

VIVEKANANDA COLLEGE
THAKURPUKUR
KOLKATA-700063

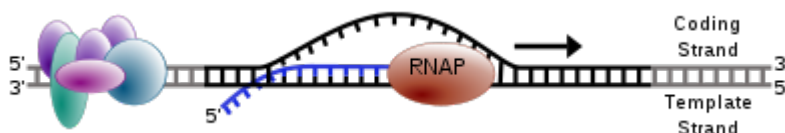
NAAC ACCREDITED 'A' GRADE



Topic : Transcription of Genes
Course Title : Gene Organisation, Expression and Regulation
Paper : GE-4 (CC-4)
Unit : 5
Semester : 4
Name of the Teacher : Dr. Kakali Roy
Name of the Department : Biochemistry

General features of Gene Transcription

- The production of a RNA copy from a DNA strand by [RNA polymerases](#) is called [transcription](#) which add one ribonucleotide at a time to a growing RNA strand as per the [complementarity](#) law of the nucleotide bases. This RNA is [complementary](#) to the template 3' → 5' DNA strand, with the exception that [thymines](#) (T) are replaced with [uracils](#) (U) in the RNA.
- In prokaryotes, transcription is carried out by a single type of RNA polymerase (RNAP), which needs to bind a DNA sequence called a [Pribnow box](#) with the help of the [sigma factor](#) protein (σ factor) to start transcription.
- In eukaryotes, transcription is performed in the nucleus by three types of RNA polymerases, each of which needs a special DNA sequence called the [promoter](#) and a set of DNA-binding proteins—[transcription factors](#)—to initiate the process.
- [RNA polymerase I](#) is responsible for transcription of ribosomal RNA (rRNA) genes.
- [RNA polymerase II](#) (Pol II) transcribes all protein-coding genes but also some non-coding RNAs (e.g., snRNAs, snoRNAs or long non-coding RNAs).
- [RNA polymerase III](#) transcribes 5S rRNA, transfer RNA (tRNA) genes, and some small non-coding RNAs.
- Transcription ends when the polymerase encounters a sequence called the [terminator](#).



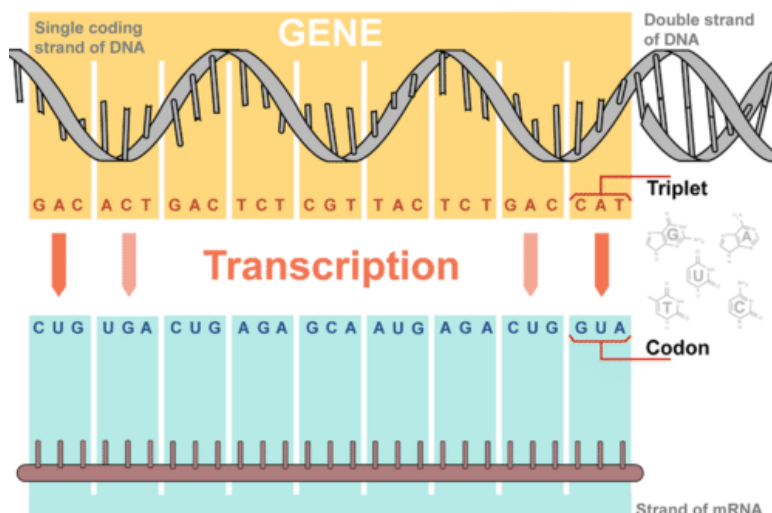
RNAP uses DNA (black) as a template and produces RNA (blue)

TRANSCRIPTION

General features:

- RNA polymerase (one kind in prokaryote containing five subunits and several kinds in eukaryotes where each transcribes a different type of genes)
- Promoter sequences immediately upstream of the gene and contain sequences that have high affinity to bind RNA polymerase
- Synthesis of RNA is in the 5' to 3' direction. At the transcription bubble, RNA forms a duplex with the template DNA strand where A is complementary to U and C is complementary to G.
- Transcription is terminated at the the 3' end of the gene at sequences know as terminators which direct RNA polymerase to stop synthesis.

