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**Topic : Prokaryotic Transcription
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Transcription in Prokaryotes

By Sumana Mukherjee

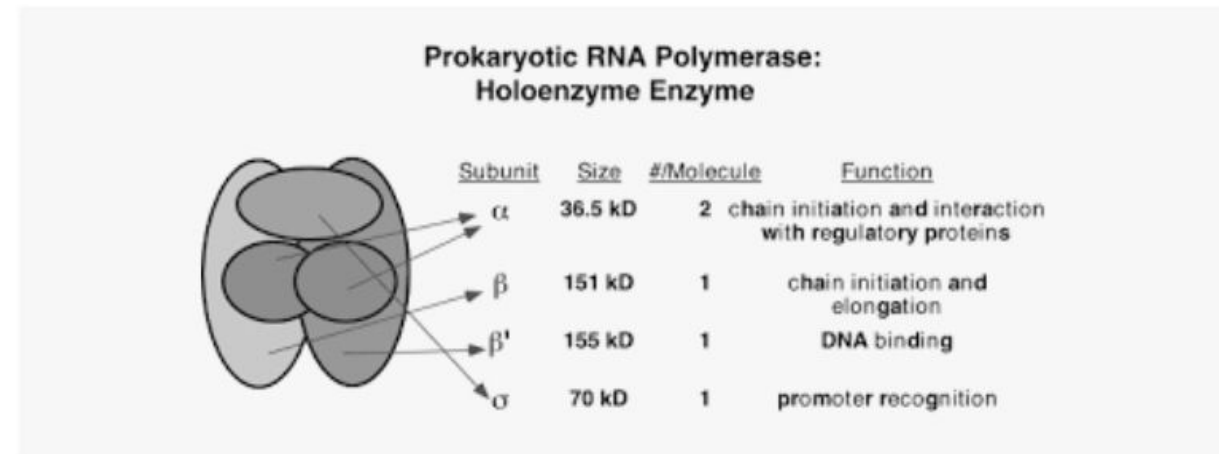
What is transcription?

- The process of synthesis of RNA by copying the template strand of DNA is called transcription.
- Bacterial transcription is the process in which a segment of bacterial DNA is copied into a newly synthesized strand of messenger RNA (mRNA) with use of the enzyme RNA polymerase.
- The process occurs in three main steps: initiation, elongation, and termination; and the end result is a strand of mRNA that is complementary to a single strand of DNA.
- Bacterial transcription differs from eukaryotic transcription in several ways. In bacteria, transcription and translation can occur simultaneously in the cytoplasm of the cell, whereas in eukaryotes transcription occurs in the nucleus and translation occurs in the cytoplasm.

Prokaryotic RNA polymerase enzyme:

