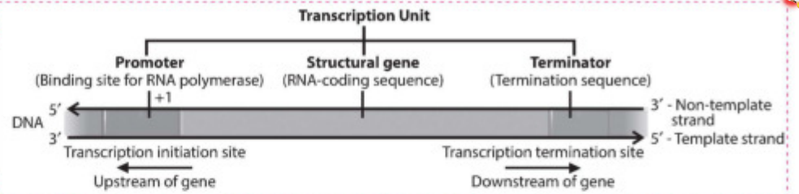
CONCEPT MAP

TRANSCRIPTION

Transcription is the process of copying of genetic information from template strand of DNA to an RNA molecule. Template strand refers to DNA strand that directs synthesis of RNA and have 3′ → 5′ polarity. The other strand having 5′–3′ polarity is called antisense strand. RNA synthesis occurs in 5′ → 3′ direction and requires an enzyme complex called RNA polymerase and other initiation and termination proteins.

TRANSCRIPTION UNIT

Refers to the sequence of nucleotides in DNA that codes for an RNA molecule along with other sequences necessary for transcription.

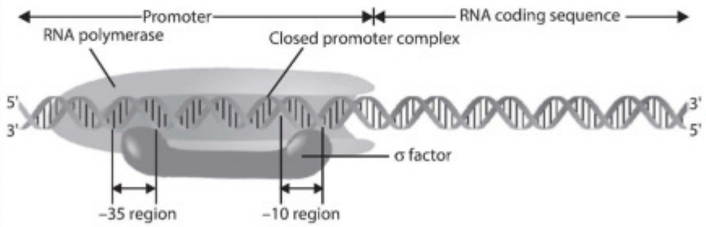


- Transcription takes place in cytoplasm.
- **Structural genes** are polycistronic *i.e.*, encodes for more than one polypeptide.
- **Promoters include** (i) "– 10 sequence" is TATAAT; called "Pribnow box". (ii) "–35 sequence" is TTGACA, called "recognition sequence".
- Only one type of RNA polymerase is involved, represented by $(2\alpha\beta\beta'\omega)\sigma$.

IN PROKARYOTES

The sigma (σ) factor binds to promoter site of DNA and initiates transcription.

(1) In initiation, the RNA polymerase holoenzyme first recognises the promoter at the -35 region and binds to the full promoter.



(2) As initiation continues, RNA polymerase binds more tightly to the promoter at the -10 region, accompanied by a local untwisting of the DNA in that region. At this point, the RNA polymerase is correctly oriented to begin transcription.

MECHANISM OF TRANSCRIPTION

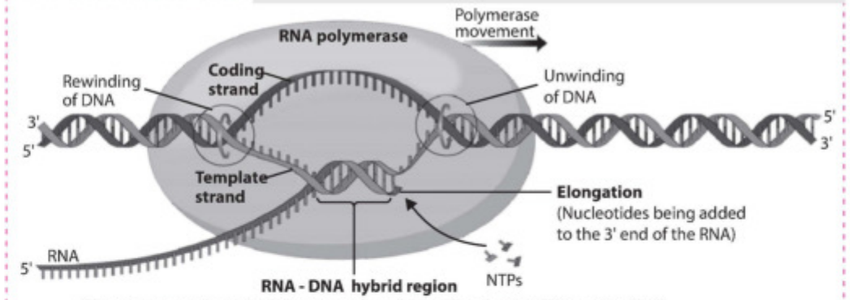
Involves three steps:

Initiation

Just before initiation, RNA polymerase and accessory proteins bind to a DNA molecule upstream of the initiation point. The DNA is unwound to separate and expose the strand to be transcribed. Then, the RNA polymerase complex binds to promoter sequence, which initiates transcription. Polymerase begins to synthesise a strand of RNA complementary to one side of the DNA strand, moving into the coding sequence portion of the gene being transcribed. The enzyme and the factors involved are different in both eukaryotes and prokaryotes.

Elongation

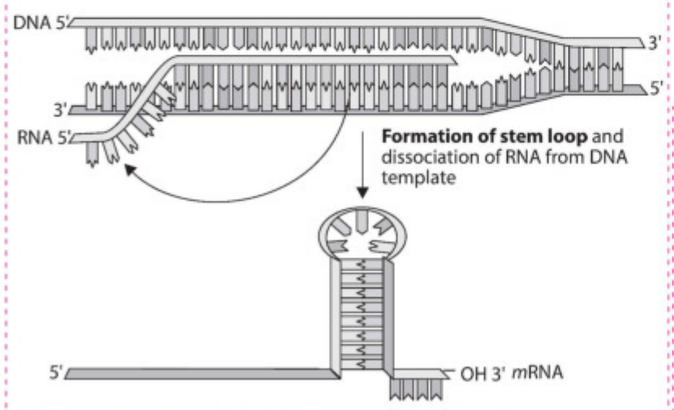
During elongation, a lengthening RNA molecule is synthesised by DNA polymerase as it reads the DNA triplet code on the template strand. The DNA polymerase will continue reading the template until it reaches a sequence that provides a signal indicating that transcribed region is at an end. Another RNA polymerase can attach to the promoter to begin synthesising another RNA before the first one is finished.



