SNS ACADEMY

A fingerprint International School

Affiliated to CBSE New Delhi

Affiliation No :1930610

GRADE XII A (2020-21)

COURSE NAME : BIOLOGY (044)

Chapter-6 PROTEIN SYNTHESIS

GENETIC CODE

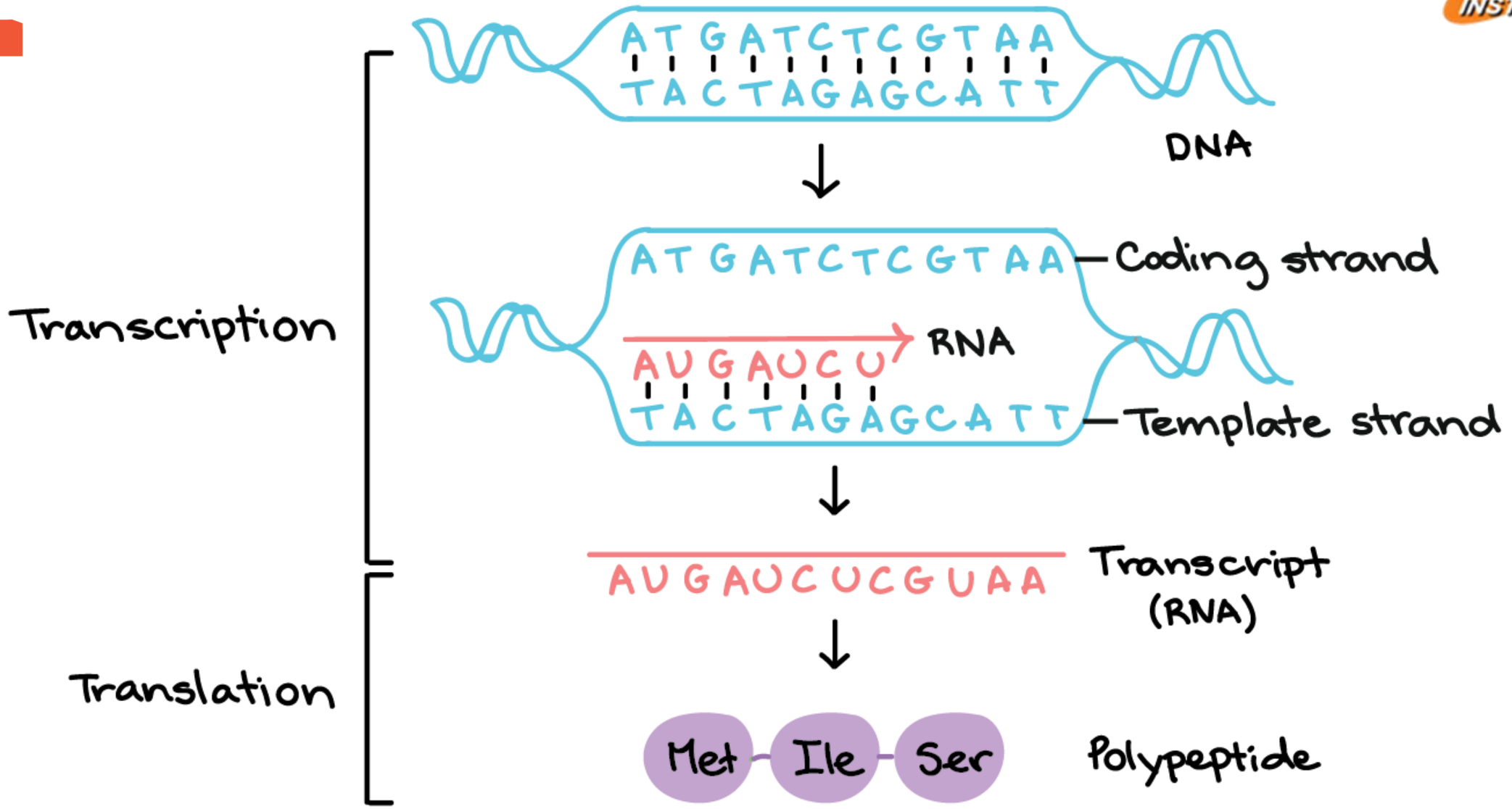
- Genetic code that directs the sequence of amino acids during synthesis of proteins.
- Change in nucleic acid is responsible for the change in amino acids in proteins.
- **George Gamow**: Proposed that in order to code for all the 20 amino acids, the code should be made up of 3 nucleotides.
- **Codon**: Sequence of three nucleotides that corresponds to a specific amino acid or stop signal during protein synthesis.
- **Har Gobind Khorana**: gave rise to the checker-board for the genetic code.

TRANSCRIPTION

- The process of copying genetic information from one strand of the DNA into RNA is termed as transcription.

- The principle of complementarity governs the process, except that adenosine now base pairs with uracil instead of thymine, as in replication.

- Unlike replication, only a single –stranded fragments of DNA gets copied into RNA.