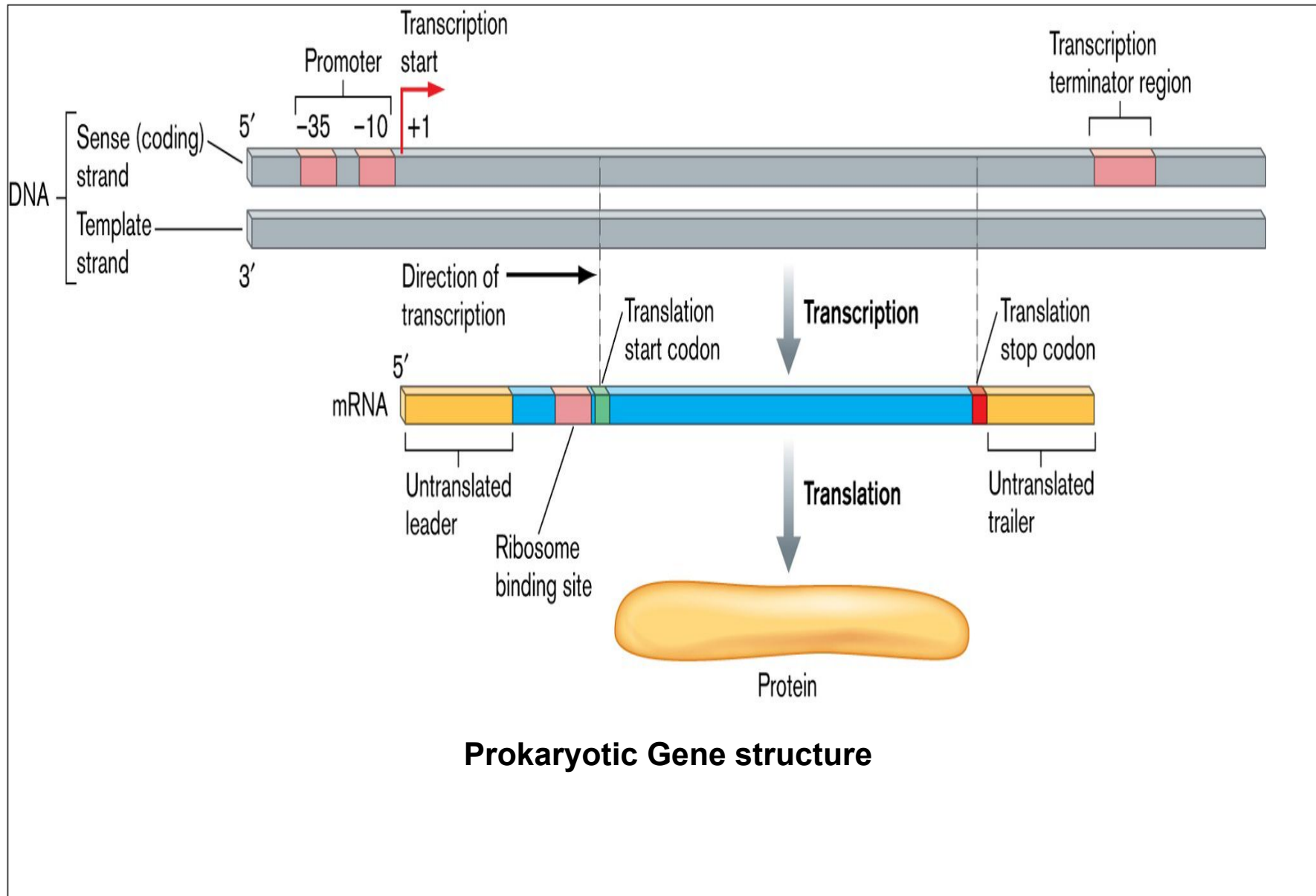
- RNA polymerase is composed of a core and a holoenzyme structure. The core enzymes contains the catalytic properties of RNA polymerase and is made up of $\beta\beta'\alpha_2\omega$ subunits.

SUBUNIT	FUNCTION
α	Determination of the DNA to be transcribed
β	Role in catalysis of the polymerization process
β'	Binds and opens DNA template
ω	Restores denatured RNA polymerase to its functional form in vitro
σ	Recognition of the promoter region for synthesis initiation. The promoter is the DNA sequence that RNA – pol can bind.



Prokaryotic gene structure

- The region 5' of the promoter sequence is called **upstream sequence**
- The region 3' of the terminator sequence is called **downstream sequence**



Prokaryotic genes to be transcribed are composed of mainly three sequence regions:

- 1.Promoter region
- 2.RNA coding sequence
- 3.Terminator region

1.Promoter region:

- Upstream of the sequence that codes for mRNA.
- Site of interaction with RNA polymerase before making mRNA.
- The region that gives the location and direction to start transcribing.

2.RNA coding sequence:

- The DNA sequence that will become copied into an RNA molecule (RNA transcript).

3.Terminator region:

- The region that tells the RNA polymerase to stop making mRNA from DNA template.

