Protein synthesis

10-08-2023

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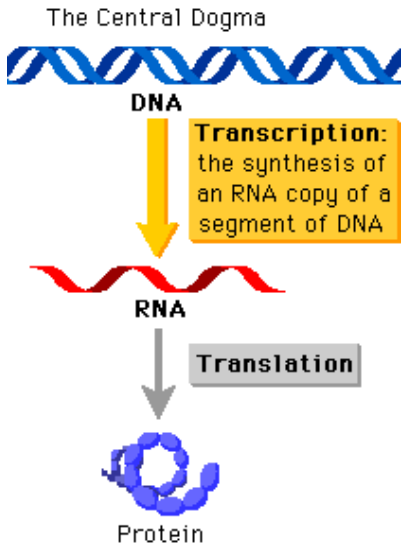
- The **central dogma of molecular biology** describes the two-step process,

1.transcription

2.translation

- Transcription is the synthesis of an RNA copy of a segment of DNA. RNA is synthesized by the enzyme RNA polymerase.



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What is a gene?

- Genes are small sections of DNA within the genome that code for proteins. They contain the instructions for our individual characteristics – like eye and hair colour.
- Genes come in different forms, called alleles.
- The characteristic associated with a certain allele can sometimes be dominant or recessive.

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The purpose of genes?

- To store information required to build specific **proteins** needed in an organism.
- The human genome contains 20,687 protein-coding genes.

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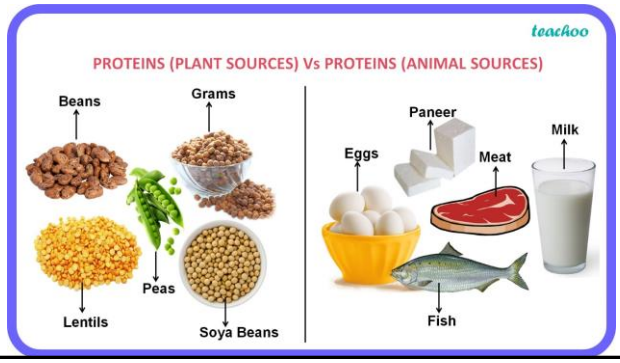
What are proteins?

- Proteins are large biomolecules or macromolecules that comprise one or more long chains of amino acid residues.
- Sources of proteins



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Amino acids link together to form proteins

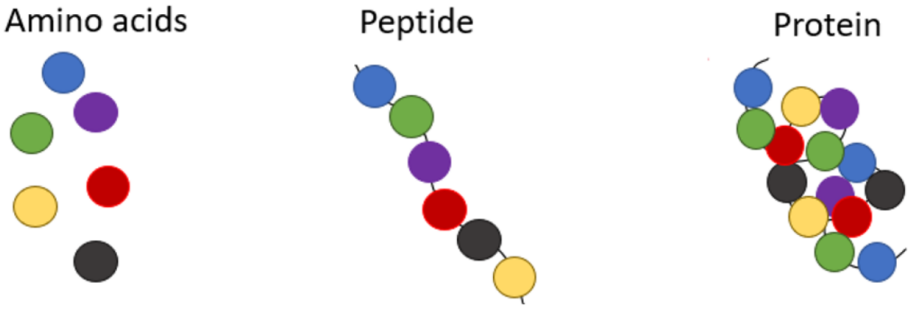

Figure 3. Schematic representations of an amino acid, a peptide, and a protein.

