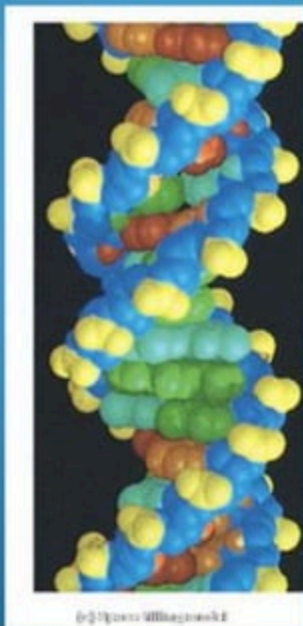
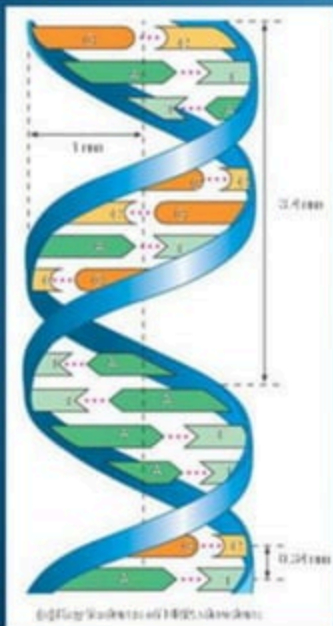


TRANSCRIPTION & TRANSLATION



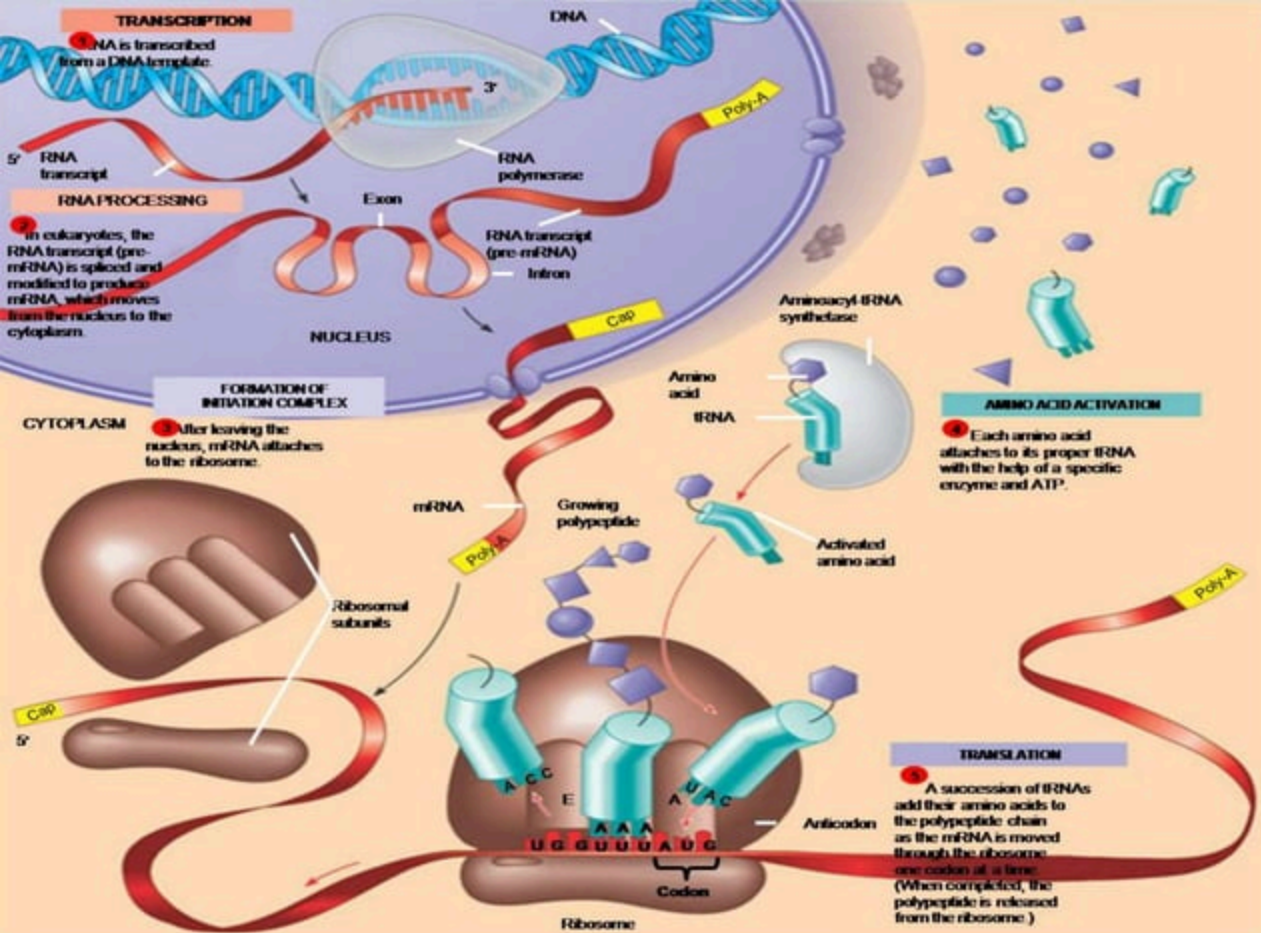
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DEFINITION :-