The transcription process involves three steps:

1. Initiation

1. Elongation

1. Termination

Promoter region :

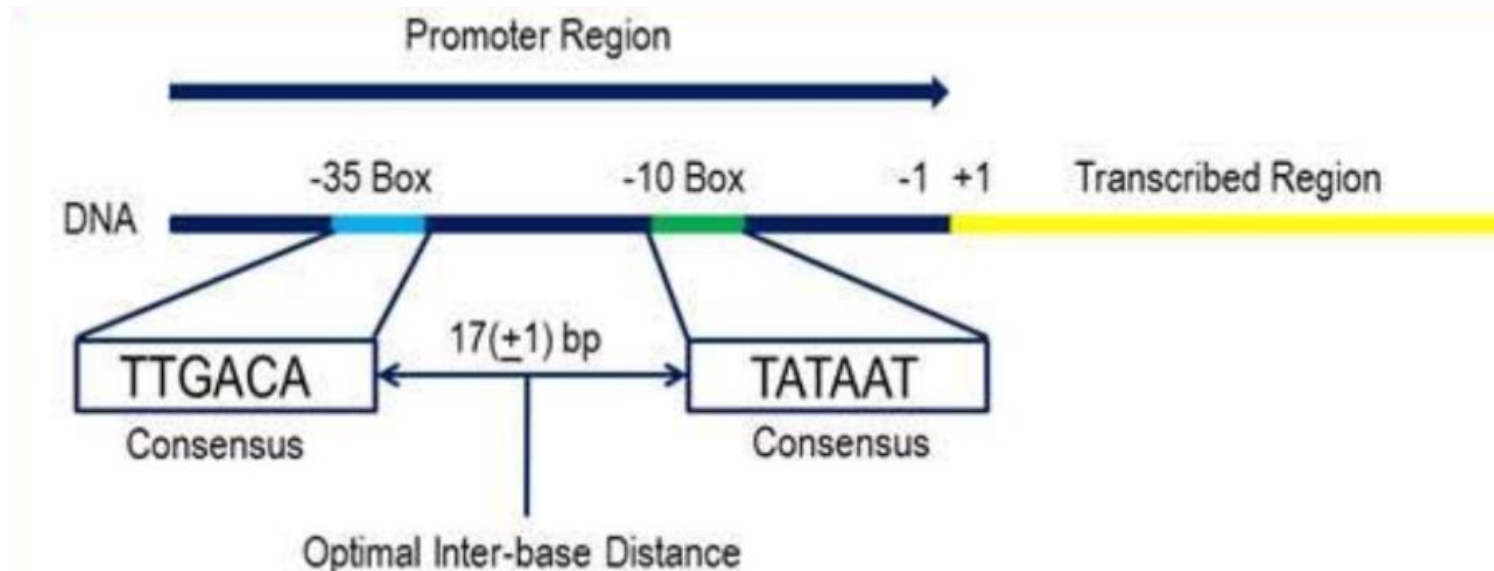
1.It is present at Upstream region of the transcribed sequence.

2.It has a specific sequence at (-10) called:

-10 Box (5' TATAAT3')

3.It has a specific sequence at (-35) called:

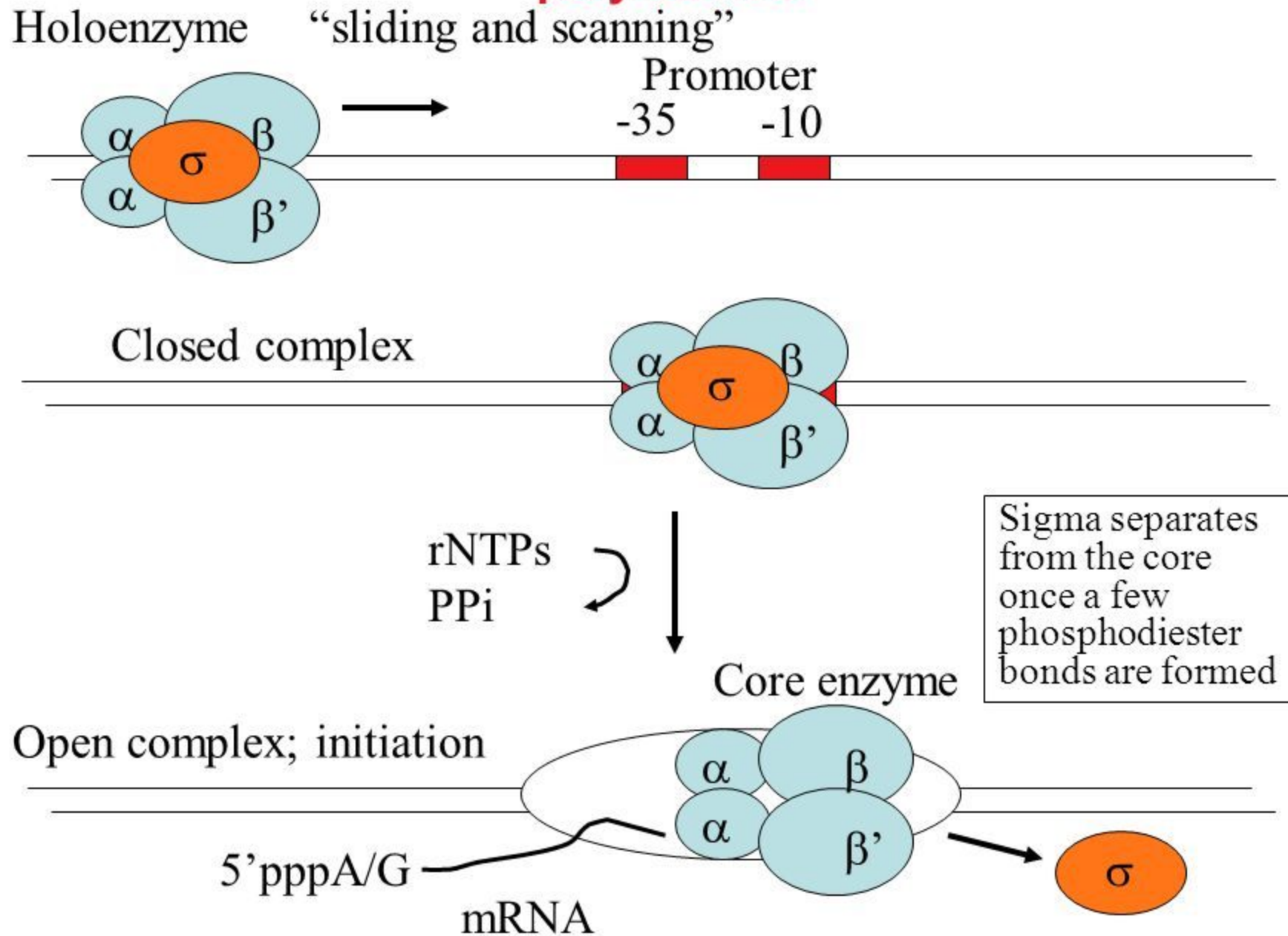
-35 Box (5' TTGACA 3')



Initiation of Transcription:

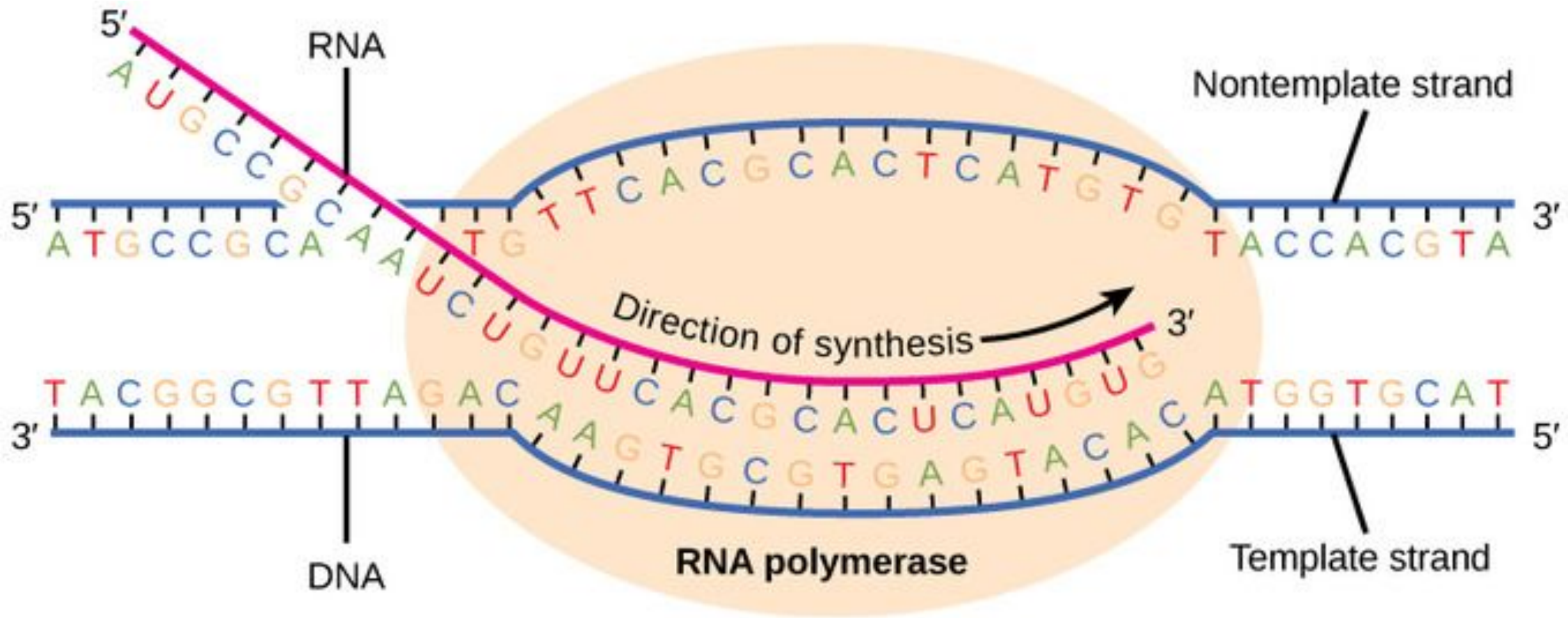
1. Sigma factor (σ) of RNA polymerase binds to promoter sequence (-10, -35 sequence).
2. Core enzyme binds to the sigma factor (σ) and promoter but DNA is still closed.
3. This is called the closed promoter complex.
4. Holoenzyme untwist the double strands of DNA.
5. Untwisted promoter is called the open promoter complex.
6. RNA polymerase binds to -10 sequence and placed in position to start transcription.
7. Sigma factor (σ) is released so that core enzyme can carry on transcribing.

