RNA translation

The Central Dogma of Molecular Biology

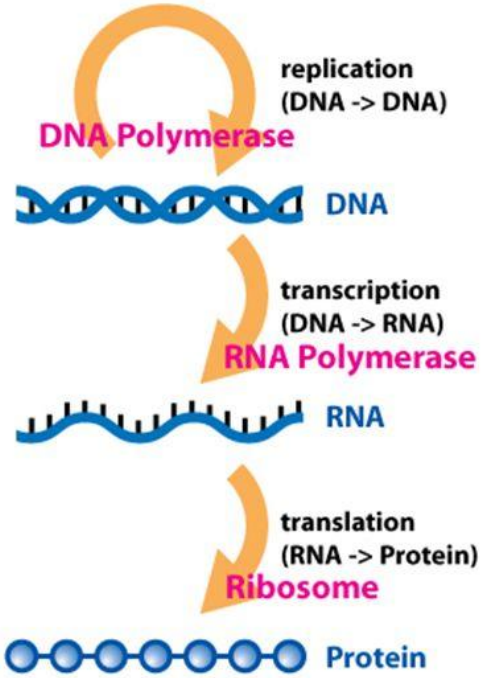
- Information is transferred from DNA to RNA to protein

  DNA -> RNA -> Protein

- Proteins create traits

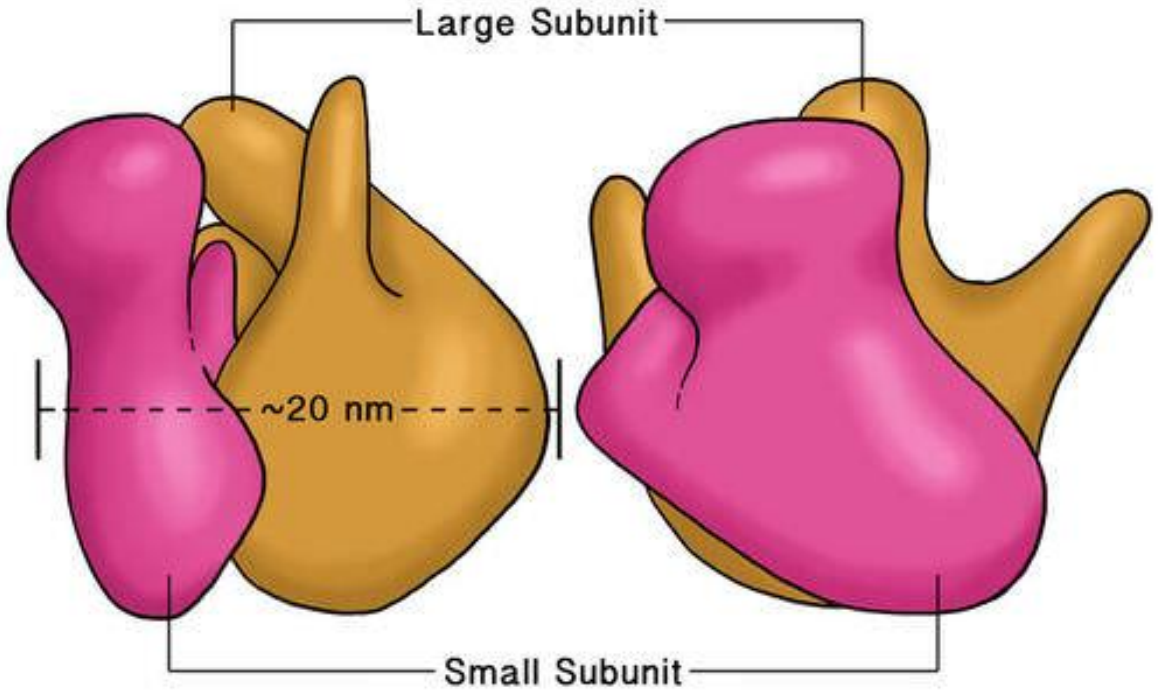
- This is called **gene expression**

- This process is found in all organisms



- RNA transcribed from DNA is called *messenger RNA (mRNA).* It encodes the sequence of the protein to be synthesized.
- The protein synthesis is performed by a complex molecular machine called *ribosome*.

