VI A

TRANSLATION

B.SC III Paper VI (2)

Genetics

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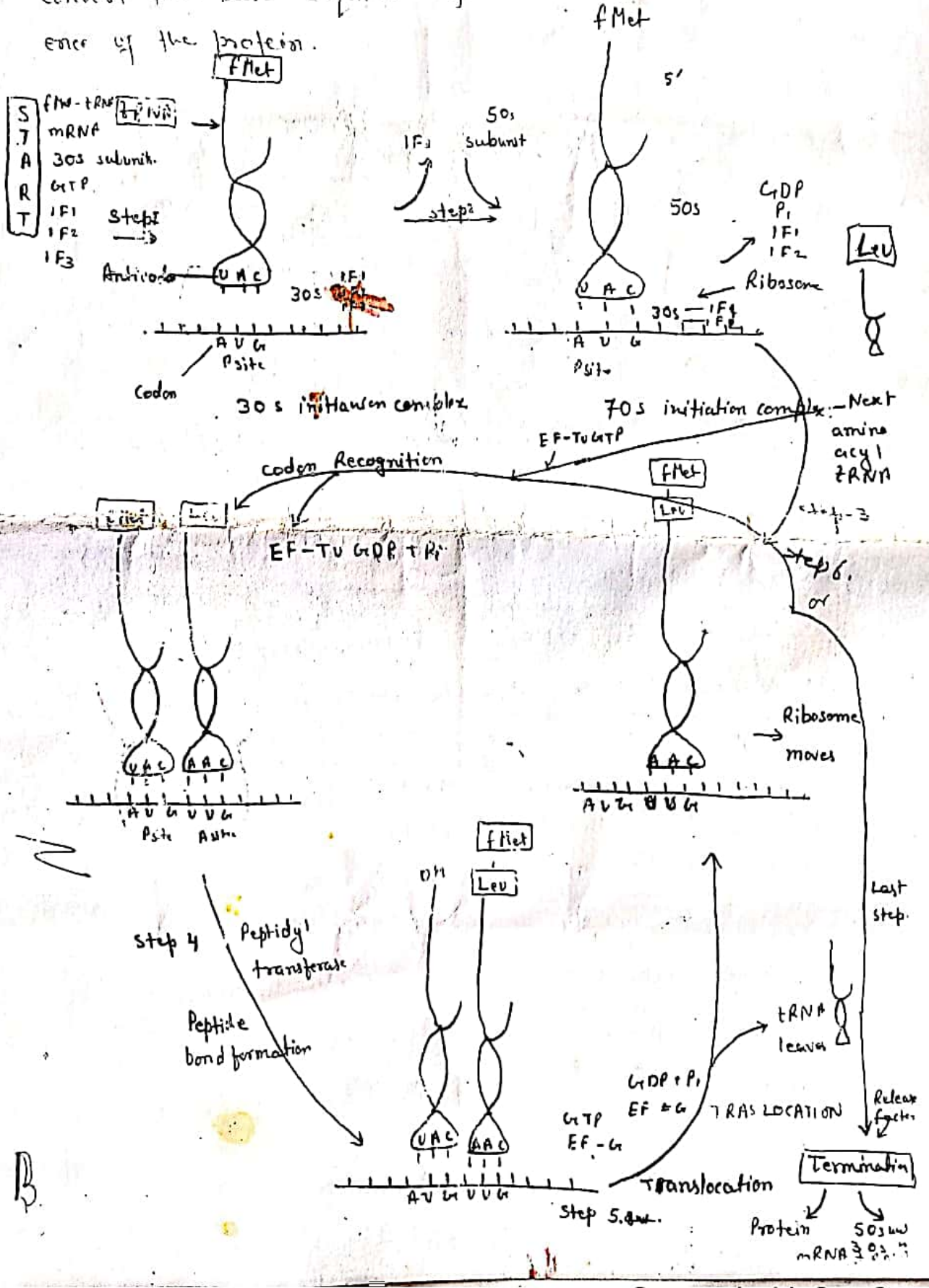
Introduction :- Translation refers to the decoding operation which convert the base sequence of mRNA into the amino acid sequence of the protein.



