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Commentary

Protein Biosynthesis in Cellular Protein Production

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DESCRIPTION

Proteins are responsible for executing a vast array of biological processes essential for life. The process by which proteins are synthesized within cells is known as protein biosynthesis. This intricate and highly regulated process involves the coordinated efforts of various biomolecules and cellular structures, working together to ensure the accurate and efficient assembly of proteins. Protein biosynthesis begins with the transcription of genetic information stored in the DNA. DNA a double-stranded molecule serves as the repository of an organism's genetic code. In order to protect the delicate DNA molecule and facilitate its transport to other cellular compartments a complementary molecule called RNA (ribonucleic acid) is synthesized through a process known as transcription. During transcription a specific region of the DNA molecule known as a gene is unwound and exposed. An enzyme called RNA polymerase then synthesizes a single-stranded RNA molecule known as messenger RNA (mRNA) by incorporating complementary nucleotides in accordance with the DNA template. The resulting mRNA molecule carries the genetic information encoded in the DNA out of the cell nucleus and into the cytoplasm, where protein synthesis will occur.

The mRNA molecule synthesized during transcription acts as a template for protein synthesis in a process known as translation. This critical step takes place in cellular structures called ribosomes which serve as the site of protein assembly. Translation involves three key types of RNA molecules include transfer RNA (tRNA), messenger RNA (mRNA) and ribosomal RNA (rRNA), tRNA molecules are responsible for transporting the amino acids the building blocks of proteins to the ribosome. Each tRNA molecule is specific to a particular amino acid and has an anticodon sequence that pairs with the complementary codon sequence on the mRNA. The ribosome consists of two subunits a small subunit that binds to the mRNA molecule and a large subunit that catalyzes the formation of peptide bonds between the amino acids. The ribosome reads the codons on the mRNA in sets of three known as codon triplets or codon sequences. Each codon corresponds to a specific amino acid or a signal to start or stop protein synthesis. The process of translation involves initiation, elongation and termination phases. During initiation the ribosome assembles around the start codon on the mRNA with the help of initiation factors. Then tRNA molecules carrying their corresponding amino acids bind to the ribosome guided by the codons on the mRNA. As the ribosome moves along the mRNA molecule, the amino acids are joined together through peptide bond formation resulting in the elongation of the growing polypeptide chain. Termination occurs when a stop codon is reached on the mRNA, signaling the end of protein synthesis. Release factors facilitate the detachment of the completed protein from the ribosome. Once the polypeptide chain is synthesized it often undergoes various modifications to become a functional protein. These modifications are known as post-translational modifications and can include processes such as folding, cleavage and the addition of functional groups. Protein folding is a critical step in which the polypeptide chain adopts its three-dimensional structure. Chaperone proteins assist in this process ensuring that the protein attains its functional conformation. Some proteins are synthesized as larger precursor molecules that require cleavage to become active. Enzymes known as proteases cleave specific peptide bonds to release the active protein fragments.

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