- ❖ **Transcription** is synthesis of **single stranded RNA** from a **double stranded DNA** template. It produces **messenger RNA (mRNA)**.
- ❖ **Translation** is the **1st stage of protein biosynthesis from RNA**. In this process formation of a **polypeptide** by using mRNA as a template. It occurs in ribosomes.
- ❖ Transcription and Translation both process are the part of **gene expression**.

Cont...

- ❖ In a eukaryotic cell the nuclear envelope separates transcription from translation.
- ❖ Extensive RNA processing occurs in the nucleus.



TRANSCRIPTION

INTRODUCTION :-

- ❖ Transcription is the synthesis of mRNA from a DNA template which occurs in 5'-3' direction.
- ❖ During transcription , a DNA sequence is read by an RNA polymerase which produce a complementary and antiparallel RNA strand.
- ❖ Transcription is the first step leading to gene expression.

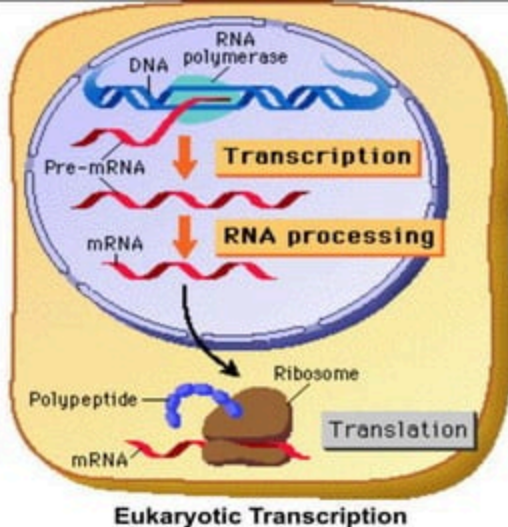
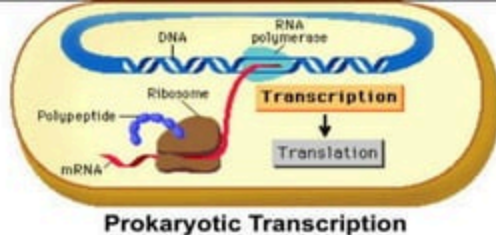
Cont...

- ❖ The stretch of DNA transcribed into an RNA molecule is called as transcription unit which encoded at least one gene.
- ❖ The result of the transcription is a mRNA which will then be used to create that protein via the process of translation

Transcription

Prokaryotes Vs Eukaryotes.

