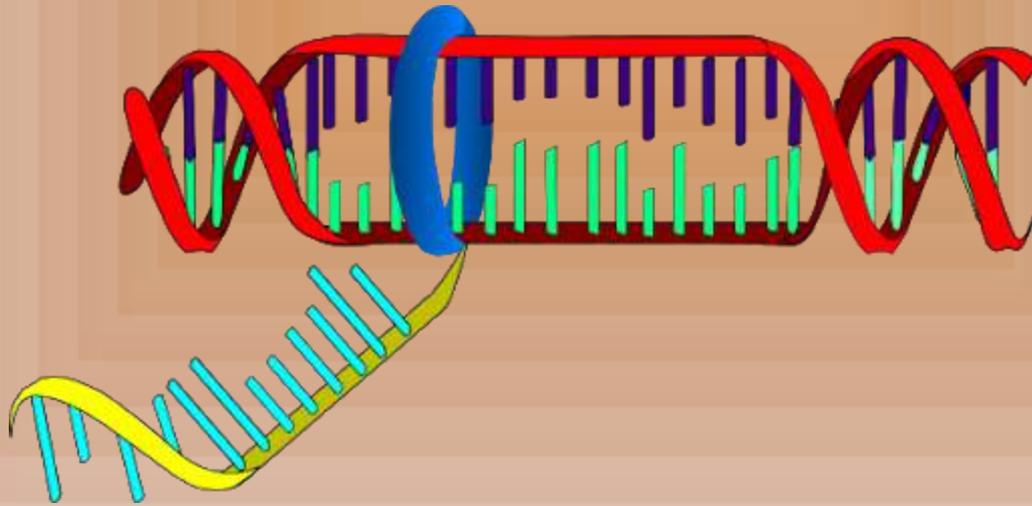


TRANSCRIPTION



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TRANSCRIPTION

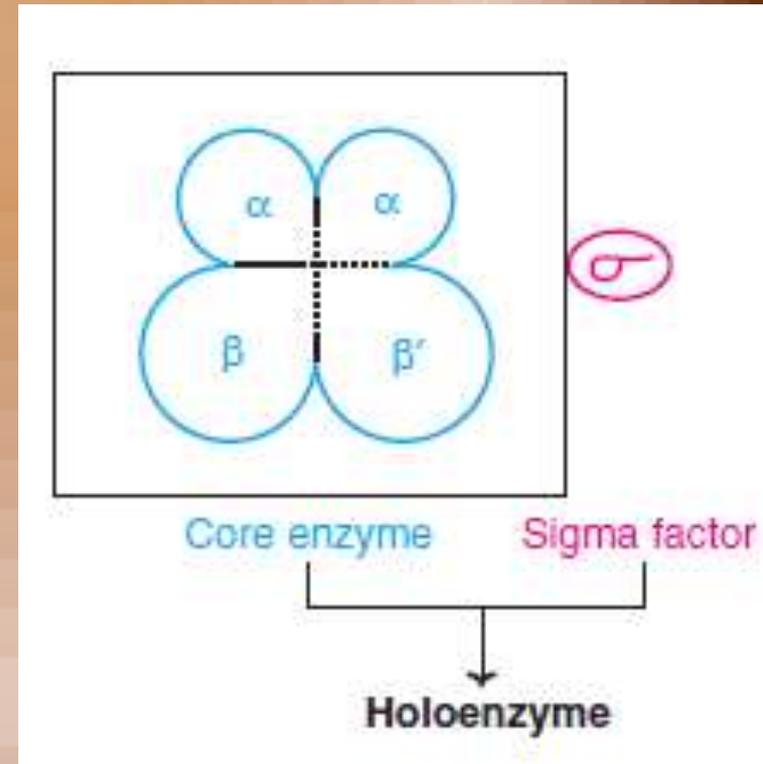
- Roger Kornberg, s/o Arthur Kornberg worked on Transcription.
- Transcription is a process in which ribonucleic acid (**RNA**) is synthesized from **DNA**.
- The word **gene** refers to the functional unit of the **DNA** that can be transcribed.
- **Thus, the** genetic information stored in DNA is expressed through RNA. For this purpose, one of the two strands of DNA serves as a **template** (**non-coding** strand or **antisense** strand) and produces working copies of RNA molecules.

TRANSCRIPTION

- **The other** DNA strand which does not participate in transcription is referred to as coding strand or sense strand or non-template strand. (Coding strand commonly used since with the exception of T for U, primary mRNA contains codons with the same base sequence).

TRANSCRIPTION IN PROKARYOTES

- A single enzyme—DNA dependent RNA polymerase or simply **RNA polymerase**— synthesizes all the RNAs in prokaryotes.
- RNA polymerase of *E. coli* is a complex holoenzyme (mol wt. 465 kDa) with five polypeptide subunits— 2α , 1β and $1\beta'$ and one sigma(s) factor.
- **The enzyme without sigma factor is referred to as core enzyme (α 2β β').**



TRANSCRIPTION IN PROKARYOTES

- Transcription involves three different stages--
 - ❖ Initiation
 - ❖ Elongation and
 - ❖ Termination
 - ❖ Post transcriptional modification