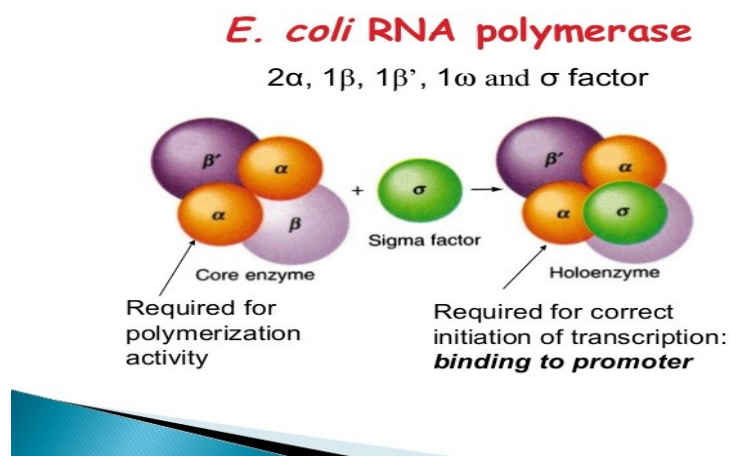
- Transcription is the first part of the central dogma of molecular biology: DNA → RNA. It is the transfer of genetic instructions in DNA to messenger RNA (mRNA). During transcription, a strand of mRNA is made that is complementary to a strand of DNA.
- Transcription takes place in the nucleus.



Transcription uses the sequence of bases in a strand of DNA to make a complementary strand of mRNA. Triplets are groups of three successive nucleotide bases in DNA. Codons are complementary groups of bases in mRNA.

Prokaryotic RNA Polymerase

- The prokaryotic RNA polymerase is the single type of RNA polymerase responsible for prokaryotic transcription.
- The complete holoenzyme of prokaryotic RNA polymerase consists of five subunits; β β' α_1 and $\alpha_2\omega\sigma$.
- There are distinct sigma factors which oversee the transcription of specific sets of genes. Moreover, they can be distinguished by the distinct sets of promoters to which these transcription factors bind.



Eukaryotic RNA Polymerase

- The eukaryotic RNA polymerase is the group of enzymes responsible for the transcription in eukaryotes.
- Generally, eukaryotic transcription is more complex than prokaryotic transcription. Moreover, this is achieved by the presence of different types of RNA polymerases to transcribe specific types of RNA genes.
- The three main types of RNA polymerases in eukaryotes are RNA pol I responsible for the transcription of rRNA, RNA pol II responsible for the

transcription of mRNA, and RNA pol III responsible for the transcription of tRNA, rRNA 5S, and other small RNAs.

- There are other two types of RNA polymerases.
- RNA pol IV is responsible for the transcription of siRNA in plants and RNA pol V is responsible for the transcription of RNAs in siRNA-directed heterochromatin formation in plants.

Type	Present in	Transcribes
RNA polymerase I	All eukaryotes	Large rRNAs
RNA polymerase II	All eukaryotes	Pre-mRNA, some snRNAs, snoRNAs, some miRNAs
RNA polymerase III	All eukaryotes	tRNAs, small rRNAs, some snRNAs, some miRNAs
RNA polymerase IV	Plants	Some siRNAs
RNA polymerase V	Plants	RNA molecules taking part in heterochromatin formation

**PROKARYOTIC RNA POLYMERASE
VERSUS
EUKARYOTIC RNA POLYMERASE**

PROKARYOTIC RNA POLYMERASE	EUKARYOTIC RNA POLYMERASE
The RNA polymerase in prokaryotes, consisting of four subunits and a sigma factor	The five types of RNA polymerases occur in eukaryotes
Types: A Single Type occurs in prokaryotes	Types: RNA pol I, II, III, IV, and V
The core enzyme contains five subunits	Contains 10-20 subunits
Size: Around 400 kDa	Size: Around 500 kDa
Synthesizes polycistronic RNA	Synthesizes monocistronic RNA
Prokaryotes regulate transcription with the use of different types of sigma factors	Eukaryotic transcription is regulated by the presence of different types of RNA polymerases

