

# Protein Synthesis, Part 2: Translation

by Sophia



## WHAT'S COVERED

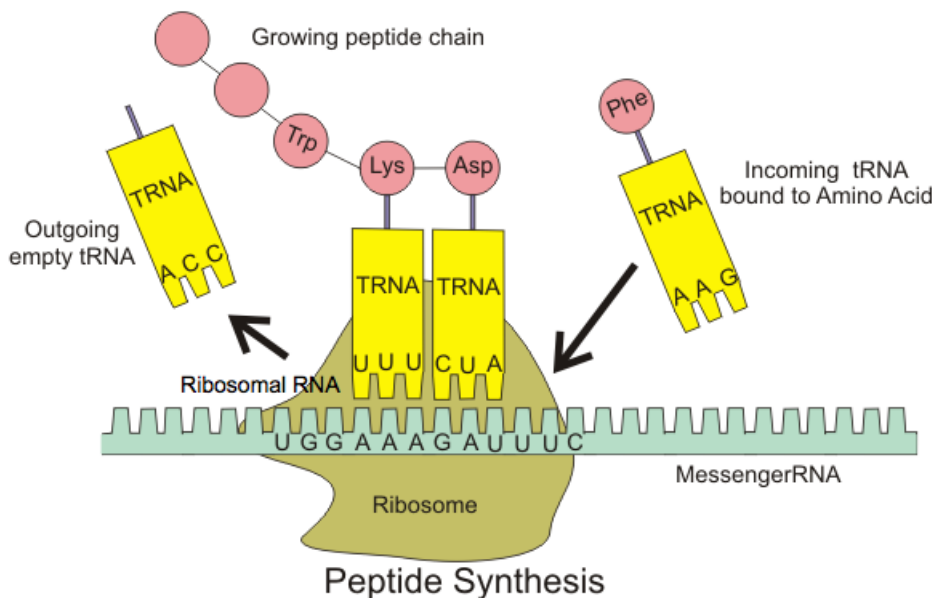
In this lesson, you will learn more about the translation portion of protein synthesis. Specifically, this lesson will cover:

## 1. Translation Overview

**Translation** is the second step in protein synthesis, following transcription. Once mRNA leaves the nucleus, it enters the rough endoplasmic reticulum (rough ER) in the cell's cytoplasm. It's rough in appearance because it has a lot of ribosomes. As soon as mRNA leaves the nucleus for the ER, it's going to encounter a ribosome that can convert its nucleic acid message into functional protein.

Remember that mRNA is a nucleic acid, and protein is a sequence of amino acids. This means that converting the information coded in a gene into a protein means translating that information into a different chemical "language." That translator is **rRNA**—the RNA enzyme (called a "ribozyme") within ribosomes that reads the information contained within the mRNA's nucleotides to the amino acids of a protein.

To do this, rRNA uses "decoders" called **tRNA**. These are short pieces of RNA that have a unique **codon** (a sequence of three RNA nucleotides) on one end and the corresponding amino acid on the other end. Recall that there are four different nucleotides in RNA: A, C, G, and U. This means that there are  $4 \times 4 \times 4 = 64$  unique three-nucleotide codon combinations. This more than covers the 20 different amino acids we use to make our proteins. Each tRNA ("transfer RNA") has a unique three-nucleotide codon and a corresponding amino acid attached to it.



#### TERMS TO KNOW

##### Translation

The process of “reading” a strand of mRNA and translating its message into a protein; this occurs in ribosomes and consists of mRNA and tRNA interacting with one another.

##### rRNA

Ribosomal RNA is used to produce the structure of ribosomes.

##### tRNA

Transfer RNA that is used to bind ribosomes to the start codon of a nucleotide chain in order for translation to occur.

##### Codons

Sections of three nucleotides that code for an amino acid.

## 2. Codons

If only 20 codons are needed to cover all the amino acids, and there are 64 possible codons, what do we do with the excess? One of the amino acid-coding codons (methionine) is the **start codon**. The start codon marks the first amino acid of a polypeptide chain.

➔ **EXAMPLE** AUG is the start code. This is adenine, uracil, guanine together in this chunk of three nucleotides. It signals the start of a polypeptide chain.

Three of the excess codons are **stop codons**. A stop codon marks the end of a polypeptide chain. Stop codons are UAA, UAG, and UGA. It marks the end of a polypeptide chain and when that polypeptide chain would be finished being made.

The other 41 excess codons are duplicates. This is part of the reason why most gene mutations don't have any effect: Most mutations in any given codon result in another codon for the same amino acid.



#### TERMS TO KNOW

#### Start Codon

A codon used to signal the start of an amino acid sequence on a strand of mRNA.

#### Stop Codon

A codon used to signal the stop of an amino acid sequence on a strand of mRNA.

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## 3. Stages of Translation

In translation, instructions from a single-stranded mRNA, which was formed from transcription, are translated into proteins. This occurs in the rough endoplasmic reticulum of the cell's cytoplasm. There are three stages to translation:

- Initiation
- Elongation
- Termination

### 3a. Initiation

The first step is **initiation**. During initiation, the small and large ribosomal subunits will join together, and then initiator tRNA will arrive at the start codon (UAG) on mRNA. The start codon marks the beginning of a new **polypeptide chain**, and codons are groups of three nucleotides that code for amino acids. After this first amino acid (start codon = the amino acid methionine), more amino acids can be added.

The tRNA carries an anticodon, and these will match up with the strand of mRNA using the base pair rules. The tRNA also carries an amino acid.

The same thing will happen with this next codon or group of three nucleotides. The next codon and anticodon will match, which signal for a certain amino acid. These amino acids will start building up in this chain called a polypeptide chain.



#### TERMS TO KNOW

##### Initiation

The beginning of translation, initiation occurs by the assembly of the ribosomal subunits and when tRNA interacts with the start codon on mRNA.

##### Polypeptide Chain

The primary structure of a protein, a polypeptide chain is a linear chain of amino acids that are covalently bound by peptide bonds.

### 3b. Elongation

The newly formed polypeptide chains compose proteins. These amino acids are held together by a peptide bond. This stage is where those amino acids are being built into a growing polypeptide chain through a process called **elongation**.



#### TERM TO KNOW

##### Elongation

When the appropriate anticodon of tRNA interacts with its codon counterpart on mRNA during translation. Elongation is the second step of translation and will continue until the stop codon is

reached.

### 3c. Termination

Being the last stage of translation, **termination** is when the stop codon of mRNA signals the end of translation. With that, the polypeptide chain is complete.



#### TERM TO KNOW

##### Termination

When the stop codon is reached during translation, translation ends, and the polypeptide chain is released.



#### SUMMARY

**Initiation** is the first **stage** in **translation**. Here the ribosomal units come together, and then tRNA will arrive at the start codon of mRNA. The anticodons on the tRNA will match up with the **codons** on the mRNA. They will signal for certain amino acids, which then begin to build up and form a polypeptide chain. **Elongation** occurs as the chain gets longer, and **termination** occurs when stop codon of the mRNA signals the end of translation.

Keep up the learning and have a great day!

Source: This work is adapted from Sophia Author Amanda Soderlind



#### ATTRIBUTIONS

- [Types of RNA](#) | Author: Wikipedia | License: Creative Commons



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**Stop Codon**

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**Termination**

When the stop codon is reached during translation, translation ends and the polypeptide chain is released.

**Translation**

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**rRNA**

Ribosomal RNA is used to produce the structure of ribosomes.

**tRNA**

Transfer RNA that is used to bind ribosomes to the start codon of a nucleotide chain in order for translation to occur.