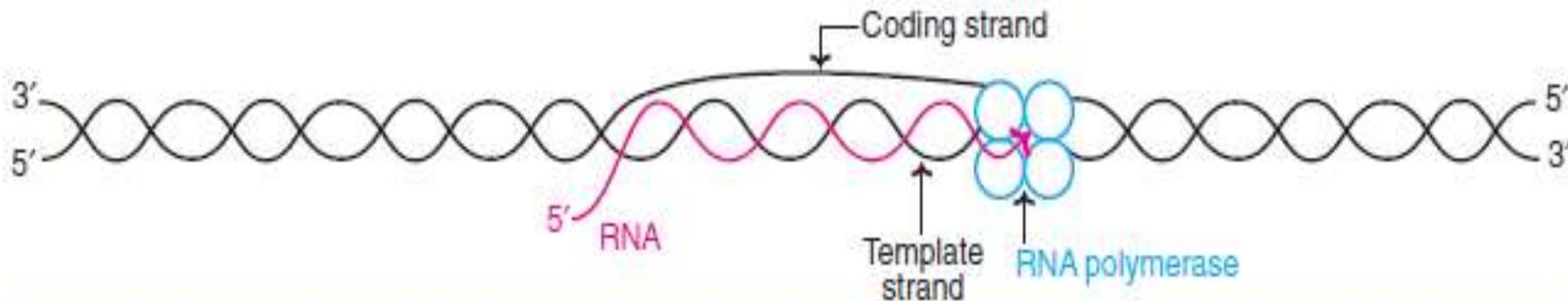


Fig. 25.3 : An overview of transcription.

Step 1st -Initiation

- The binding of the enzyme RNA polymerase to DNA is the prerequisite for the transcription to start.
- The specific region on the DNA where the enzyme binds is known as **promoter region**.
- There are two base sequences on the **coding DNA strand** which the **sigma factor** of RNA polymerase can recognize for initiation of transcription.



Step 1st -Initiation

- ❖ **Pribnow box (TATA box)** : This consists of 6 nucleotide bases (TATAAT), located on the left side about 10 bases away (upstream) from the starting point of transcription.
- ❖ **The ‘-35’ sequence** : This is the second recognition site in the promoter region of DNA. It contains a base sequence TTGACA, which is located about 35 bases (upstream, hence -35) away on the left side from the site of transcription start.

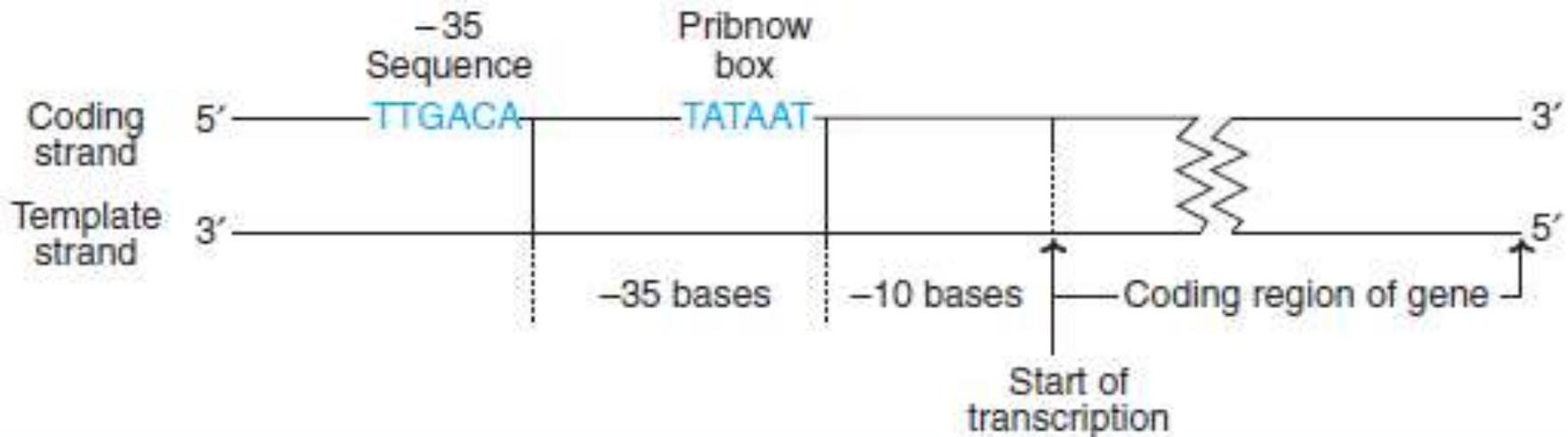
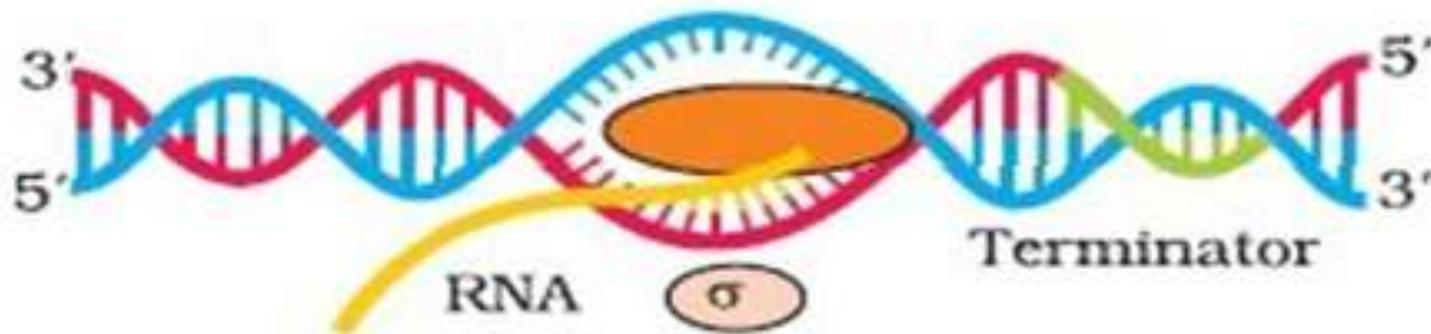


Fig. 25.5 : Promoter regions of DNA in prokaryotes.

