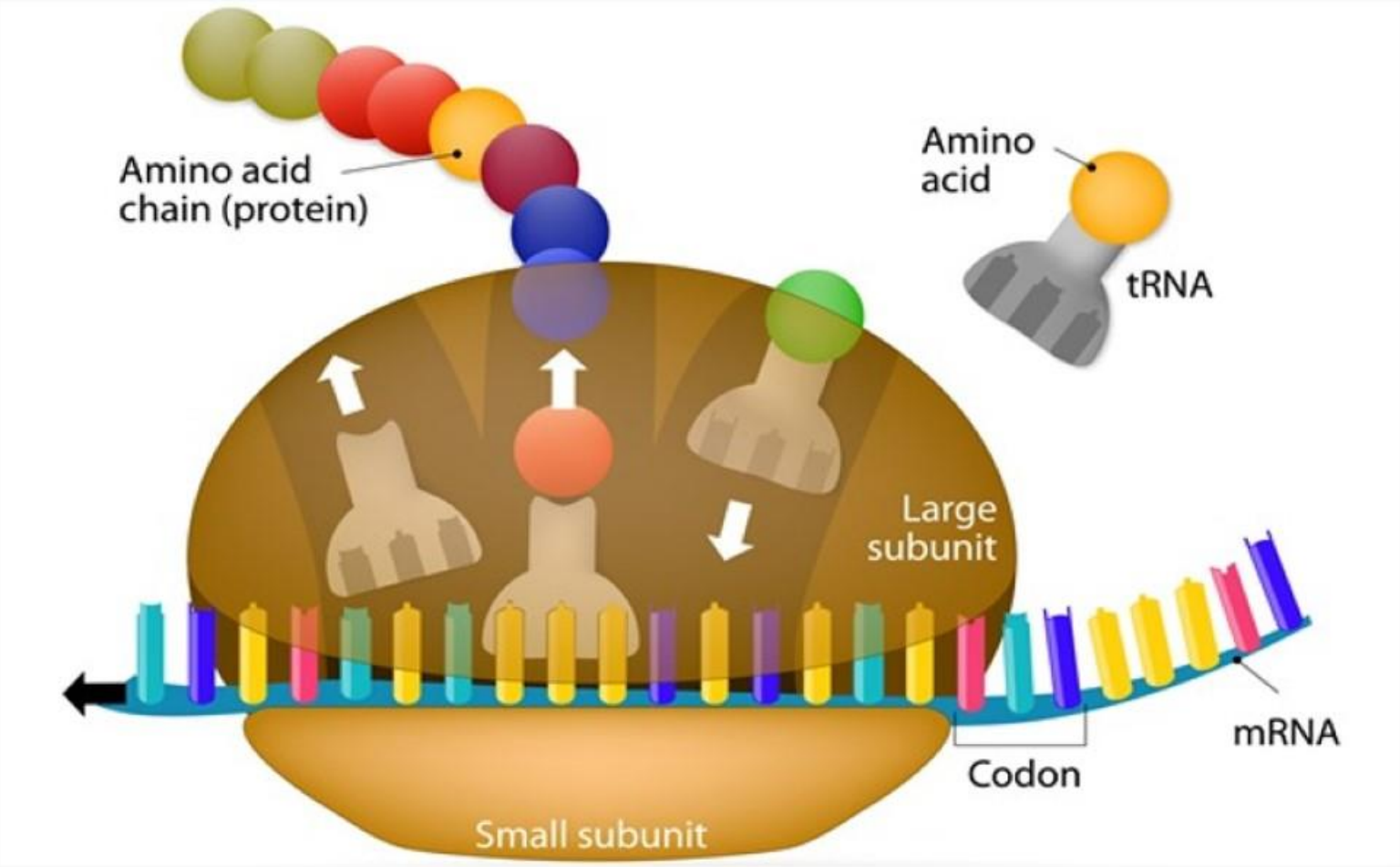
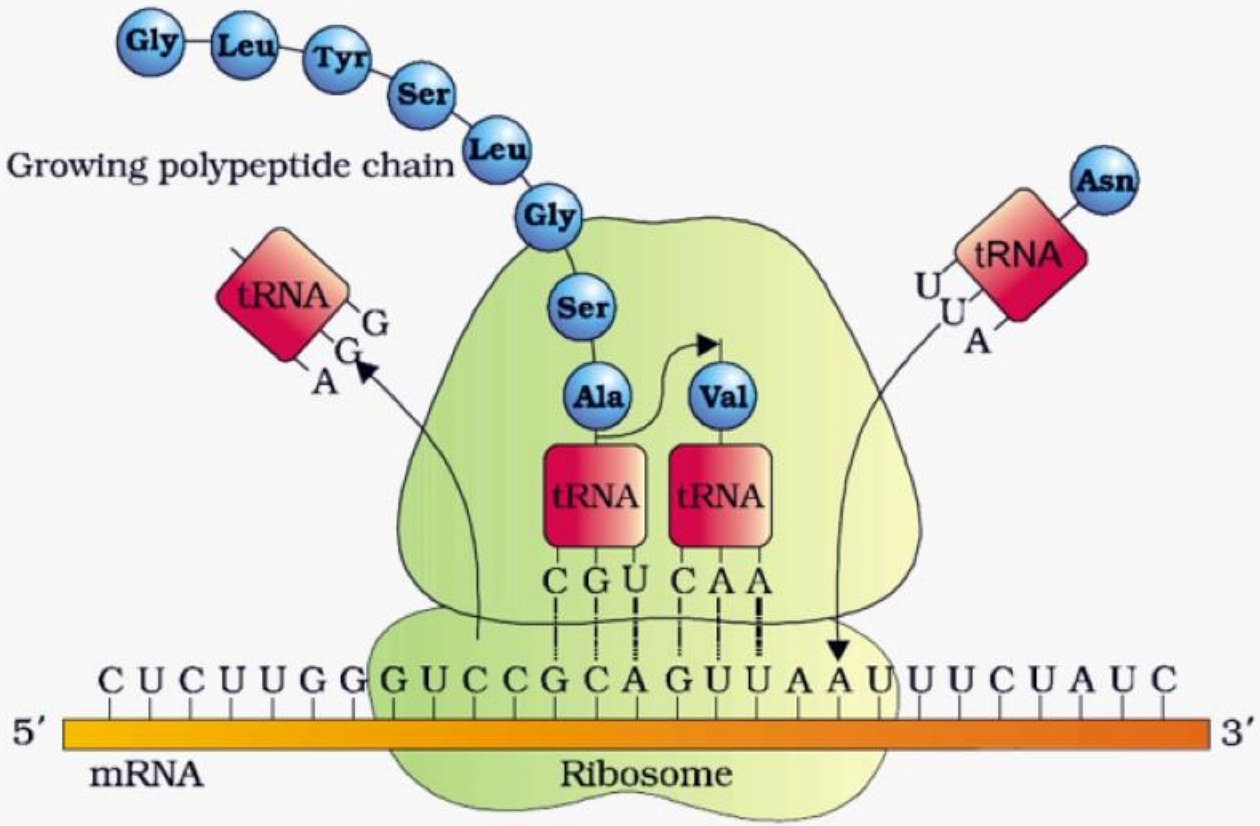


TRANSLATION

TRANSLATION (PROTEIN SYNTHESIS)

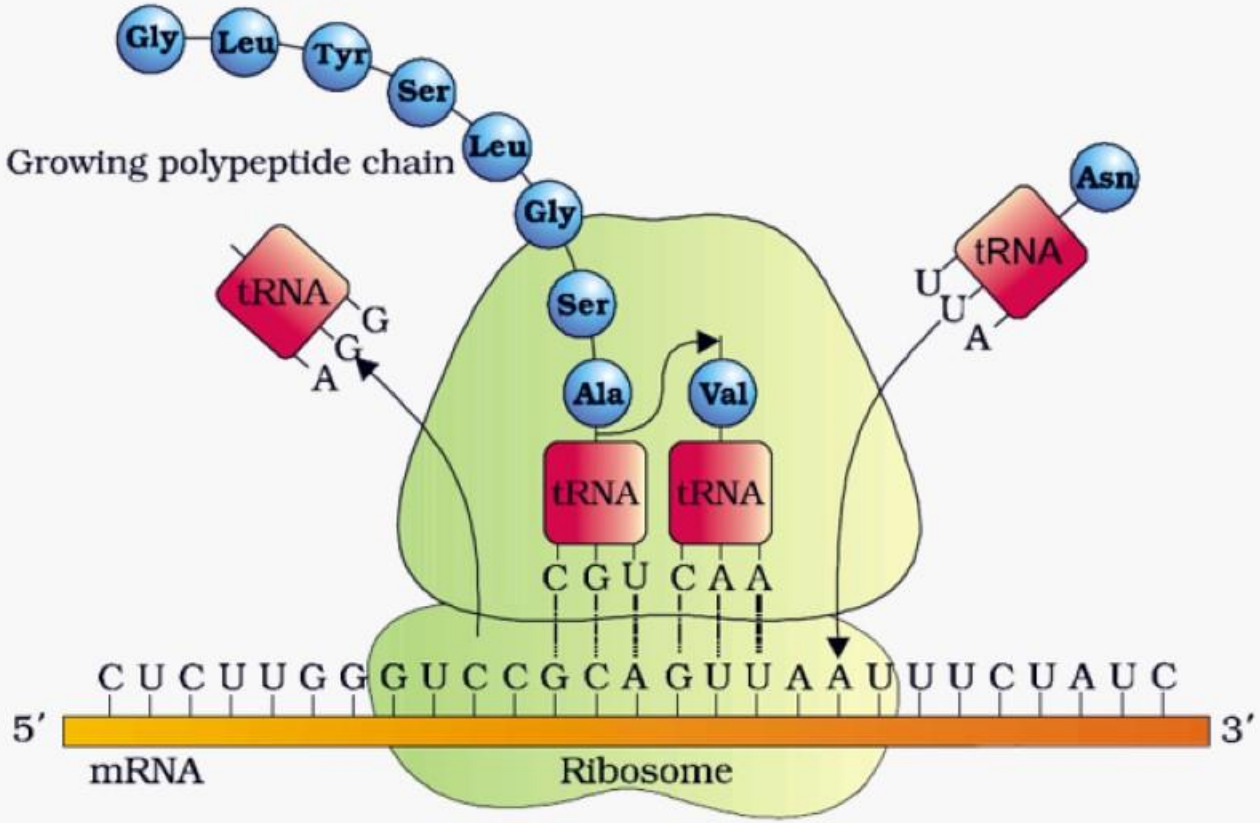
- It is the process of polymerisation of amino acids to form a polypeptide based on the sequence of codons in mRNA.
- It takes place in ribosomes.
- Ribosome consists of structural RNAs and about 80 types of proteins.
- Ribosome also acts as a catalyst (23S rRNA in bacteria is the enzyme-ribozyme) for the formation of peptide bond (*peptidyl transferase* enzyme in large subunit of ribosome).