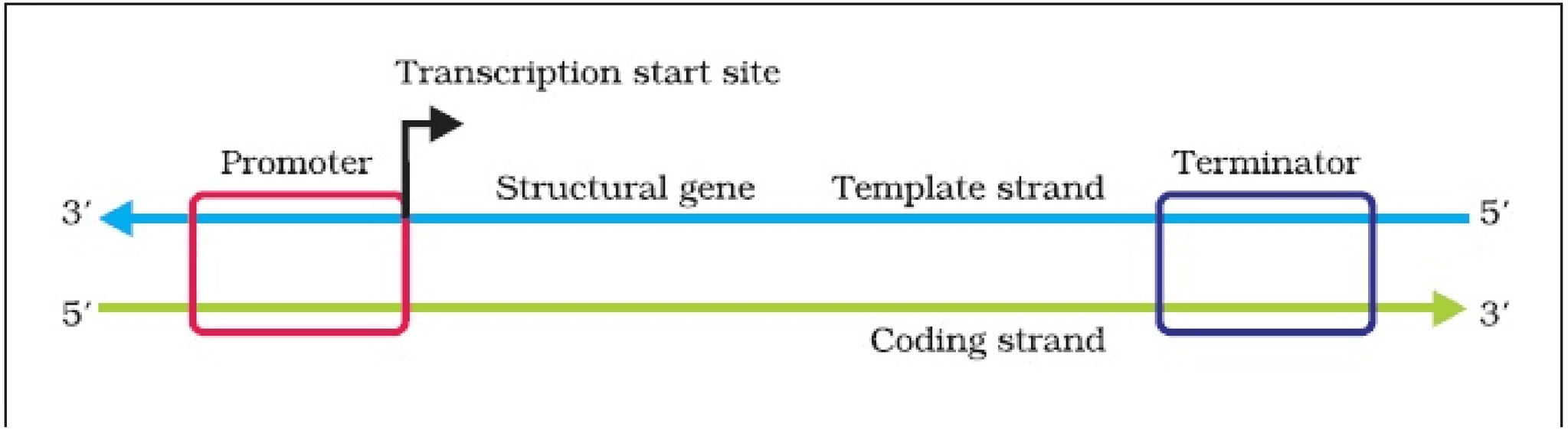

Transcription
Translation
ATGATCTCGTAA
TACTAGAGCATT
DNA
ATGATCTCGTAA
Coding strand
AUGAUCU
RNA
TACTAGAGCATT
Template strand
AUGAUCUCGUAA
Transcript (RNA)
Met
Ile
Ser
Polypeptide

TRANSCRIPTION UNIT

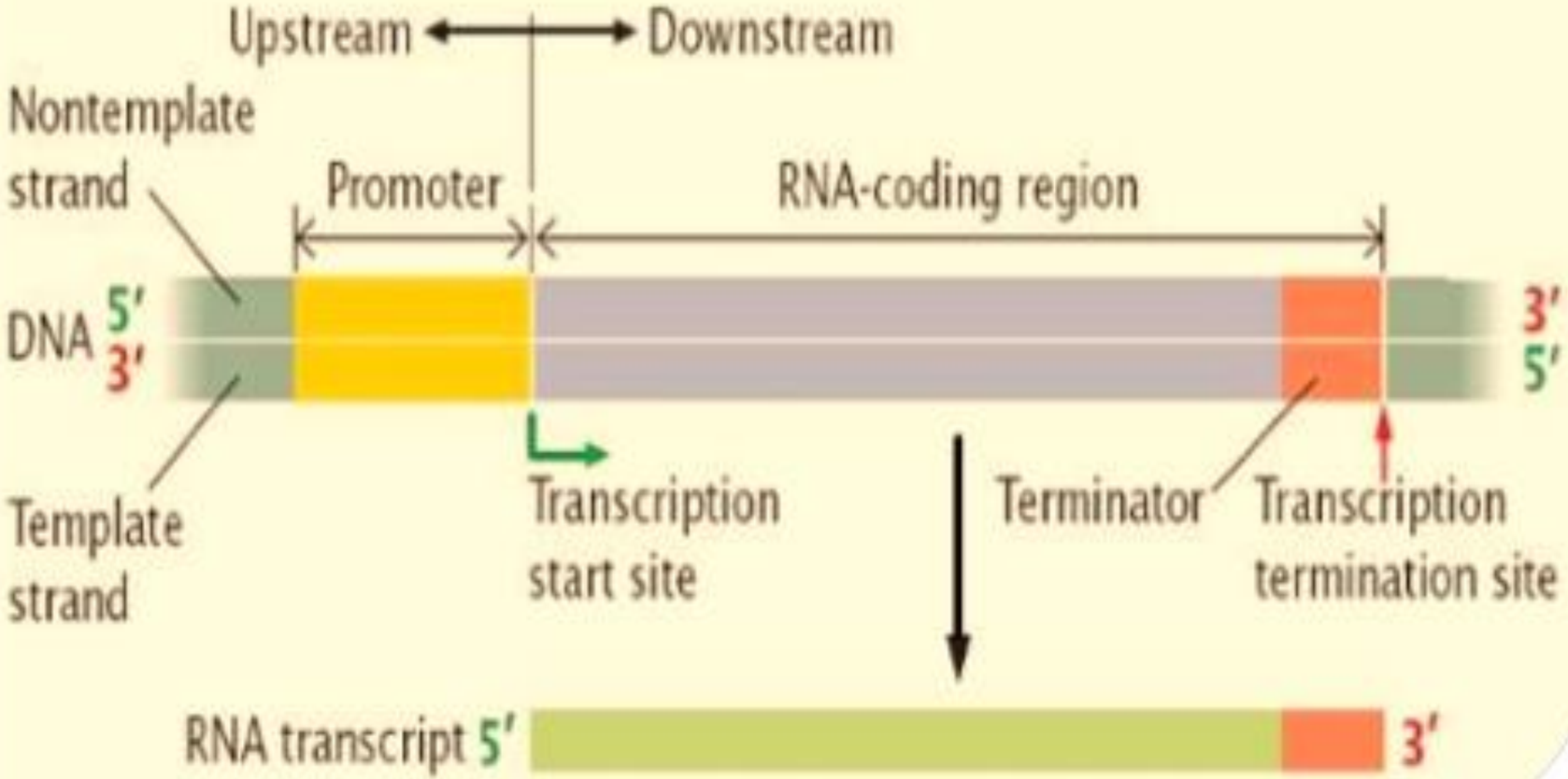
- A transcription unit in DNA is defined primarily by the three regions in the DNA
- (i) A Promotor
- (ii) A Terminator
- (iii) The Structural gene
  - It can be monocistronic (eukaryotes) or polycistronic (Prokaryotes)

Cistron – is segments of DNA which codes for polypeptide

Transcription unit



Transcription unit



TRANSCRIPTION IN PROKARYOTES

- In prokaryotes, the structural gene is polycistronic and continuous.