Ribosome



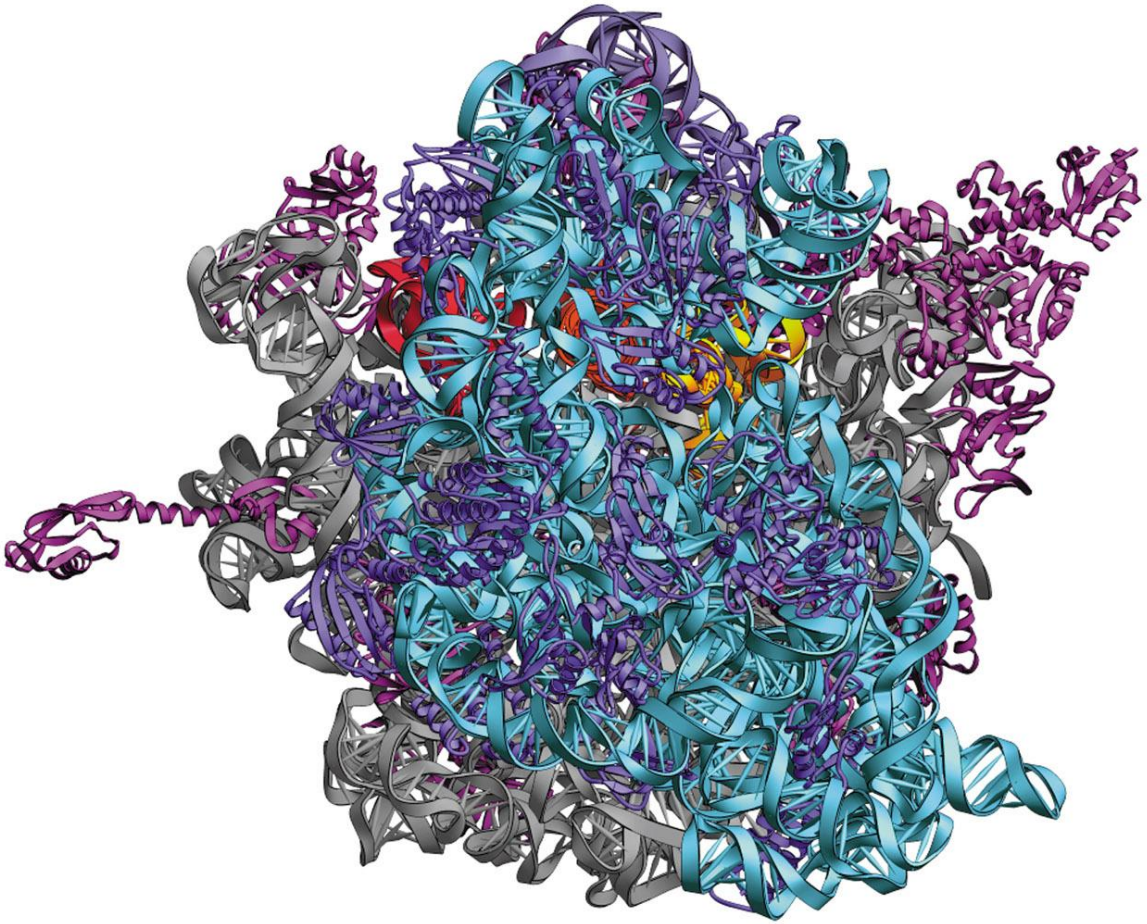
Prokaryotic ribosome

ribosome	subunit	rRNAs	r-proteins
70S	50S	23S (2904 nt)	31
		5S (120 nt)	
	30S	16S (1542 nt)	21

Eukaryotic ribosome

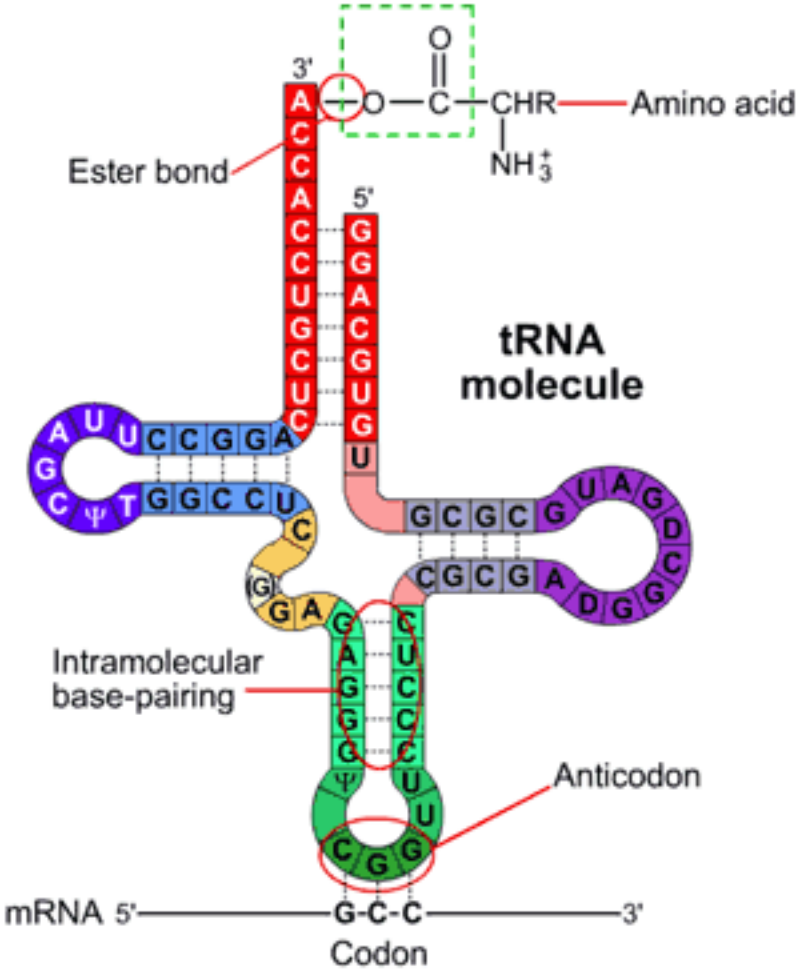
ribosome	subunit	rRNAs	r-proteins
80S	60S	28S (4718 nt)	49
		5.8S (160 nt)	
		5S (120 nt)	
	40S	18S (1874 nt)	33