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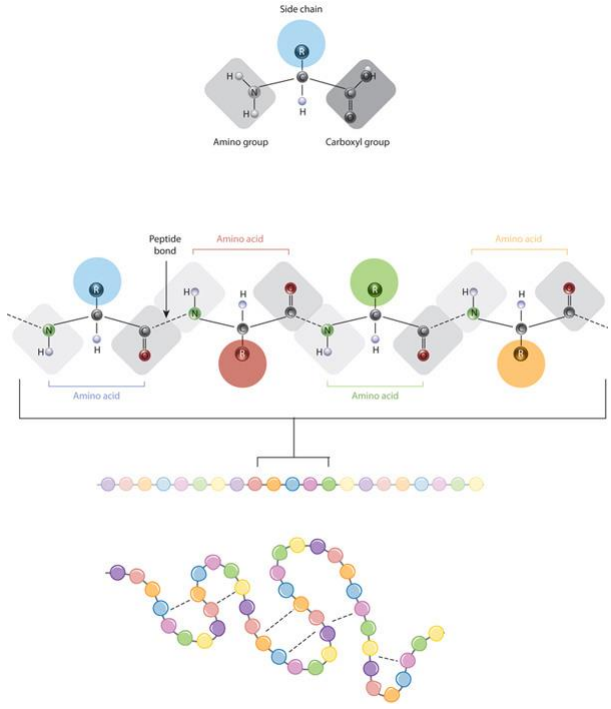

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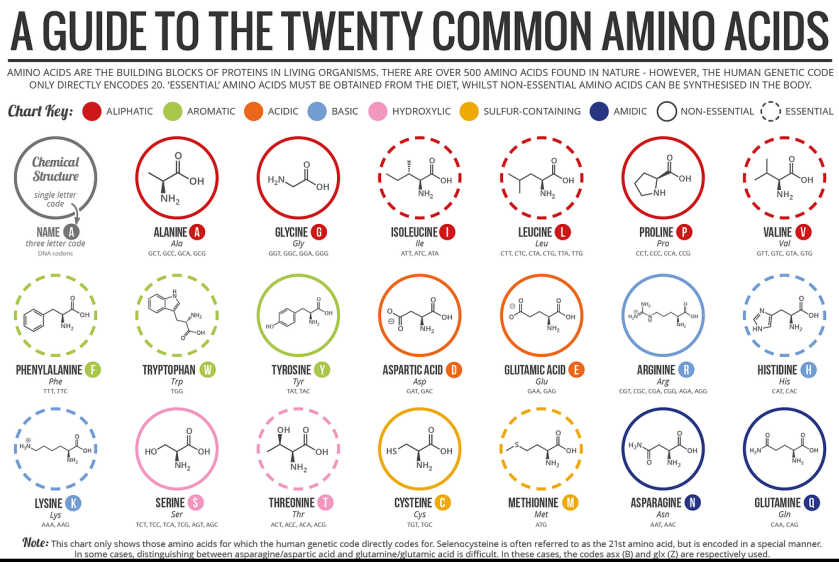
There are 20 amino acids which synthesize the proteins



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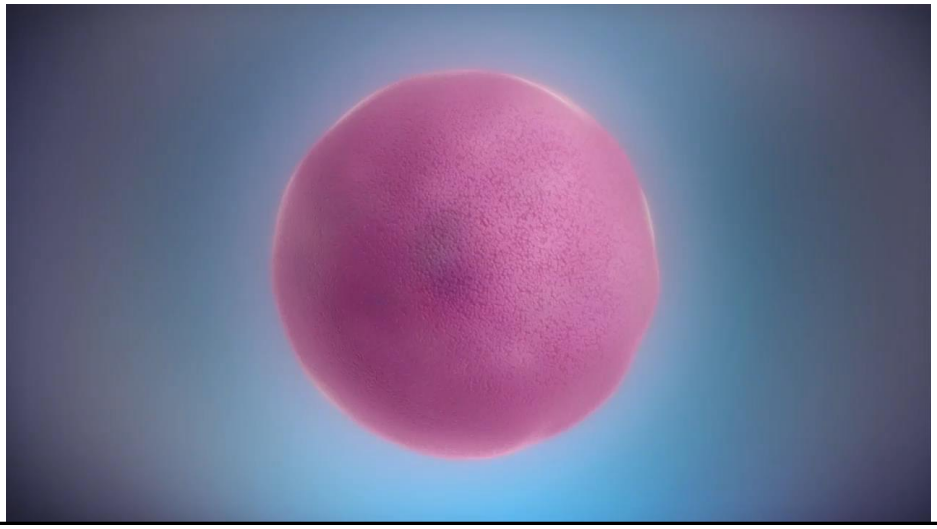
https://www.youtube.com/watch?v=gG7uCskUOrA