- In bacteria, the transcription of all the three types of RNA (mRNA, tRNA, and rRNA) is catalysed by single DNA-dependent enzyme called RNA polymerase.

- In E.coli, the RNA polymerase has co-factors β, β’, α, α’ and ω along with σ (sigma factor) to catalyse the process.

TRANSCRIPTION IN PROKARYOTES

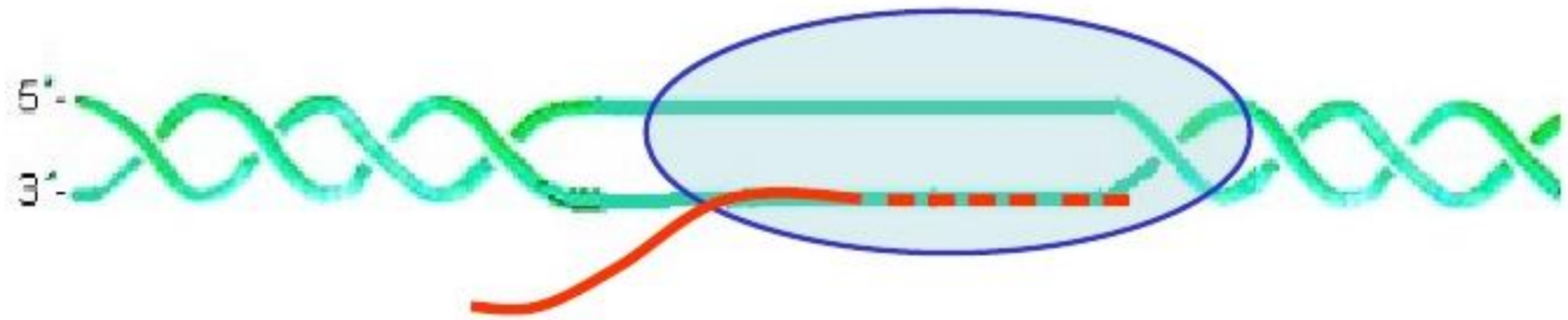
- I- INITIATION

  - (σ) sigma factor recognises the start signal and promotor regio on DNA.

  - RNA polymerase binds and separates DNA starnds.

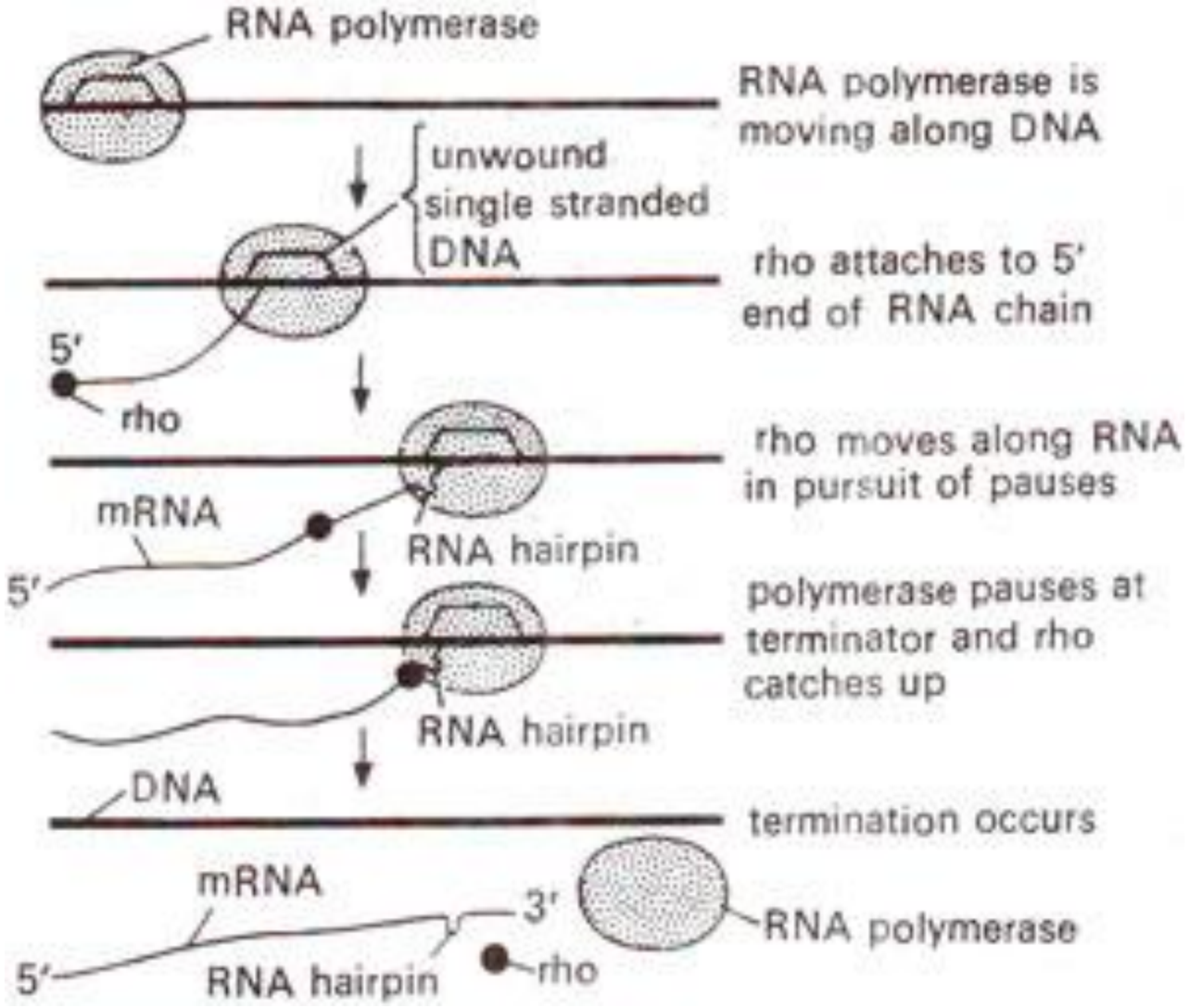
ELONGATION IN PROKARYOTIC TRANSCRIPTION

- II. ELONGATION :
  - Release of stigma subunit from RNA polymerase.
  - RNA polymerase moves along with template strand, unwinding of DNA double helix.
  - Formation of covalent ester bonds among the nucleotides
  - Newly formed RNA is released.



