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Commentary

Transcription and Translation: The Two Phases of Protein Biosynthesis

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DESCRIPTION

Protein biosynthesis is the process of producing proteins from the genetic information encoded in DNA. Proteins are essential molecules that perform various functions in living cells such as catalyzing chemical reactions, providing structural support and regulating gene expression. Protein biosynthesis involves two main steps includes transcription and translation.

Transcription is the process of copying a segment of DNA, called a gene into a complementary strand of RNA, called Messenger RNA (mRNA). Transcription occurs in the nucleus of eukaryotic cells and in the cytoplasm of prokaryotic cells. Transcription is carried out by an enzyme called RNA polymerase, which binds to a specific sequence of DNA called the promoter at the beginning of the gene. RNA polymerase then moves along the DNA strand adding nucleotides to the growing mRNA strand according to the base-pairing rules includes Adenine (A) pairs with Uracil (U), Cytosine (C) pairs with guanine (G) and vice versa. Transcription ends when RNA polymerase reaches a termination signal on the DNA strand.

In eukaryotic cells, the mRNA produced by transcription is not yet ready for translation. It undergoes several modifications in the nucleus before being exported to the cytoplasm. These modifications include.

The addition of a 5' cap and a poly-A tail at the ends of the mRNA molecule which protect it from degradation and help it bind to ribosomes.

The removal of non-coding regions called introns and the splicing of coding regions called exons by a complex of proteins and RNA molecules called spliceosome.

The editing or modification of some nucleotides in the mRNA sequence by enzymes.

The resulting mature mRNA contains only the information needed for protein synthesis.

Translation is the process of decoding the mRNA sequence into a chain of amino acids called a polypeptide. Translation occurs in the cytoplasm of both eukaryotic and prokaryotic cells.

It is read by ribosomes in groups of three nucleotides, called codons.

rRNA forms part of the ribosomes which are the sites of protein synthesis. The small subunit binds to the mRNA and scans for the start codon (AUG) which initiates translation. The large subunit joins the small subunit and provides three binding sites for tRNA molecules. A site, P site, and E site.

tRNA carries amino acids to the ribosomes and matches them with the codons on the mRNA. Each tRNA molecule has an anticodon which is a sequence of three nucleotides that is complementary to a codon on the mRNA. Each tRNA molecule also has an amino acid attached to its 3' end by an enzyme called aminoacyl-tRNA synthetase.

Initiation is the formation of an initiation complex that consists of a small ribosomal subunit an mRNA molecule and a tRNA molecule carrying methionine (the first amino acid in most proteins). The initiation complex recognizes the start codon on the mRNA and aligns it with the P site on the ribosome. Then a large ribosomal subunit joins the complex and completes the initiation phase.

A tRNA molecule carrying an amino acid that matches the next codon on the mRNA binds to the A site on the ribosome. A peptide bond forms between the amino acid on the A site and the amino acid on the P site, transferring the polypeptide chain from the P site to the A site. The ribosome then moves one codon along the mRNA, shifting the tRNA from the A site to the P site, and the tRNA from the P site to the E site, where it is released. This cycle repeats until the ribosome reaches a stop codon on the mRNA, which signals the end of translation.

Termination is the release of the polypeptide chain.

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