- ❖ Prokaryotic transcription occurring in cytoplasm alongside translation and eukaryotic transcription occurring only in the nucleus where it is separated from the cytoplasm by the nuclear membrane.
- ❖ Eukaryotic DNA not currently used in stored as heterochromatin around histones to form nucleosomes and must be unwound as euchromatin to be transcribed.



1	Coupled transcription-translation is the rule.	Coupled transcription translation is not possible.
2	Occurs in the cytoplasm.	Occurs in the nucleus.
3	There is no definite phase for its occurrence.	Take place in the G1 and G2 phases of cell cycle.
4	A single RNA polymerase synthesises all the three types of RNA (mRNA, tRNA, rRNA)	The RNA polymerases I, II and III synthesizes rRNA, mRNA and tRNA respectively.

STAGES OF TRANSCRIPTION :-

- There are three stages involved in transcription :-

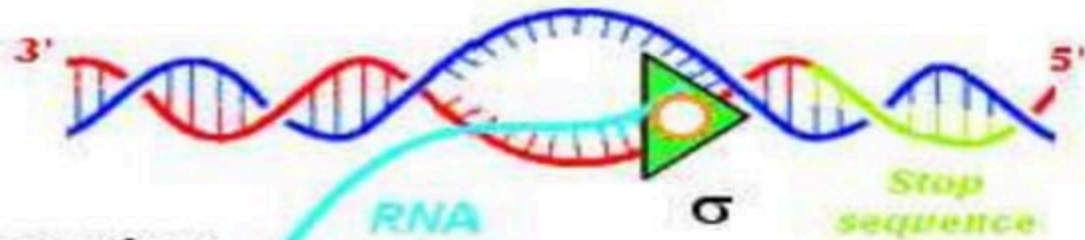
A. INITIATION

B. ELONGATION

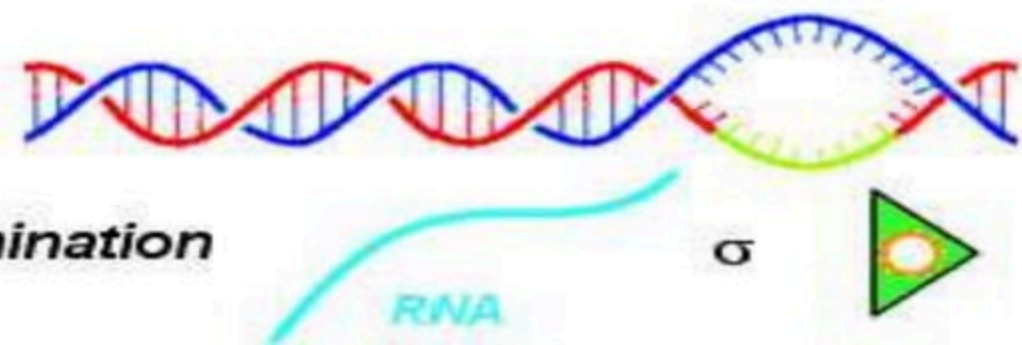
C. TERMINATION



Initiation



Elongation



Termination

INITIATION:-

- **RNA polymerase** binds to specific DNA region and initiate transcription called as **promoter site**.
- RNA polymerase is the enzyme responsible for transcription. It have 5 subunits:-
 2α subunit, β subunit, β' subunit, ω subunit.
- After polymerase is bound to the promoter DNA, the two DNA strands unwind and the enzyme starts transcribing the template strand.

