UNIVERSITY BATNA 02

FACULTY OF NATURAL AND LIFE SCIENCES

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Protein synthesis

Protein synthesis is the cellular process by which proteins are produced using the information encoded in DNA. It involves two main stages: transcription and translation.

1-Transcription

Transcription is the first step in protein synthesis, during which the information in a gene's DNA sequence is transcribed into a complementary mRNA molecule. This process takes place in the cell nucleus.Transcription in eukaryotic cells is a complex process that involves multiple steps :

1-1-Initiation

Transcription begins with the binding of RNA polymerase to the promoter region of a gene on the DNA molecule. The promoter is a specific sequence of nucleotides that signals the starting point for transcription.

Once RNA polymerase II is properly positioned on the promoter, it unwinds a small section of the DNA double helix, creating the transcription bubble.

1-2-Elongation

RNA polymerase II begins moving along the DNA template strand in the 3' to 5' direction, synthesizing the RNA molecule in the 5' to 3' direction.

As it moves, it adds complementary ribonucleotides to the growing RNA chain, using the DNA template strand as a guide. Adenine (A) in the DNA template pairs with uracil (U) in the RNA, while cytosine (C) pairs with guanine (G).

1-3-Termination

Transcription continues until the RNA polymerase encounters a termination signal. Polyadenylation Termination is the most common termination mechanism for eukaryotic transcription, especially for protein-coding genes.

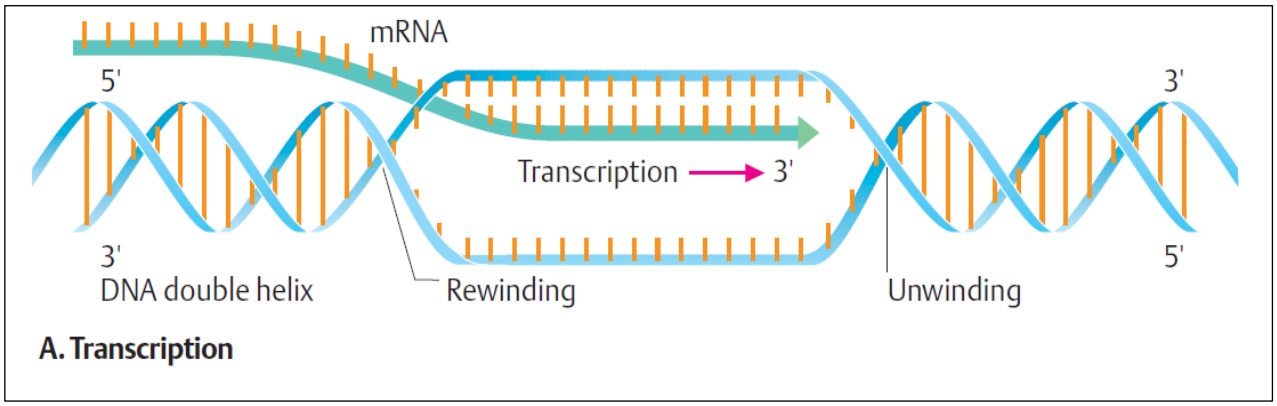
In polyadenylation termination, a specific sequence (AAUAAA) is recognized, and the pre-mRNA is cleaved downstream from this sequence. A poly-A tail is then added to the 3' end of the mRNA.

1-4-Post-transcriptional modifications (in eukaryotes)

The initial RNA transcript, called the primary transcript or pre-mRNA, undergoes several modifications before becoming functional mRNA, these modifications include :

- **Polyadenylation:** At the 3' end of the pre-mRNA, a poly-A tail is added. This poly-A tail is important for mRNA stability, export from the nucleus, and translation.
- **Capping:** a 7-methylguanosine cap (the 5' cap) is added to the 5' end of the pre-mRNA. This cap is essential for mRNA stability, splicing, and translation initiation. The 5' cap also protects the mRNA from degradation.
- **Splicing:** The pre-mRNA often contains non-coding regions called introns and coding regions called exons. Splicing is the process of removing introns and ligating exons together to generate mature mRNA.

These steps collectively result in the synthesis of a mature RNA molecule, which can then serve as a template for protein synthesis during translation.



2-Translation

Translation is the second step in protein synthesis, occurring in the cytoplasm, where the mRNA is used as a template to synthesize a protein. This process occurs within the ribosome and involves three main stages: initiation, elongation, and termination.

2-1-Initiation

Initiation begins with the binding of the small ribosomal subunit to the mRNA. In eukaryotic cells, this small ribosomal subunit binds to the 5' cap of the mRNA and scans along the mRNA until it finds the start codon, typically AUG (encoding methionine).

Once the start codon is located, the initiator tRNA (tRNA carrying methionine) forms a complex with the small ribosomal subunit, and this complex attaches to the mRNA. Finally, the large ribosomal subunit joins the complex, creating the functional ribosome, and translation begins.

2-2-Elongation

During elongation, the ribosome moves along the mRNA in the 5' to 3' direction. A new aminoacyl tRNA binds to the A-site (aminoacyl site) of the ribosome based on complementary base pairing between the tRNA anticodon and the mRNA codon. Peptide bond formation occurs between the amino acid on the tRNA in the P-site (peptidyl site) and the amino acid on the tRNA in the A-site. This forms a growing polypeptide chain.

The ribosome then translocates, moving the tRNAs from the A and P-sites to the P and E-sites, respectively. This step exposes a new mRNA codon in the A-site. The process continues with the binding of the next aminoacyl tRNA, and the cycle repeats, leading to the stepwise elongation of the polypeptide chain.

2-3-Termination

Termination occurs when a stop codon (UAA, UAG, or UGA) is encountered in the A-site of the ribosome. Stop codons do not code for any amino acids, but rather signal the end of translation. There are no tRNAs that recognize stop codons, but instead, release factors (proteins) bind to the ribosome when a stop codon is in the A-site.

The binding of release factors triggers the hydrolysis of the final tRNA-mRNA bond and the release of the newly synthesized polypeptide chain from the ribosome. The ribosome then dissociates into its constituent subunits, and the translation process is complete.

2-4-Post-Translational Modifications

After translation, the newly synthesized polypeptide may undergo various post-translational modifications, such as folding into its proper three-dimensional structure, addition of chemical groups (e.g., phosphorylation, glycosylation,), and cleavage into smaller functional proteins if needed.