Transcription initiation by prokaryotic RNA polymerase



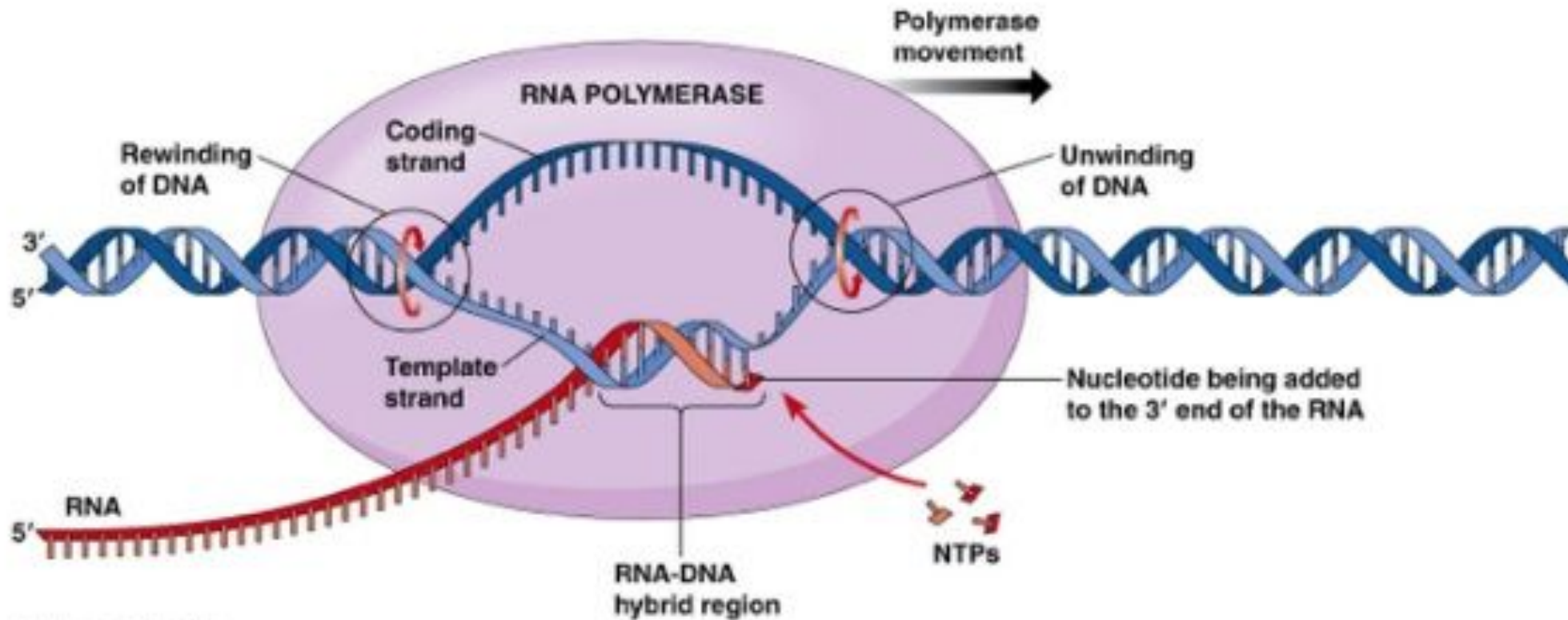
Transcription elongation

1. RNA polymerase (core enzyme) moves along to transcribe the DNA sequence into a single strand RNA of the coding gene.
2. When transcribing, the RNA polymerase interact with DNA sequence forming transcription bubble.
3. DNA double helix is reformed as the RNA polymerase moves forward.
4. Few RNA nucleotides (newly synthesized) form an RNA/DNA hybrid within RNA polymerase.
5. As transcription proceed, single strand RNA gets out of the RNA polymerase.



Elongation of transcription

Transcription elongation



RNA polymerase has proof-reading capabilities (3' – 5')

- 1. Removing 1 nucleotide and adding correct one**
 - 2. Removing several nucleotides and adding new ones**
- Transcription termination**

There are specific signals for the termination of transcription (stop).

Terminators are:

- 1. Rho-independent terminator (type 1 terminator)**
- 2. Rho-dependent terminator (type 2 terminator)**
 - Sequences with the DNA code consisting of inverted repeats upstream of termination point.**