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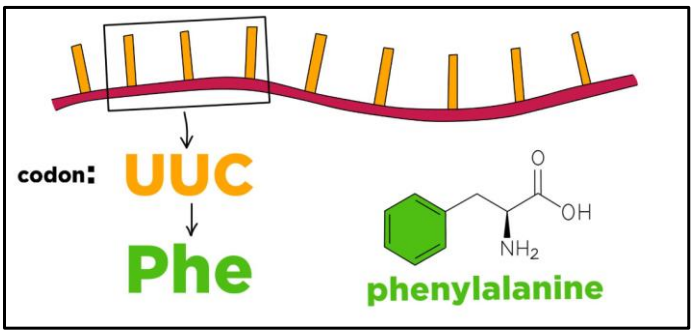
Key terms

- Codon: A codon is a group of three nucleotides that codes for a specific amino acid.



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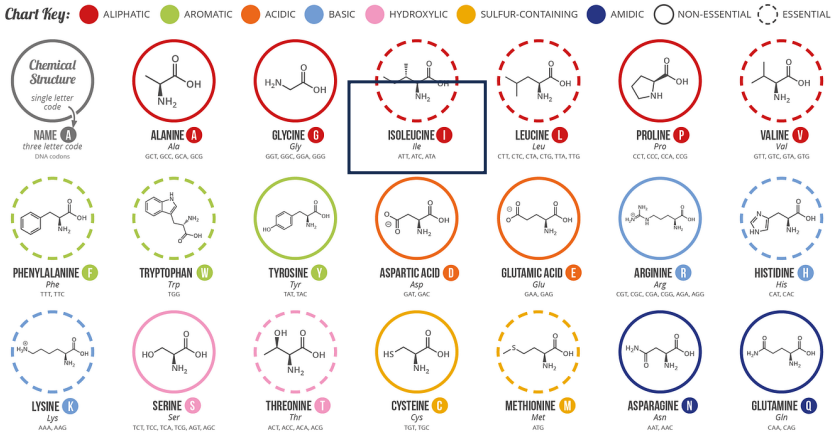
A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.



Note: This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.

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The codon table below shows the triplet code and the amino acids that each combination codes for. These combinations make up the standard genetic code.

1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe UUC Phe UUA Leu UUG Leu	UCU Ser UCC Ser UCA Ser UCG Ser	UAU Tyr UAC Tyr UAA Stop UAG Stop	UGU Cys UGC Cys UGA Stop UGG Trp	U C A G
C	CUU Leu CUC Leu CUA Leu CUG Leu	CCU Pro CCC Pro CCA Pro CCG Pro	CAU His CAC His CAA Gln CAG Gln	CGU Arg CGC Arg CGA Arg CGG Arg	U C A G
A	AUU Ile AUC Ile AUA Ile AUG Met	ACU Thr ACC Thr ACA Thr ACG Thr	AAU Asn AAC Asn AAA Lys AAG Lys	AGU Ser AGC Ser AGA Arg AGG Arg	U C A G
G	GUU Val GUC Val GUA Val GUG Val	GCU Ala GCC Ala GCA Ala GCG Ala	GAU Asp GAC Asp GAA Glu GAG Glu	GGU Gly GGC Gly GGA Gly GGG Gly	U C A G

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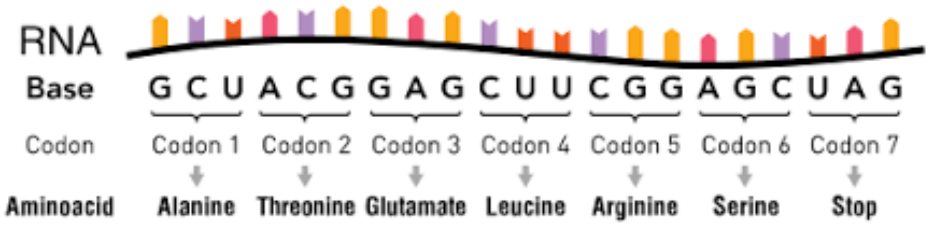