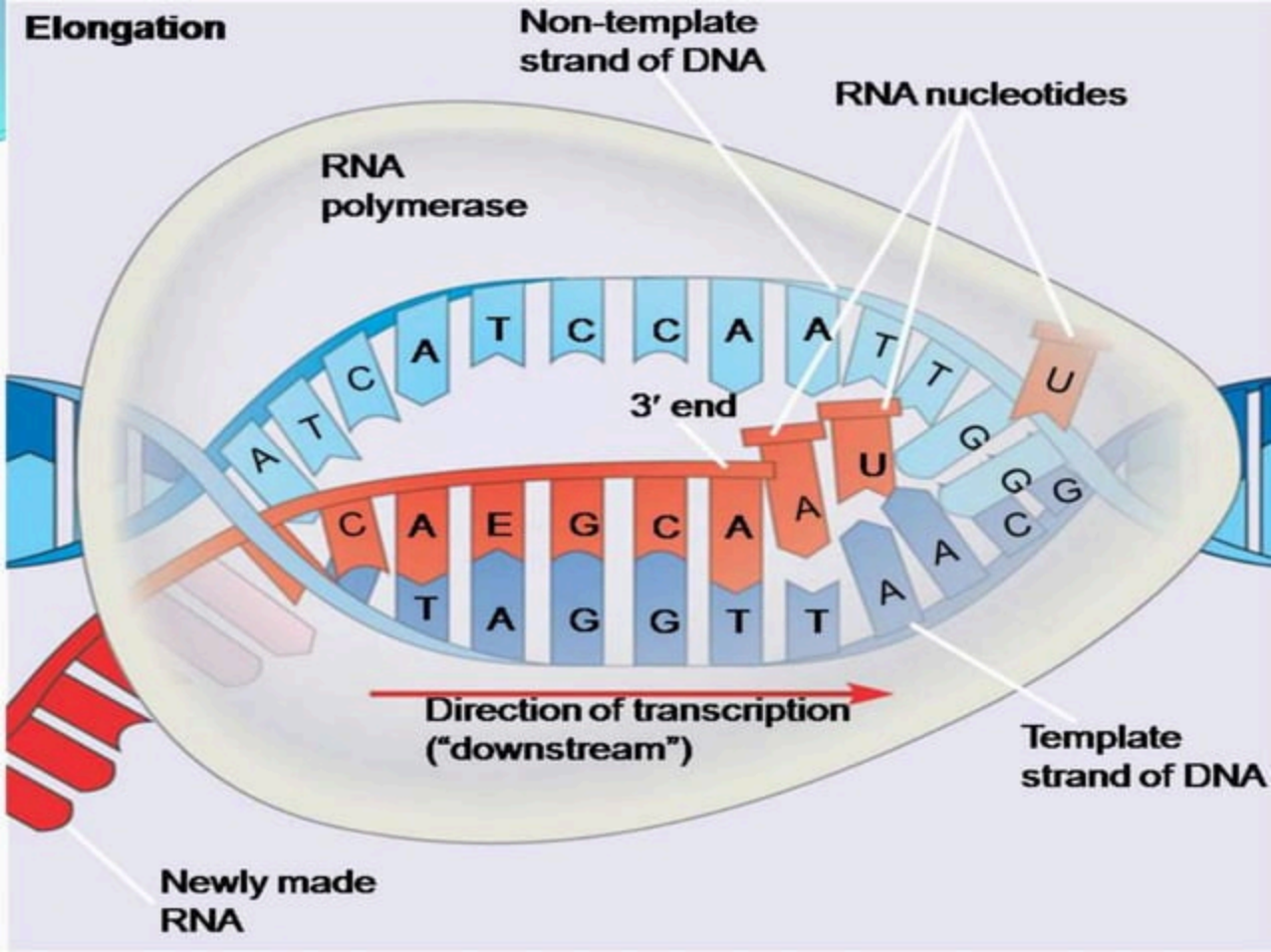
Cont...

- The position of the first synthesized base of the RNA is called the **start site** .

ELONGATION:-

- RNA polymerase moves along DNA template and sequentially synthesizes the RNA chain.
- DNA is unwinding ahead of the moving polymerase and the helix is reformed behind it. It unwinds 10-20 DNA bases at a time.
- RNA polymerase add nucleotides in the 5'-3' direction.
- The new section of RNA 'peels away' as the double helix reforms.

Elongation



TERMINATION:-

- Transcription stops when RNA polymerase reaches a section of DNA called the terminator.
- Terminator sequence = AAUAAA.
- Next, the RNA strand is released and RNA polymerase dissociates from the DNA.
- The RNA strand will go through more processing.

