Al- Mustaqbal University
College of Science
Medical Physics Department
First Stage

General biology

Lecture : 6

Transcription

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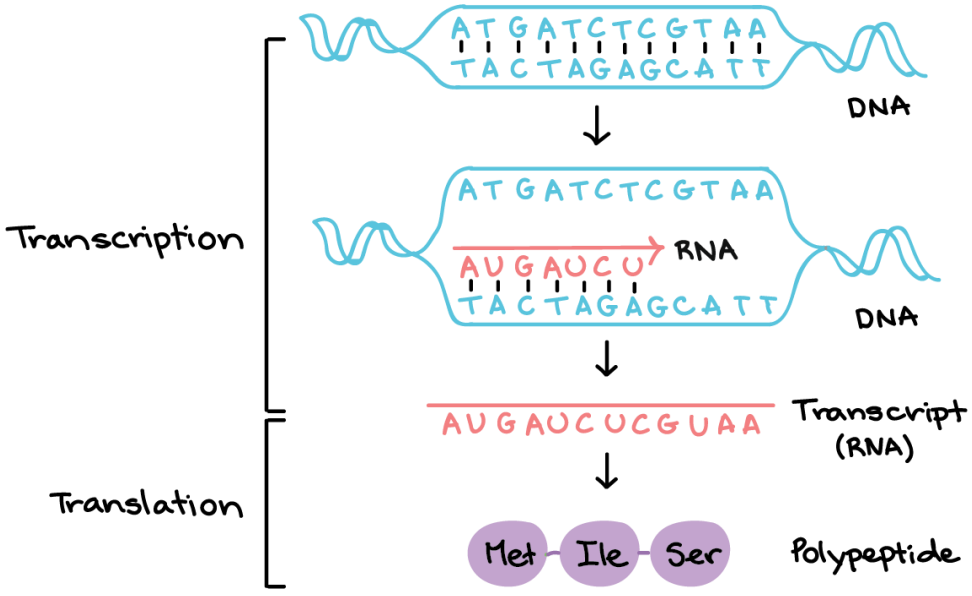
Transcription: The Process of Copying Genetic Information from DNA to RNA