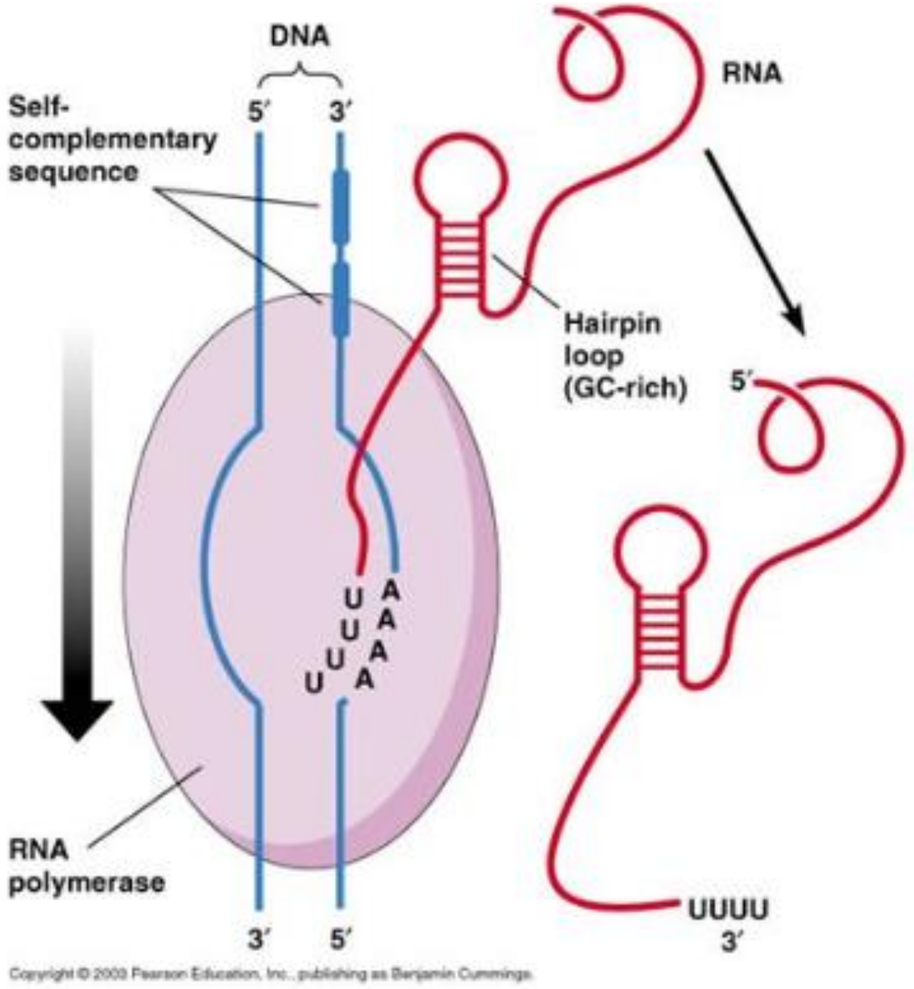
TERMINATION IN PROKARYOTIC TRANSCRIPTION

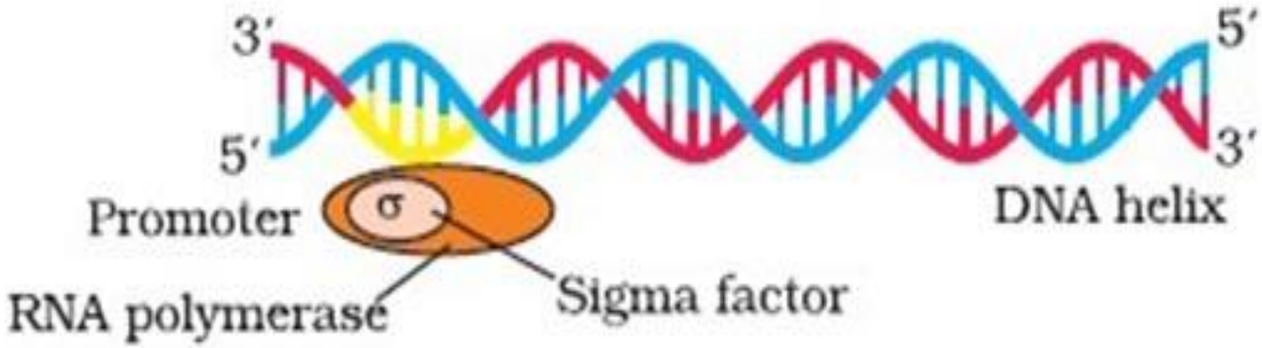
- III. TERMINATION
  - RNA polymerase dissociate.
  - Rho factor facilitates the process.
    - rho dependent
    - rho independent



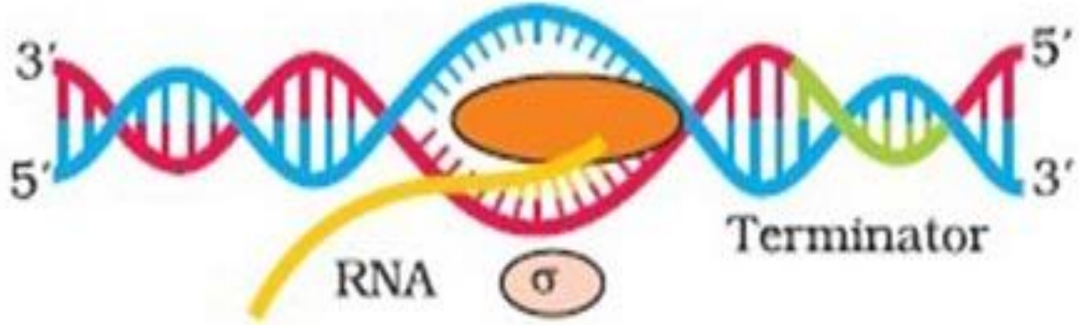
Conti.....