RNA Processing :-

- The original transcript from the DNA is called as pre-m RNA.
- It contains transcript of both intron and exons.
- **Intron:-** it is non-coding sections of nucleic acid found between coding regions.
- **Exons:-** coding regions of nucleic acids
- Pre-mRNA never leaves the cell's nucleus.

Cont...

- The introns are excised and exons are joined together to form mRNA.
- The introns are removed by a process called **splicing** to produce messenger RNA (mRNA)

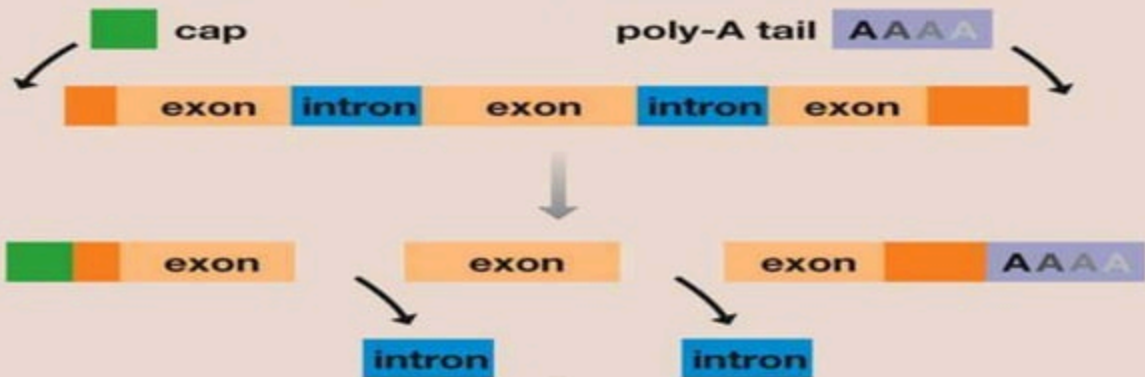
DNA



initial mRNA transcript



mRNA processing



"mature" mRNA



TRANSLATION

- Translation is a process in which the formation of polypeptide (PROTEIN) by decoding mRNA produced in transcription.
- It occurs in ribosome which are present in cytoplasm.
- It begins after mRNA enters in cytoplasm.
- It uses tRNA as the interpreter of mRNA.

PHASES IN TRANSLATION :-

- Translation proceed in four phases:-

1. INITIATION
2. ELONGATION
3. TRANSLOCATION
4. TERMINATION

INITIATION :-

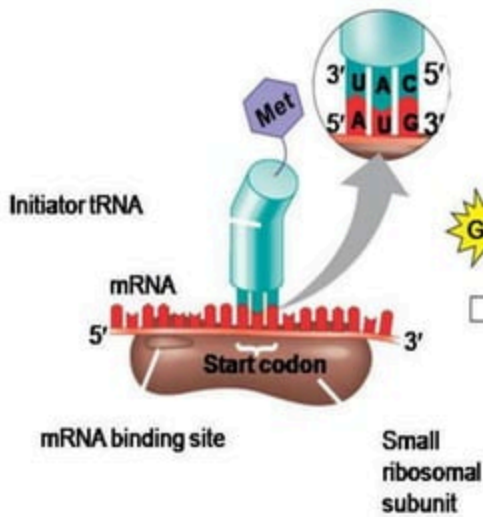
- The initiation stage of translation brings together mRNA, tRNA bearing the first amino acid of the polypeptide, and two subunits of a ribosome
- The components involved are the large and small subunits of ribosome, mRNA, initiator tRNA in its charged form and three factors (IF₁,IF₂,IF₃) and GTP.
- The tRNA has a amino acid linked to it is term as **Charged tRNA**.

Cont...