TRANSLATION (PROTEIN SYNTHESIS)

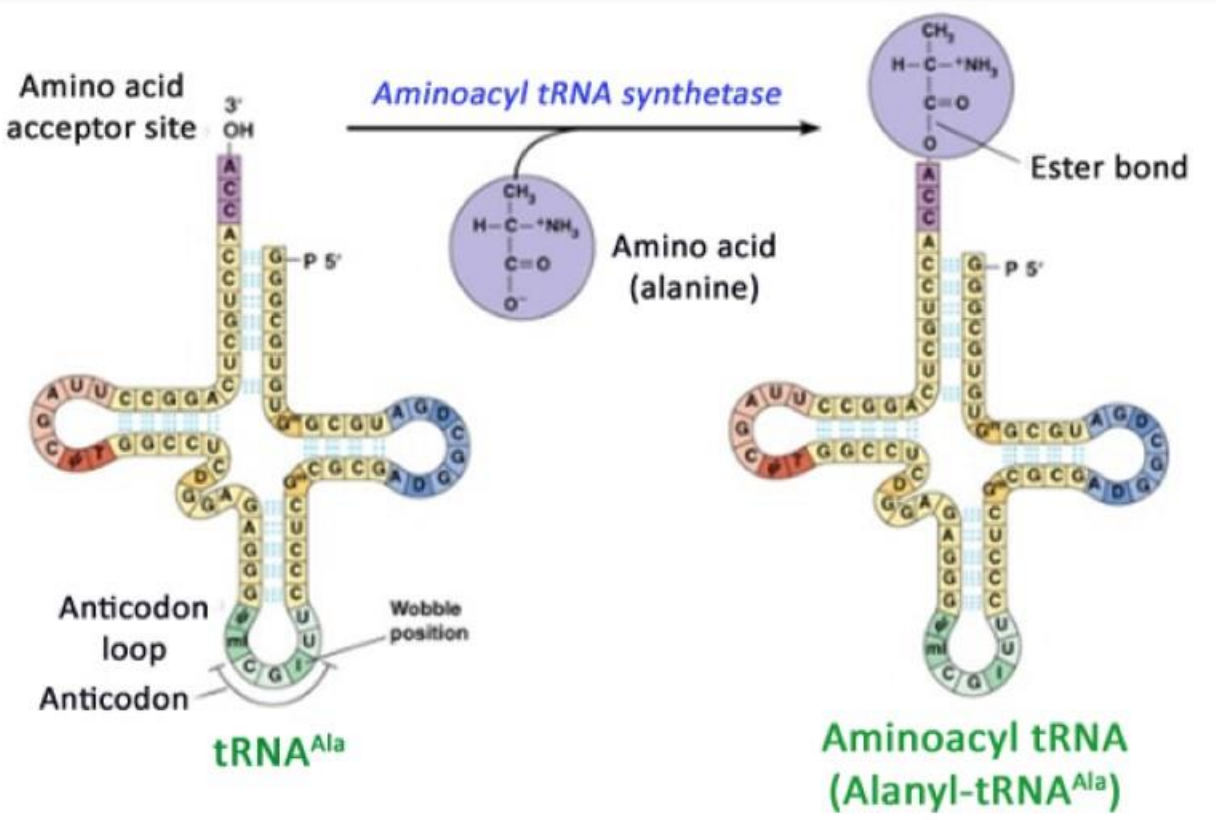
Steps of Translation

- CHARGING OF tRNA
- INITIATION
- ELONGATION
- TERMINATION



TRANSLATION

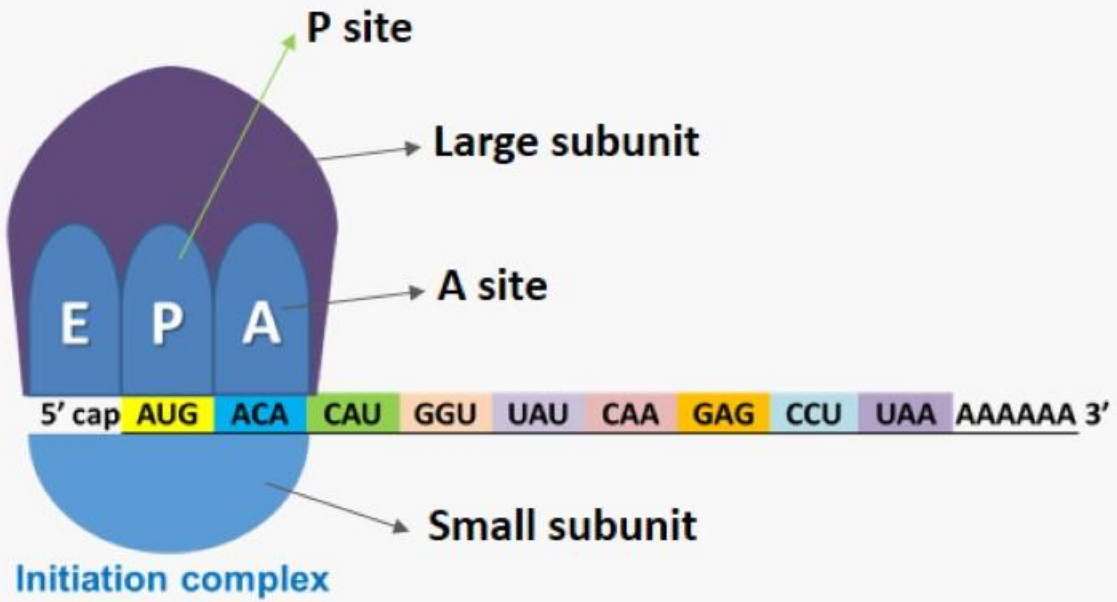
1. CHARGING (AMINOACYLATION) OF tRNA

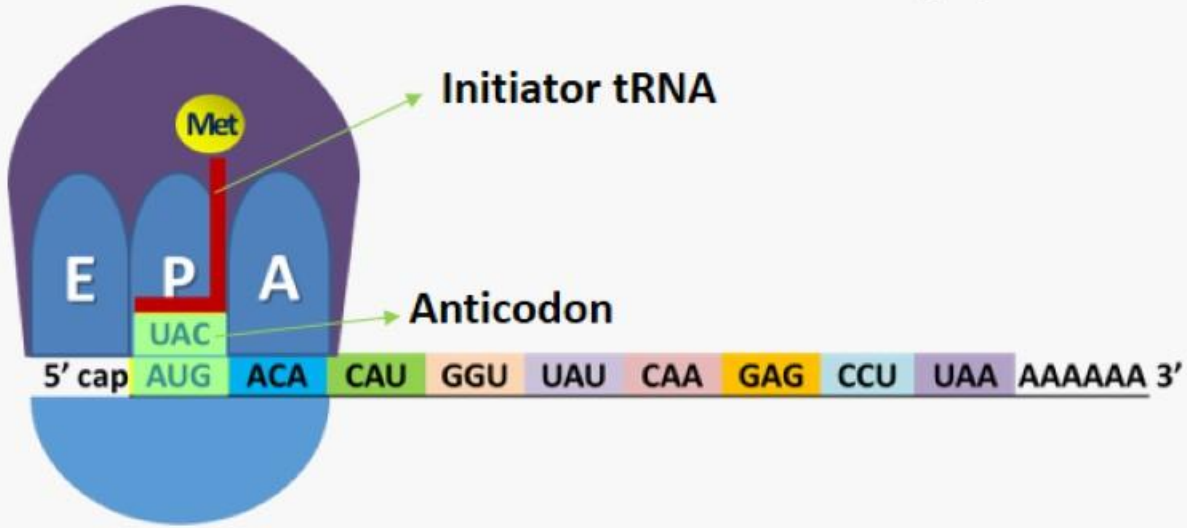


- Formation of peptide bond needs energy obtained from ATP.
- For this, amino acids are activated (amino acid + ATP) and linked to their cognate tRNA in presence of *aminoacyl tRNA synthetase.* Thus, the tRNA becomes charged.