Visit www.PEDIAA.com

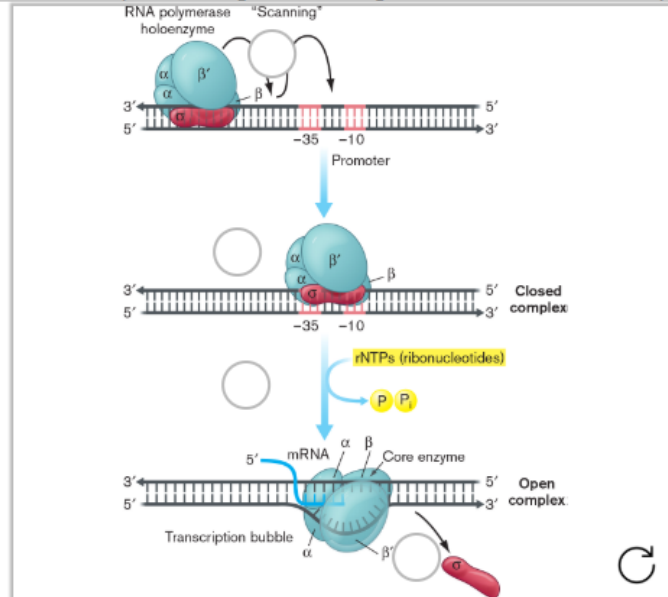
Stages of Transcription

Transcription takes place in three steps: initiation, elongation, and termination.

1. **Initiation** is the beginning of transcription.

- It occurs when the enzyme RNA polymerase binds to a region of a gene called the promoter.
- This signals the DNA to unwind so the enzyme can “read” the bases in one of the DNA strands.
- The enzyme is now ready to make a strand of mRNA with a complementary sequence of bases.

Label the steps in the figure showing the initiation of transcription.



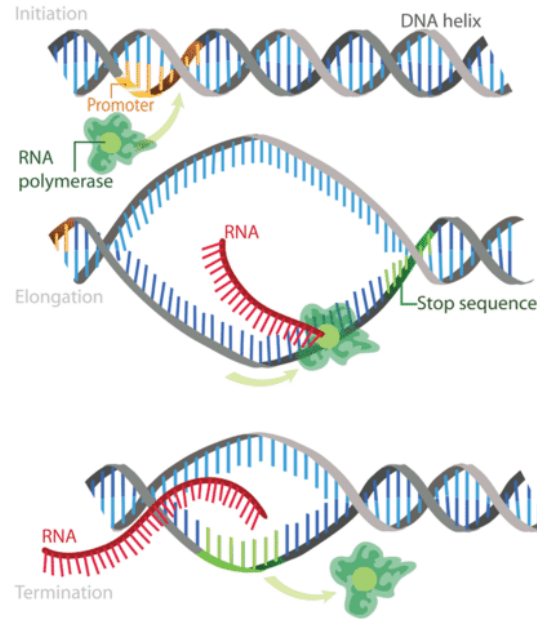
- (A) RNA polymerase binds to promoter
- (B) RNA polymerase begins transcription
- (C) RNA polymerase searches for promoter
- (D) Sigma factor leaves complex

2. **Elongation** is the addition of nucleotides to the mRNA strand.

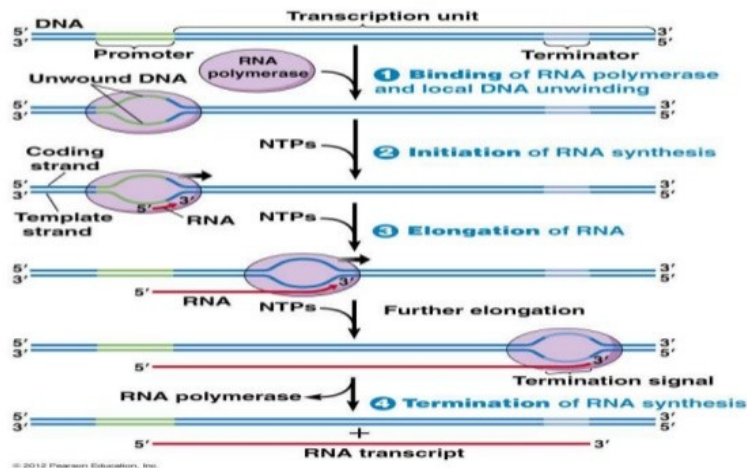
- RNA polymerase reads the unwound DNA strand and builds the mRNA molecule, using complementary base pairs.
- There is a brief time during this process when the newly formed RNA is bound to the unwound DNA.
- During this process, an adenine (A) in the DNA binds to an uracil (U) in the RNA.

3. **Termination** is the ending of transcription.