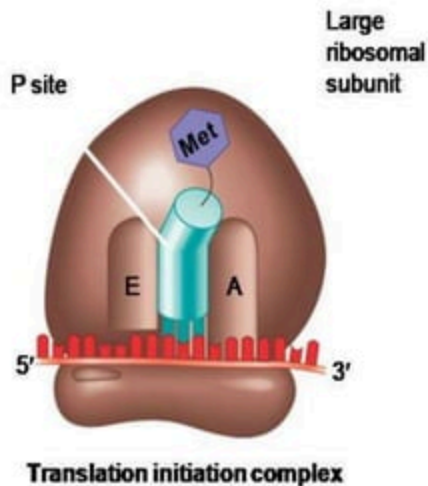
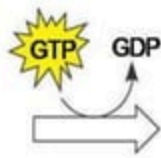
- IF1 and IF2 bind to free 30S subunit.
- IF3 complexed with GTP then bind to the small subunit. It will assist the charged initiator tRNA to bind.
- The assembled ribosome has 2 tRNA binding sites. These are called A-site (acceptor) for aminoacyl and P-site(donor)for polypeptide.
- The A-site is where incoming aminoacyl-tRNA molecules bind and P-site where the growing polypeptide chain usually found.

Cont...

- One major outcome of initiation is the placement of initiator tRNA in the P-site.
- Start codon :- AUG
- Start anticodon :- UAC
- The small ribosomal subunit attaches to 5' end of mRNA.



1 A small ribosomal subunit binds to a molecule of mRNA. In a prokaryotic cell, the mRNA binding site on this subunit recognizes a specific nucleotide sequence on the mRNA just upstream of the start codon. An initiator tRNA, with the anticodon UAC, base-pairs with the start codon, AUG. This tRNA carries the amino acid methionine (Met).



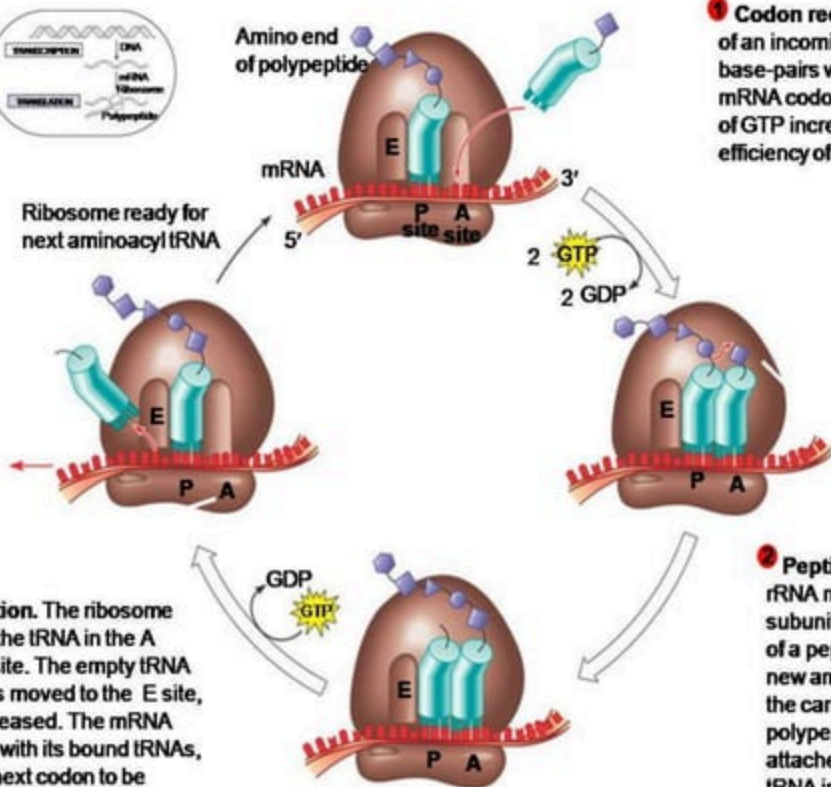
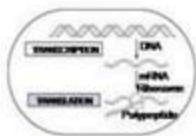
2 The arrival of a large ribosomal subunit completes the initiation complex. Proteins called initiation factors (not shown) are required to bring all the translation components together. GTP provides the energy for the assembly. The initiator tRNA is in the P site; the A site is available to the tRNA bearing the next amino acid.