- **Rho dependent:**
  - Rho factor – an ATP dependent unwinding factor
  - Binds to specific termination sequence and unwinds RNA from DNA template.
  - ✓ **Rho independent**
  - ✓ Fromation of GC- rich hair pin loop forms and pulls RNA away from DNA.

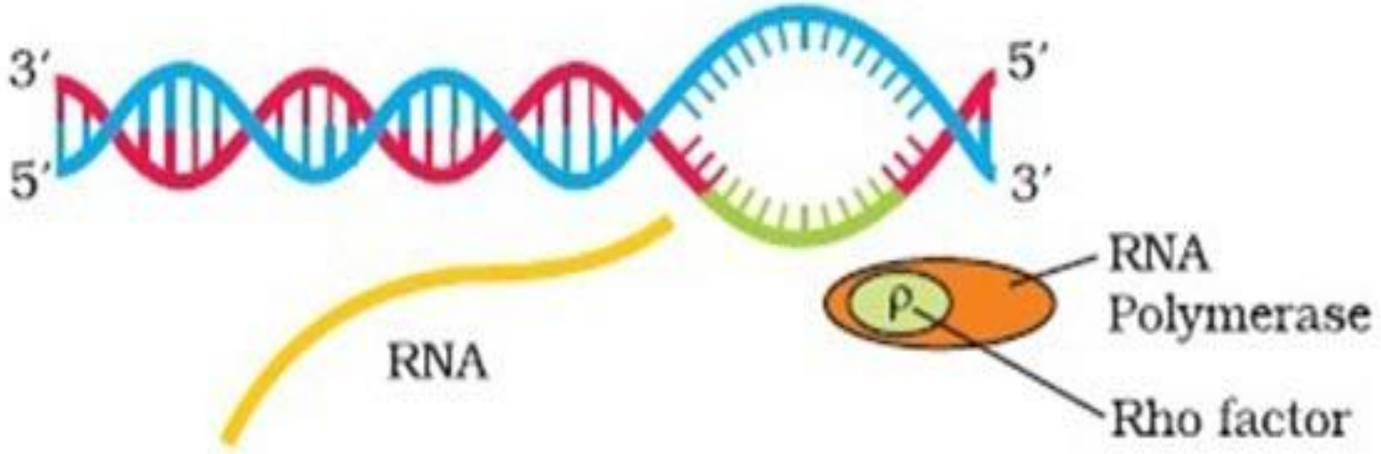




Initiation



Elongation



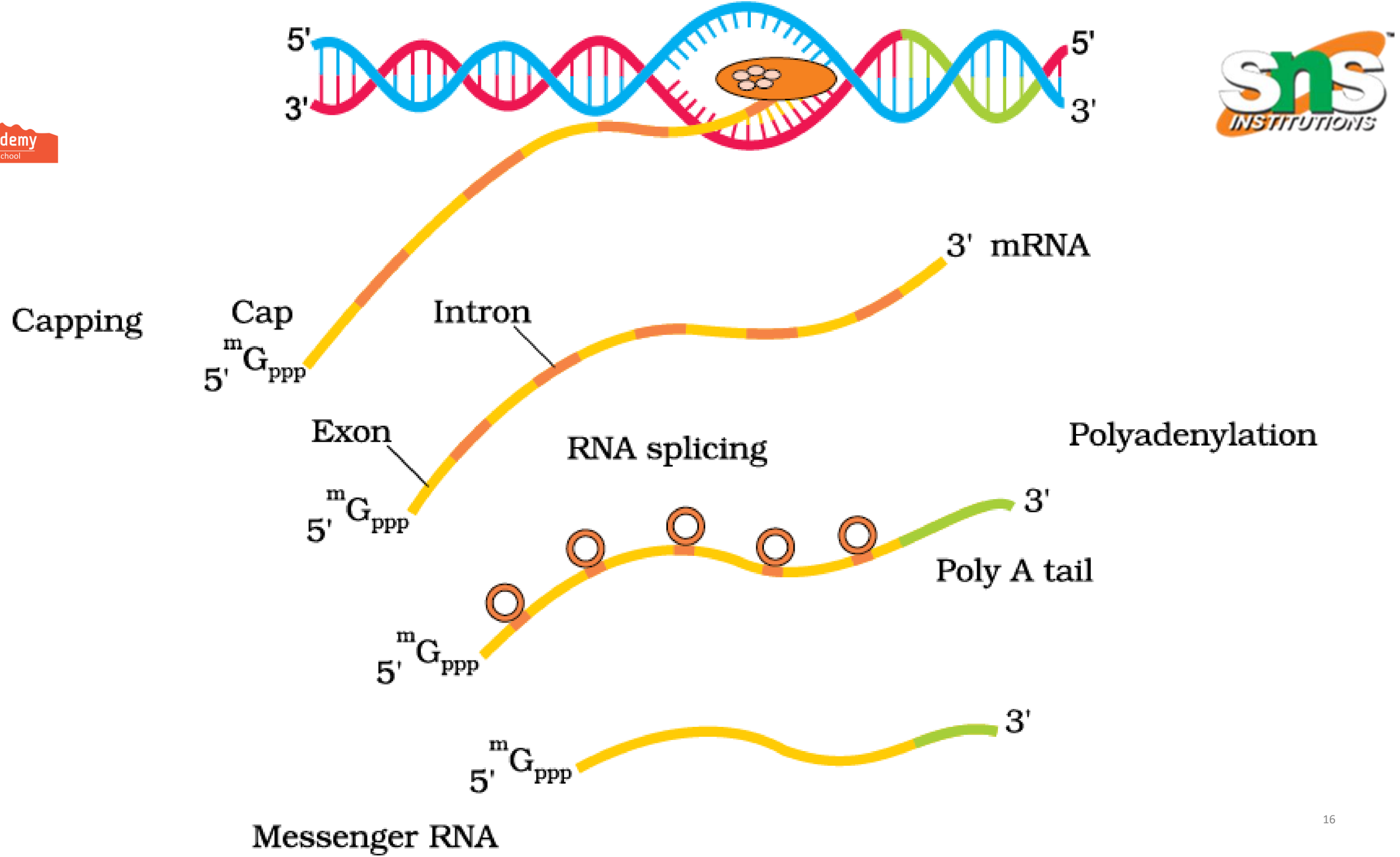
Termination

TRANSCRIPTION IN EUKARYOTES

- The structural genes are monocistronic in eukaryotes.
- The process of transcription is similar to that in prokaryotes.
- It takes place in nucleus of the cell.
- Coding sequences called **exons** from the part of mRNA and non –coding sequence called **introns** are removed from during RNA splicing.
- In eukaryotes, three types of RNA polymerase are found in the nucleus
  - **RNA polymerase I** (transcribes rRNAs 28s,18s,5.8s)