Step 2nd -Elongation

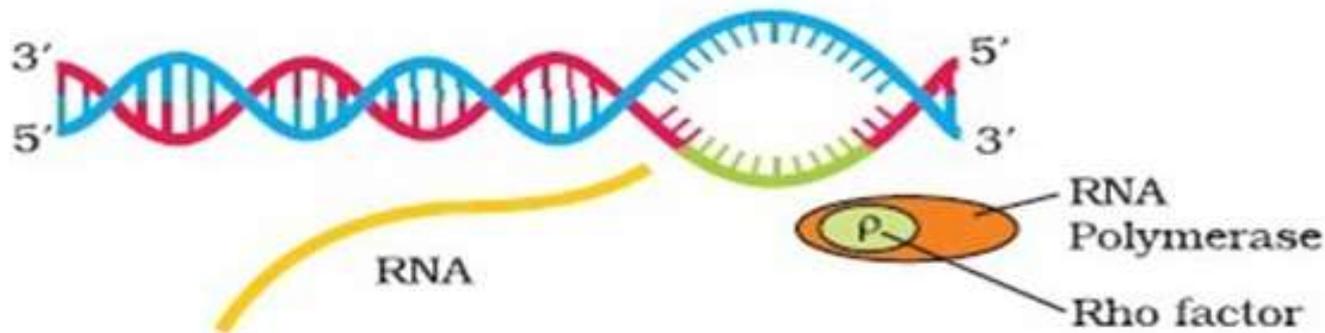
- As the holoenzyme, RNA polymerase recognizes the promoter region, the sigma factor is released and transcription proceeds.
- RNA is synthesized from 5' end to 3' end (5'→3') antiparallel to the DNA template.
- RNA polymerase utilizes ribonucleotide triphosphates (ATP, GTP, CTP and UTP) for the formation of RNA.



Step 3rd - Termination

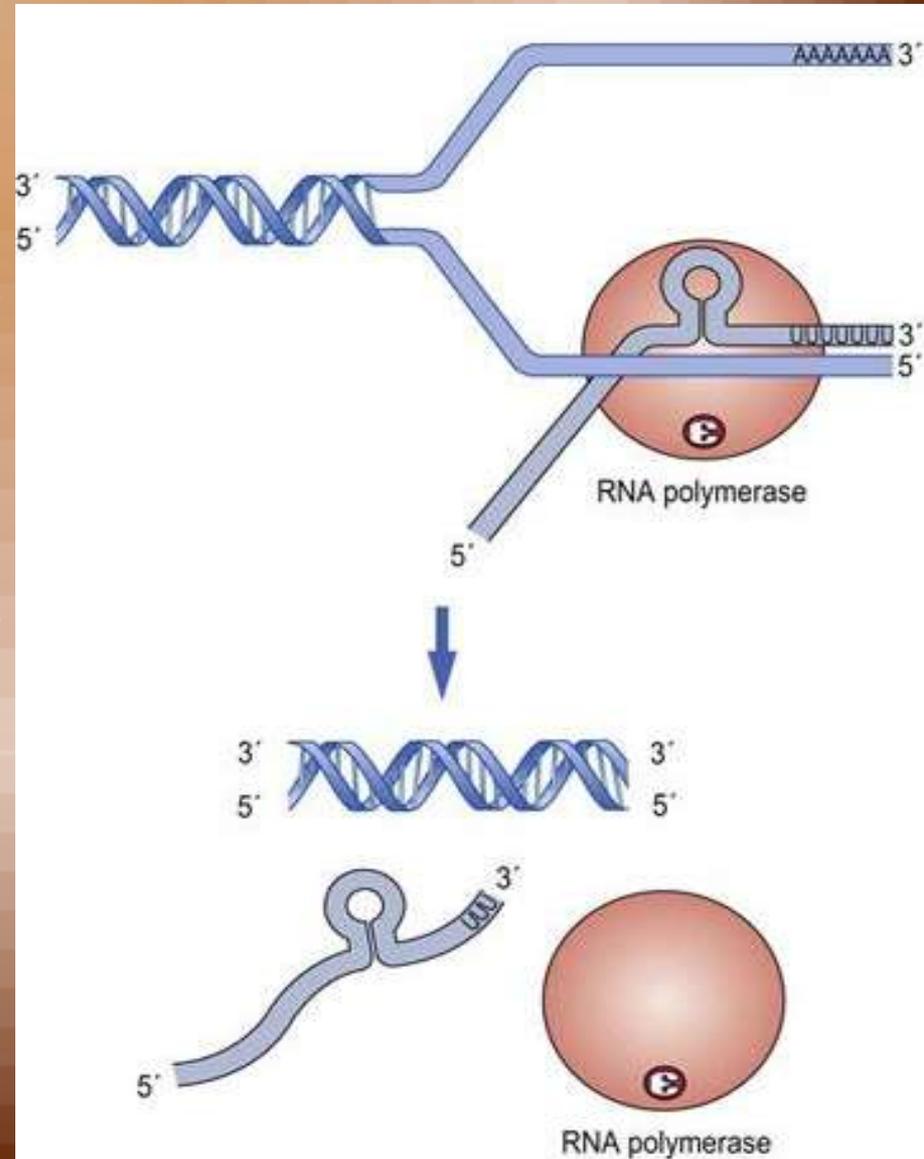
The process of transcription stops by termination signals. Two types of termination are identified.