TRANSLATION

2. INITIATION

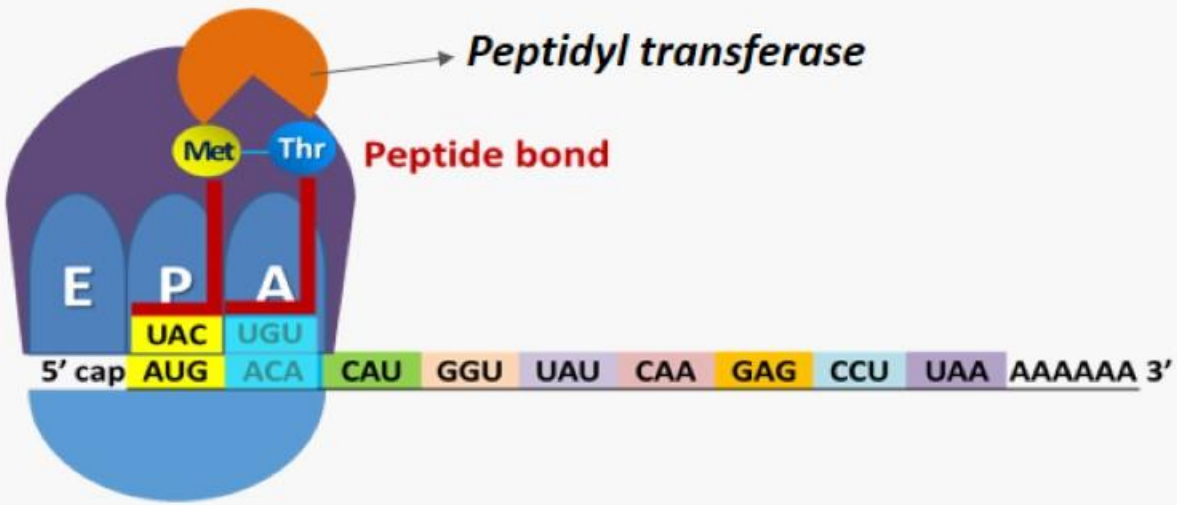


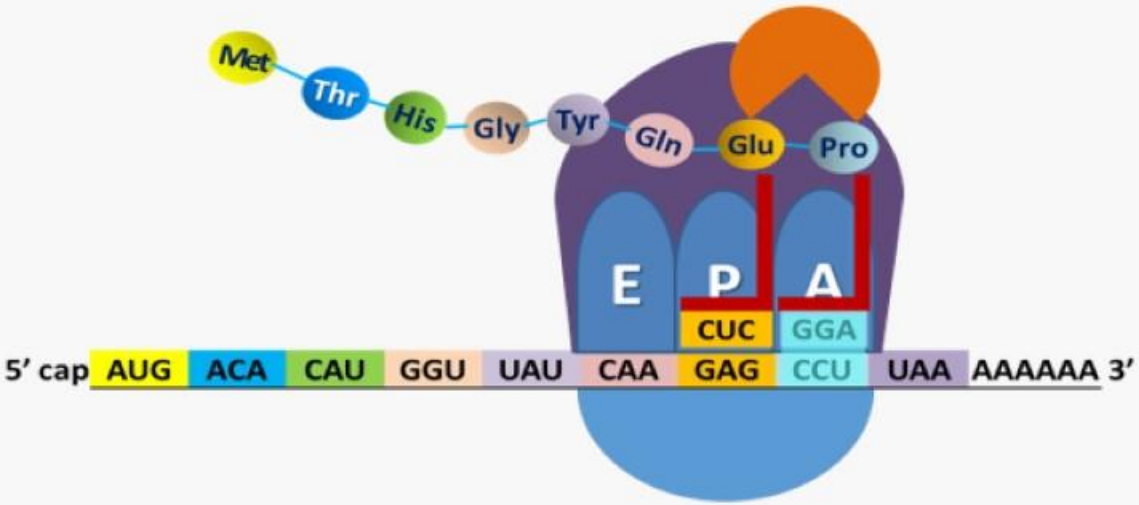


- In this, small subunit of ribosome binds to mRNA at the start codon (AUG).
- Now large subunit binds to small subunit to form initiation complex.
- Large subunit consists of aminoacyl tRNA binding site (A site) and peptidyl site (P site).
- The initiator tRNA (which carries methionine) binds on P site. Its anticodon (UAC) recognizes start codon AUG.

TRANSLATION

3. ELONGATION

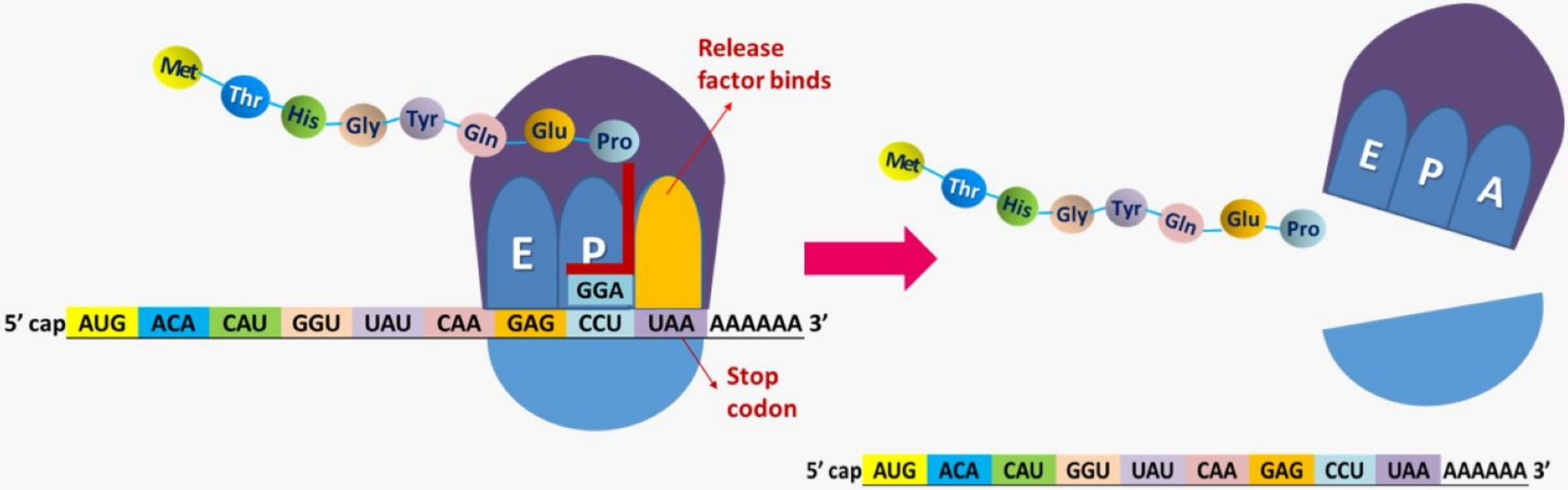




- Second aminoacyl tRNA binds to the A site of ribosome. Its anticodon binds to the second codon on the mRNA and a peptide bond is formed between first and second amino acids in presence of *peptidyl transferase.*
- First amino acid and its tRNA are broken. This tRNA is removed from P site and second tRNA from A site is pulled to P site along with mRNA. This is called translocation.
- These processes are repeated for other codons in mRNA.
- During translation, ribosome moves from codon to codon.

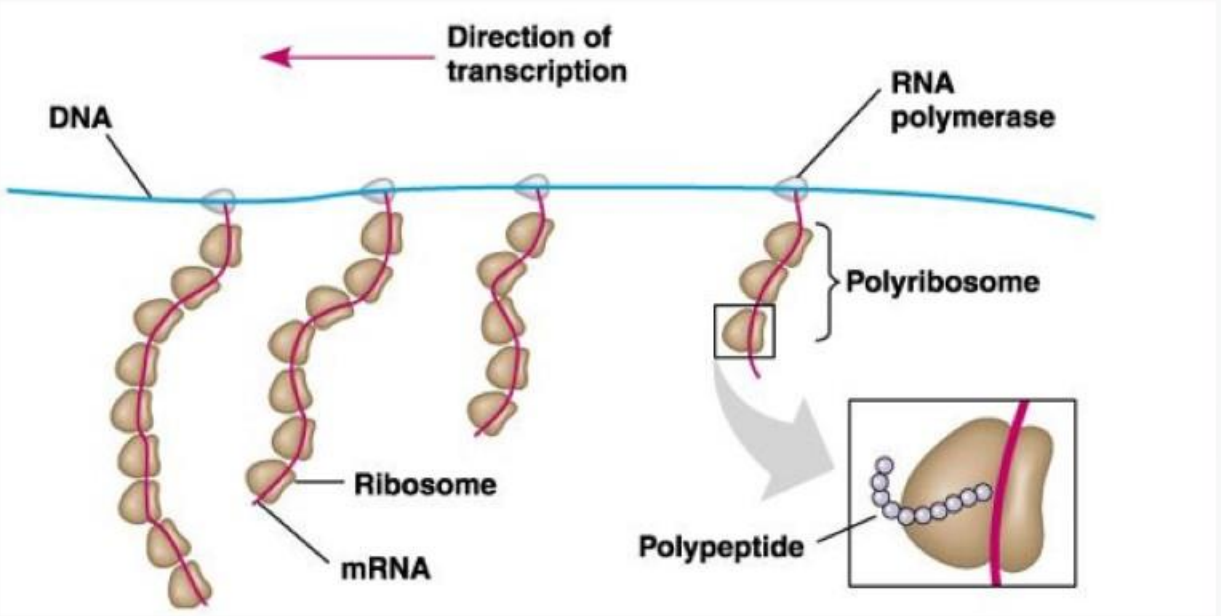
TRANSLATION

4. TERMINATION



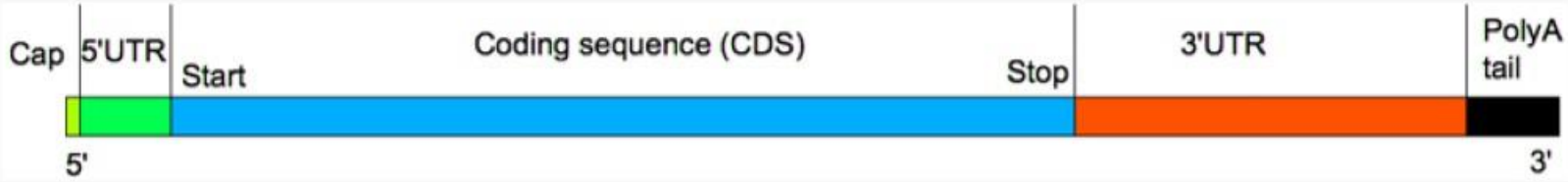
- When a release factor binds to the stop codon, the translation terminates.
- The polypeptide and tRNA are released from the ribosomes.
- The ribosome dissociates into large and small subunits.