  - **RNA polymerase II** (transcribes the precussor of mRNA called heterogeneous or hnRNA)
  - **RNA polymerase III** (transcribes tRNA 5s RNA and sn RNA (small nuclear RNA)

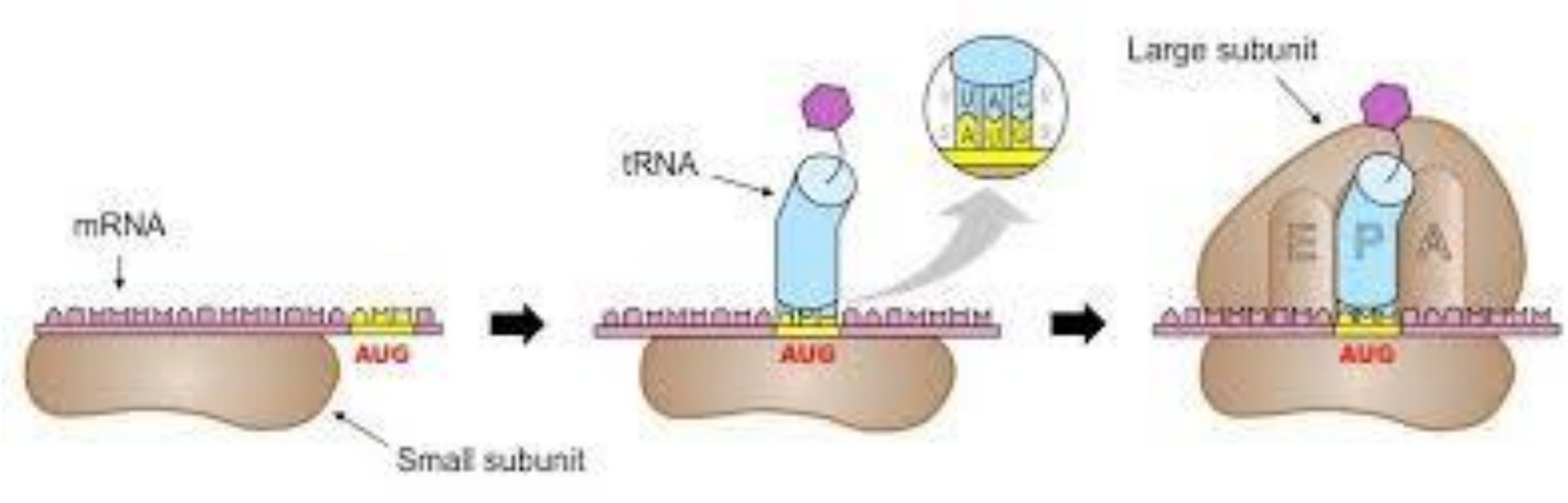
POST - TRANSCRIPTIONAL MODIFICATIONS

- The primary transcripts are non functional.
- Containing both coding region, exon and non coding region intron in RNA called heterogeneous RNA or *hn*RNA
- The hnRNA undergoes two additional processes called **capping** and **tailing.**
- In capping, an unusual nucleotide, methyl guanosine triphosphate , is addad to the 5’ end of hnRNA
- In tailing, adenylated residues (about 200-300) are added at 3’ end in a template independent manner.
- Finally the hnRNA undergoes process where intron are removed and exons are joined to form mRNA by th eprocess called splicing.