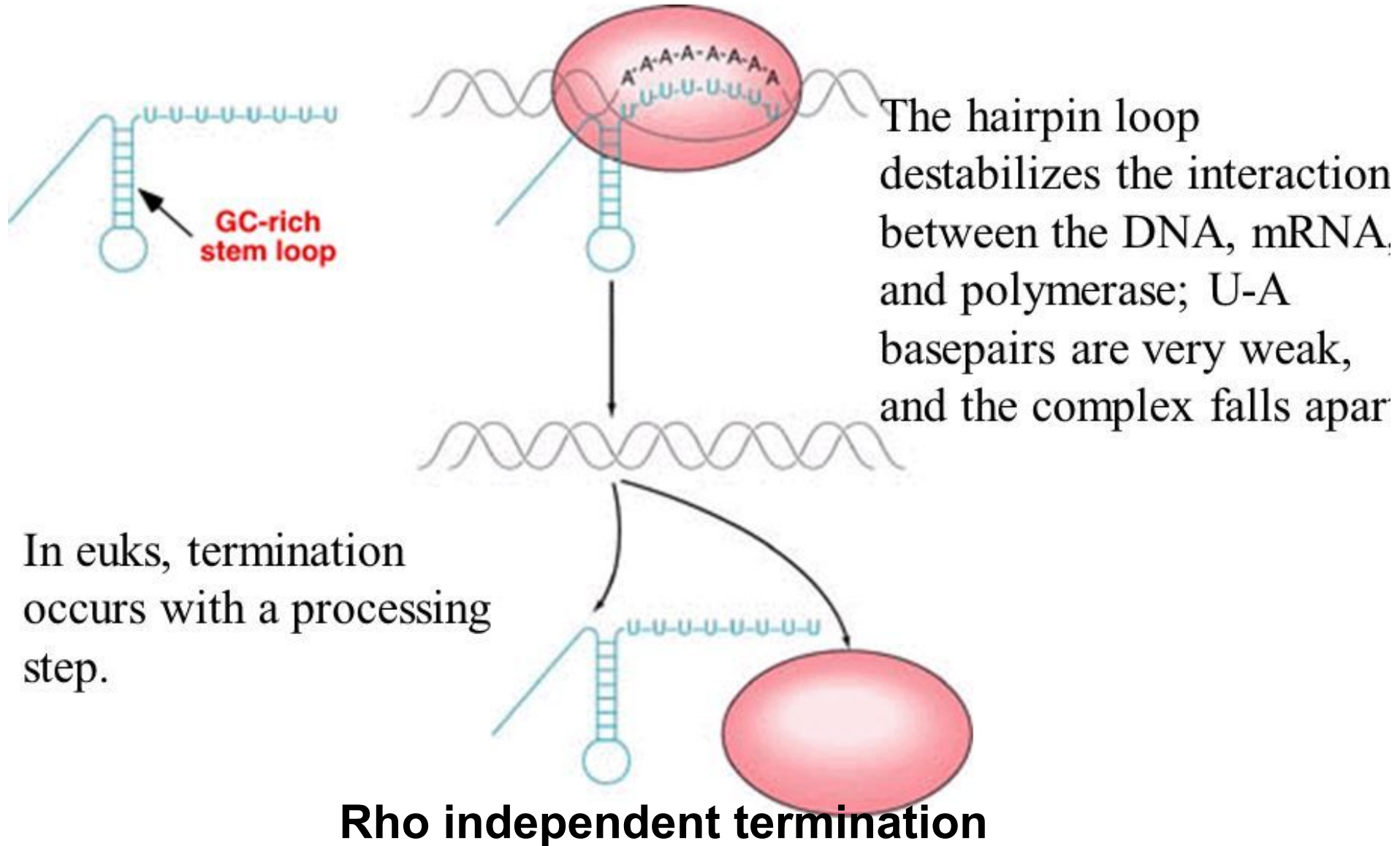
Termination (Rho-independent terminator) - type 1 termination

- RNA moves past the inverted repeats and transcribes the termination sequence.
- Because of the inverted repeat arrangement → RNA synthesized forms a hairpin loop structure.
- Hairpin loop makes the RNA polymerase slow down and eventually stops.