TRANSLATION

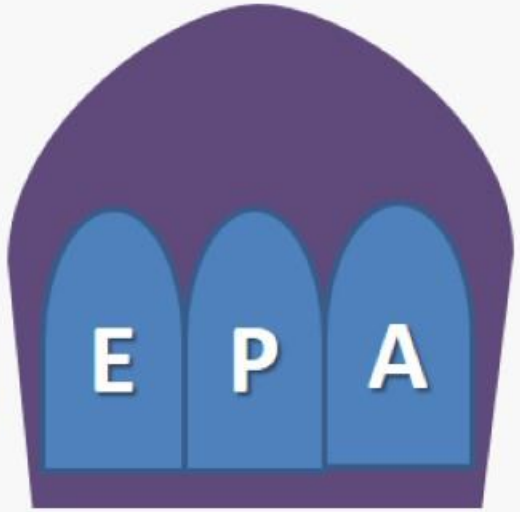


- A group of ribosomes associated with a single mRNA for translation is called a polyribosome (polysomes).

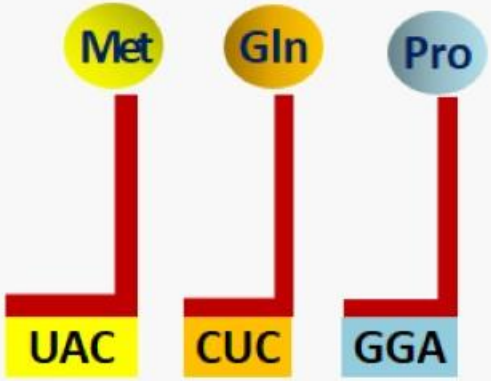
- An mRNA has additional sequences that are not translated (untranslated regions or UTR). UTRs are present at both 5'-end (before start codon) and 3'-end (after stop codon). They are required for efficient translation process.



TRANSLATION IN ACTION



Ribosome
Large
subunit



tRNAs

5’ cap AUG ACA CAU GGU UAU CAA GAG CCU UAA AAAAAA 3’