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Translation in prokaryotes :-

Translation in prokaryotes will be illustrated by the mechanism that occurs in E. Coli.

The start signal on the mRNA for protein synthesis is the codon AUG that codes for methionine (Met) (or occasionally the codon GUG for valine (Val)). Either Met or Val will be the first residue in the chain. A problem exist as to how the start signal is distinguished from those AUG or GUG codons occurring in the middle of the mRNA. The problem is solved by having a modified form of either Met (or Val) and a special initiation tRNA.

Formylmethionine (fMet) is a modified form of Met that specifically starts protein synthesis. It is held on a special initiation tRNA molecule ($tRNA_f$) which differs from the $tRNA^{Met}$ that incorporates Met into the middle of a chain. Both $tRNA_f$ and $tRNA^{Met}$ recognise the codon AUG but only $tRNA_f$ is able to bind to the start AUG.

Initiation :- Initiation of protein synthesis begins with the formation of a 30S initiation complex that consists of the mRNA, the 30S ribosomal subunit and aminoacyl $fMet-tRNA_f$ which is bound to the P site. The next step is the attachment of the 50S subunit to form the 70S initiation complex. The energy for initiation comes from the hydrolysis of GTP to GDP and P_i.

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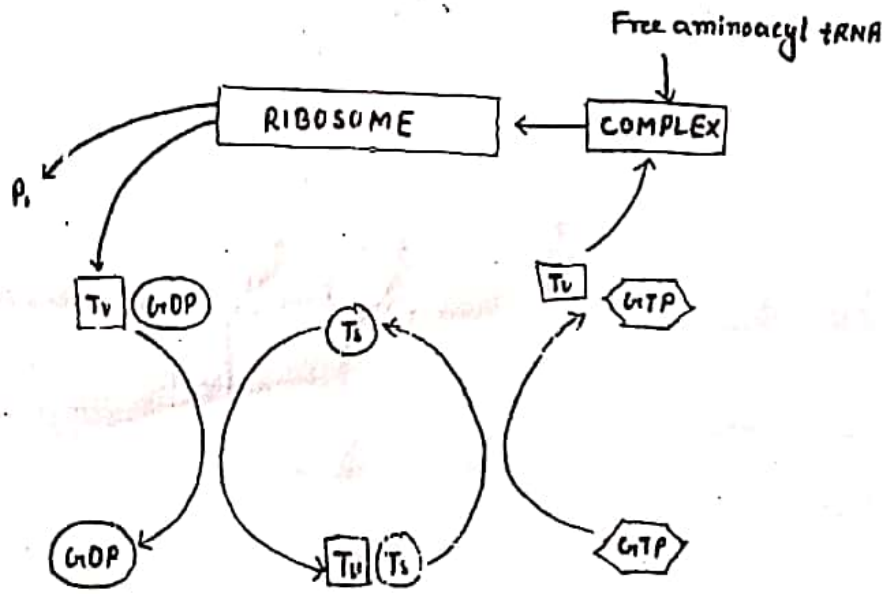
several proteins; known as initiation factors that are IF1, IF2 IF3 which are required during initiation.

Elongation refers to the addition of one amino acid residue at a time to the growing chain. Each elongation step occurs in three stages: -

1) Codon recognition
2) peptide bond formation
3) and translocation

1. Codon recognition occur when the anticodon of the appropriate aminoacyl tRNA molecules binds to the vacant A site on the ribosome. For delivery to the ribosome, the charged tRNA needs to be complexed with a protein elongation factor (EF - Tu) which has previously been activated by GTP. After the EF-Tu GTP complex has bound to the A site, the hydrolysis of GTP to GDP and P_i provides the energy for this step of elongation. The factor EF-Tu GTP, which is now