1. Introduction to Transcription

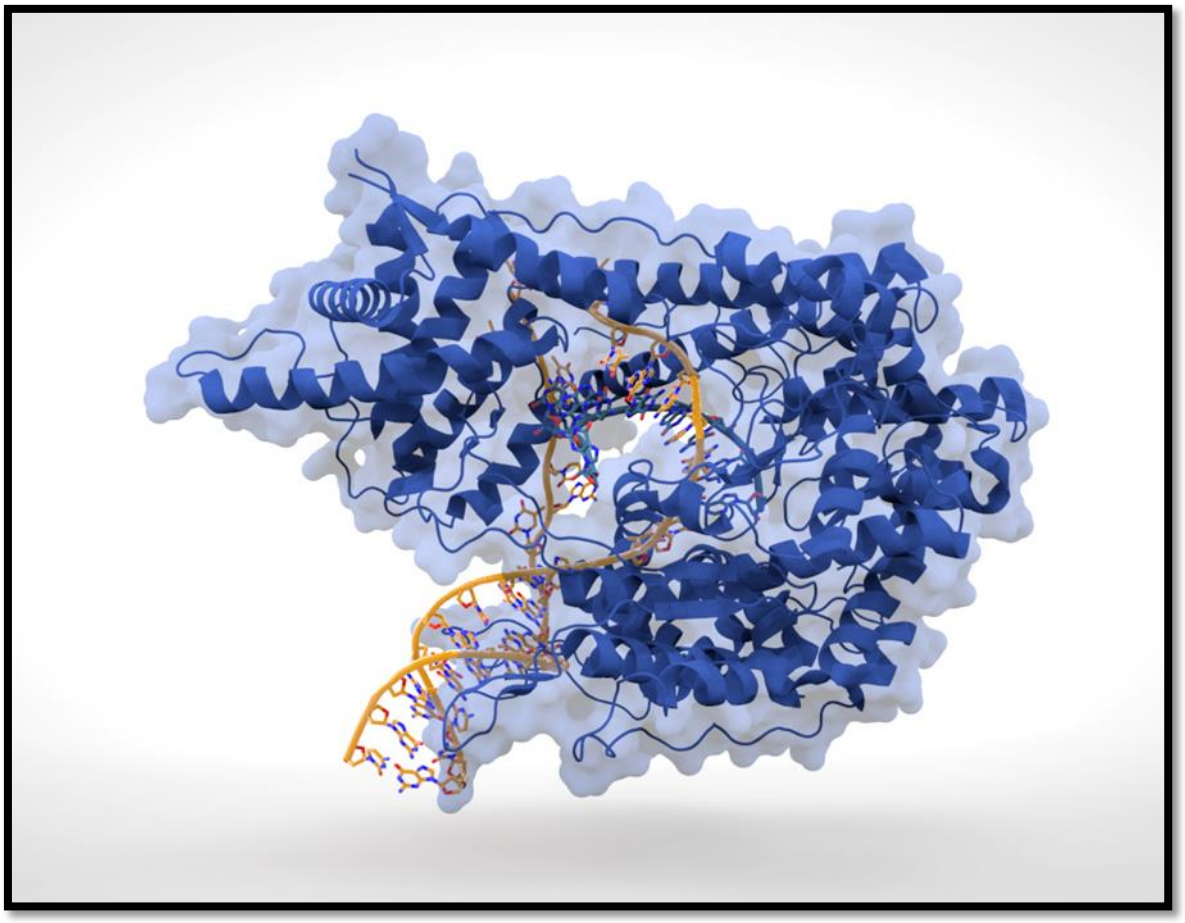
Transcription is the process by which an RNA molecule is synthesized using a DNA template. This RNA molecule, commonly known as messenger RNA (mRNA), carries the genetic instructions from the DNA to the ribosome, where it guides protein synthesis. Transcription is a key step in the central dogma of molecular biology: DNA → RNA → Protein. In this process, only specific segments of DNA are transcribed into RNA, ensuring that proteins are produced as needed by the cell.



Figar (1) Transcription and Translation

2. The Role of RNA Polymerase

The enzyme (RNA polymerase) plays a central role in transcription. RNA polymerase binds to a region of the DNA known as the promoter, which signals the start of a gene. The enzyme then unwinds the DNA and begins synthesizing an RNA strand using one of the DNA strands as a template. RNA polymerase reads the DNA in the 3' to 5' direction, synthesizing the RNA in the 5' to 3' direction. This process requires the presence of ribonucleotides (A, U, C, G), which are complementary to the DNA template strand.



