TRANSCRIPTION

The process of transcribing genetic information from one strand of DNA into RNA is termed transcription. Similar to DNA replication, transcription follows the principle of complementarity, although adenosine now pairs with uracil instead of thymine.

However, unlike DNA replication, where the entire DNA molecule is duplicated, transcription only involves a segment of DNA, with only one of its strands serving as a template for RNA synthesis. In transcription, there is a single template strand, whereas in replication, both strands act as templates.

There are two reasons why both DNA strands are not copied during transcription:

(1) If both strands were templates, they would encode RNA molecules with different sequences. Consequently, if these RNAs were translated into proteins, the resulting amino acid sequences would also differ. This would complicate the transfer of genetic information.

(2) Simultaneously producing two RNA molecules from both strands would result in complementary sequences. This would lead to the formation of double-stranded RNA, which inhibits RNA translation into proteins.

Transcription Unit

The portion of DNA involved in transcription is referred to as a transcription unit. It consists of three main components:

(i) A promoter sequences
(ii) The structural gene
(iii) A terminator sequences

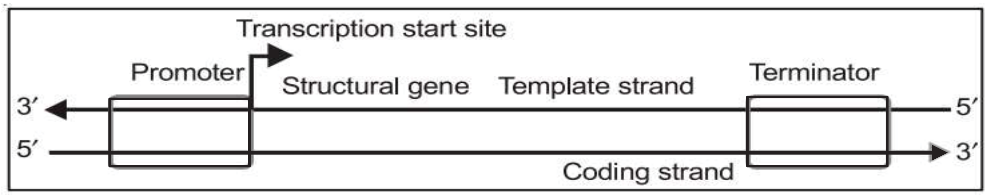
Template Strand and Coding Strand

- Formation of RNA over DNA template is called transcription. Out of two strands of DNA only one strand participates in transcription and called "Antisense strand" or "Template strand".
- If both strands act as a template during transcription they would code for RNA molecule with different sequence and if they code for proteins the sequence of Arnin acid in this protein would be different and another reason that if the two RNA molecule produced, they would be complementary to each other and form a ds RNA which prevent translation of RNA.
- A gene is defined as the functional unit of inheritance. It is difficult to literally define a gene in terms of DNA sequence because the DNA sequence coding for tRNA or rRNA molecule is also define a gene (But information of protein is present on the DNA segment which code mRNA).
- The segment of DNA which contains signal for the esthesis of one polypeptide is known as "Cistron ".
- RNA polymerase enzyme is involved in transcription. In eukaryotes there are three types of RNA polymerases.
- RNA polymerase-I for 28s rRNA 18s rRNA. 5.8s rRNA synthesis.
- RNA polymerase-II for hn-RNA synthesis (Precursor of m-RNA)
- RNA polymerase-III for t-RNA 5s rRNA SnRNA synthesis.
- Prokaryotes have only one type of RNA polymerase which synthesizes all types of RNAs.
- RNA polymerase (Core enzyme) of E. Coli has five polypeptide chains 13, 13: a, a and ro.
- polypeptide chain is also known as σ factor (sigma factor).
- Core enzyne + Sigma factor ⇒ RNA Polymerase

  (β, β; α, α, ω)   (σ)

  A transcription unit in DNA is defined primarily by three regions in the DNA

  (i) A promoter,   (ii) The structural gene,   (iii) A terminator



Types of RNA and the process of Transcription

Three primary categories of RNA exist within cellular biology: messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA). They vary in abundance within the cell, with mRNA constituting approximately 5% of total RNA, rRNA dominating with about 80%, and tRNA comprising roughly 15%. In terms of size, mRNA stands as the longest among the trio, followed Smaller by rRNA, while tRNA is the smallest.

Each type of RNA fulfills distinct roles crucial for protein synthesis. mRNA, often referred to as template, nuclear, or messenger RNA, serves as the carrier of genetic information provided by DNA. During translation, it acts as a blueprint for protein synthesis, conveying the precise sequence of amino acids required for protein formation.