mRNA

Ribosome
Small
subunit

Peptidyl transferase

TRANSLATION IN ACTION

mRNA

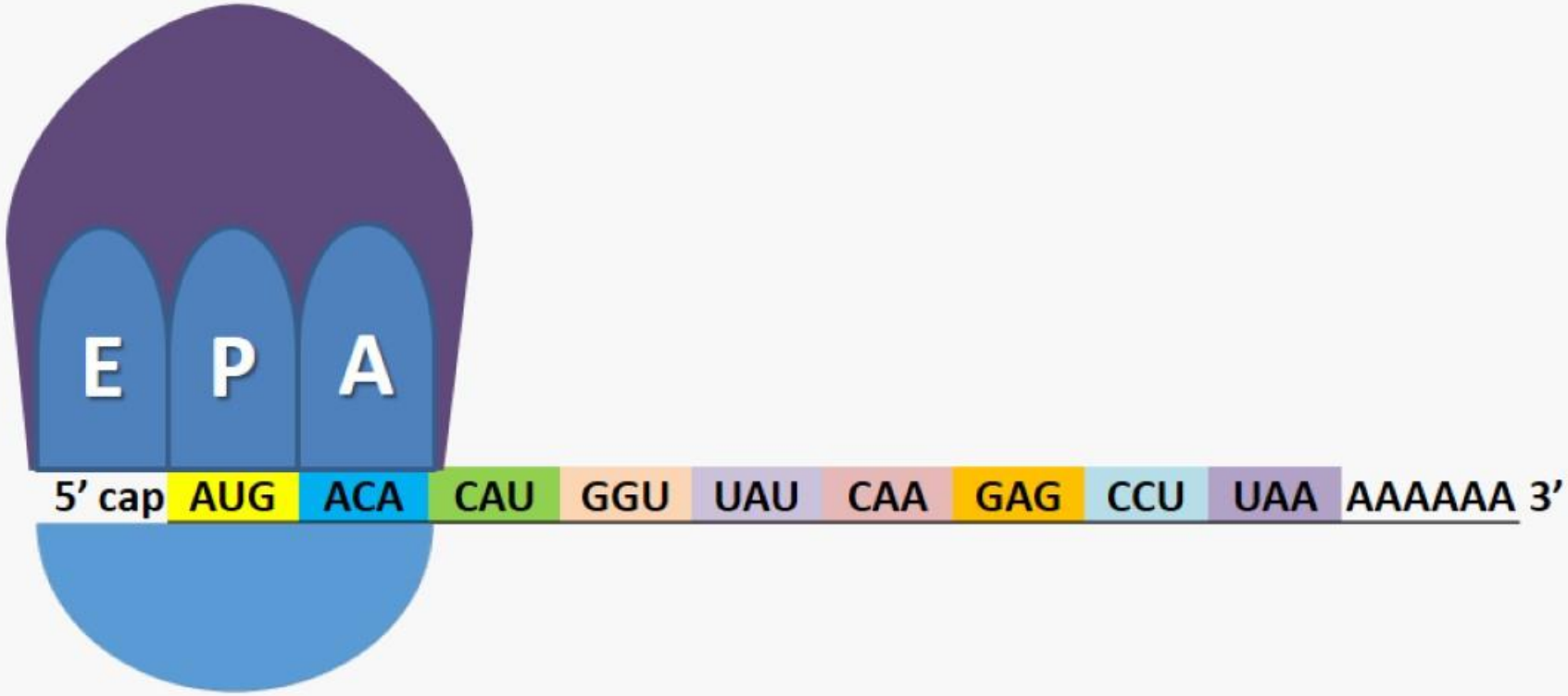
Ribosome Large subunit

Ribosome Small subunit

tRNAs

Peptidyl transferase

1.Initiation



Initiation complex

TRANSLATION IN ACTION

mRNA

Ribosome Large subunit

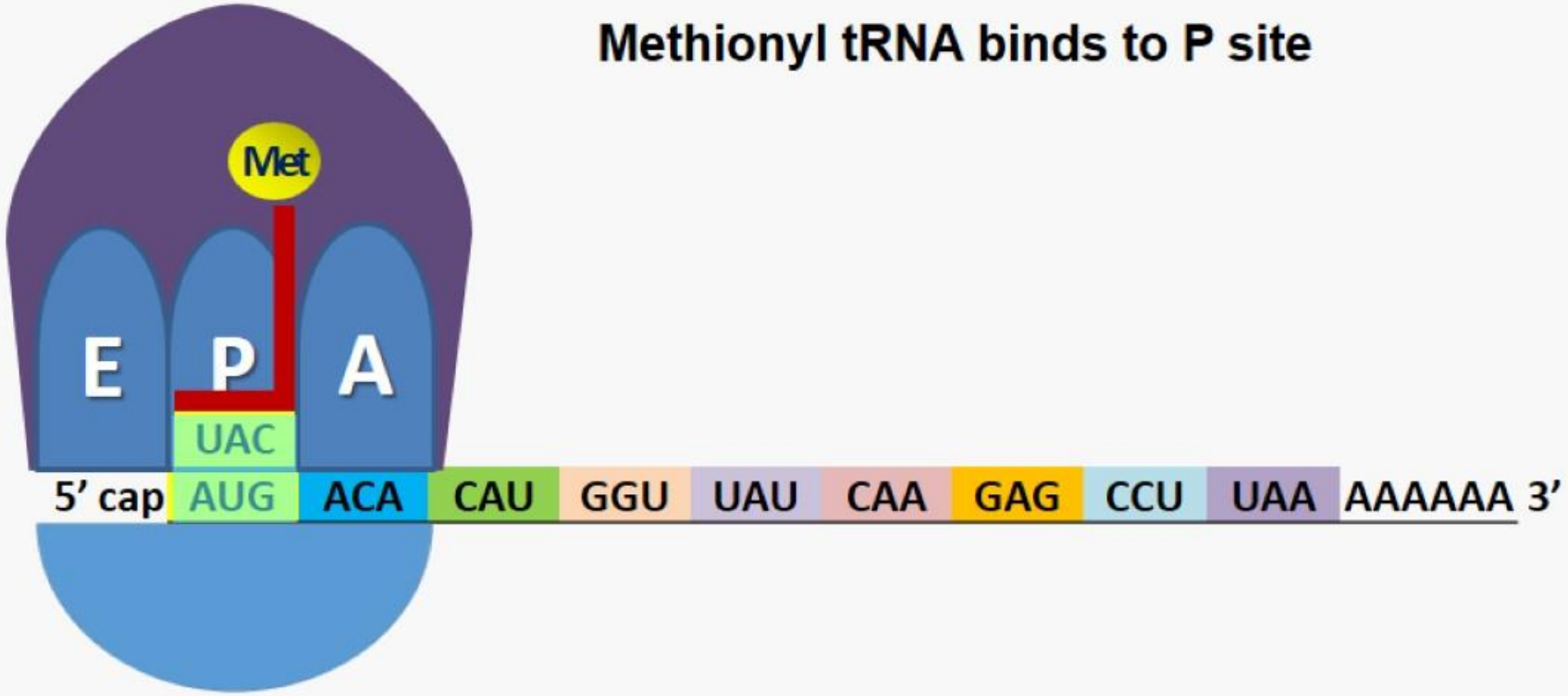
Ribosome Small subunit

tRNAs

Peptidyl transferase

1.Initiation

Methionyl tRNA binds to P site



TRANSLATION IN ACTION

mRNA

Ribosome Large subunit

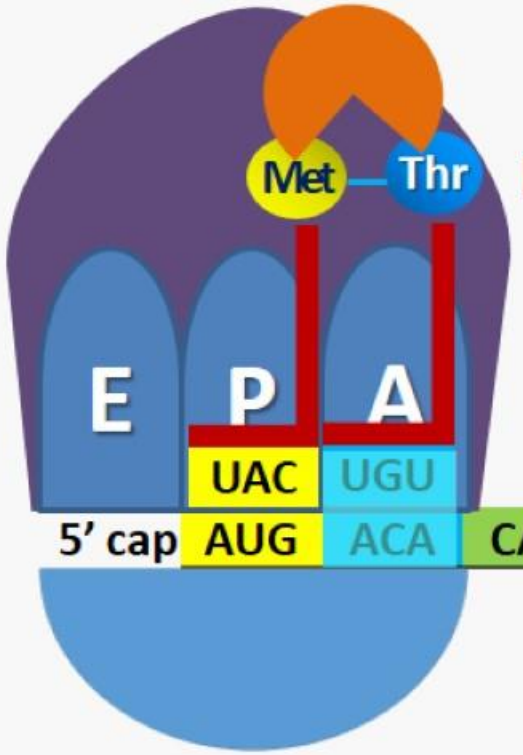
Ribosome Small subunit

tRNAs

Peptidyl transferase

2. Elongation

Second tRNA binds to A site



Peptide bond is formed

TRANSLATION IN ACTION

mRNA

Ribosome Large subunit

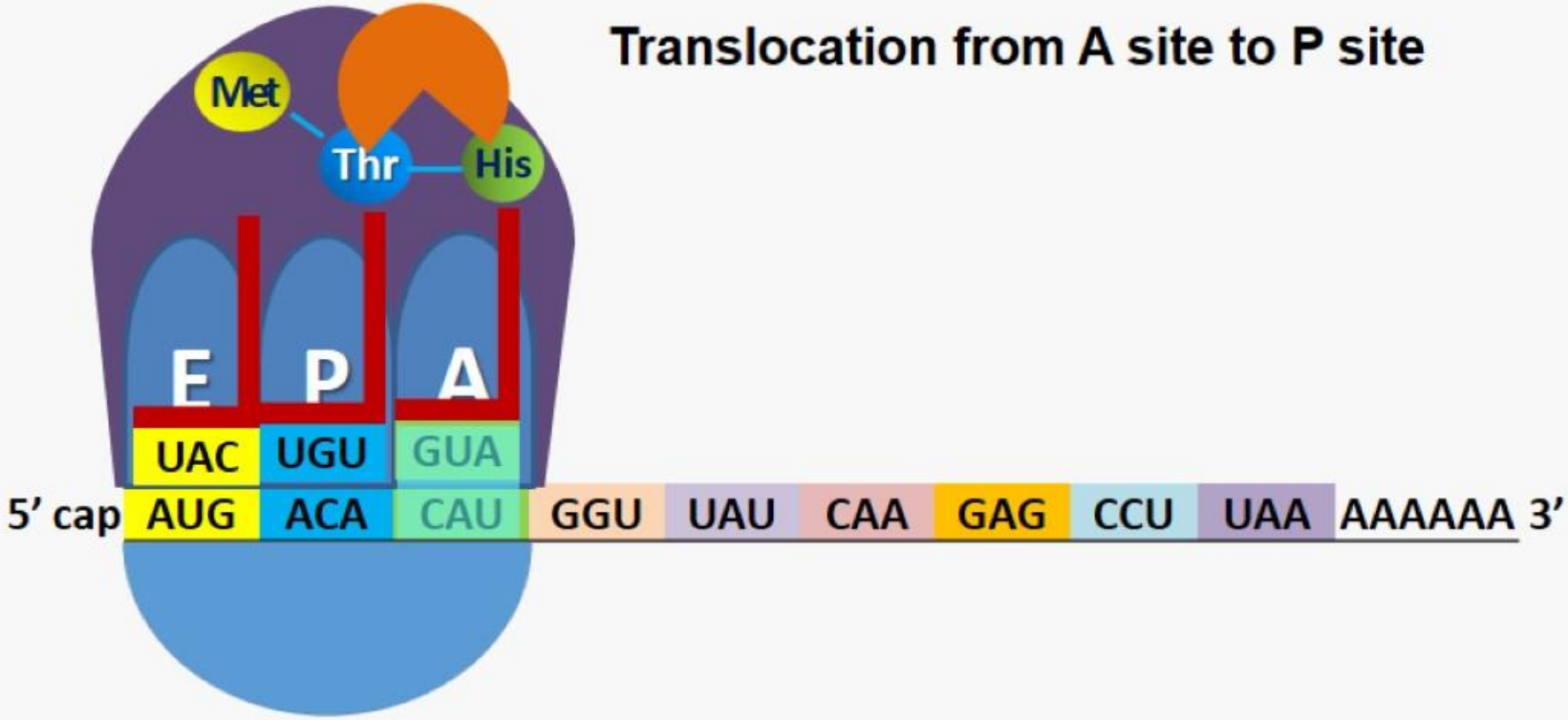
Ribosome Small subunit

tRNAs

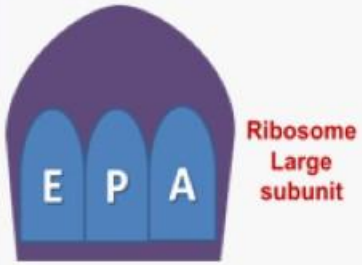
Peptidyl transferase

2. Elongation

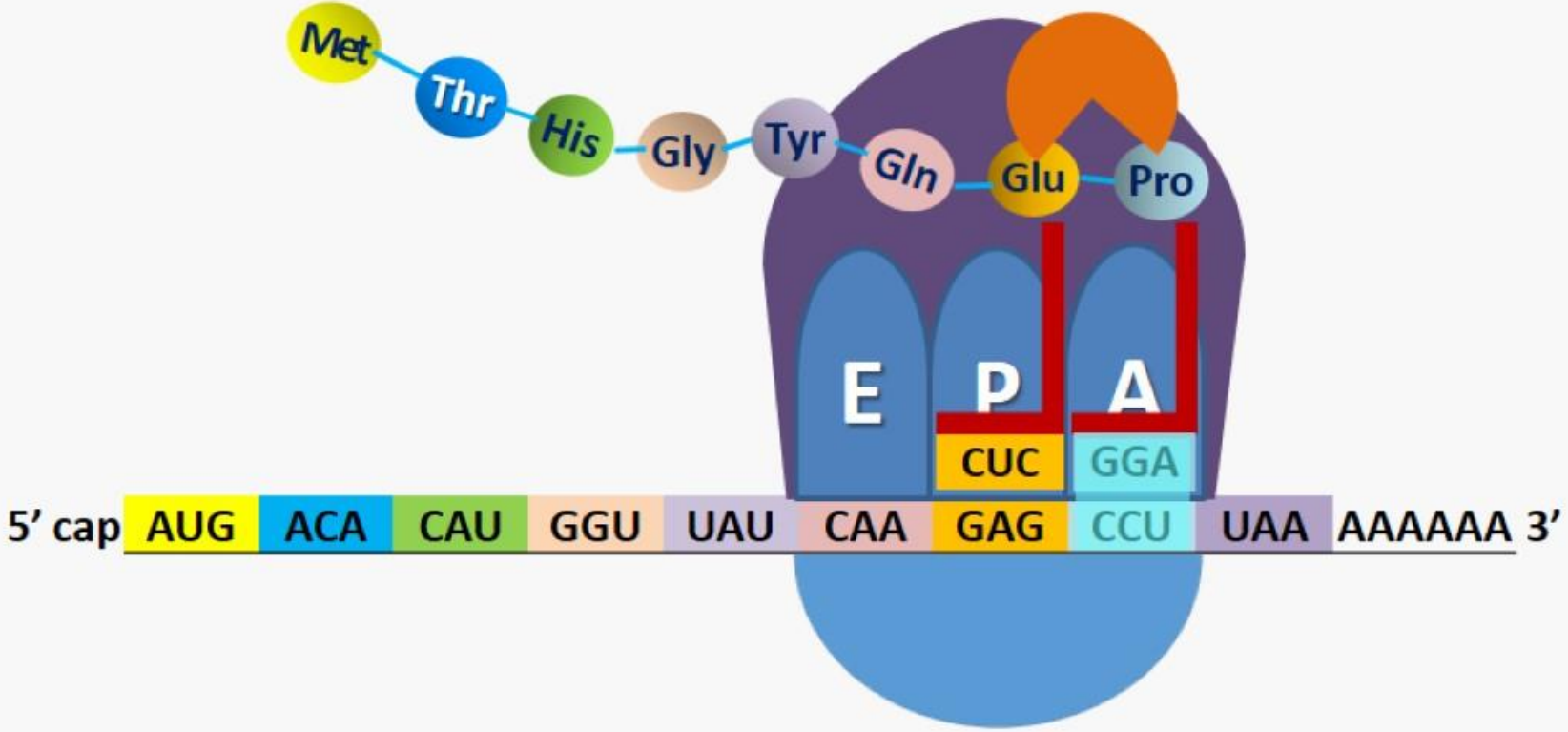