- ❖ **Rho (ρ) dependent termination** : A specific protein, named ρ factor, binds to the growing RNA (and not to RNA polymerase) or weakly to DNA, and in the bound state it acts as ATPase and terminates transcription and releases RNA.
- The ρ factor is also responsible for the dissociation of RNA polymerase from DNA.



Step 3rd - Termination

- **Rho (ρ) independent termination** : The termination in this case is brought about by the formation of **hairpins of newly synthesized RNA** due to the presence of **palindromes**.
- The presence of palindromes in the base sequence of DNA template, the newly synthesized RNA folds to form hairpins.



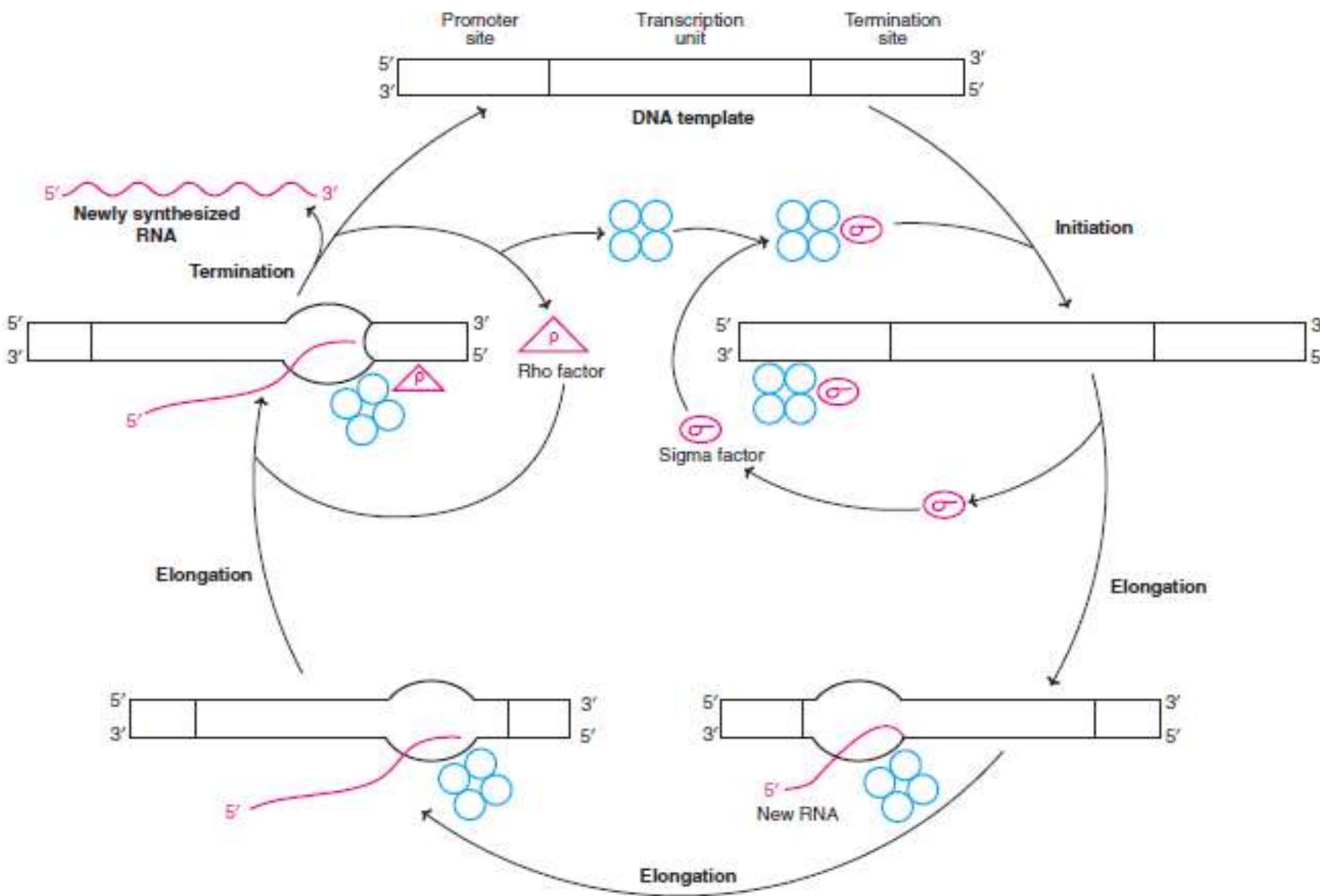


Fig. 25.4 : Synthesis of RNA from DNA template (transcription).