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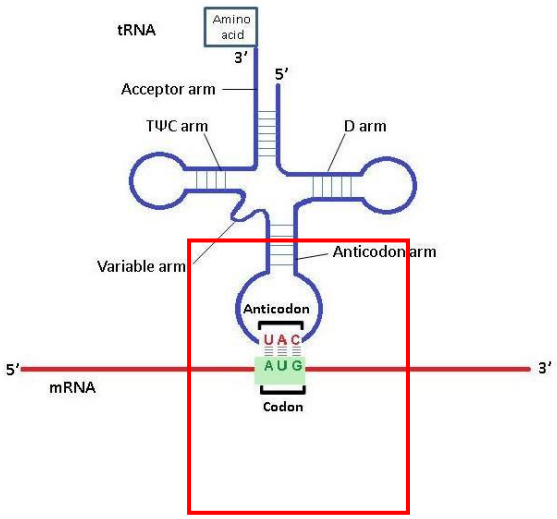
Anticodon

- An anticodon is a <u>trinucleotide sequence</u> located at one end of a transfer RNA (tRNA) molecule, which is complementary to a corresponding codon in a messenger RNA (mRNA) sequence.



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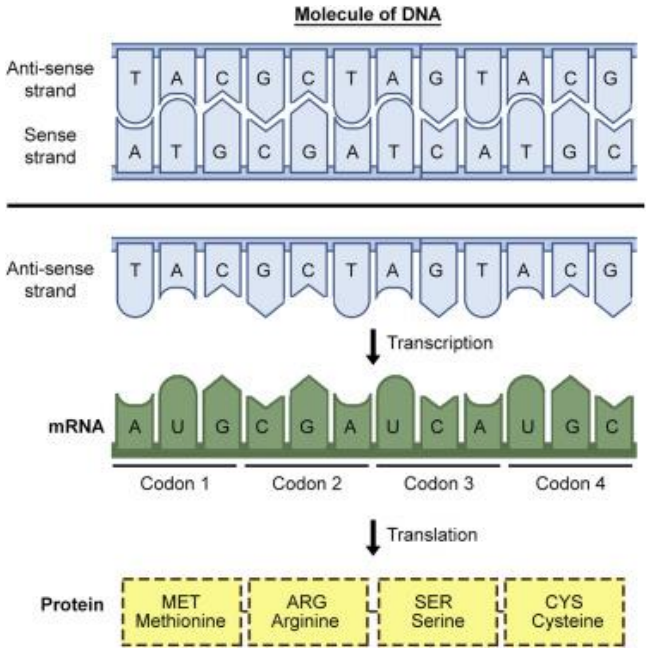

Antisense is the non-coding DNA **strand** of a gene.
In a cell, **antisense** DNA serves as the template for producing messenger RNA (mRNA)

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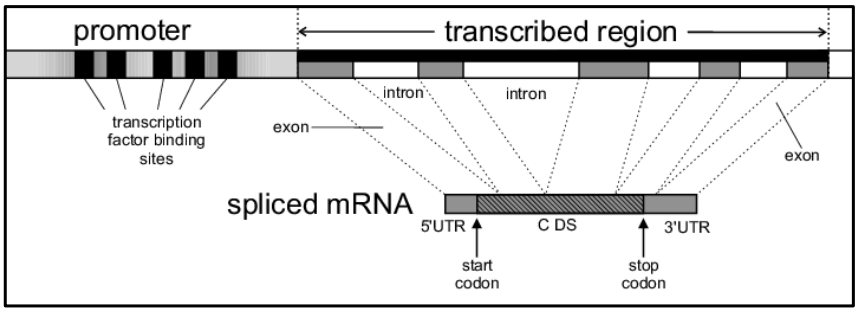

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Components involved in Translation

1. mRNA
2. tRNA
3. Ribosomes
4. Amino acids
5. Enzymes
6. Initiation factors (IFs)
7. Elongation factors (EFs)
8. Release factors (RFs)

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- The 5 stages of protein synthesis are

1. Activation of amino acids
2. Initiation
3. Elongation
4. Translocation
5. Termination

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I. Activation of amino acids

- The activated amino acid is bound to its own particular tRNA by an ester bond between the carboxyl group of the amino acid and the 3'OH of the tRNA.