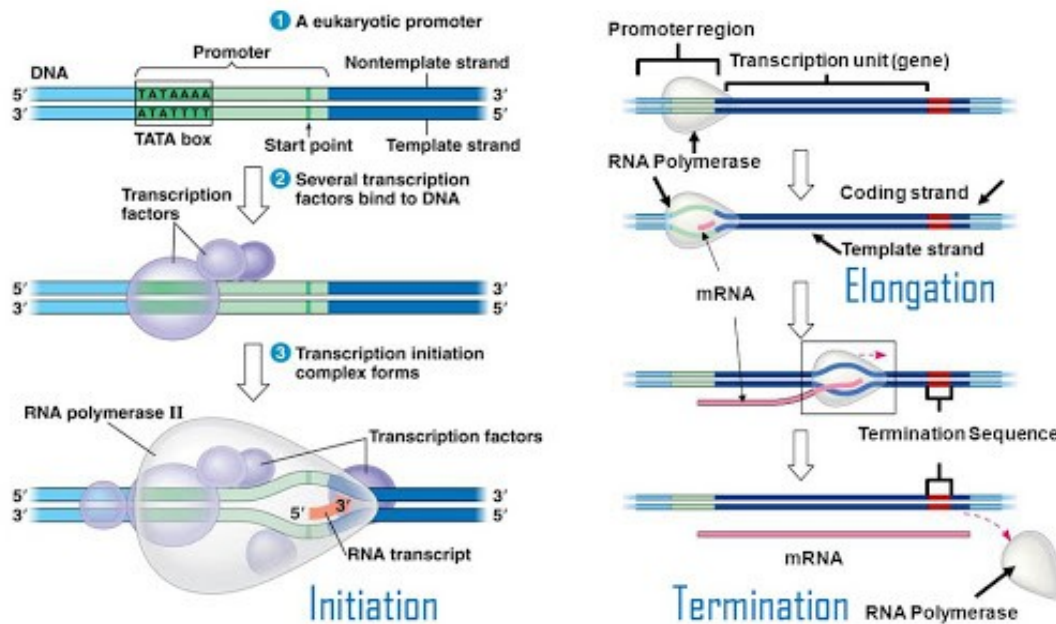
- It occurs when RNA polymerase crosses a stop (termination) sequence in the gene.
- The mRNA strand is complete, and it detaches from DNA.



Overview of Prokaryotic DNA Transcription



Transcription in Eukaryotes



Inhibitors of Transcription

Inhibitors of gene expression

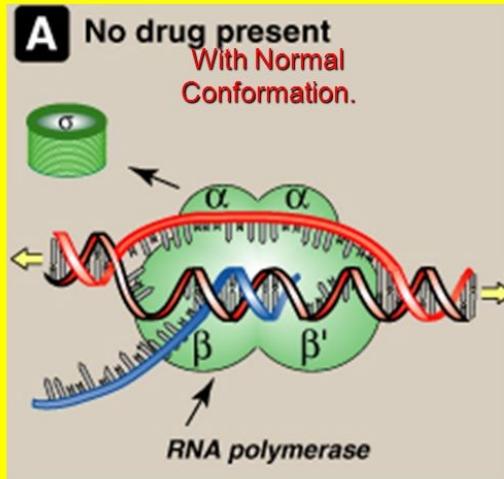
1. Inhibitors of prokaryotic transcription:

- **Actinomycin D** binds to DNA and blocks transcription
- **Rifampicin** binds to RNA polymerase and blocks initiation of RNA synthesis
- **Streptolydigin** inhibits elongation of transcription by binding to RNA polymerase

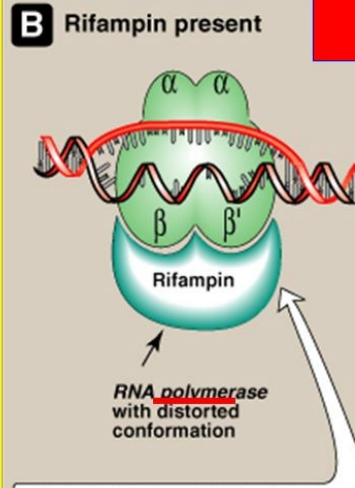
2. Inhibitors of eukaryotic transcription:

- **α -Amanitin** inhibits RNA polymerase II and RNA polymerase III (at high doses). RNA polymerase I is insensitive

Inactivation of Prokaryotic RNA Polymerase By Rifampin



Rifampin specifically binds to Prokaryotic RNA polymerase AND **NOT Eukaryotic.**



Rifampin binds to *RNA polymerase* and changes its conformation so that it cannot initiate RNA synthesis. *RNA polymerase* from eukaryotic cells does not bind rifampin, and RNA synthesis is unaffected.

Reference

1. www.pediaa.com
2. Courses.lumenlearning.com/bio1
3. www.google.com