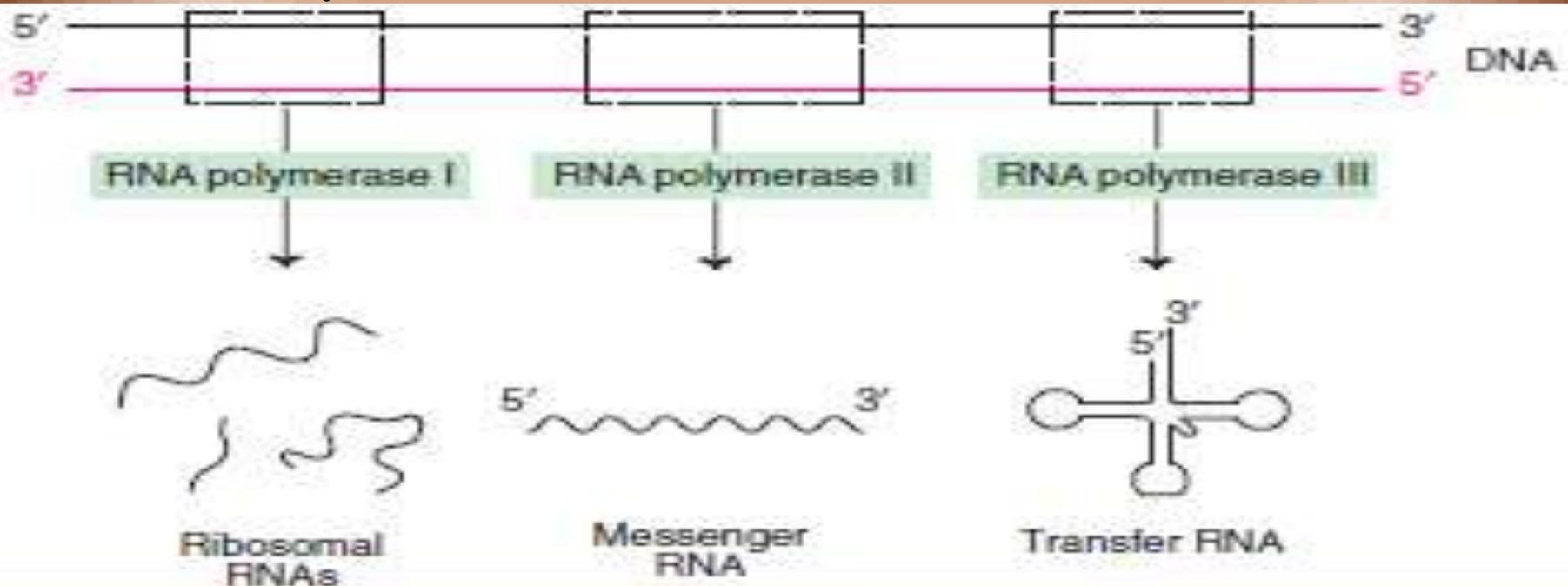
TRANSCRIPTION IN EUKARYOTES

- RNA synthesis in eukaryotes is a much more complicated process than the transcription described above for prokaryotes.
- As such, all the details of eukaryotic transcription (particularly about termination) are not clearly known.
- The salient features of available information are given hereunder.

Step 1st - Initiation

The nuclei of eukaryotic cells possess three distinct RNA polymerases..

- I. **RNA polymerase I** is responsible for the synthesis of precursors for the large ribosomal RNAs.
- II. **RNA polymerase II** synthesizes the precursors for mRNAs and small nuclear RNAs.
- III. **RNA polymerase III** participates in the formation of tRNAs and small ribosomal RNAs. Besides the three RNA polymerases found in the nucleus, there also exists a mitochondrial RNA polymerase in eukaryotes.



Step 1st -Initiation

- **Promoter sites:** In eukaryotes, a sequence of DNA bases— which is almost identical to pribnow box of prokaryotes—is identified. This sequence, known as **Hogness box (or TATA box)**, is located on the left about 25 nucleotides away (upstream) from the starting site of mRNA synthesis.

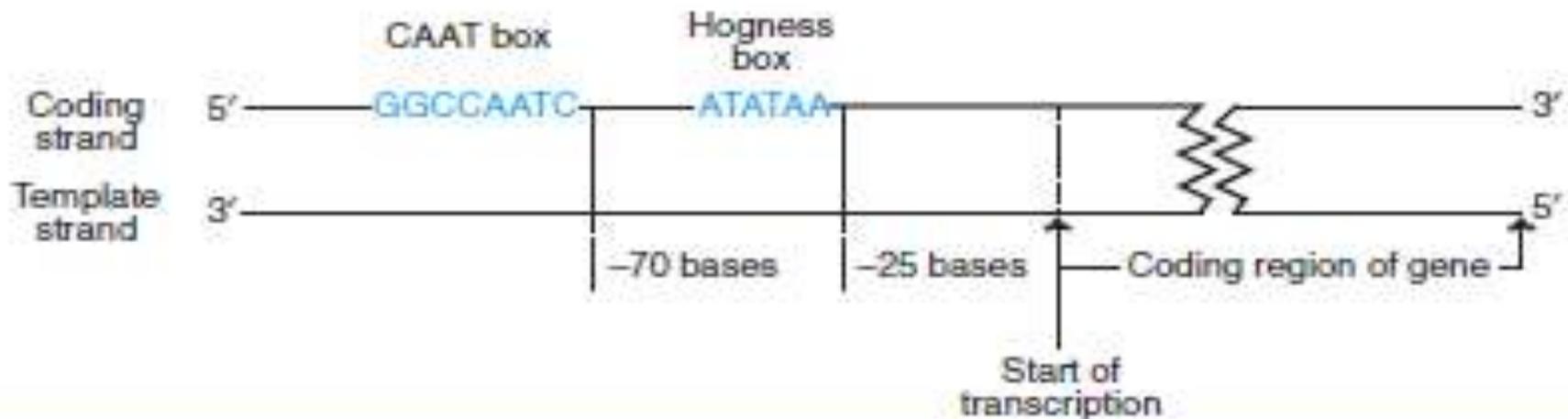


Fig. 25.8 : Promoter regions of DNA in eukaryotes.

