OPEN ACCESS Freely available online

ISSN: 2167-7956
Journal of Biomolecular Research & Therapeutics

Perspective

A Comprehensive Overview of Protein Biosynthesis

Richard Davis*

Department of Biomolecular Chemistry, University of Melbourne, Melbourne, Australia

DESCRIPTION

Protein biosynthesis is a fundamental process in molecular biology that plays a vital role in the growth, development, and maintenance of living organisms. This complex and highly regulated mechanism involves the synthesis of proteins, which are essential macromolecules responsible for a wide range of biological functions. From the structure of DNA to the final three-dimensional configuration of a functional protein, protein biosynthesis is a multi-step process that occurs within the cellular machinery of all living cells. Protein biosynthesis can be broadly divided into two main stages: transcription and translation. These processes occur in the cellular organelle called the ribosome and involve the coordination of various molecular components, including DNA, RNA, and amino acids.

Transcription is the first step in protein biosynthesis and takes place in the cell nucleus. The genetic information encoded in the DNA is transcribed into a complementary Messenger RNA (mRNA) molecule. This process is catalyzed by an enzyme called RNA polymerase, which binds to the DNA template strand and synthesizes a corresponding mRNA strand. The mRNA molecule serves as a temporary copy of the genetic information, carrying it from the nucleus to the cytoplasm, where protein synthesis will occur. During transcription, only one strand of the DNA, the template strand, is used to generate the mRNA, ensuring that the genetic code is faithfully transcribed.

Translation is the second stage of protein biosynthesis and takes place in the cytoplasm at the ribosomes. During translation, the information encoded in the mRNA is used to assemble a polypeptide chain, the precursor of a functional protein. This process involves transfer RNA (tRNA) molecules that carry specific amino acids to the ribosome, where they are added to the growing polypeptide chain. The sequence of nucleotides in the mRNA is read in groups of three, known as codons, each of which corresponds to a specific amino acid or a signal to start or stop protein synthesis. The tRNA molecules recognize these codons through their complementary anticodons, ensuring the accurate incorporation of amino acids into the growing protein chain.

The initiation of protein synthesis is a key step that marks the beginning of the translation process. It involves the assembly of the ribosome, mRNA, and the initiator tRNA at the start codon. In eukaryotic cells, the small ribosomal subunit binds to the mRNA, and the initiator tRNA carrying methionine is recruited. The large ribosomal subunit then joins the complex, forming a functional ribosome ready to initiate translation. In prokaryotic cells, the process is slightly different. The small ribosomal subunit binds to a specific sequence on the mRNA called the Shine-Dalgarno sequence, and the initiator tRNA carrying formylmethionine is recruited. The large ribosomal subunit follows, and translation begins.

Once initiation is complete, the ribosome moves along the mRNA in a process called elongation. During elongation, the ribosome reads the mRNA codons in sequence, and tRNA molecules bring amino acids to the ribosome according to the codons. Peptide bonds form between the amino acids, creating a growing polypeptide chain. The ribosome has three binding sites for tRNA; the A site (amino acyl site), the P site (peptidyl site), and the E site (exit site). The A site is where the incoming tRNA carrying the next amino acid binds. The P site is where the tRNA attached to the growing polypeptide chain is located. The E site is where the tRNA, which no longer carries an amino acid, exits the ribosome.

The process of elongation continues until a stop codon is encountered on the mRNA. Stop codons (UAA, UAG, and UGA) do not code for any amino acids but signal the termination of protein synthesis. When a stop codon enters the A site, a release factor binds to the ribosome, causing the newly synthesized protein to be released.

The freshly synthesized polypeptide chain is not always a fully functional protein. Post-translational modifications play a important role in modifying and refining the structure and function of proteins. These modifications can include the addition of functional groups, cleavage of certain segments, and the attachment of various chemical moieties. Phosphorylation, glycosylation, acetylation, and ubiquitination are common post-translational modifications. Phosphorylation involves the addition of phosphate groups to specific amino acids, often

Correspondence to: Richard Davis, Department of Biomolecular Chemistry, University of Melbourne, Melbourne, Australia, E-mail: davis.richard89@gmail.com

Received: 04-Oct-2023, Manuscript No. BOM-23-24141; **Editor assigned:** 06-Oct-2023, Pre QC No. BOM-23-24141 (PQ); **Reviewed:** 23-Oct-2023, QC No. BOM-23-24141; **Revised:** 30-Oct-2023, Manuscript No. BOM-23-24141 (R); **Published:** 06-Nov-2023, DOI: 10.35248/2167-7956.23.12.349

Citation: Davis R (2023) A Comprehensive Overview of Protein Biosynthesis. J Biol Res Ther. 12:349.

regulating the activity of the protein. Glycosylation involves the attachment of sugar molecules and is important for the stability and function of many proteins. Acetylation adds acetyl groups to amino acids, affecting protein-protein interactions, and ubiquitination tags proteins for degradation.

The process of protein biosynthesis is tightly regulated to ensure the accurate and timely synthesis of proteins based on the cell's needs. Several levels of regulation exist, including transcriptional, translational, and post-translational control mechanisms. The rate of transcription can be controlled by regulatory proteins that bind to specific DNA sequences, either enhancing or inhibiting the binding of RNA polymerase. Transcription factors play a vital role in regulating gene expression by binding to promoter regions and influencing the initiation of transcription.

The RNA world hypothesis suggests that early life forms might have relied on RNA molecules not only for genetic information but also for catalyzing biochemical reactions, including the synthesis of proteins. Protein biosynthesis is a central and complex process that underlies the functioning of all living cells. From the transcription of DNA to the final folding of a functional protein, this multistep process involves the orchestrated interplay of various molecular components.