ELONGATION:-

- In this amino acid are added one by one to the first amino acid called as amino acid delivery.
- In codon recognition , mRNA codon in the A site forms hydrogen bond with the tRNA anticodon.
- In peptide bond formation, the ribosome catalyzes the formation of the peptide bond between the amino acids. The polypeptide extending from the P-site moves to A-site to attach to the new Amino Acid.
- In elongation process three elongation factors (EF-T₄,EF-T₅,EF-G) which will bind with GTP or GDP.

TRANSLOCATION :-

- The t-RNA with the polypeptide chain in the A site is translocated to the P site. tRNA at the P site moves to the E site and leaves the ribosome.
- The ribosome moves down the mRNA in the 5'-3' direction.



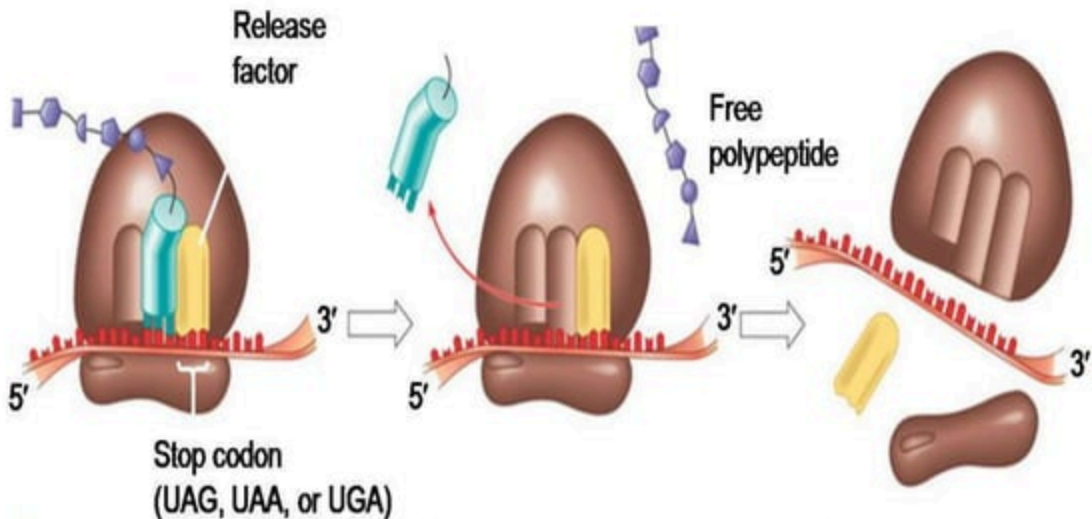
1 Codon recognition. The anticodon of an incoming aminoacyl tRNA base-pairs with the complementary mRNA codon in the A site. Hydrolysis of GTP increases the accuracy and efficiency of this step.

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.

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.

TERMINATION:-

- Protein factors called release factors interact with the stop codons and cause release of the completed polypeptide chain.
- Stop codon – UAA,UAG,UGA.
- RF1 recognises the codons UAA and UAG. RF2 recognises UAA and UGA. RF3 helps either RF1 and RF2 to carry out the reaction.



❶ When a ribosome reaches a stop codon on mRNA, the A site of the ribosome accepts a protein called a release factor instead of tRNA.

❷ The release factor hydrolyzes the bond between the tRNA in the P site and the last amino acid of the polypeptide chain. The polypeptide is thus freed from the ribosome.

❸ The two ribosomal subunits and the other components of the assembly dissociate.


Translation in Eukaryotes:-

INITIATION:-

- Eukaryotes have at least 9 initiation factors.
- Eukaryotic initiator tRNA does not become formylated as in prokaryotes.

ELONGATION:-

- The factors eEF1a, eEF1b, eEF2 are involved in elongation.



TERMINATION:- Eukaryotes have only one release factor eRF which recognize all the stop codons.



REFERENCE:-

- **BIOTECHNOLOGY
FUNDAMENTALS**

BY

FIRDOS ALAM KHAN

THANK

YOU!