Amino acid + ATP + t-RNA

↓ Amino acyl t RNA transferases

Amino acid t - RNA

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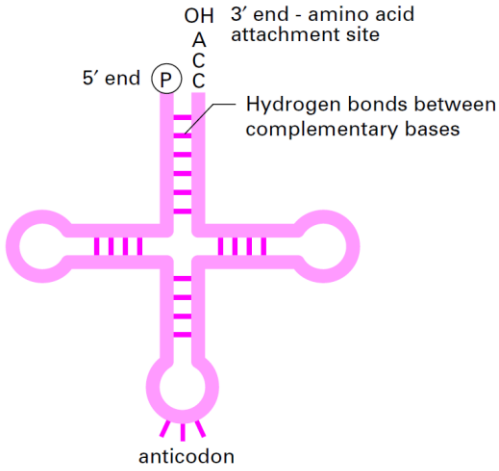
Transfer RNA (tRNA)



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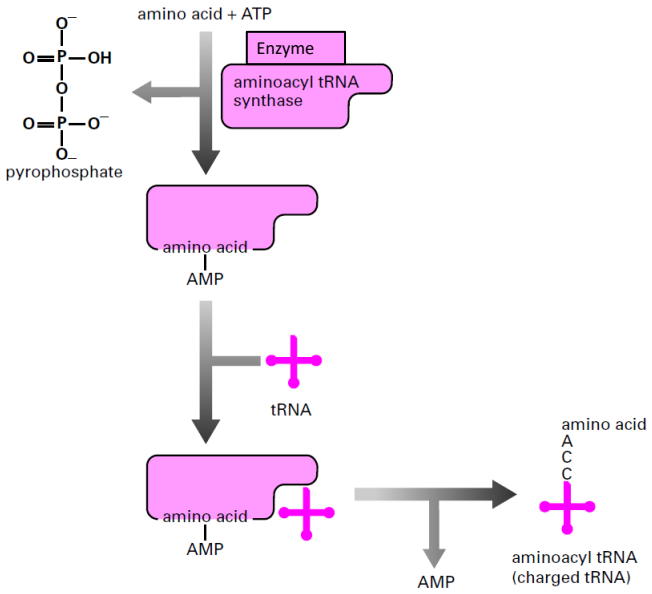
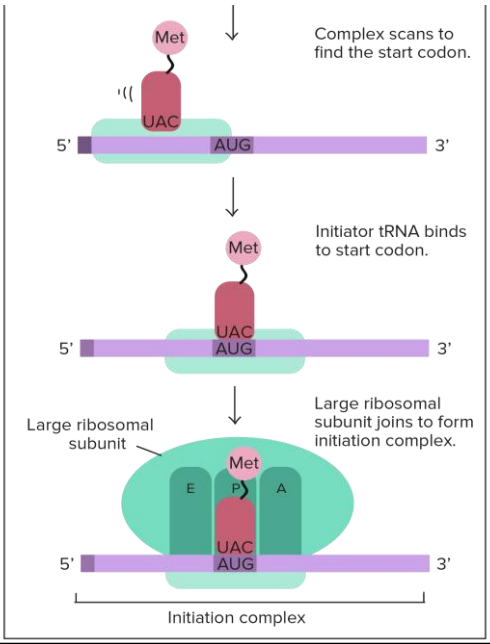


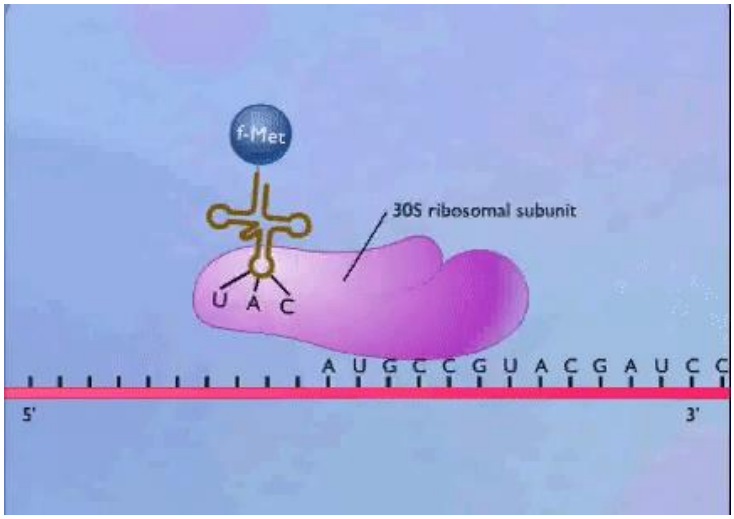
Figure 8.3. Attachment of an amino acid to its tRNA.