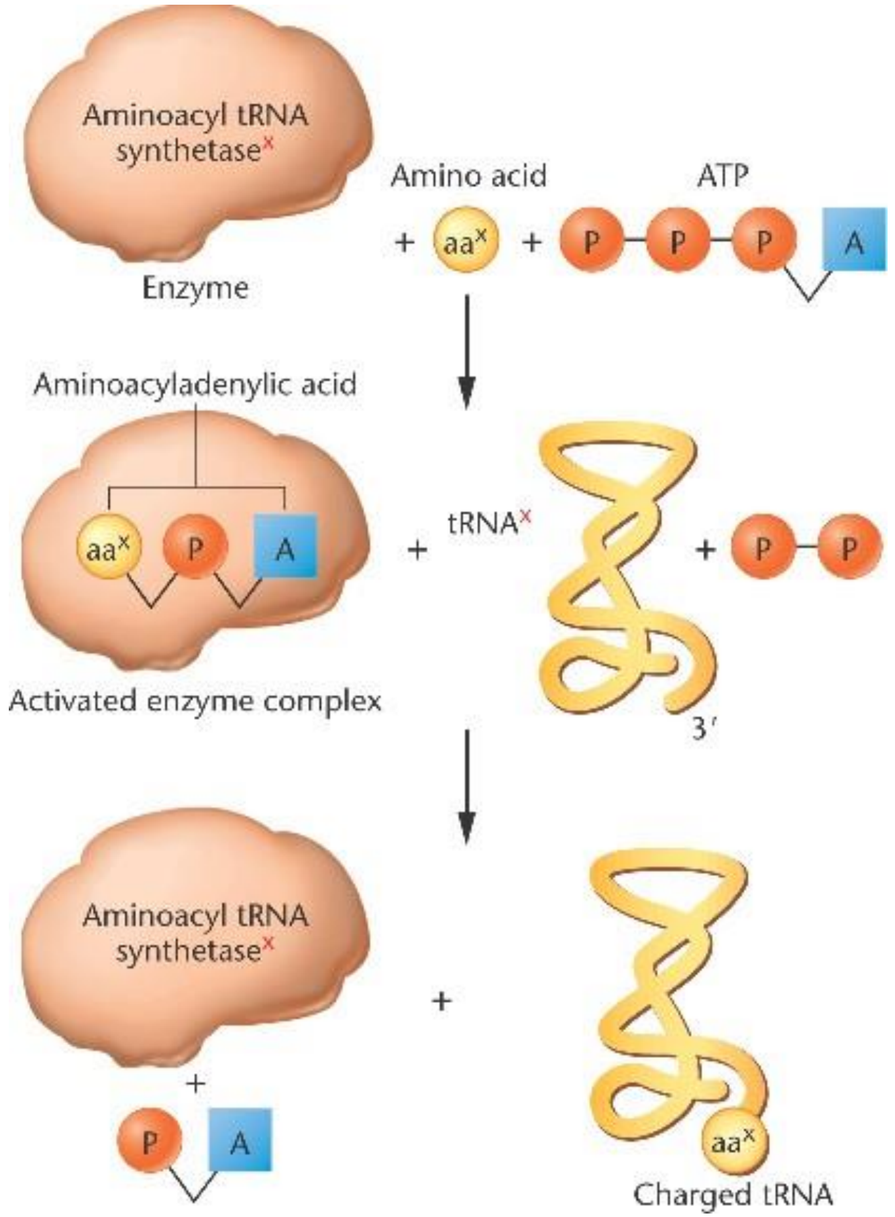

5'
3'
5'
3'
3' mRNA
Capping
Cap
$^{m}G_{ppp}$
5'
Intron
Exon
$^{m}G_{ppp}$
5'
RNA splicing
Polyadenylation
3'
Poly A tail
$^{m}G_{ppp}$
5'
3'
$^{m}G_{ppp}$
5'
Messenger RNA

INTRODUCTION – PROTEIN SYNTHESIS

- It is the process where polypeptide chains (proteins) are formed from an mRNA.
- Amino acids are polymerized (joined by a peptide bond) to form a polypeptide.
- Protein synthesis has two steps
  - **Transcription**
  - **Translation**



Charging of tRNA (aminoacylation of tRNA)