Translocation from A site to P site



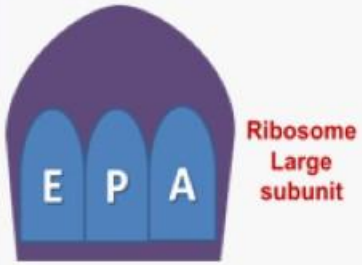
TRANSLATION IN ACTION



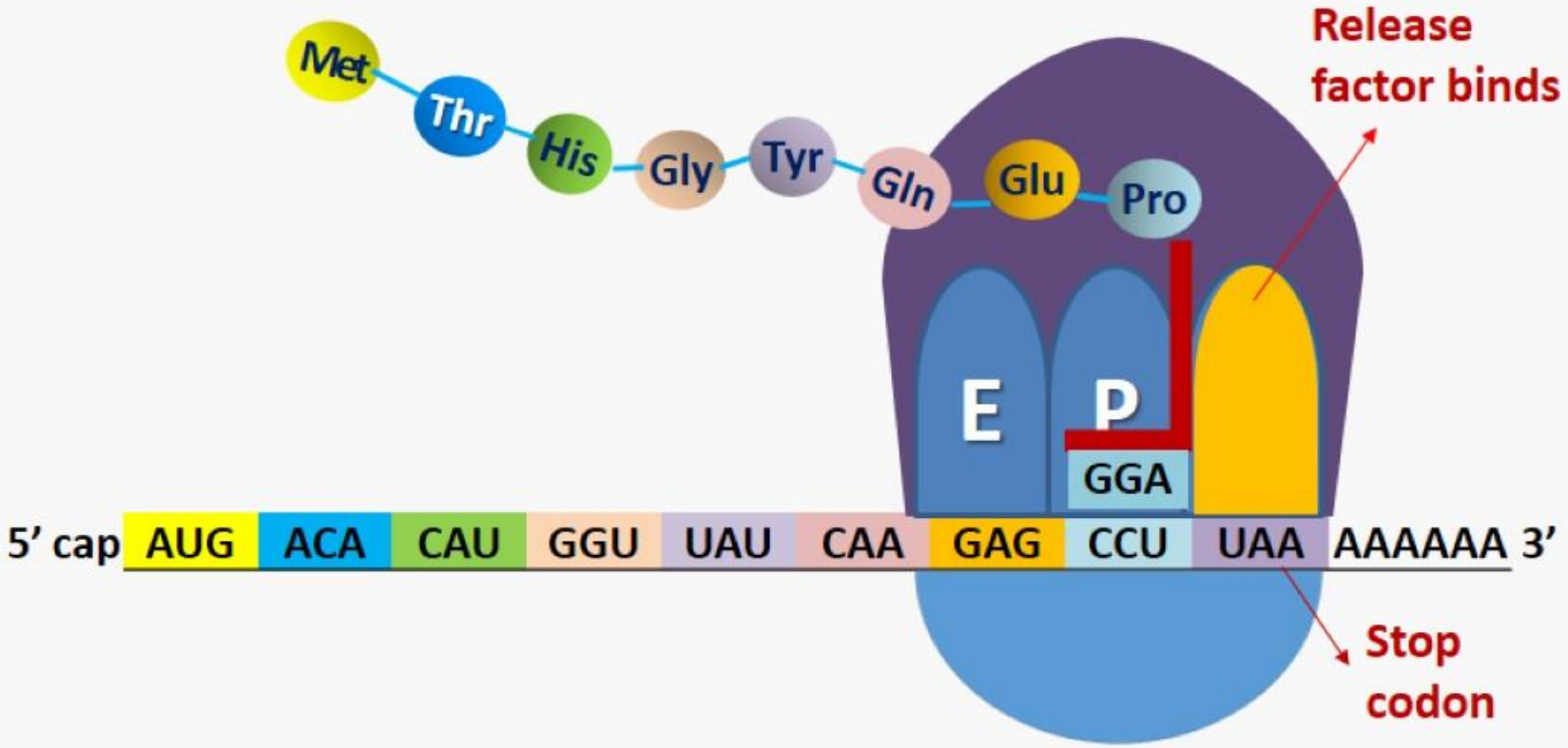
2. Elongation



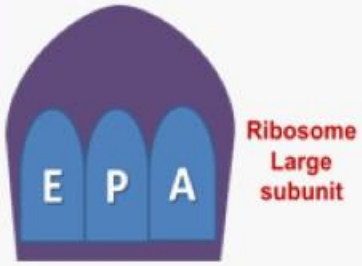
TRANSLATION IN ACTION



3. Termination

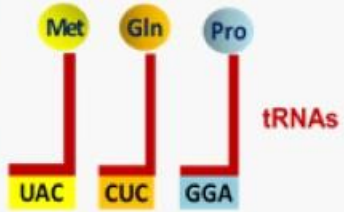


TRANSLATION IN ACTION



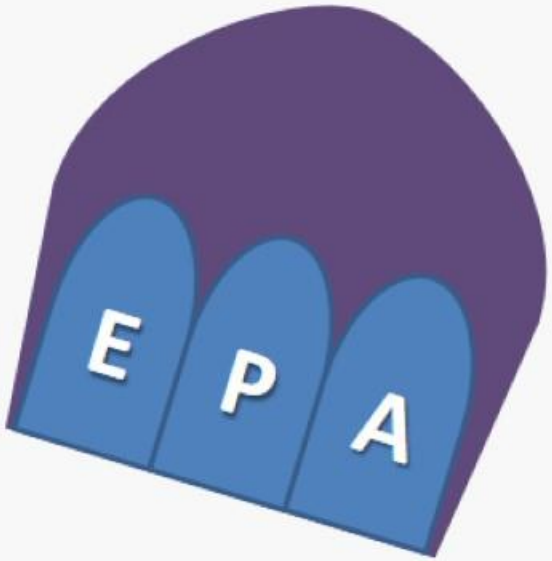
Ribosome Large subunit

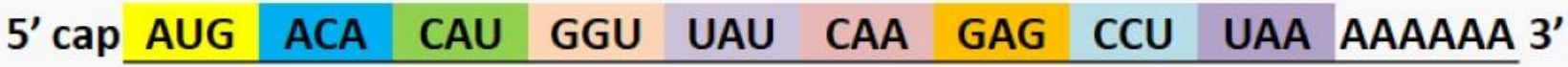
Ribosome Small subunit



tRNAs

Peptidyl transferase



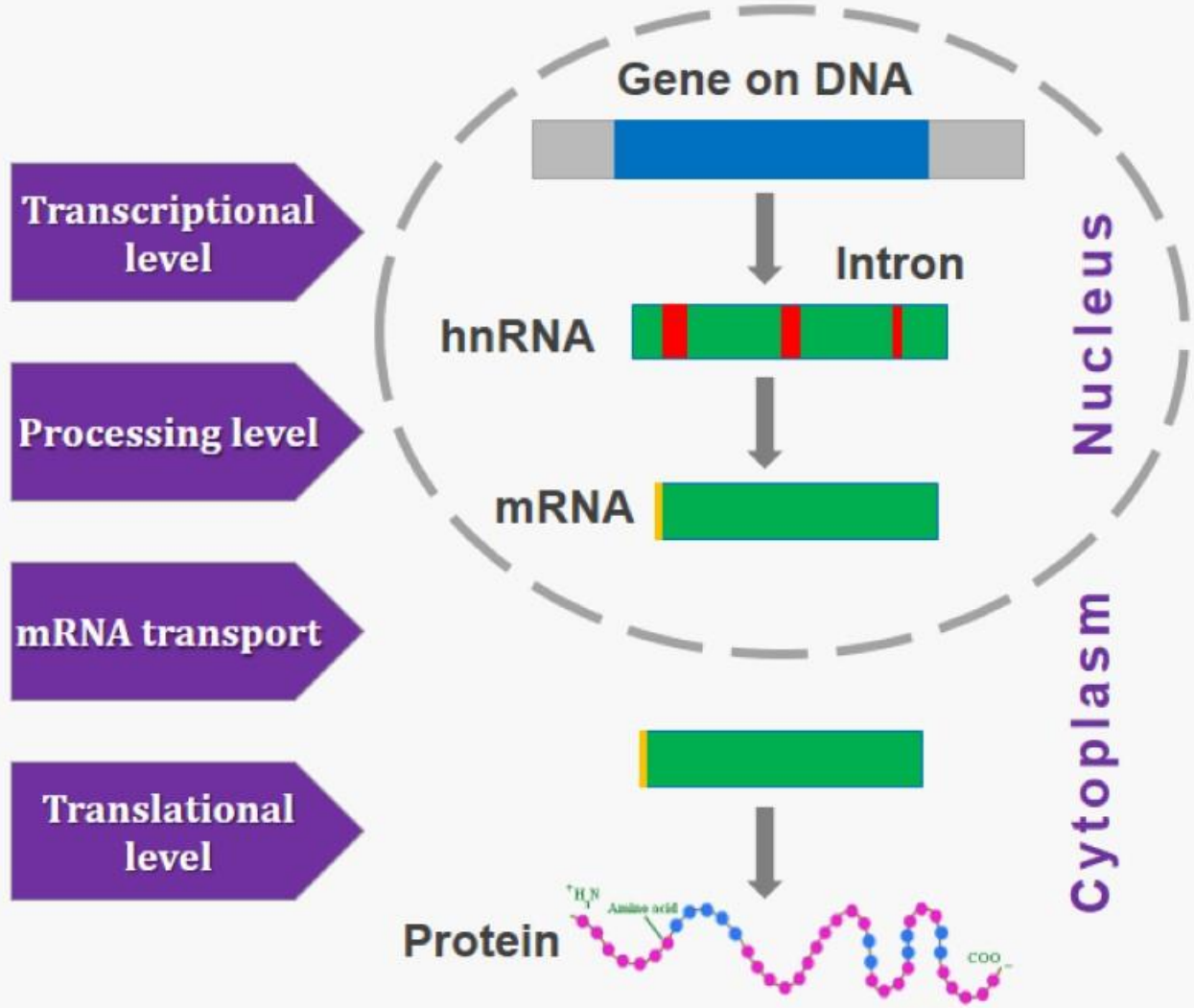



REGULATION OF GENE
EXPRESSION

REGULATION OF GENE EXPRESSION

- In eukaryotes, gene expression occurs by following levels:

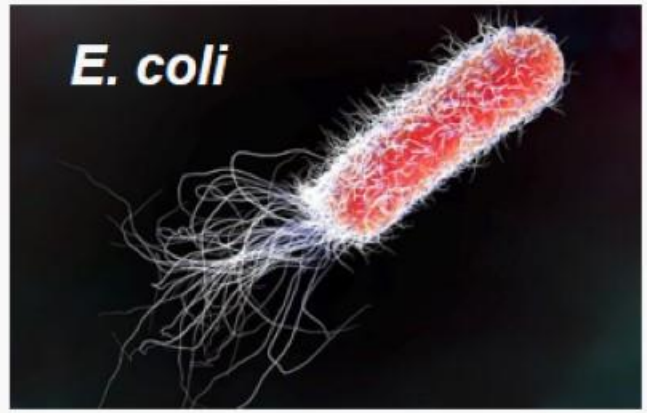
1. Transcriptional level (formation of primary transcript).
2. Processing level (splicing, capping etc.).
3. Transport of mRNA from nucleus to the cytoplasm.
4. Translational level (formation of a polypeptide).