II. Initiation



1. mRNA binds to smaller unit of ribosome 30S and the aminoacyl t-RNA
2. The initiator tRNA binds to the starter codon **AUG.**
3. Large ribosomal subunit 50S binds to form the initiation complex.

II. Initiation



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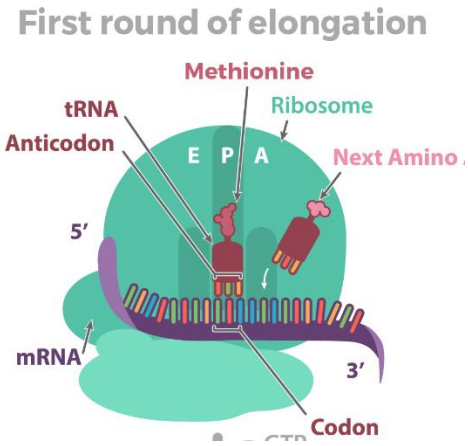
III. Elongation



- The ribosome contains 3 sites

1. Amino acyl or A site
2. Peptidyl site or P site
3. Exit site or E site

A and P site exist on both 50S and 30S subunit.

E site exist on 50S

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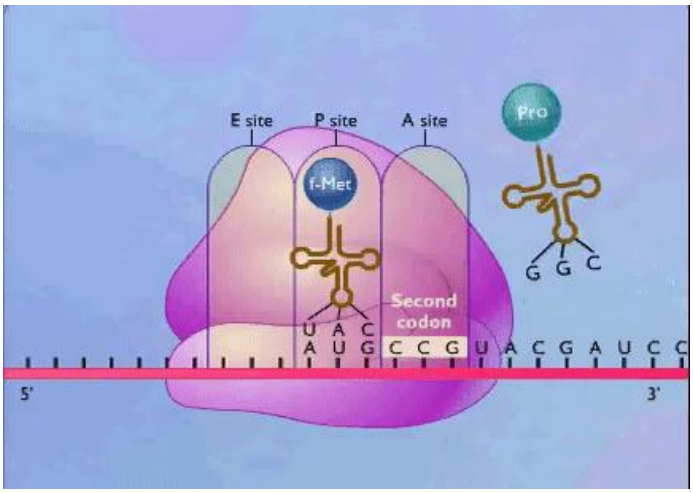
Elongation



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- Elongation factors like EF-Tu, EF-T, EFG play a role in elongation
- GTP provides the energy needed for elongation
- Incoming amino acyl-tRNA binds to the A-site
- Peptide bond is formed between the 2 amino acids at the P and A sites of the ribosomes.
- **Peptidyl transferase** catalyzes the reaction.