Step 1st -Initiation

- There also exists another site of recognition between 70 and 80 nucleotides upstream from the start of transcription.
- This second site is referred to as **CAAT box**. **One of** these two sites (or sometimes both) helps RNA polymerase II to recognize the requisite sequence on DNA for transcription.

Step 1st -Initiation

The molecular events required for the initiation of transcription in eukaryotes are complex, and broadly involve three stages.

1. Chromatin containing the promoter sequence made accessible to the transcription machinery.
2. Binding of transcription factors (TFs) to DNA sequences in the promoter region.
3. Stimulation of transcription by enhancers. A large number of **transcription factors** interact with eukaryotic promoter regions.
4. In humans, about six transcription factors have been identified (TFIID, TFIIA, TFIIB, TFIIF, TFIIE, TFIIH). It is postulated that the TFs bind to each other, and in turn to the enzyme RNA polymerase.

POST-TRANSCRIPTIONAL MODIFICATIONS

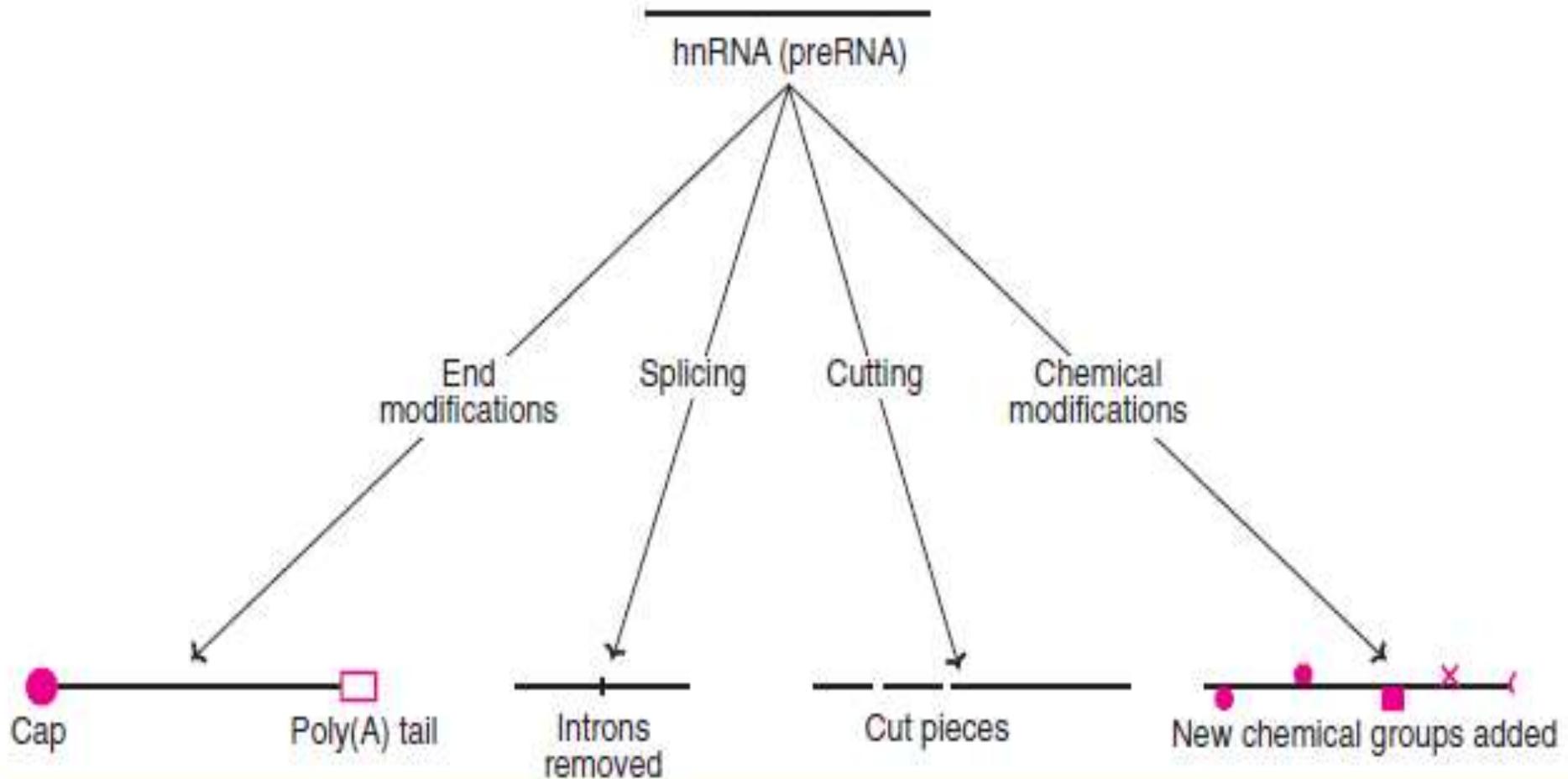


Fig. 25.9 : An outline of post-transcriptional modifications of RNA (hnRNA-Heterogeneous nuclear RNA).