Ribosome

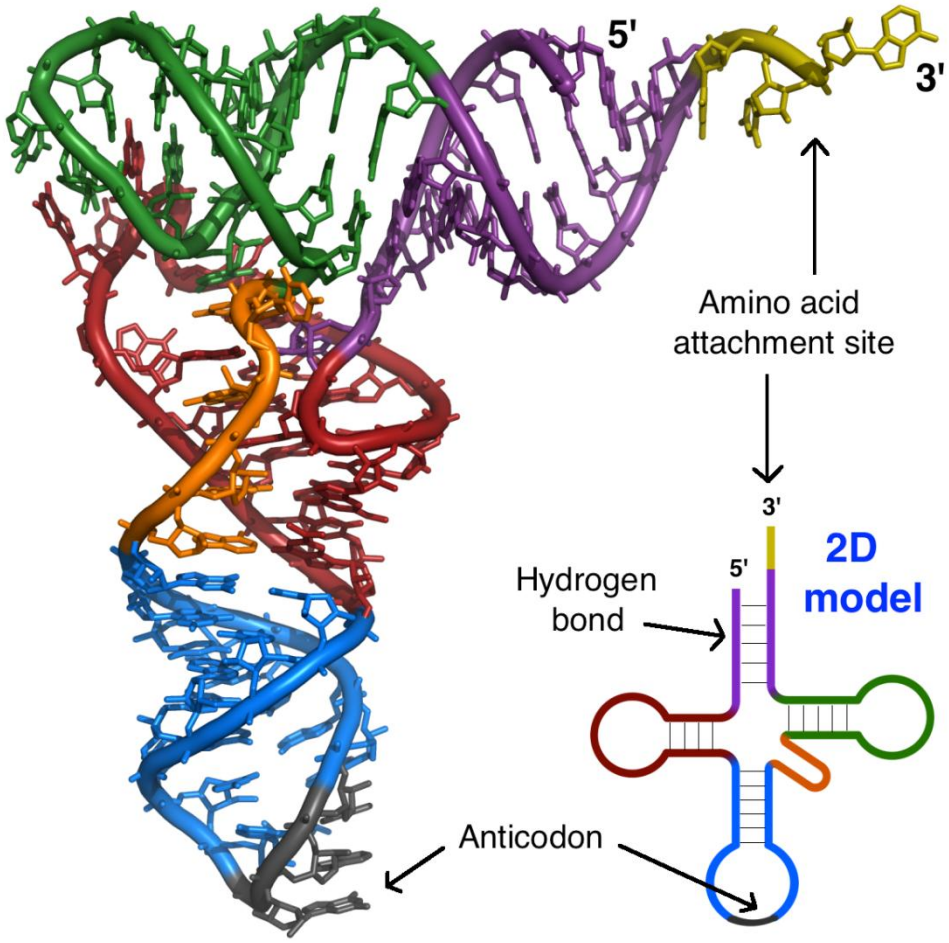


- The protein is synthesized from monomers – amino acids bound to special small RNA molecules, called *transfer RNA (tRNA)*
- tRNA is an **adaptor** molecule. It contains a nucleotide triplet called *anticodon* can interact with complementary mRNA codon by forming hydrogen bonds with it. For each of the 61 codons there is a corresponding tRNA in the cell.
- Amino-acids could be covalently attached to the 3'-end of tRNA molecules resulting in *aminoacyl-tRNA (aa-tRNA).*