Figar (2) RNA Polymerase

3. The Stages of Transcription

a. Initiation

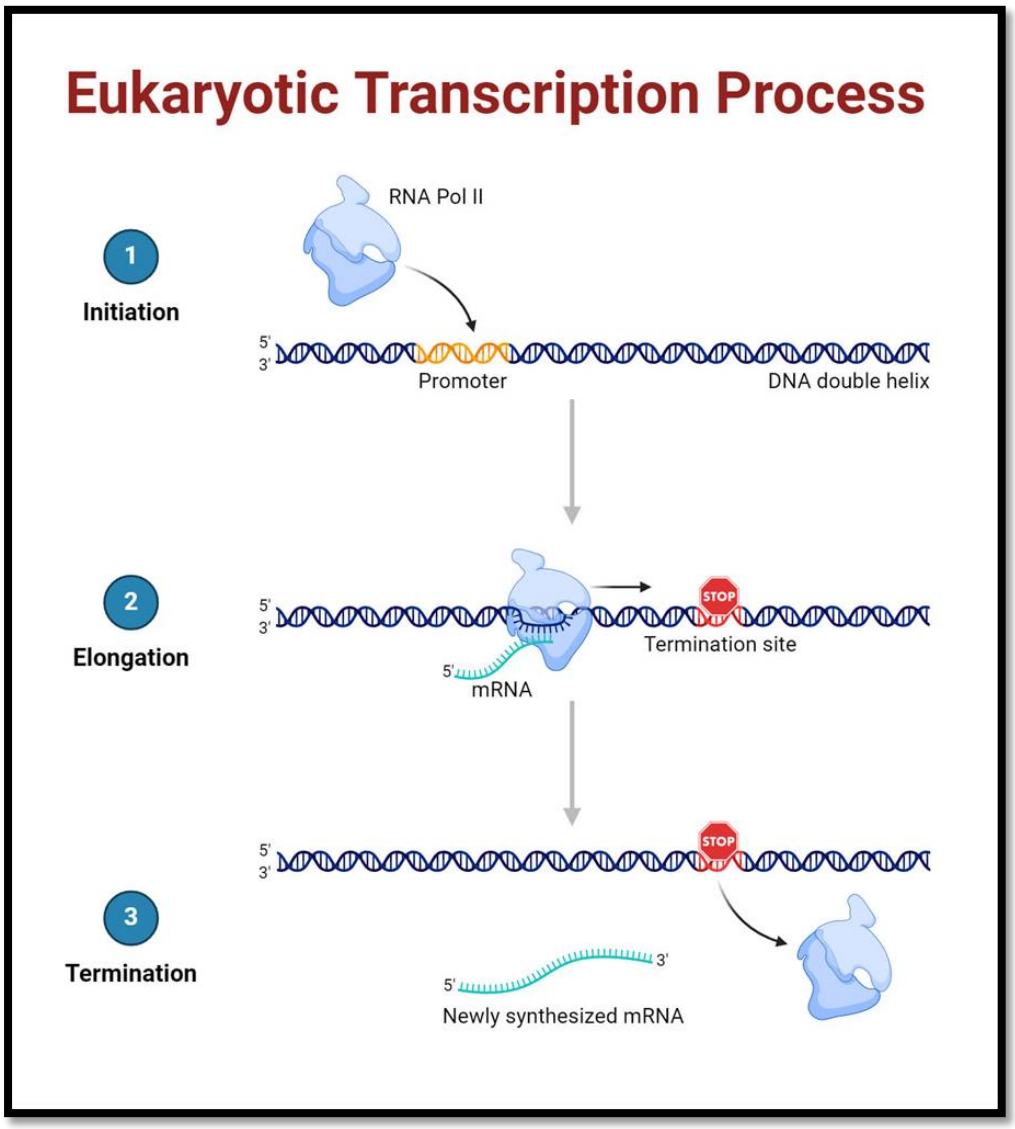
Transcription begins when RNA polymerase binds to the promoter region of a gene. The promoter contains specific sequences, such as the TATA box, that help RNA polymerase recognize where to start. Once RNA polymerase is bound to the promoter, it begins to unwind the DNA, separating the two strands. The DNA template strand is now available for RNA polymerase to begin synthesizing RNA.

b. Elongation

During the elongation phase, RNA polymerase moves along the DNA template strand, synthesizing RNA in the 5' to 3' direction. As the enzyme moves, it continues to unwind the DNA and adds ribonucleotides to the growing RNA chain. The RNA molecule grows as each nucleotide is added in a sequence complementary to the DNA template. As the RNA polymerase progresses, the DNA behind it rewinds into its double-helix structure.

c. Termination

Transcription terminates when RNA polymerase encounters a termination signal in the DNA sequence. This signal causes the RNA polymerase to detach from the DNA template and release the newly synthesized RNA molecule. The RNA transcript, which is a precursor to mRNA, then undergoes additional modifications in eukaryotic cells before becoming mature mRNA capable of being translated into a protein.