REGULATION OF GENE EXPRESSION

The **metabolic, physiological and environmental conditions** regulate the gene expression. E.g.

- ✓ In *E. coli,* the ***beta-galactosidase*** enzyme hydrolyses **lactose** into galactose and glucose. In the absence of lactose, the synthesis of *beta-galactosidase* stops.
- ✓ The development and differentiation of embryo into adult are a result of the expression of several set of genes.



REGULATION OF GENE EXPRESSION

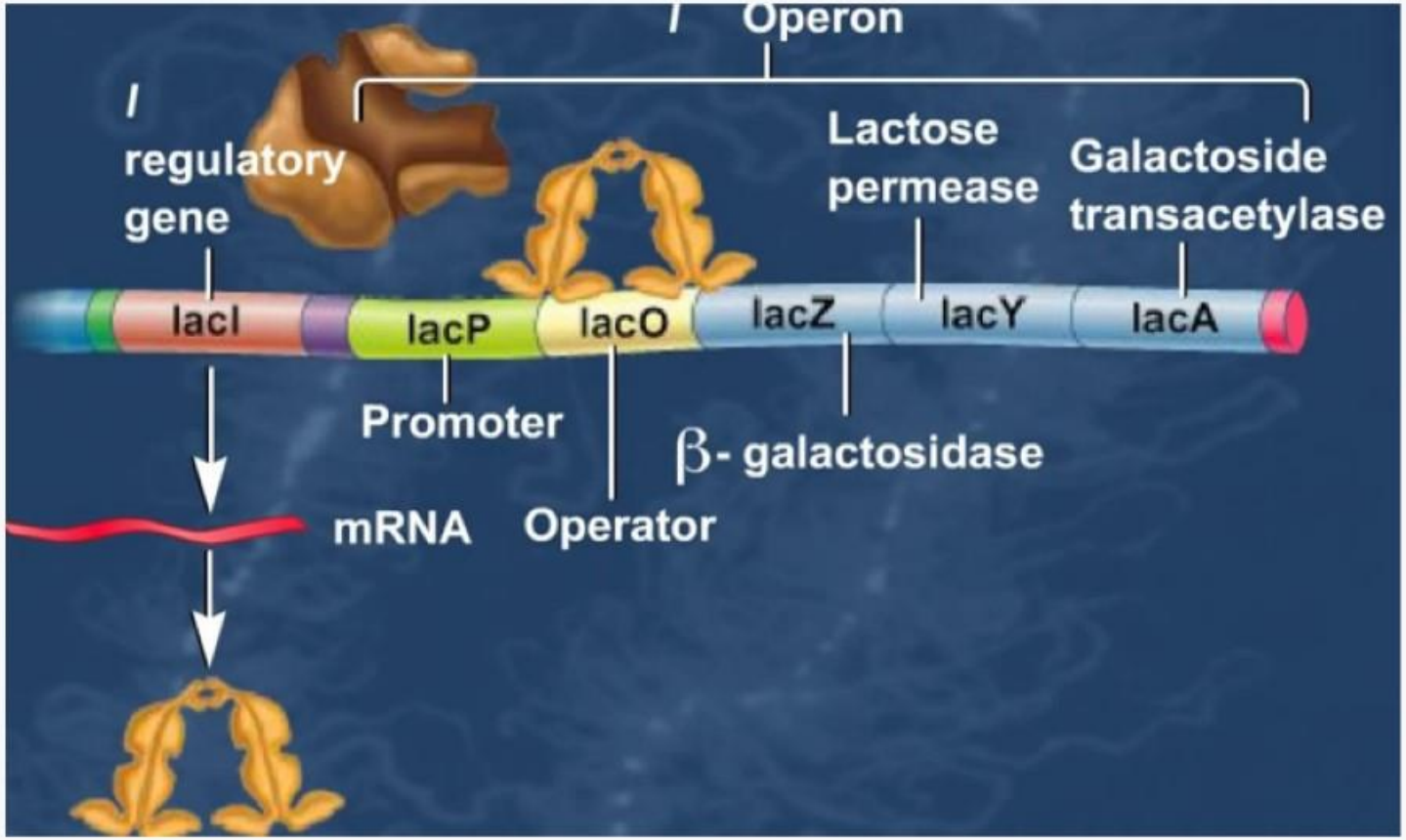
- If a **substrate** is added to growth medium of bacteria, a set of genes is switched on to metabolize it. It is called **induction.**
- When a **metabolite (product)** is added, the genes to produce it are turned off. This is called **repression.**

E. Coli growth medium

REGULATION OF GENE EXPRESSION

OPERON CONCEPT

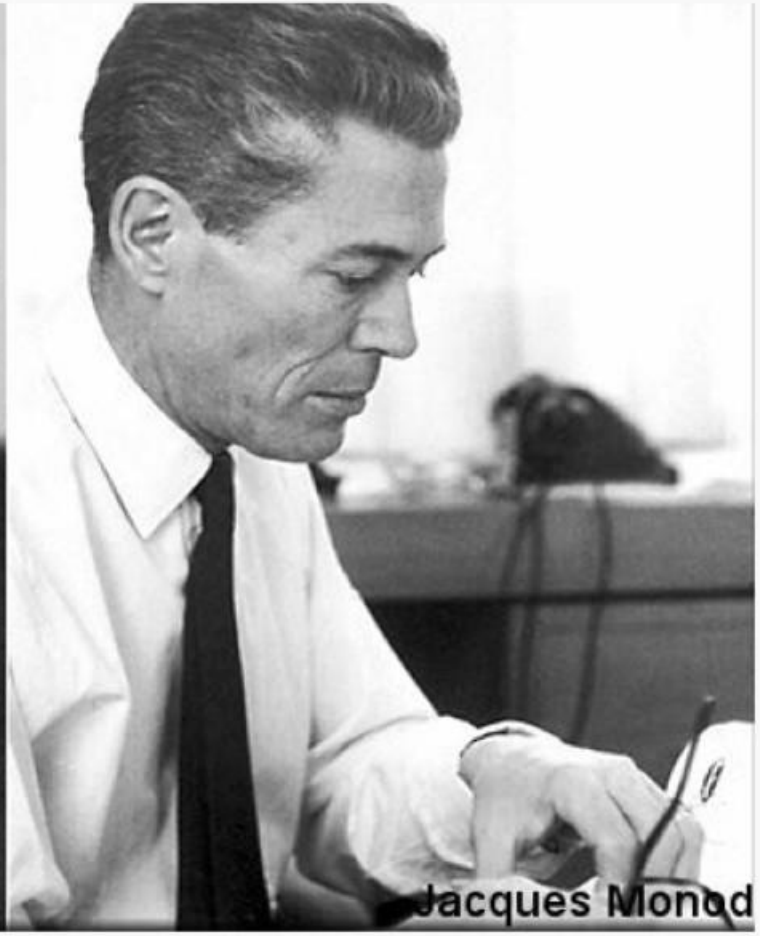
- *"Each metabolic reaction is controlled by a set of genes."*
- All the genes regulating a metabolic reaction constitute an **Operon.**
- E.g. **lac operon, trp operon, ara operon, his operon, val operon** etc.



REGULATION OF GENE EXPRESSION

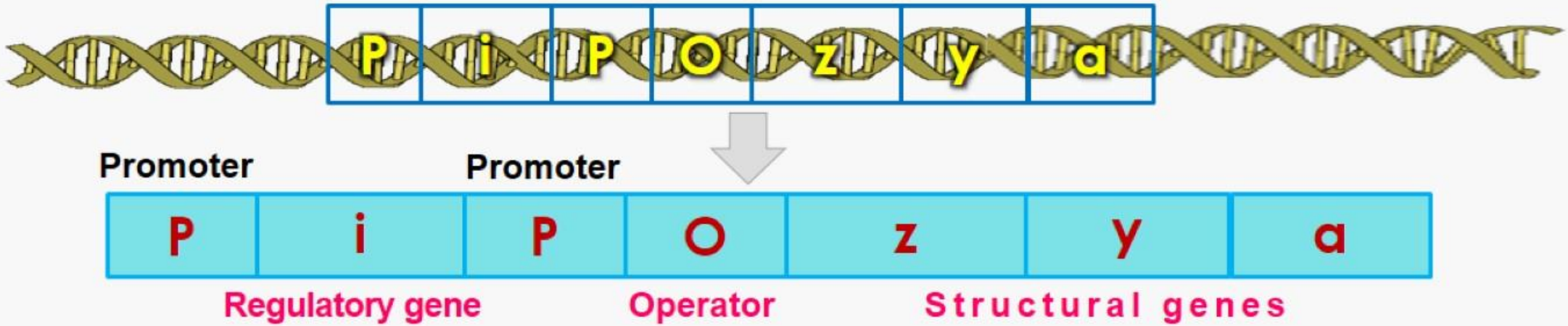
LAC OPERON

- Lac operon is the operon controlling **lactose metabolism.**
- It is proposed by **Francois Jacob & Jacque Monod.**



REGULATION OF GENE EXPRESSION

LAC OPERON



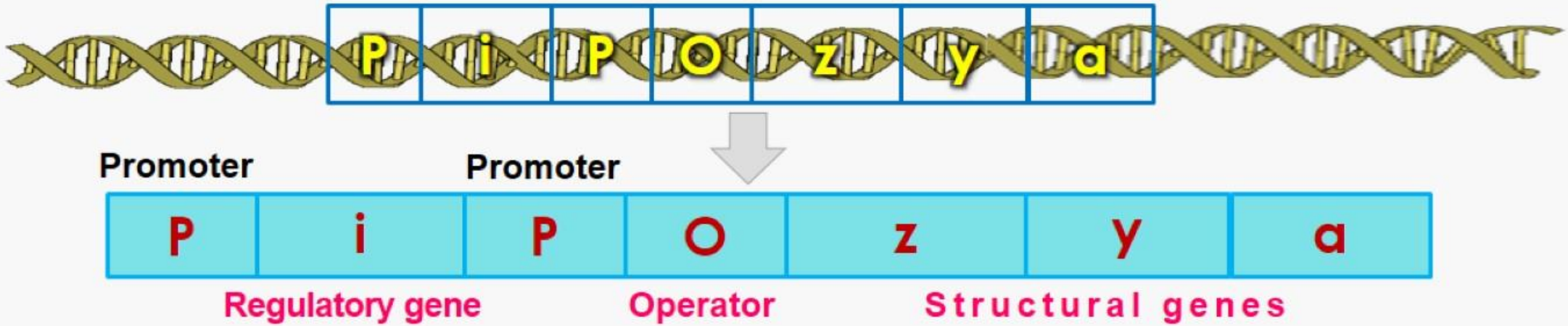
Lac operon consists of

a. A regulatory or inhibitor (i) gene: Codes for repressor protein.
b. 3 structural genes: z gene, y gene and a gene.
c. An Operator region.