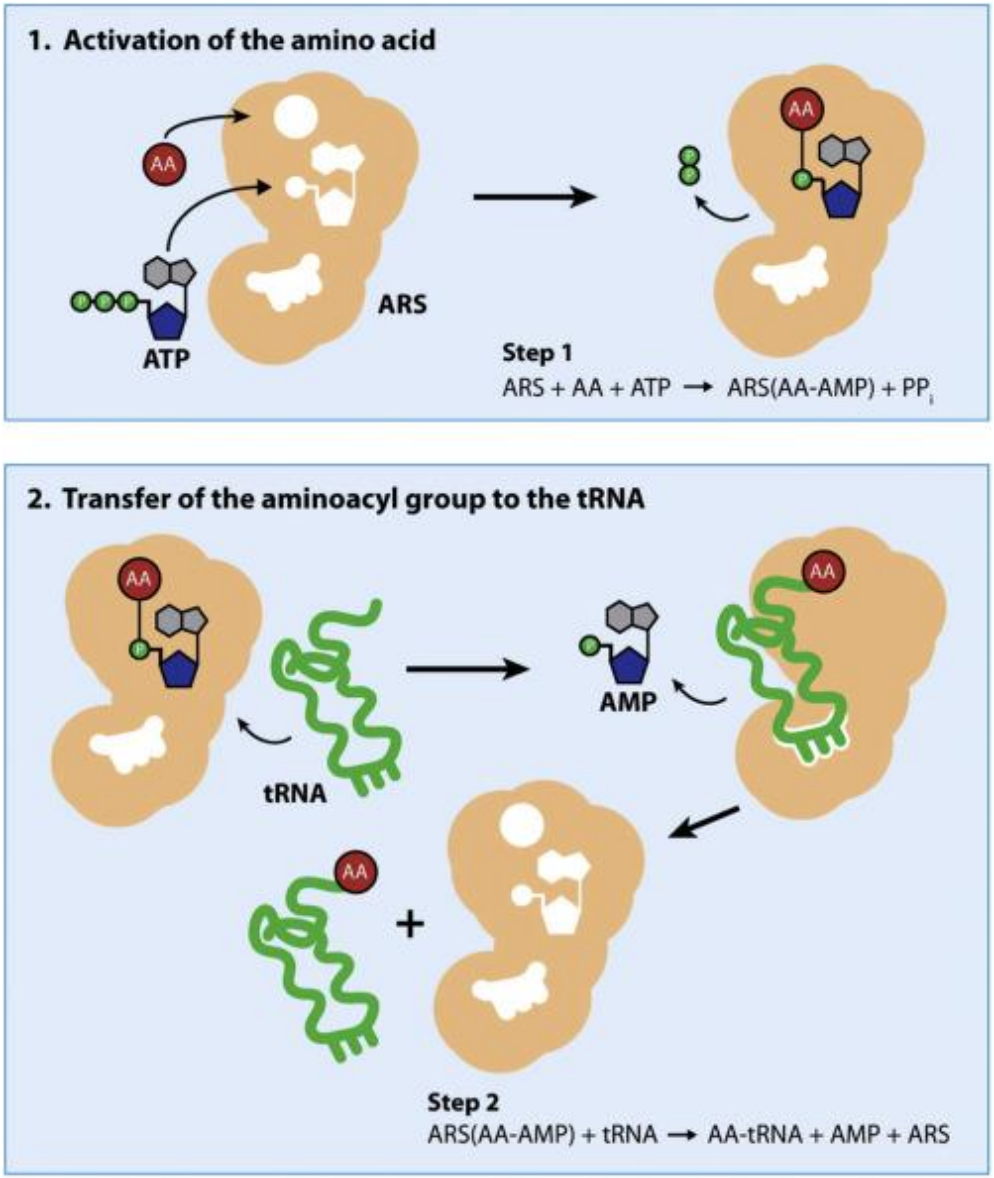
tRNA


3'
5'
Ester bond
Amino acid
CHR
NH3+
tRNA molecule
Intramolecular base-pairing
Anticodon
mRNA 5'
3'
G-C-C
Codon

tRNA


5'
3'
Amino acid
attachment site
3'
5'
2D
model
Hydrogen
bond
Anticodon

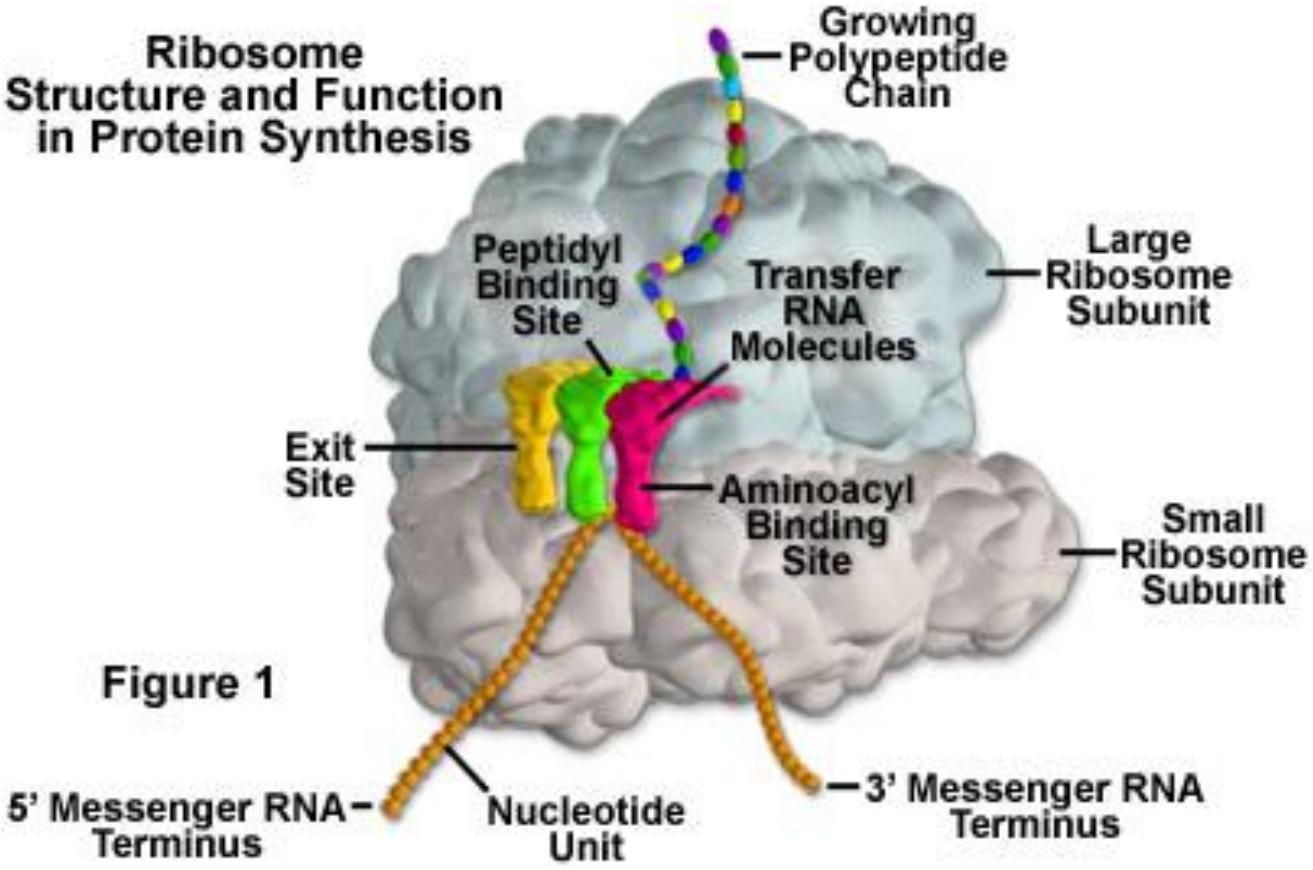
- Appropriate amino acid is attached to the 3’-end of tRNA molecule by an enzyme called *aminoacyl-tRNA synthetase*
- In humans, the 20 different types of aa-tRNA are made by the 20 different aminoacyl-tRNA synthetases, one for each amino acid of the genetic code.