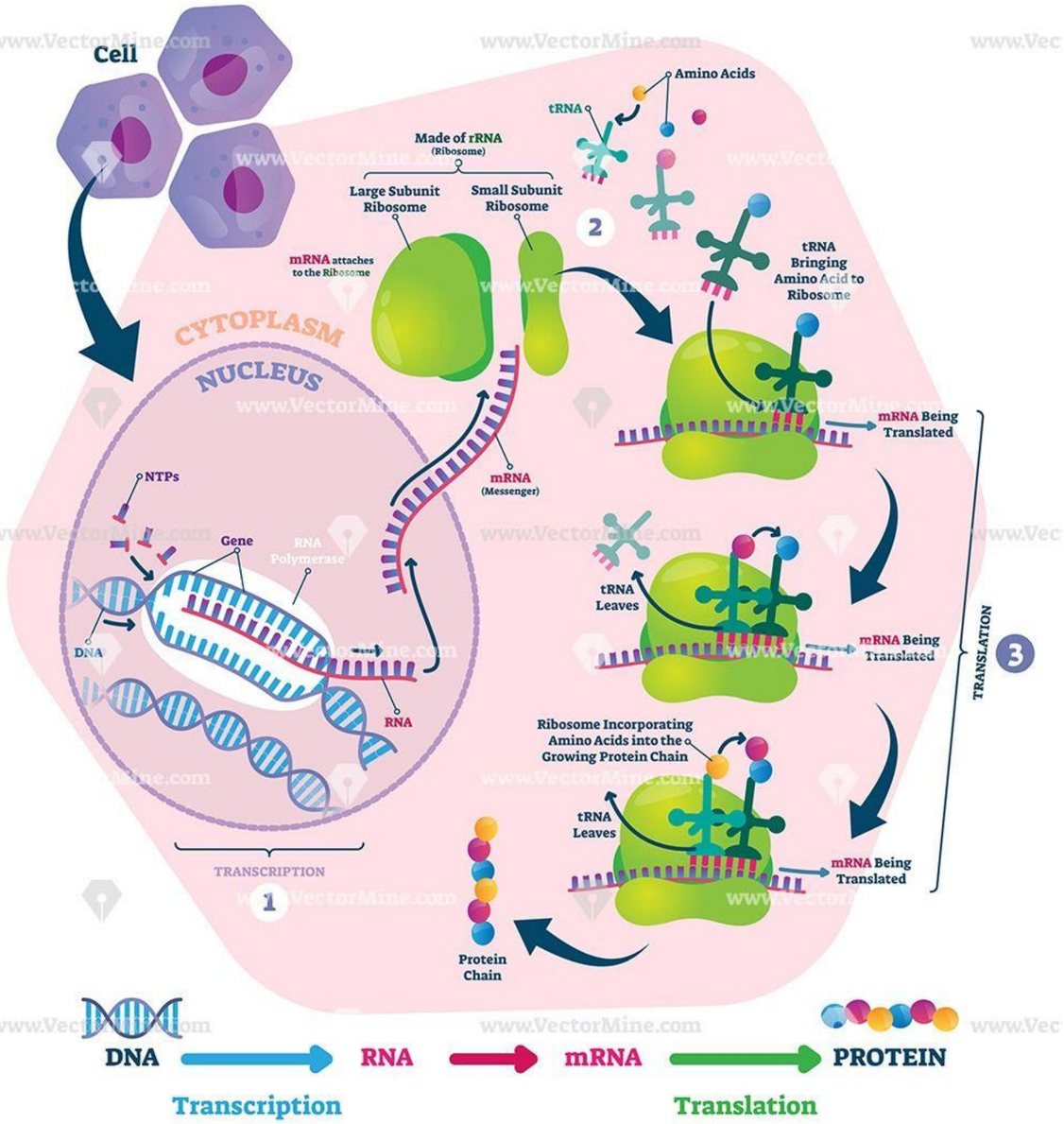
Translation

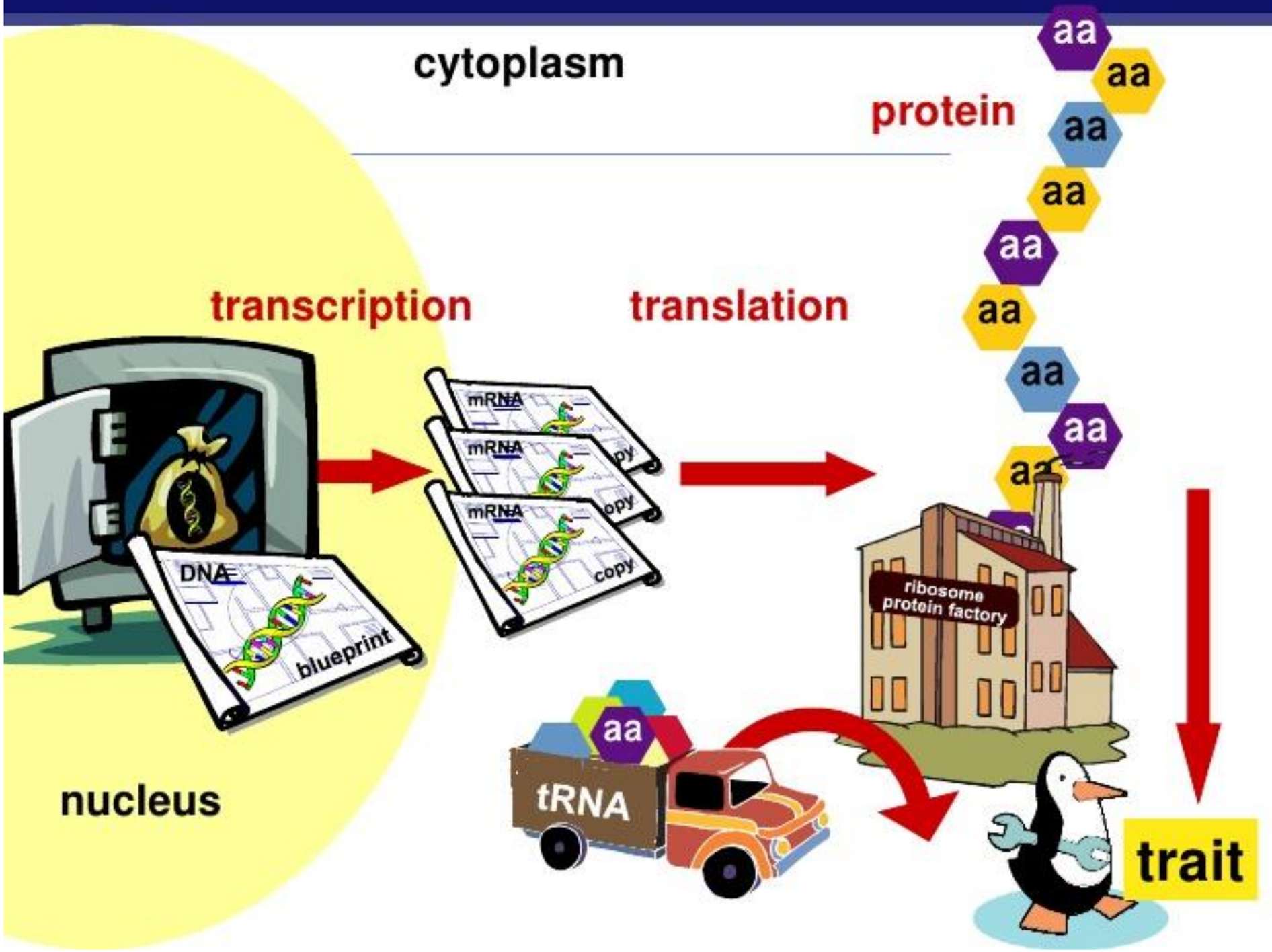
- Translation occurs in Ribosome. Ribosomes have 2 subunits: a large subunit and a small subunit.
- Smaller subunit comes in contact with mRNA to initiate the process of translation.
- Translational unit in an mRNA is the region flanked by a start codon and stop codon.
- Untranslated regions (**UTR**) are the regions on mRNA that are not translated but are required for the efficient translation process. They are present before start codon (5’ UTR) or after stop codon (3’ UTR).

Steps involved in translation

- **Initiation**: Initiator tRNA recognizes the start codon.
- **Elongation**: The t-RNA-amino acid complexes bind to their corresponding codon on the mRNA and base pairing occurs between codon on mRNA and tRNA anticodon. tRNA moves from codon to codon on the mRNA and amino acids are added one by one.
- **Termination**: Release factor binds to stop codon to terminate the translation.

Protein Synthesis




cytoplasm
protein
aa
transcription
translation
mRNA
copy
DNA
blueprint
ribosome
protein factory
tRNA
trait
nucleus

mRNA to protein = Translation

- The working instructions → mRNA
- The reader → ribosome
- The transporter → transfer RNA (tRNA)