Inhibitors of transcription

The synthesis of RNA is inhibited by certain antibiotics and toxins.

- **Actinomycin D** : This is also known as dactinomycin. It is synthesized by Streptomyces. Actinomycin D binds with DNA template strand and blocks the movement of RNA polymerase. This was the very first antibiotic used for the treatment of tumors.
- **Rifampin** : It is an antibiotic widely used for the treatment of tuberculosis and leprosy. Rifampin binds with the β -subunit of prokaryotic RNA polymerase and inhibits its activity.

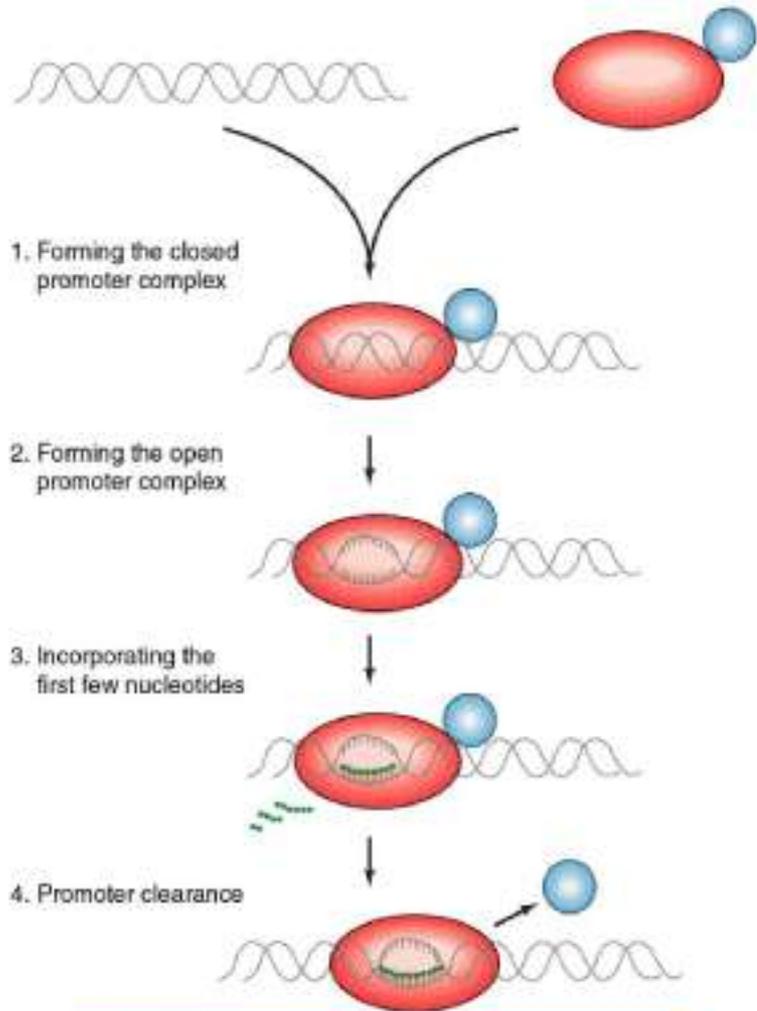
Inhibitors of transcription

- **α -Amanitin** : It is a toxin produced by mushroom, *Amanita phalloides*. This mushroom is delicious in taste but poisonous due to the toxin α -amanitin which tightly binds with RNA polymerase II of eukaryotes and inhibits transcription.