1. Activation of the amino acid
AA
ATP
ARS
AA
Step 1
ARS + AA + ATP → ARS(AA-AMP) + PPi
2. Transfer of the aminoacyl group to the tRNA
AA
tRNA
AMP
AA
AA
+
Step 2
ARS(AA-AMP) + tRNA → AA-tRNA + AMP + ARS

Elongation

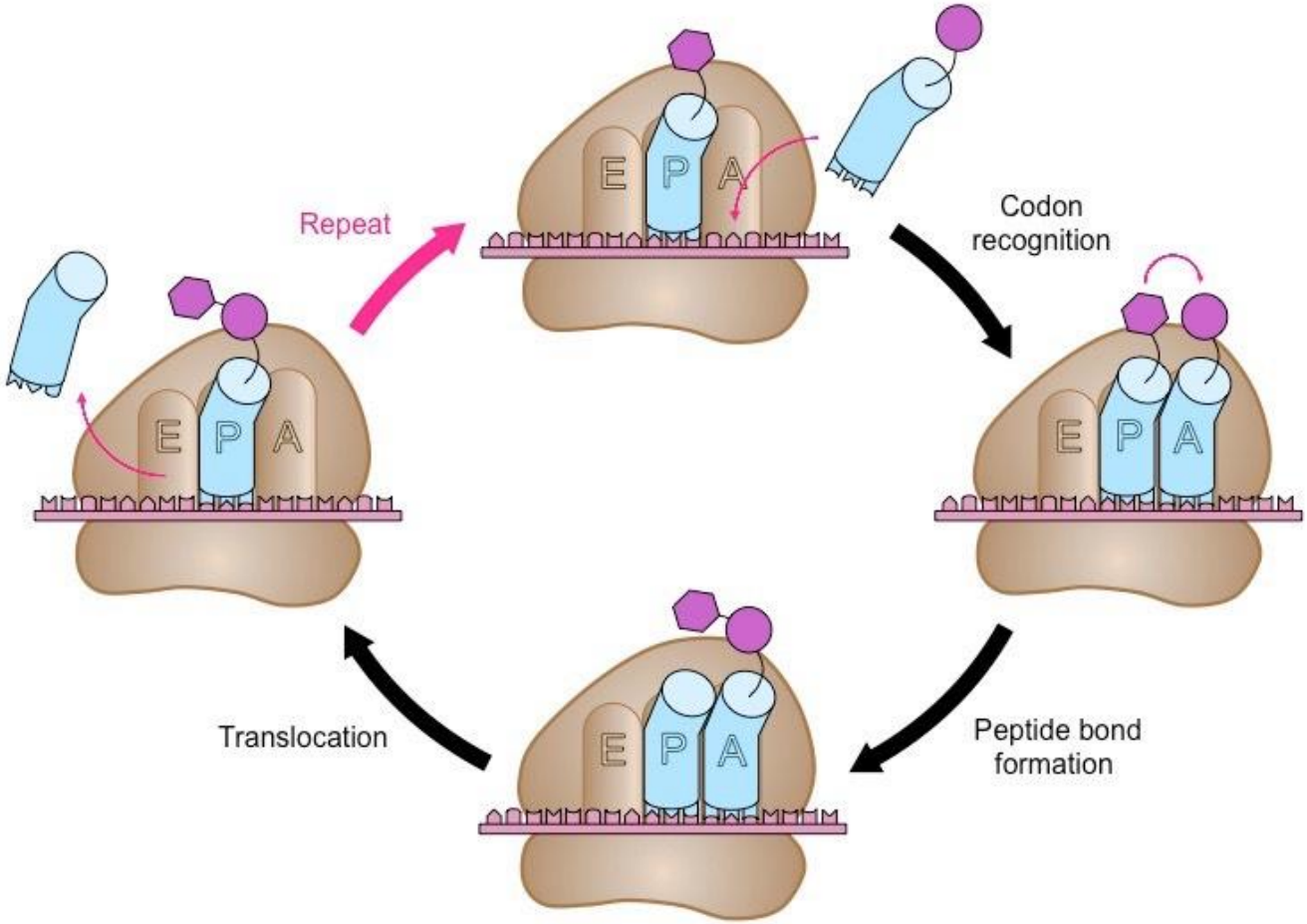
- There are 3 stages in the translation process – *initiation, elongation and terminatio*n.
- The process of growing of polypeptide chain during translation is called *elongation*
- The direction of the polypeptide chain growth is from N-terminus to C-terminus.
- During elongation the growing polypeptide chain is covalently attached to tRNA molecule. This complex is called *peptidyl-tRNA*.

