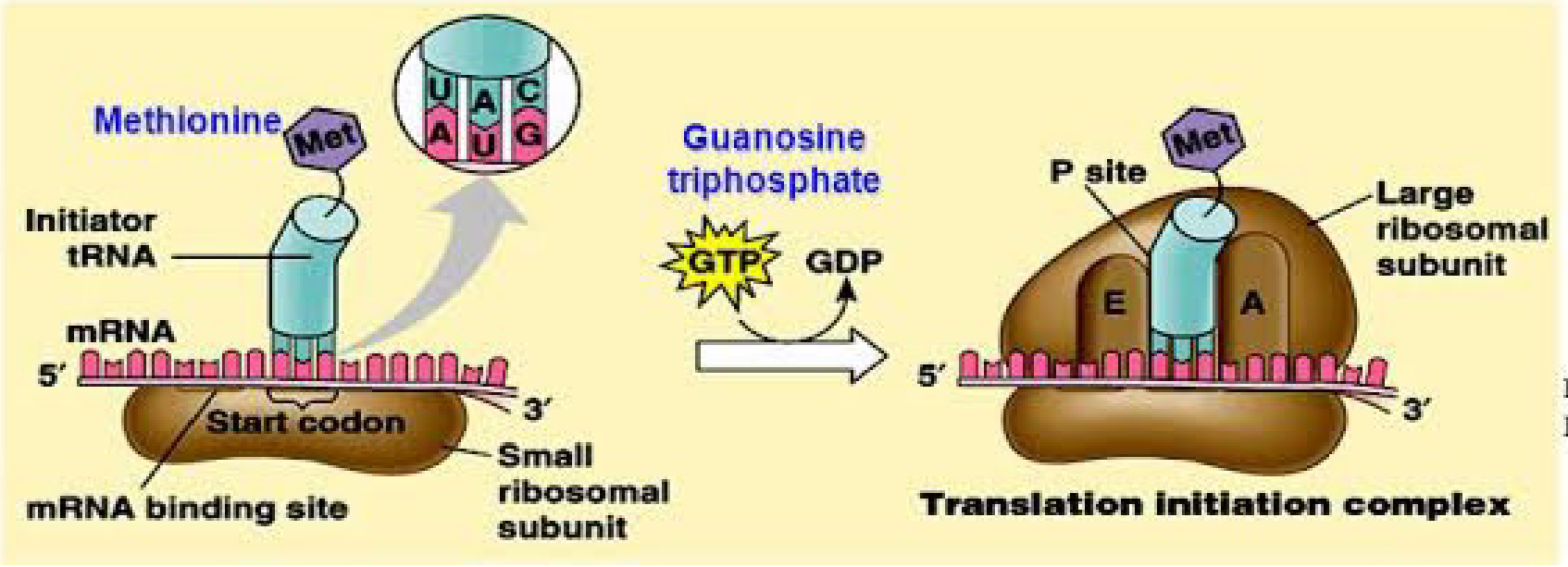


Structure of ribosome

1. Initiation:

brings together mRNA, a tRNA (with the first amino acid) and the two ribosomal subunits (large & small).

- First, a small ribosomal subunit binds with mRNA and a special initiator tRNA, which carries methionine and attaches to the start codon.
- *Initiation factors* bring in the large subunit such that the initiator tRNA occupies the P site.