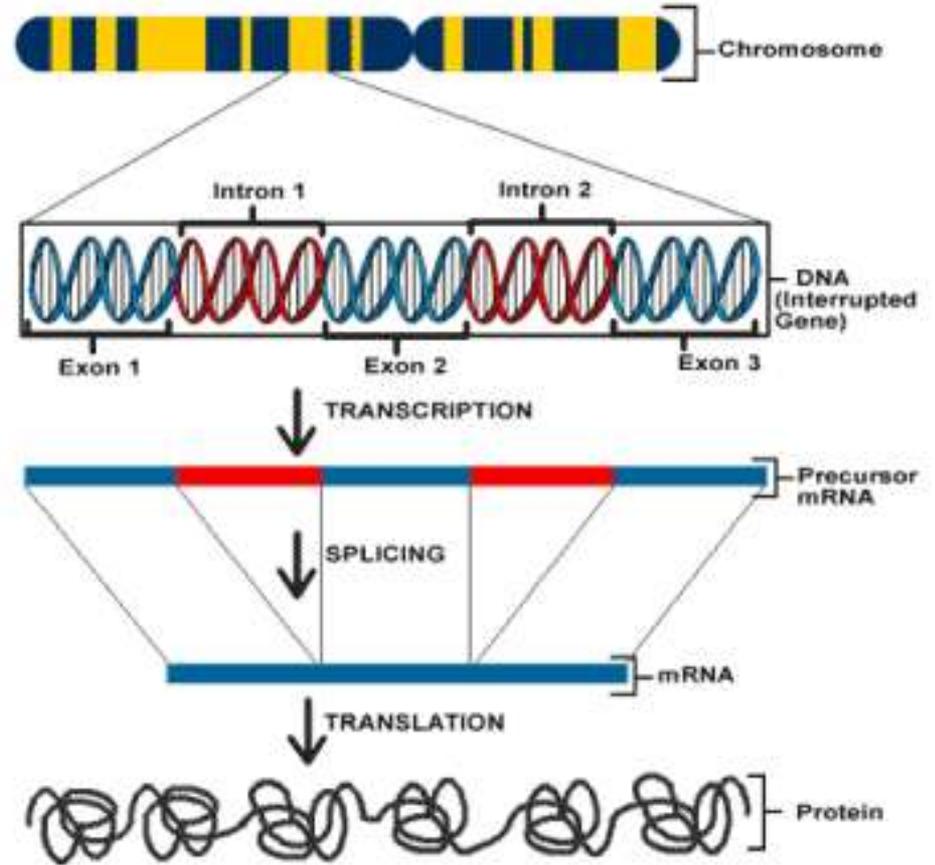
Prokaryotic vs Eukaryotic Transcription

Prokaryotic Transcription	Eukaryotic Transcription
Transcription and translation occur simultaneously	Transcription and translation don't occur simultaneously.
Prokaryotic transcription occurs in the cytoplasm	Eukaryotic transcription occurs in the nucleus and translation occurs in the cytoplasm.
RNAs are released and processed in the cytoplasm	RNAs are released and processed in the nucleus
RNA polymerases are a complex of five polypeptides.	RNA polymerases are a complex of 10 -15 polypeptides.
Doesn't require any proteins or other factors for the initiation of transcription	Requires proteins known as transcription factors for the initiation.

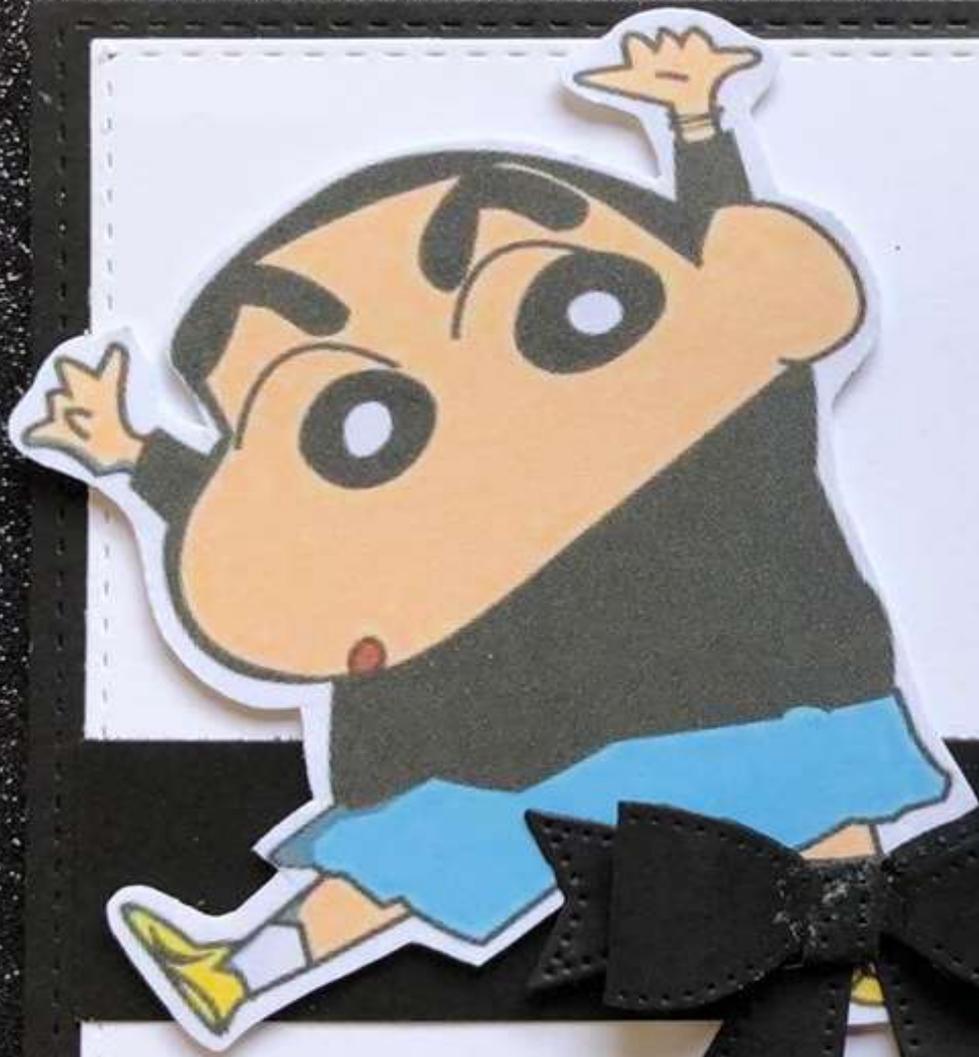
PROKARYOTIC TRANSCRIPTION VS. EUKARYOTIC TRANSCRIPTION



PROKARYOTIC TRANSCRIPTION



EUKARYOTIC TRANSCRIPTION



Thank
You