Figar (3) Eukaryotic Transcription Process Translation

4. Post-Transcriptional Modifications in Eukaryotes

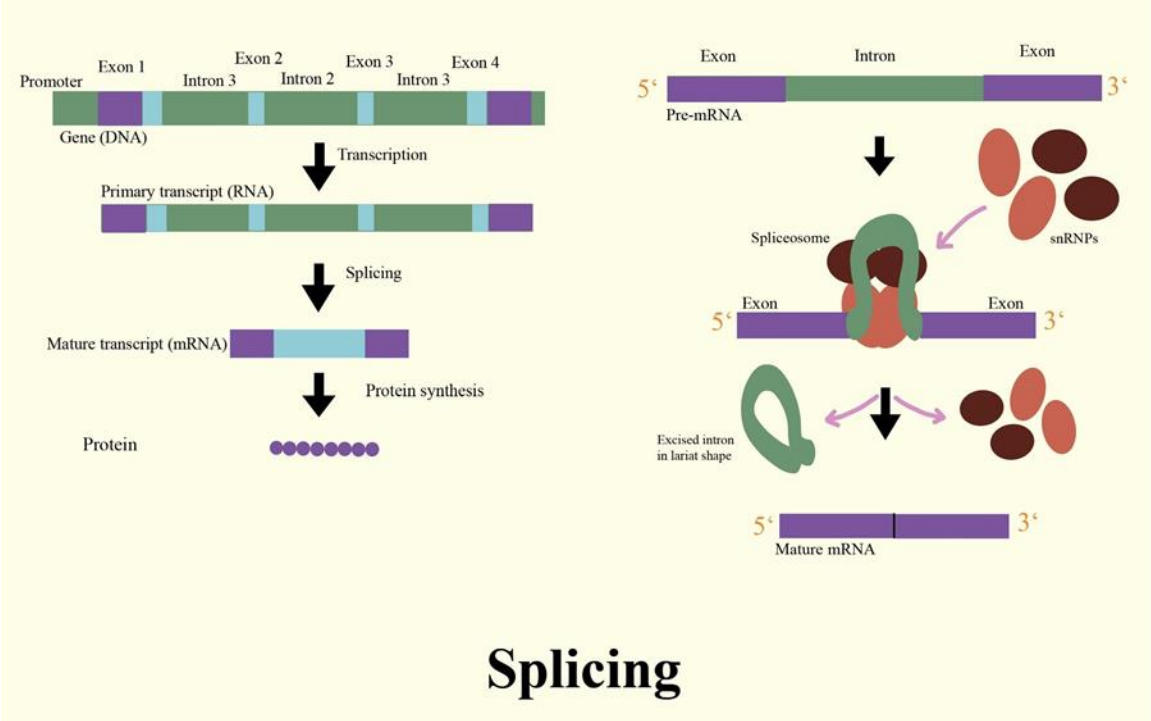
In eukaryotes, the primary RNA transcript (pre-mRNA) undergoes several modifications before it can be used in translation. These modifications include:

a. 5’ Capping

A 5’ cap is added to the beginning of the pre-mRNA. This cap consists of a modified guanine nucleotide and serves to protect the mRNA from degradation, assist in ribosome binding during translation, and help with the export of the mRNA from the nucleus to the cytoplasm.

b. Splicing

The process of splicing removes non-coding regions of the RNA, called introns, and joins the remaining coding regions, called exons. This process ensures that the mRNA only contains the necessary information for protein synthesis.



Figar (4) Splicing

c. 3' Polyadenylation

A poly-A tail is added to the 3' end of the mRNA. This tail consists of a chain of adenine nucleotides and protects the mRNA from degradation, facilitates its transport out of the nucleus, and aids in the initiation of translation.

5. The Importance of Transcription in Gene Expression

Transcription is the first step in the process of gene expression. It allows the genetic information stored in DNA to be used to produce proteins, which are responsible for carrying out the functions of the cell. The regulation of transcription is crucial for the proper functioning of the cell, as it ensures that genes are expressed at the right time and in the right amount. Errors in transcription or its regulation can lead to diseases such as cancer or genetic disorders.

References

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https://www.youtube.com/watch?v=AT4ivtsl4d0