On the other hand, rRNA plays dual roles during translation. Structurally, it forms a fundamental component of ribosomes, the cellular machinery responsible for protein synthesis. Additionally, rRNA possesses catalytic properties, facilitating the chemical reactions involved in peptide bond formation during protein synthesis.

tRNA serves as soluble or adapter RNA, responsible for transporting amino acids to the ribosome during protein synthesis. Each tRNA molecule specifically carries a particular amino acid, ensuring its accurate incorporation into the growing polypeptide chain.

Given the distinct functions of mRNA, tRNA, and rRNA, all three types of RNA are indispensable for the intricate process of protein synthesis within a cell.

Following steps are present in transcription

(1) Initiation

DNA possesses both a "Promoter site," where RNA polymerase binds, and a "Terminator site," where transcription comes to a halt. The Sigma factor (σ) plays a crucial role in identifying and binding to the promoter site of DNA. With the assistance of the sigma factor, the RNA polymerase enzyme attaches to a specific location on the DNA known as the "Promoter site." In prokaryotes, a sequence of six base pairs (TATMT) precedes the "Starting point" by 10 nucleotides on the DNA, referred to as the "Pribnow box." Conversely, in eukaryotes, a sequence of seven base pairs (TATMM) or (TATATAT) is situated 20 nucleotides prior to the "Starting point" on the DNA, termed the "TATA box" or "Hogness box."

At the initiation of transcription, the RNA polymerase enzyme separates the two DNA strands by breaking hydrogen bonds, with one of the strands engaging in the transcription process. Transcription progresses in the 5' to 3' direction. Ribonucleoside triphosphates align opposite the complementary nitrogen bases of the antisense strand. These ribonucleotides, in the form of triphosphates (ATP, GTP, UTP, and CTP), undergo hydrolysis by pyrophosphatase, removing two phosphates from each activated nucleotide. This enzymatic process releases energy, which is subsequently utilized in the transcription process.

(2) Elongation

The RNA polymerase enzyme facilitates the formation of phosphodiester bonds between adjacent ribonucleotides, linking them together during the process of transcription. The Sigma factor initiates the transcription process by dissociating from the RNA polymerase, allowing it to navigate along the antisense strand of the DNA until it reaches the terminator site.

(3) Termination

Upon reaching the terminator site, the RNA polymerase enzyme disengages from the DNA template. While in many instances, the RNA polymerase can independently identify the terminator site and halt RNA synthesis, in prokaryotes, it relies on the assistance of the Rho factor (ρ factor) for this recognition process. The Rho factor, a specialized protein, aids the RNA polymerase enzyme in recognizing the terminator site, facilitating the termination of RNA synthesis.

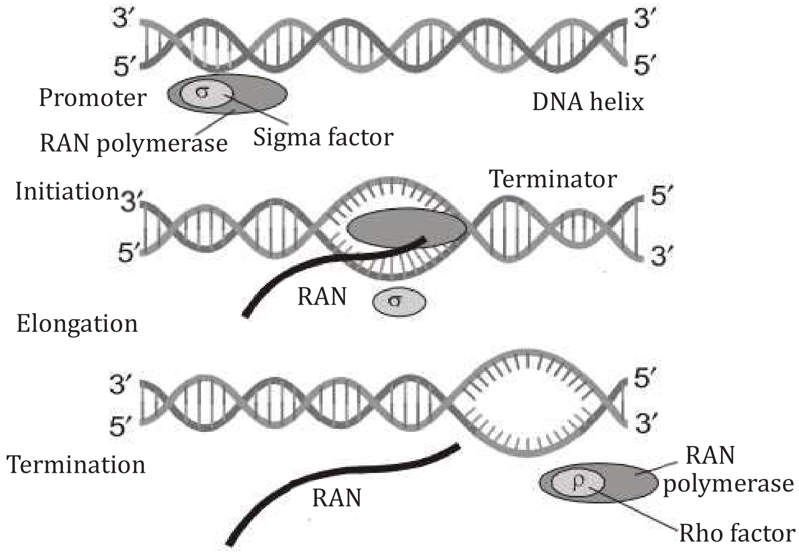


Fig.: Process of Transcription in Bacteria