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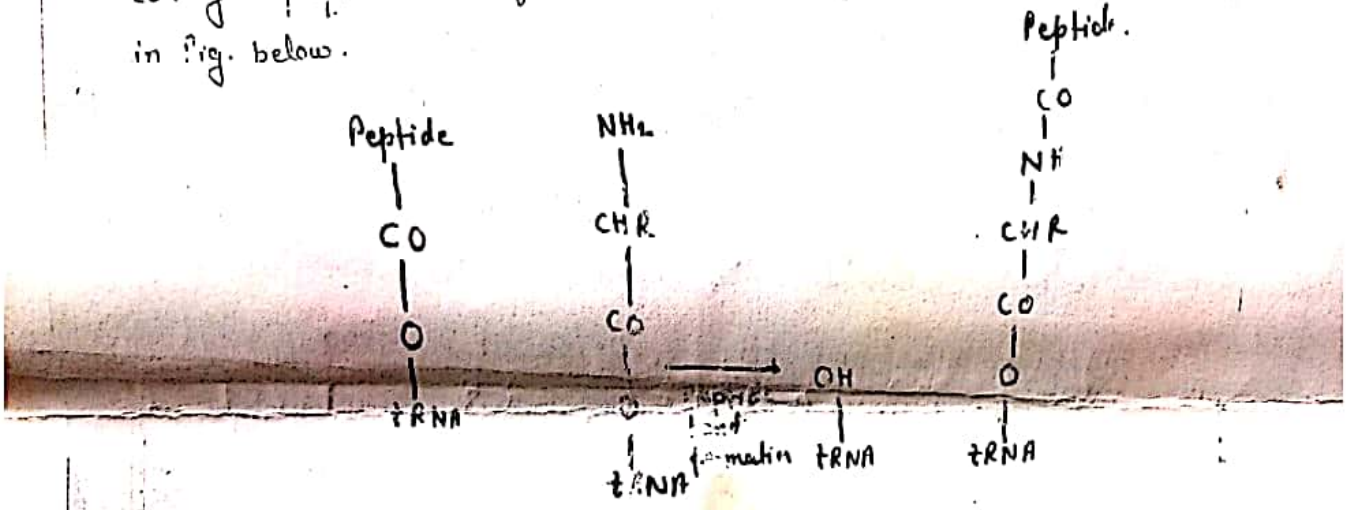
no longer able to bind to the tRNA, dissociates from the ribosome leaving the aminoacyl tRNA in place. The regeneration of EF-Tu and GTP is mediated by a second elongation factor EF-Ts which displaces the GDP during the formation of an EF-Tu-Ts complex

2) Peptide bond formation occurs when there is one aminoacyl tRNA bound to the P site and another bound to the A site. Part of the 50s subunit is an enzyme, peptidyl transferase, which catalyses peptide bond formation according to the scheme shown in Fig. below.



The result is that the growing peptide chain is attached to the tRNA at the A site while the tRNA of the P site is uncharged with an – OH at its 3' end.

3) Translocation involves three processes which are brought about by another elongation factor (EF-G) and are coupled to the hydrolysis of GTP. First, the uncharged tRNA in the P site leaves the ribosome; second, the peptide t-RNA in the A site moves and occupies the P site; and third, the ribosome moves 3 nucleotides towards the 3' end and the mRNA. These three processes of initiation can occur.

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Termination is signalled by the codon UAA, UGA or UAG. There are no tRNA molecules that contain anticodons to recognise these codons. Instead termination is brought about by special proteins called release factor (RF1 and RF2) which recognise these codons when the A site is empty. These factors alter the specificity of the enzyme peptidyl transferase so that it hydrolyses the bond between the terminal peptide and the tRNA. The freed polypeptide chain then diffuses away from the ribosome. The ribosome then dissociates into its 30S and 50S subunits. Reassociation of these subunits with another mRNA molecule starts again the whole process of protein synthesis.

TRANSLATION IN EUKARYOTES :-

Translation in Eukaryotes which occurs in the cytoplasm involves similar steps to translation in prokaryotes. A major difference is that Met rather than formyl Met is the first residue in the growing chain. There are still two tRNAs that recognise the codon AUG; one when the codon signifies initiation, the other when it codes for Met to be inserted into the middle of a growing chain. Various proteins are used as initiation and elongation factors. Another major difference is that in the cytoplasm of Eukaryotes the ribosome is an 80S structure.

Mitochondria and chloroplasts carry out translation within the organelle. They posses a 70S ribosome which resembles that of bacteria. Formyl Met is used during initiation.

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