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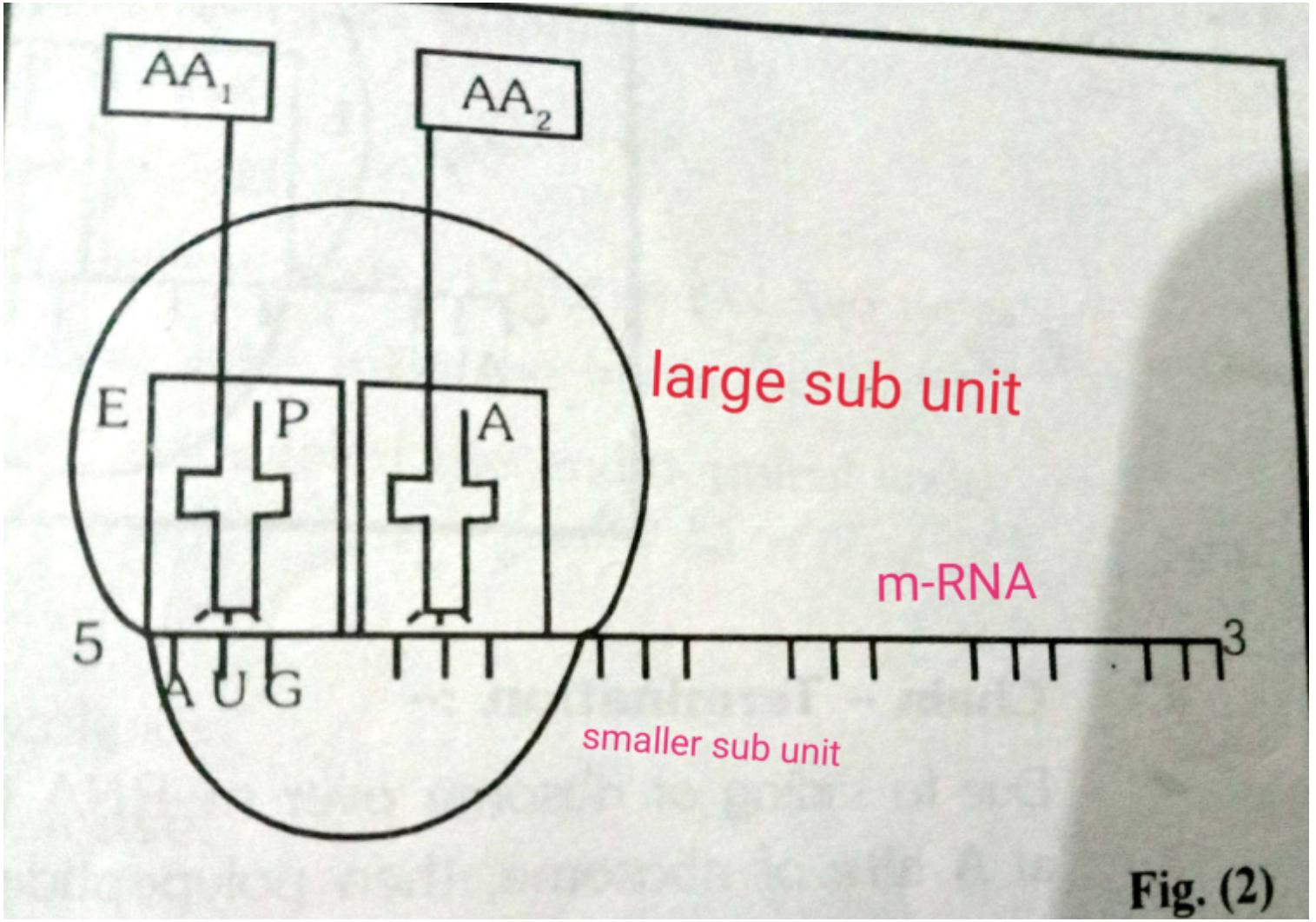


Fig. (2)

Here in this figure another (second)t-RNA attach to 'A'site of ribosome

Chain elongation

a. New t-RNA with new amino acid is attach at A site of ribosome
b. The link between amino acids of P site of t-RNA is broken and t-RNA of P site is discharge so COOH of P site A.A. become free.
c. Now peptide bond takes place between **COOH** group of P site A.A. and **NH2** group of A site amino acid.
d. Peptidyl transferase enzyme induces the formation of peptide bond. In peptide bond formation 23 'S' r-RNA is helpful. This r-RNA act as enzyme it is also called "**Ribozyme**".

e. After formation of peptide bond t-RNA of **P site** released from ribosome via **E site** and dipeptide attached with **A site.**

f. Now t-RNA of **A site** is transferred to **P site** and **A site** become empty.

g. Now ribosome slides over m-RNA strands in **5'-3'** direction. Due to sliding of ribosome on m-RNA new codon of mRNA continuously available at **A site** of ribosome and according to new codon of m-RNA new amino acids attaches in polypeptide chain.

Translocase enzyme is helpful in movement of ribosome (translocation). **GTP** provide energy for sliding of ribosome.

Figure 17.18 The elongation cycle of translation

1 Codon recognition. The anticodon of an incoming aminoacyl tRNA base-pairs with the complementary mRNA codon in the A site. Hydrolysis of GTP increases the accuracy and efficiency of this step.

2 Peptide bond formation. An rRNA molecule of the large Subunit catalyzes the formation of a peptide bond between the new amino acid in the A site and the carboxyl end of the growing polypeptide in the P site. This step attaches the polypeptide to the tRNA in the A site.