Genes in the operon function together in the same or related metabolic pathway.

REGULATION OF GENE EXPRESSION

LAC OPERON



Role of structural genes:

i. **z gene:** Codes for *β galactosidase.* It hydrolyzes lactose to galactose & glucose.

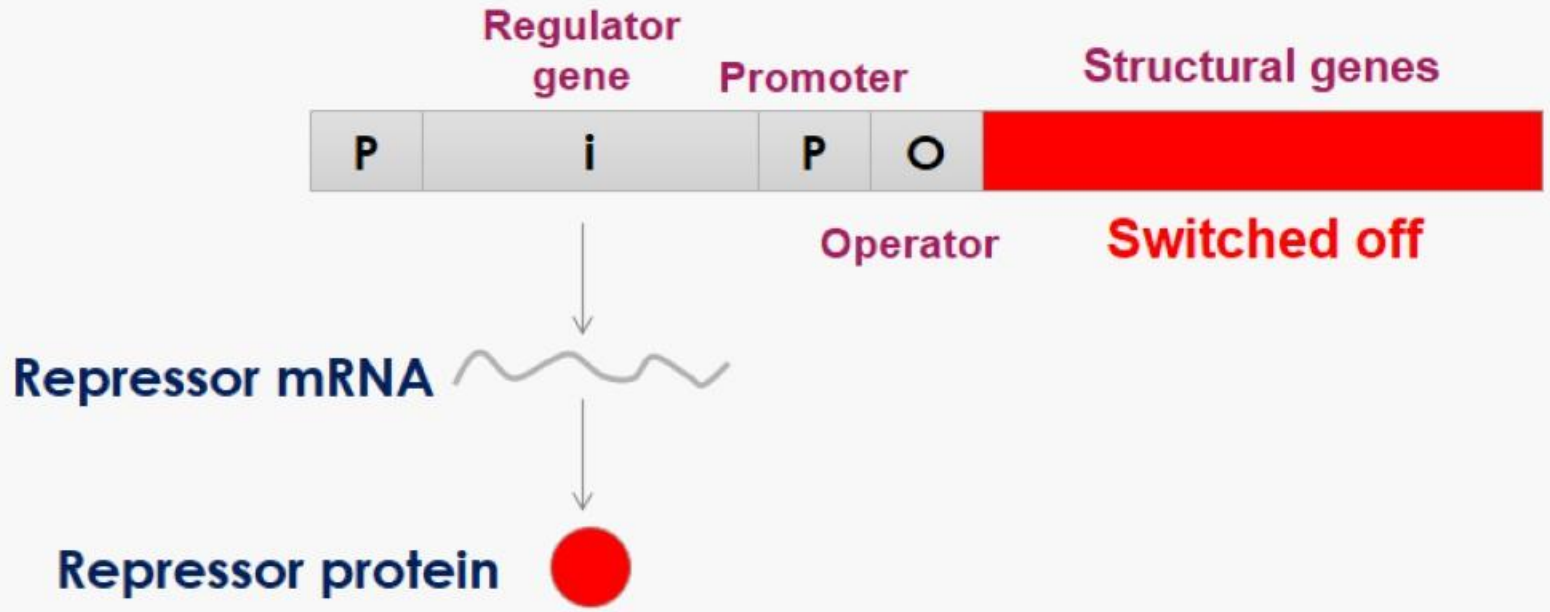
ii. **y gene:** Codes for *permease.* It increases permeability of the cell to β-galactosides (lactose).

iii. **a gene:** Codes for a *transacetylase.*

REGULATION OF GENE EXPRESSION

LAC OPERON

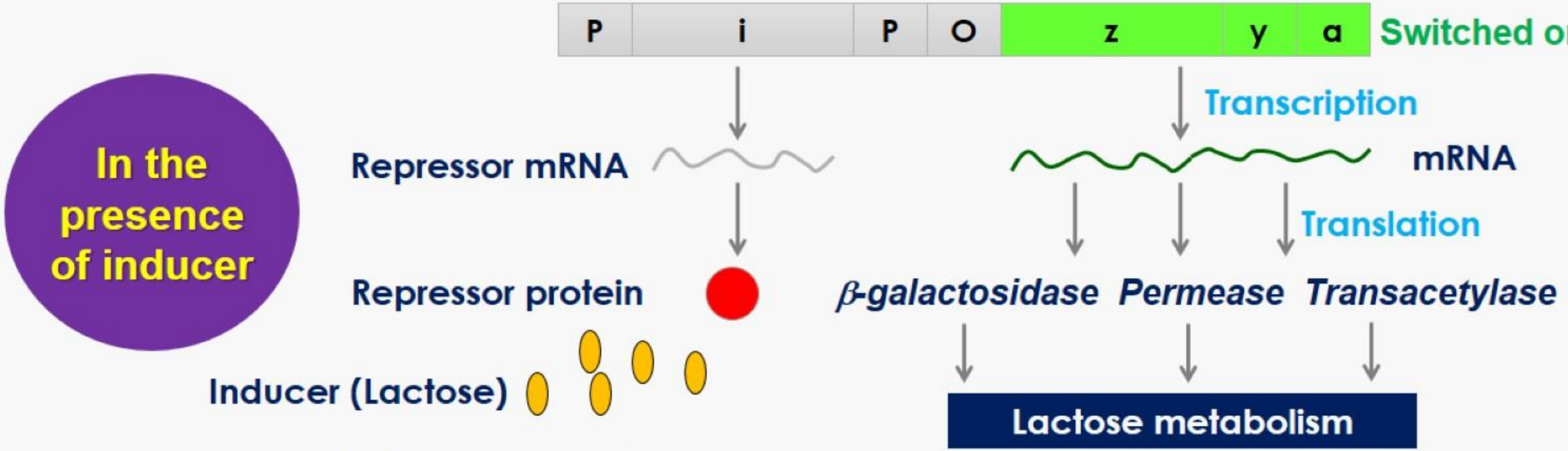
In the absence of inducer



- If there is no lactose (inducer), lac operon remains switched off.
- The regulator gene synthesizes mRNA to produce the repressor protein. This protein binds to the operator region and blocks *RNA polymerase* movement. So the structural genes are not expressed.

REGULATION OF GENE EXPRESSION

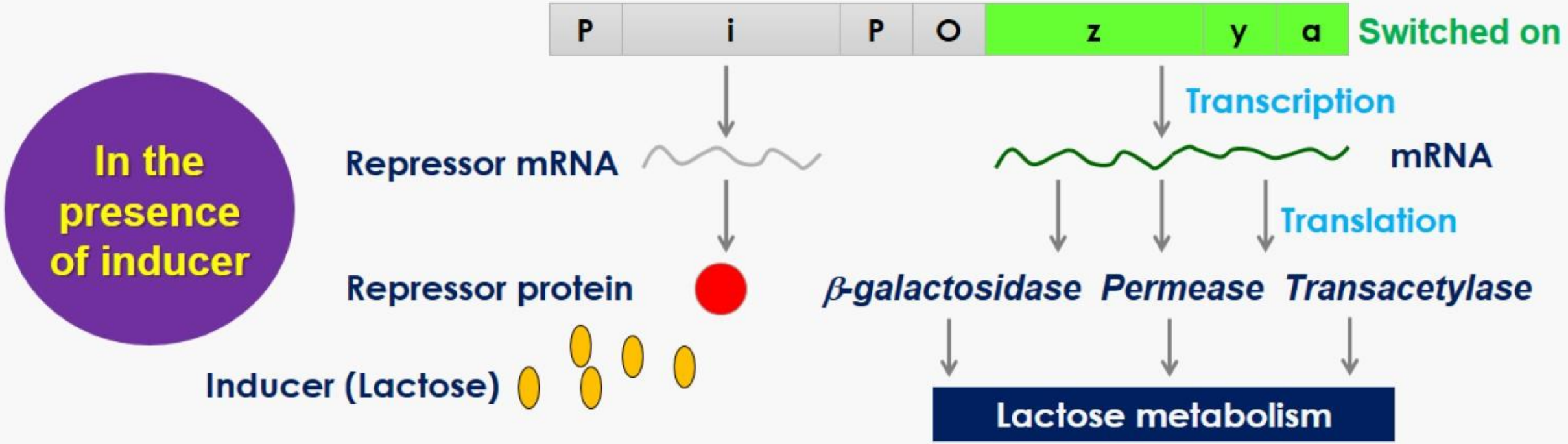
LAC OPERON



- If lactose is provided in the growth medium, the lactose is transported into the E. coli cells by the action of ***permease.*** Lactose (inducer) binds with repressor protein. So repressor protein cannot bind to operator gene. The operator region becomes free and induces the *RNA polymerase* to bind with promoter gene. Then transcription starts.

REGULATION OF GENE EXPRESSION

LAC OPERON



- Glucose or galactose cannot act as inducers for lac operon.
- Regulation of lac operon by repressor is called **negative regulation.**
- Lac operon is under control of positive regulation as well.