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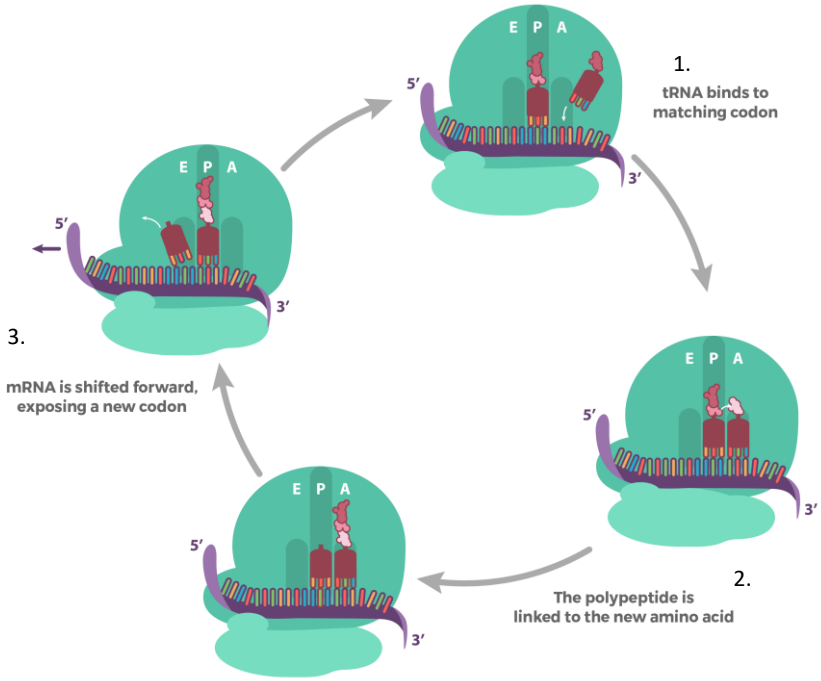

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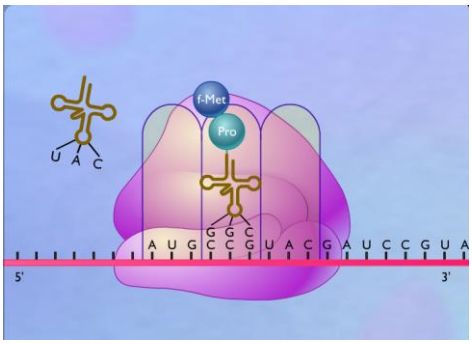
IV. Translocation



1. Final step of elongation is translocation, where ribosome moves one step/codon toward the 3'end of the m-RNA.
2. This movement shifts the t-RNA with the amino acid at the A-site to the P-site and the first tRNA from the P-site to E-site.

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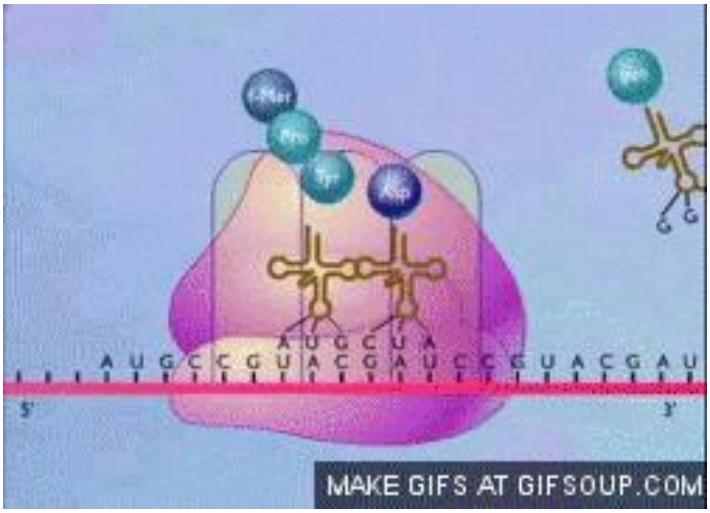

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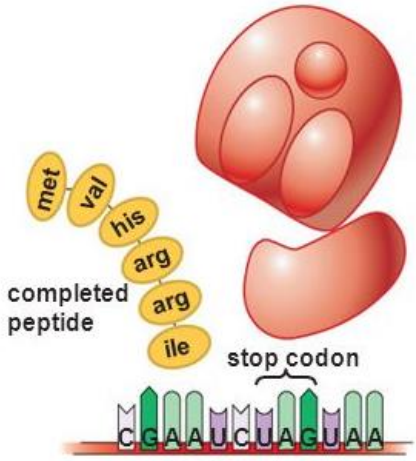
V. Termination



1. The termination sequence of mRNA – **UAA, UAG, UGA** results in the termination of the protein synthesis
2. Release factors like RF1, RF2, RF3 cause the hydrolysis of Peptidyl tRNA bond and releases the free polypeptide chain
3. Finally the 70S ribosome dissociates to 50S and 30S subunits.

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