Termination

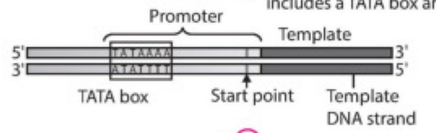
Termination of transcription is triggered when the RNA polymerase encounters a particular DNA sequence, causing the polymerase to lose affinity for the DNA template. At this point, RNA polymerase disengages from the DNA and the RNA molecule is released for translation or post-transcriptional processing.

- **Termination** may or may not require rho (σ) factor.
- *m*RNA do not undergo any processing and may undergo translation before the completion of transcription *i.e.*, coupled as both the processes takes place in cytosol and in 5′ → 3′ direction.
- Most prokaryotic *m*RNAs terminate with the sequence 5′-UUUUUUA-3′, which allows nascent transcript to form **hairpin loop** that disrupts the RNA-DNA hybrid as well as the interaction between DNA and polymerase resulting in dissociation and termination of transcription of RNA molecule.

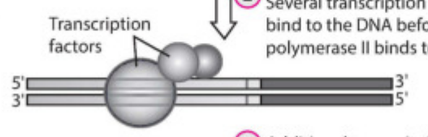


IN EUKARYOTES

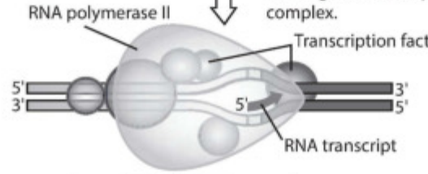
(1) An eukaryotic promoter includes a TATA box and CAAT box



(2) Several transcription factors must bind to the DNA before RNA polymerase II binds to it



(3) Additional transcription factors bind to the DNA along with RNA polymerase II, forming the transcription initiation complex.



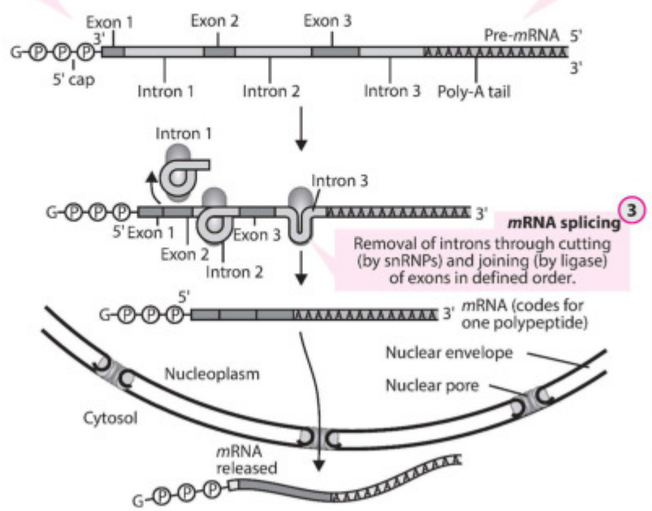
Sigma factor is absent and primer is not required.

- Transcription takes place in nucleus.
- **Structural genes** are monocistronic *i.e.*, encodes for single polypeptide.
- **Promoters include**- (i) "–25 sequence" is TATAAAA, called "Hogness box" or "TATA box" (ii) "–75 sequence" is GGCCAATCT, called "CAAT box".
- Besides promoters, eukaryotes also require enhancers.
- Three types of RNA polymerases are involved: RNA Pol I (transcribes *r*RNAs), RNA Pol II (transcribes *m*RNA, hnRNA), RNA Pol III (transcribes *t*RNA, 5S*r*RNA, etc.)

Post Transcriptional Modifications of hnRNA

(1) **Capping** Addition of methyl guanosine triphosphate (mGPPP) that protects *m*RNA from nucleases and provides ribosome binding site.

(2) **Tailing** Addition of 200-300 polyadenylate residues with the help of poly A polymerase. It protects 3′ end from degradation by exonucleases.



- **Termination** - Coupled transcription - translation is not possible in eukaryotes, as transcription products *i.e.*, RNA pass from nucleus to cytoplasm for translation. The nascent RNA *i.e.*, hnRNA or primary transcript undergoes modifications to form functional *m*RNA.