Translation complex



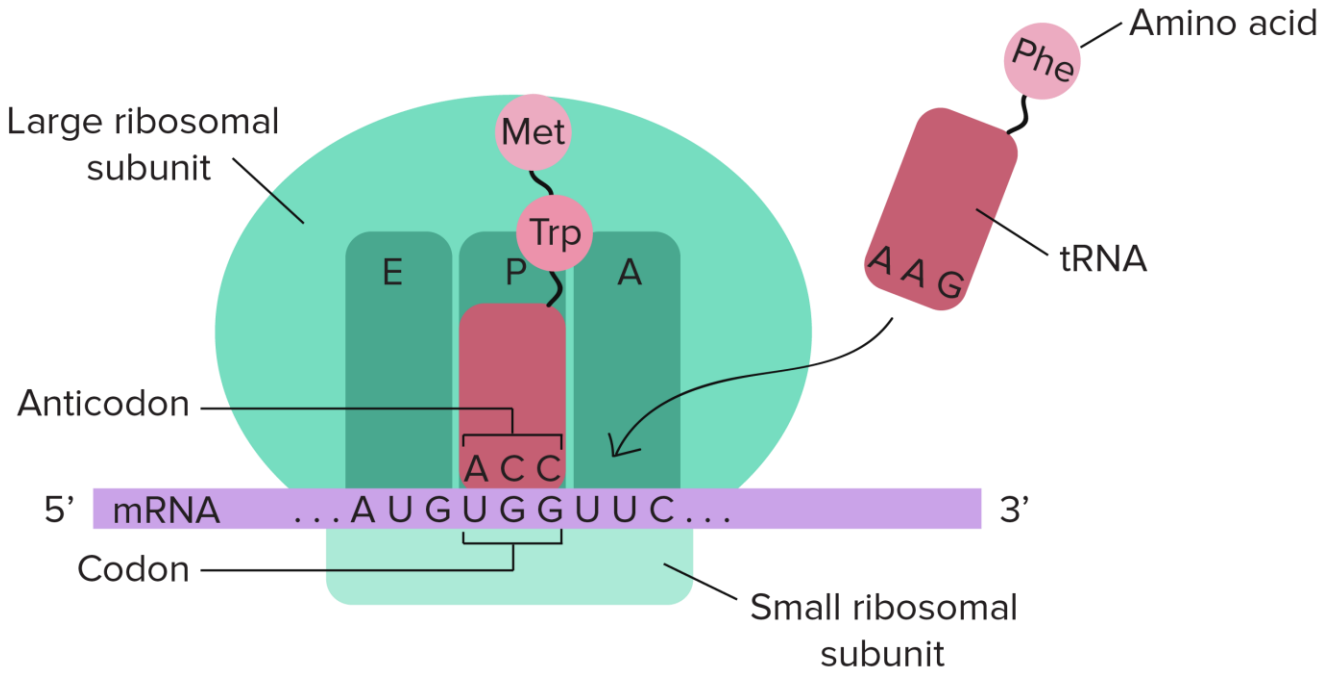
Elongation is a cyclical process. Each cycle comprises 3 steps –

