

18.14: Protein Synthesis

The assembly line is an American invention that was developed around 1901 to mass-produce cars. Prior to that time, teams of workers would build a car together. With the advent of the assembly line, cars could be produced much more quickly, and at lower cost. The assembly line idea quickly spread to other products. Being able to line up parts in order, and have a smooth process for putting those parts together, means that an item can be produced quickly and reproducibly, coming out the same way every time.

Protein Synthesis

The process of protein synthesis is summarized in the diagram below. DNA produces an RNA template, which then directs the amino acids to be introduced into the growing protein chain in the proper sequence. A specific transfer-RNA (tRNA) attaches to each specific amino acid and brings the amino acid to the RNA for incorporation.

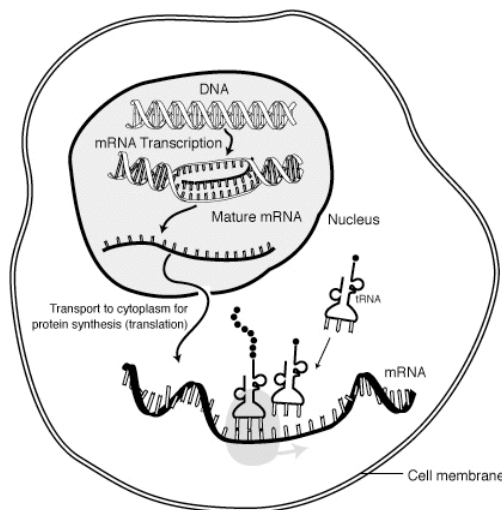


Figure 18.14.1: Overview of protein synthesis.

The first step in the process is **transcription**—the unfolding of DNA and the production of a messenger-RNA (mRNA) strand. This step takes place in the nucleus of the cell.

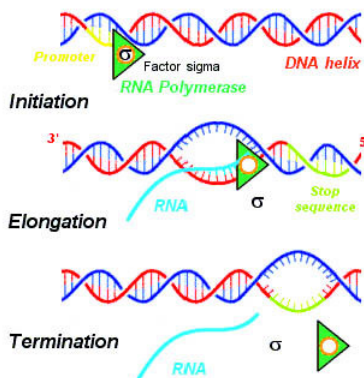


Figure 18.14.2: Formation of RNA from DNA.

The DNA uncoils and provides the pattern for the formation of a single strand of mRNA. After production of the RNA, the DNA refolds into the original double helix. The mRNA is exported to the cytoplasm (outside the nucleus) for further processing.

Amino acids will link with specific tRNA molecules for proper placement in the protein chain. The tRNA is a small coiled molecule that accepts an amino acid on one end and matches up to a specific three-base portion of the mRNA on the other end. The tRNA interacts with the mRNA so as to put the amino acid in the proper sequence for the developing protein. After adding the amino acid to the sequence, the tRNA is then cleaved from the amino acid and recycled for further use in the process.

The process of amino acid assembly takes place in the ribosome. This structure consists of two subunits containing ribosomal RNA that enclose the mRNA, and catalyze the formation of the amide linkages in the growing protein in a process known as **translation**. When protein synthesis is complete, the two subunits dissociate and release the completed protein chain.

The process of protein synthesis is fairly fast. Amino acids are added to the growing peptide chain at a rate of about 3-5 amino acids per second. A small protein (100-200 amino acids) can be produced in a minute or less.

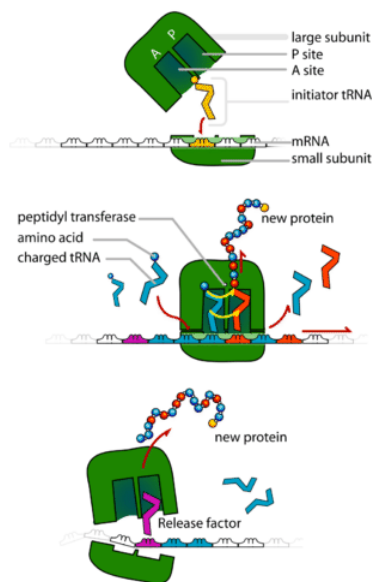


Figure 18.14.3: Role of ribosome in protein synthesis.

Summary

- The first step of protein synthesis is transcription—the unfolding of DNA and the production of a messenger-RNA (mRNA) strand.
- In the second step of protein synthesis—translation—tRNA and mRNA interact to code amino acids into growing polypeptide chains.

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