Transcription in prokaryotes

Both transcription and translation in prokaryotes are similar in many ways to eukaryotic cells, but differ in many details. In addition, there are major differences between prokaryotic organisms from the group Bacteria (or Eubacteria) and Archaea (in which many of these processes are more similar to the situation in eukaryotes), as the model organism to which all the phenomena described below relate , here we will take the bacteria *E. coli*. The big difference between prokaryotic and eukaryotic organisms is in the spatial and temporal relationship of transcription and translation, where, due to the absence of a double nuclear membrane separating these two processes, in bacteria there is usually no further processing of newly formed mRNA and ribosomes they attach themselves to the RNA before its synthesis is completed.
Transcription is the process of transcribing one strand of DNA into a complementary strand of RNA. It is catalyzed by the enzyme RNA polymerase. It takes place in the direction from the 5' end of the new RNA molecule to its 3' end and is energetically driven by the hydrolysis of the macroergic bond of the incoming ribonucleoside triphosphate. Unlike eukaryotic transcription, where usually only one gene encoding a single polypeptide or untranslated RNA is transcribed, in bacteria multiple genes can be transcribed into a single polycistronic RNA molecule. These are then gradually translated to form several separate polypeptides (see Operon model).

RNA polymerase

Transcription in bacteria is ensured by a single RNA polymerase (unlike eukaryotes), consisting of 5 protein subunits, called α, β, β', ω and σ (often also called sigma factor), where the α subunit is present in two copies. The sigma subunit serves to recognize the promoter and bind the enzyme to DNA during the initiation of transcription and dissociates shortly after the start of RNA synthesis.

Initiation of transcription

In order for RNA synthesis to begin, recognition of a sequence called the promoter upstream of the beginning of the transcribed region must occur. This is done in bacteria using the sigma factor. Sigma factor has at least seven known variants (citations) in E. coli, the most common of which is σ^{70} or RpoD. This is used in the transcription of most genes, but there are also sigma factors that recognize other promoter sequences. These are usually genes involved in a common metabolic function or responses to specific environmental conditions. In bacteria, it is thus an important element of the regulation of gene expression through the synthesis and degradation of various variants of the sigma factor.
The promoter itself contains two highly conserved sequences recognized by the sigma factor, called consensus sequences. The particular sequence at a given promoter site may differ slightly from the consensus sequence, but usually the closer it is, the stronger the promoter is for that sigma factor. For σ^{70} it is the sequence TATAAT in position −10, or TATA box, or Pribnow box, and the sequence TTGACA in position −35.
After the opening of the transcription bubble by the separation of the two DNA chains and the synthesis of a short chain (about 9 nucleotides), the dissociation of the sigma factor occurs and transcription continues similarly to eukaryotes.

Termination of transcription

The termination of transcription in bacteria is most often ensured by a specific sequence in the newly synthesized RNA. It is usually a sequence rich in GC pairs containing two inverted repeats separated by a non-repetitive stretch. This sequence is followed in DNA by a short chain of repeating adenosine bases (in RNA the conditional polyU sequence). The inverted repeats in the nascent RNA pair with each other to form a loop structure, which halts the progress of transcription. Thanks to the weak interaction of A with U (compared to G and C), dissociation of the newly formed RNA molecule subsequently occurs.
In bacteria, another possibility is termination via the protein Rho (ρ). The latter recognizes a specific sequence in the newly synthesized RNA and subsequently moves along it towards the RNA polymerase complex, where it causes dissociation of the polymerase and RNA.

Links

Related articles

- Translation
- Translation in eukaryotes
- Translation, post-translational processing of proteins in eukaryotes
- Transcription