1. New codon recognition
2. Peptide bond formation
3. Peptidyl-tRNA translocation


E P A
Repeat
Codon recognition
Translocation
Peptide bond formation

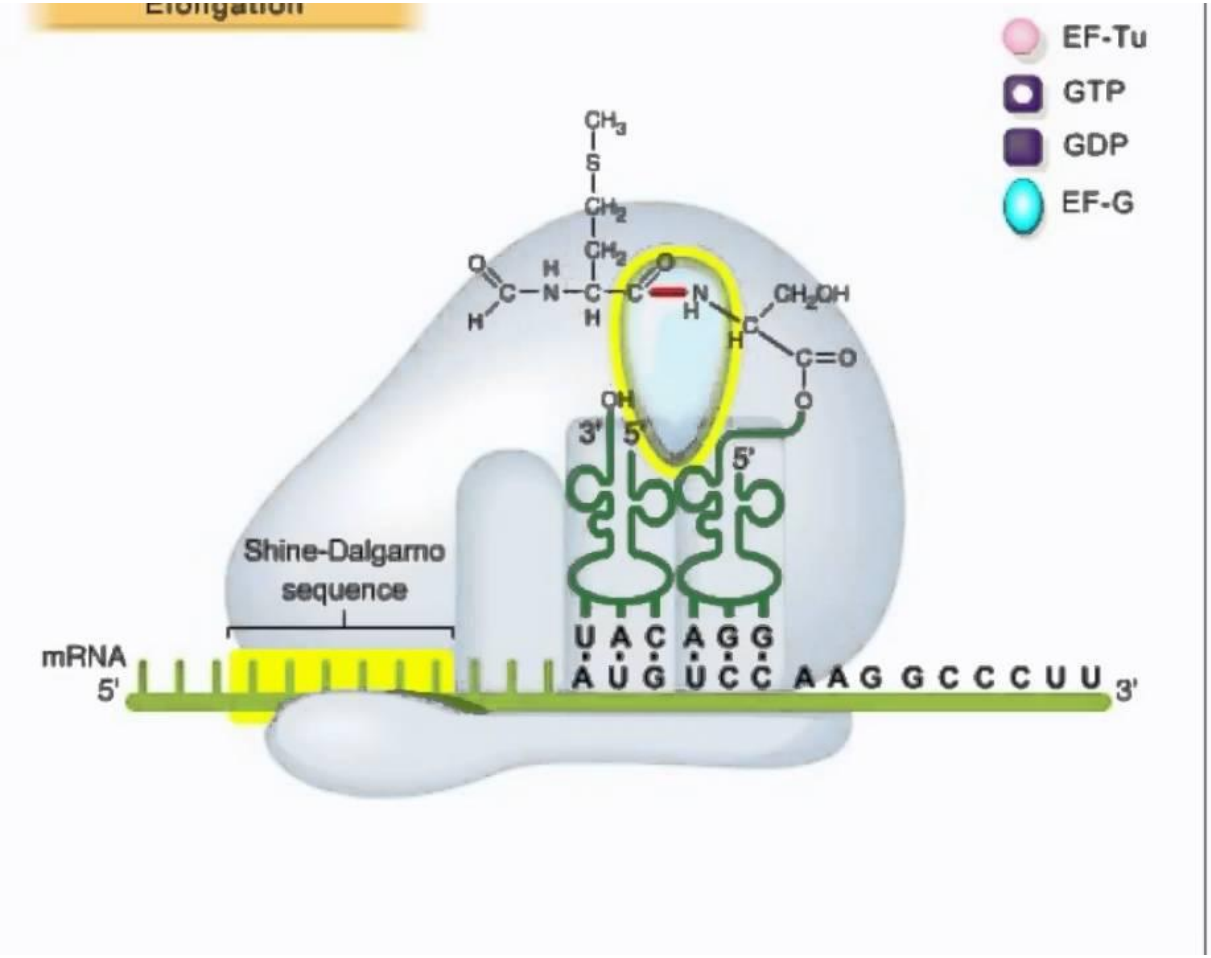
Elongation stage 1.

Next aa-tRNA binds to A-site



Elongation stage 2.

Transpeptidation

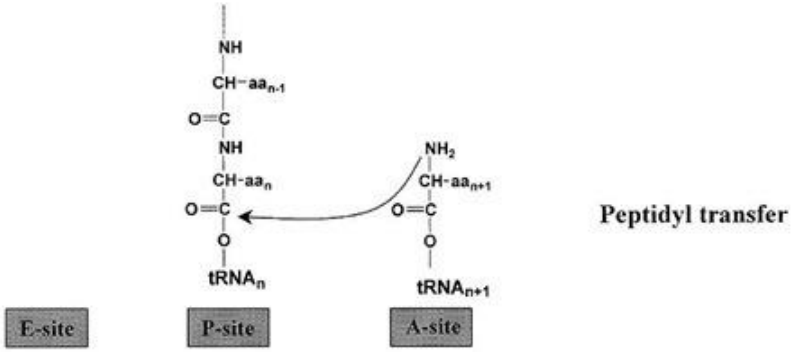


Narration Play

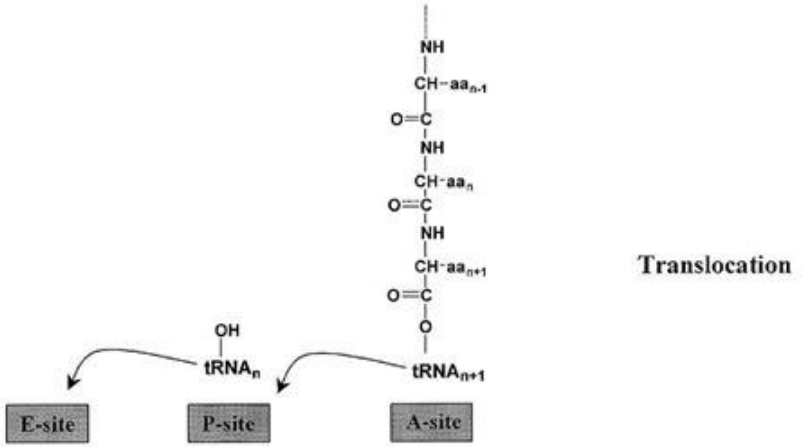
Peptide bond formation is a condensation reaction that results in the release of water. At one time it was thought that peptidyl transferase was an enzymatic protein. However, more recently, it was discovered that peptidyl transferase is a catalytic RNA molecule. An RNA capable of catalyzing a reaction is called a ribozyme.

