Chapter 4-10: Protein Synthesis (Translation)

Deoxyribonucleic acid (DNA) is the starting point for the important cellular process in which protein is constructed from single amino acids. The protein created can be an enzyme, structural material, or used for virtually any other cell need.

During transcription, the sequence of the nitrogenous bases of DNA directs the production of a strand of messenger RNA (mRNA). Then, in the process of translation, the strand of mRNA determines the sequence of amino acids, which determines the identity of the protein.

Translation is a complex process in which many things occur at the same time. To make the process clearer, we have depicted it as a sequential series of events taking place in the cytoplasm of the cell.

As you may recall, transcription begins with the production of a molecule of mRNA, which travels out into the cytoplasm to take place in translation.

Once it is in the cytoplasm, the mRNA strand complexes with a ribosomal complex. Take a look at the plate; first color the **ribose-phosphate backbone (B)** of the mRNA, and the nitrogenous bases; **adenine (A)**, **cytosine (C)**, **guanine (G)**, and **uracil (U)**. As you can see, the mRNA molecule is associated with the **ribosomal complex (D)**. In the eukaryotic cell, ribosomes are near the endoplasmic reticulum, while in prokaryotic cells, such as bacteria, ribosomes float freely in the cytoplasm.

The mRNA molecule is now anchored within the ribosomal complex of the cell. Each group of three bases in a strand of mRNA is called a codon, and each codon specifies a particular amino acid in a polypeptide chain. We will now see how these codons are involved in the production of polypeptides.

While the mRNA-ribosome complex is assembling, many other important activities are occurring in the cytoplasm. For instance, tRNA (transfer RNA) subunits are binding loosely with particular amino acids in energy-requiring processes.

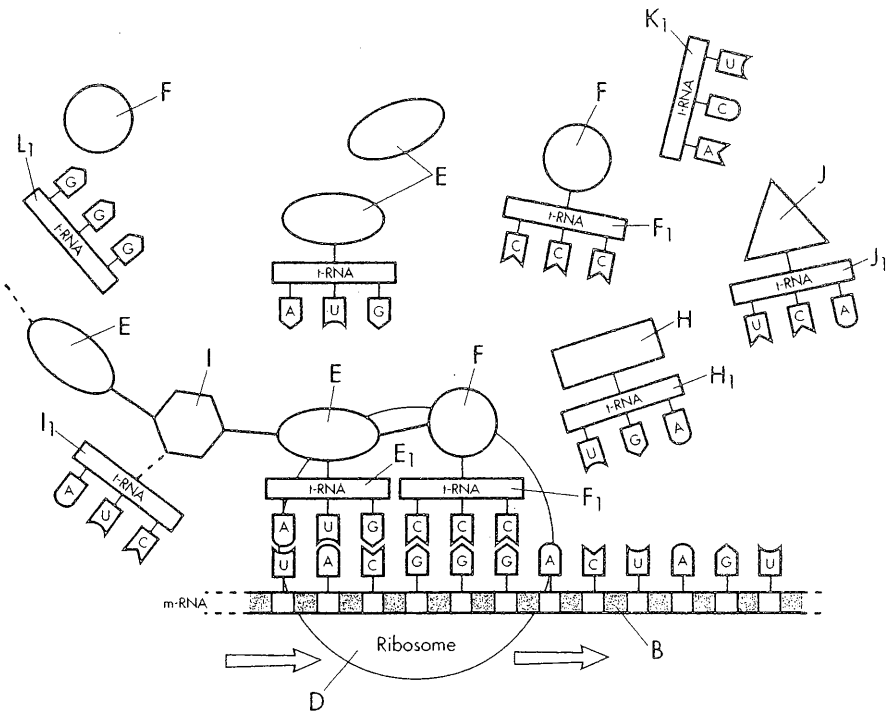
We can see in the diagram, for example, that the amino acid **alanine (E)** has united with the **tRNA for alanine (E_1)**, and one molecule of **lysine (F)** is floating free, while another has united with a **tRNA molecule for lysine (F_1)**. Notice that different tRNA molecules have different three-base sequences. These are called anticodons. For instance, for alanine, the tRNA has an anticodon of A-U-G, while for lysine, the anticodon is C-C-C.

Also in the cytoplasm is a molecule of **tryptophan (H)** united with the **tRNA molecule for tryptophan (H_1)**, and a **valine (J)** that is united with the **tRNA for valine (J_1)**. Note that there is no tyrosine molecule shown for the **tRNA for tyrosine (K_1)**, nor is there a leucine molecule available for the **tRNA for leucine (L_1)**.

Having established the specificity of amino acids for their tRNA molecules, we now show how these complexes function in the translation process.

Once bound to their amino acids, the tRNA molecules travel to the ribosome where the mRNA molecule is anchored. The critical step is the matching of the codon on the mRNA molecule with the anticodon on the tRNA molecule. When this is accomplished, a certain amino acid is brought into position. For example, we see the amino acid lysine (F) attached to its tRNA molecule (F_1). The anticodon of the tRNA is complementary to the codon of the mRNA, and lysine is placed into position. Immediately to its left, an alanine (E) has been put into place by its tRNA (E_1). The alanine molecule is bonded to a **serine molecule (I)** which is in the process of breaking free from its **tRNA molecule (I_1)**, and at the far left, an alanine molecule (E) has already detached from its tRNA. Note how the process unfolds as you color. Can you guess which amino acid will follow after the tryptophan?

As the arrow indicates, the ribosome moves along the mRNA, ensuring that each codon and anticodon matches. Enzymes create peptide bonds between the amino acids to form a polypeptide of increasing length. The translation process terminates when specific codons on the mRNA molecule signal a halt. At this point the polypeptide is released from the ribosome and is further processed to yield a functional protein.



Protein Synthesis (Translation)

○ Ribose-Phosphate Backbone ..... B	○ Alanine ..... E	○ Serine I
○ Adenine ..... A	○ tRNA for Alanine ..... E_1	○ tRNA for Serine ..... I_1
○ Cytosine C	○ Lysine ..... F	○ Valine ..... J
○ Guanine ..... G	○ tRNA for Lysine ..... F_1	○ tRNA for Valine ..... J_1
○ Uracil ..... U	○ Tryptophan ..... H	○ tRNA for Tyrosine ..... K_1
○ Ribosomal Complex ..... D	○ tRNA for Tryptophan ..... H_1	○ tRNA for Leucine ..... L_1

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a. In this process, the mRNA determines the sequence of amino acids, which determines the protein:
b. Where must the mRNA travel, to take place in translation?
c. In the cytoplasm, with what does the mRNA complex (bind)?
d. What are tRNA's doing while mRNA is complexing?
e. Name for the three base sequence in tRNA:
f. Where does the tRNA travel once it is bound to it's amino acid?
g. The ____ of the mRNA matches with the ____ of the tRNA.
h. What kind of bond forms between the amino acids?
i. When does the translation terminate?