Termination (Rho-independent terminator) - type 1 terminator

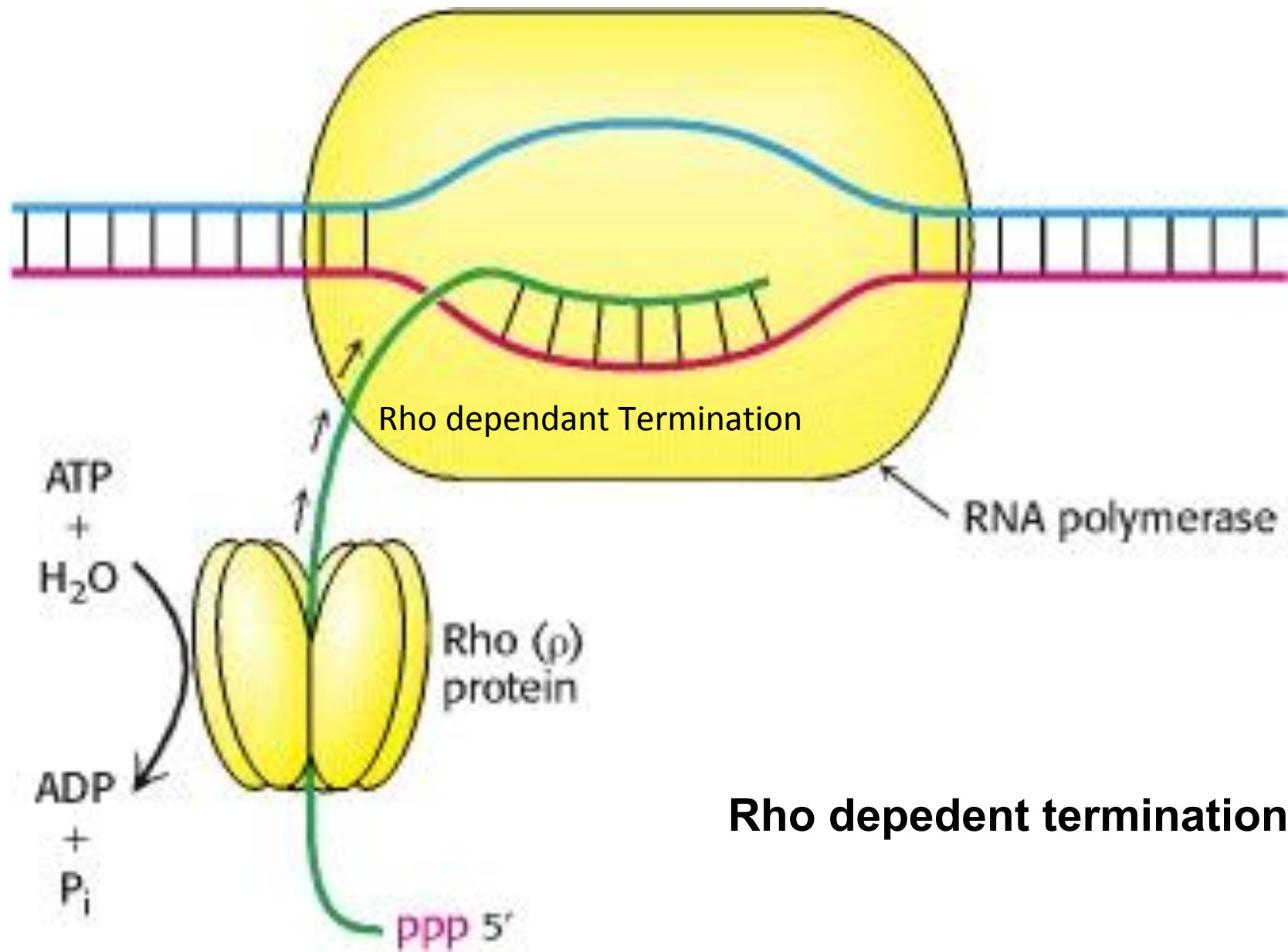
- RNA polymerase can not continue attached to DNA.
- RNA polymerase dissociates.

Termination of Transcription in Bacteria



Termination (Rho-dependent terminator) – type 2 termination

- Terminator is a sequence rich in C (C-rich) and poor in G (G-poor).
- Terminator Does not form a hairpin loop structure.
- Rho (protein) binds to C-rich sequence upstream of the termination site.
- Rho, which is a ATPase protein that moves to the location of the RNA polymerase.
- Rho unwinds the DNA/ RNA hybrid and the RNA transcript is released.
- RNA polymerase and Rho dissociate.



Happy reading