Replay

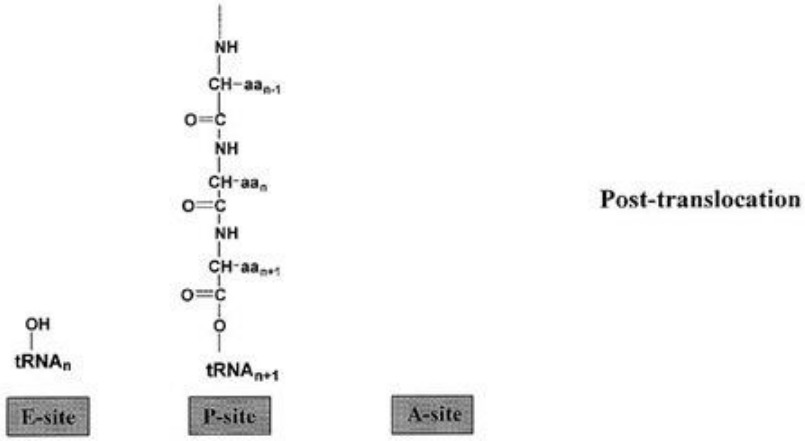
Pause between scenes



Peptidyl transfer

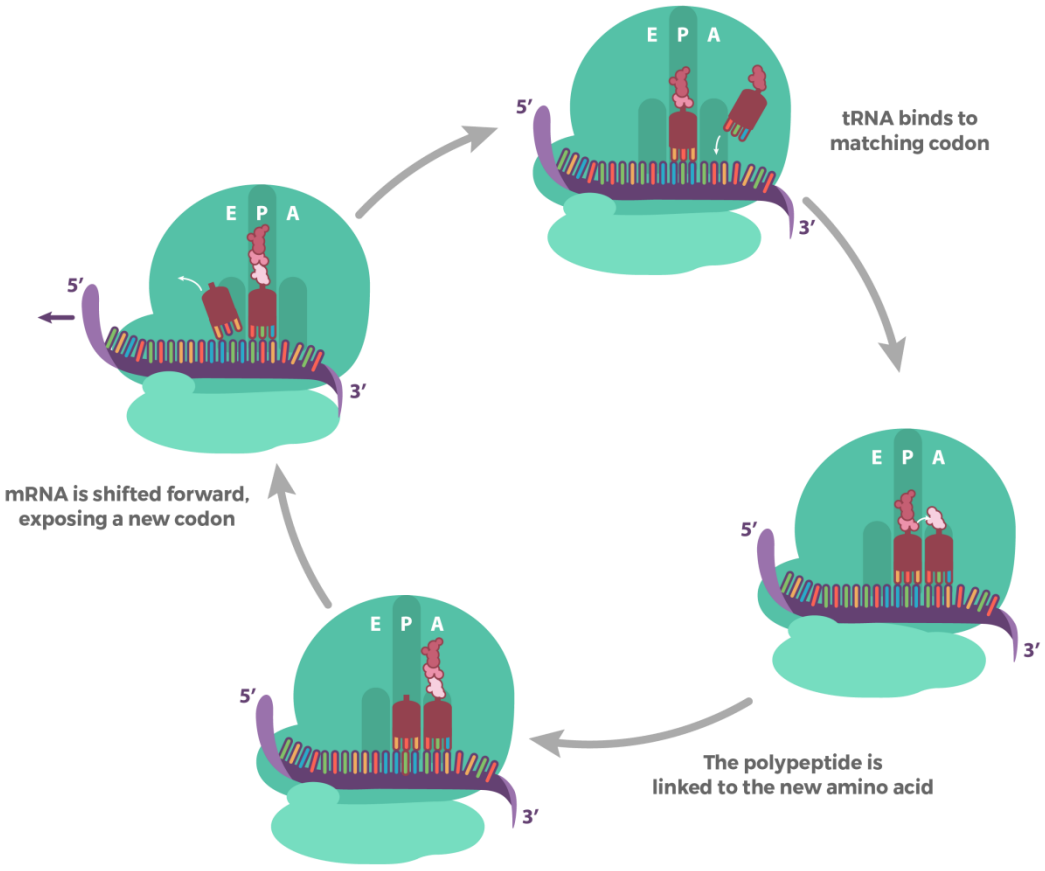


Translocation



Post-translocation

Elongation


E P A
5′
3′
tRNA binds to matching codon
E P A
5′
3′
The polypeptide is linked to the new amino acid
E P A
5′
3′
mRNA is shifted forward, exposing a new codon
E P A
5′
3′