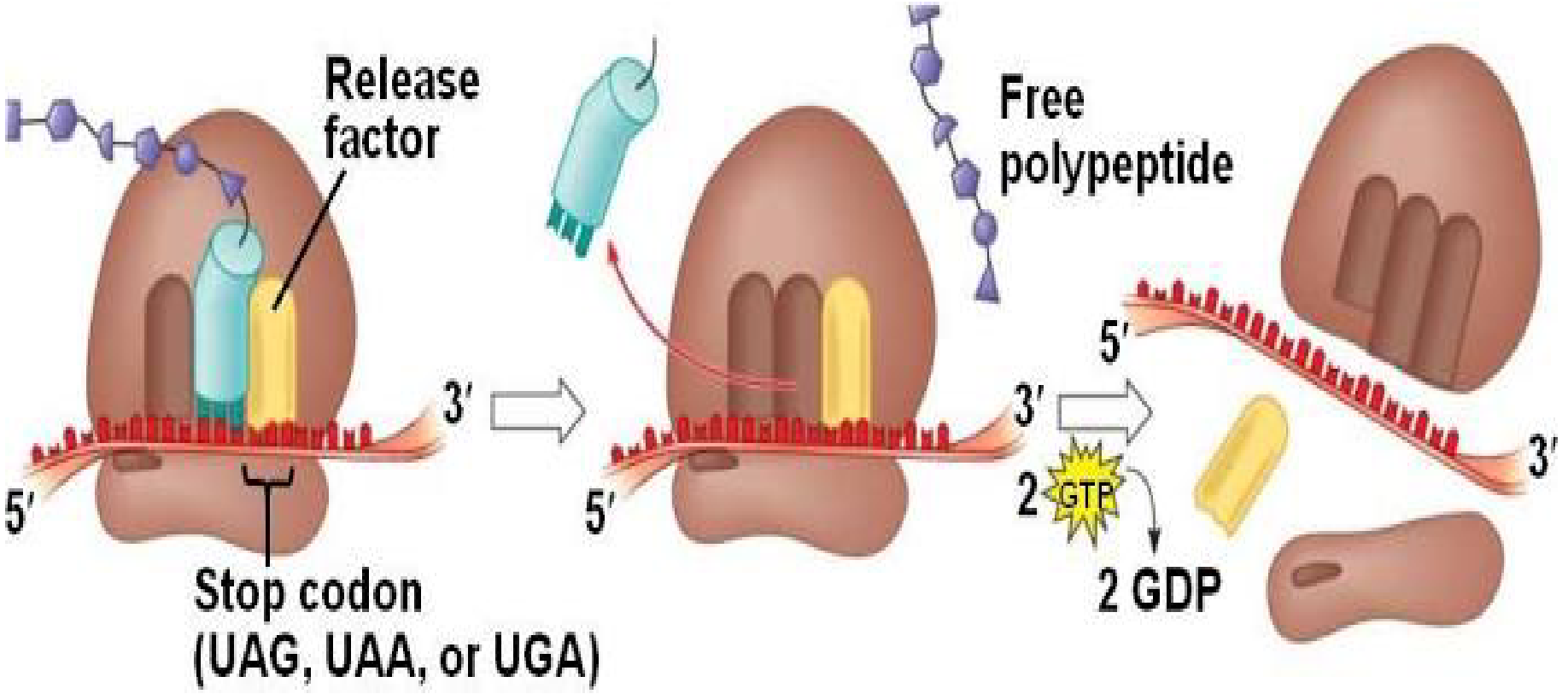
3 Translocation. The ribosome translocates the tRNA in the A site to the P site. The empty tRNA in the P site is moved to the E site, where it is released. The mRNA moves along with its bound tRNAs, bringing the next codon to be translated into the A site.

- In elongation process some protein factors are also helpful , which is called '**Elongation factors.**'
- In prokaryotes three '**Elongation factors'** are present**- EF-Tu, EF-Ts, EF-G.**
- In Eukaryotes two elongation factors are present - **eEF1, eEF2.**

Chain - termination:-

a. Due to sliding of ribosome over m-RNA when any **Nonsense condon (UAA, UAG, UGA)** available at **A site** if Ribosome, than polypeptide chain to terminates.
b. The linkage between the last t-RNA and the polypeptide chain is broken by three release factors called **RF1, RF2, RF3, with help of GTP.**
c. In Eukaryotes only one **Release factor** is known - **eRF1.**

Chain termination steps



As Ribosome reach to termination codon (stop codon) Polypeptide formation stop.

Summary of translation..