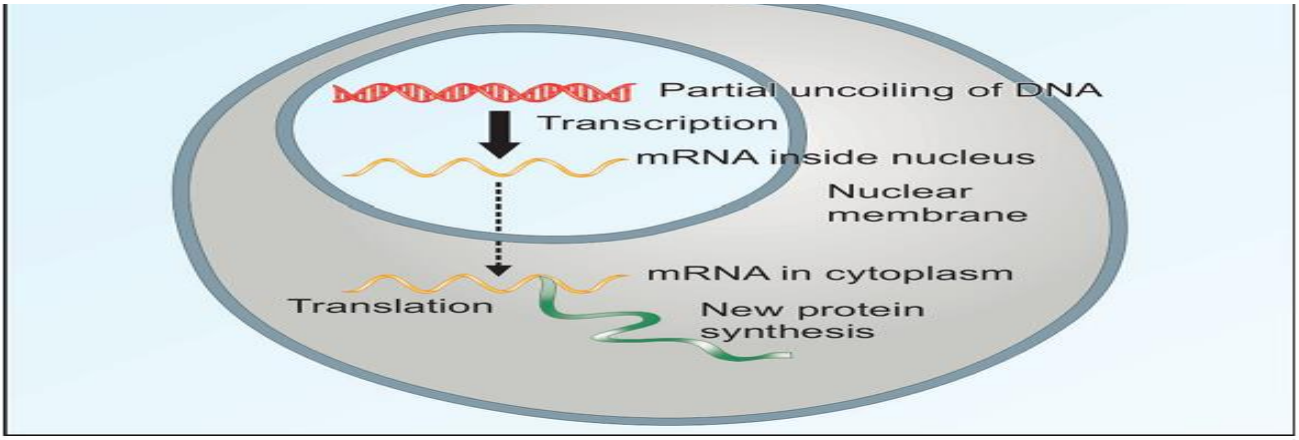
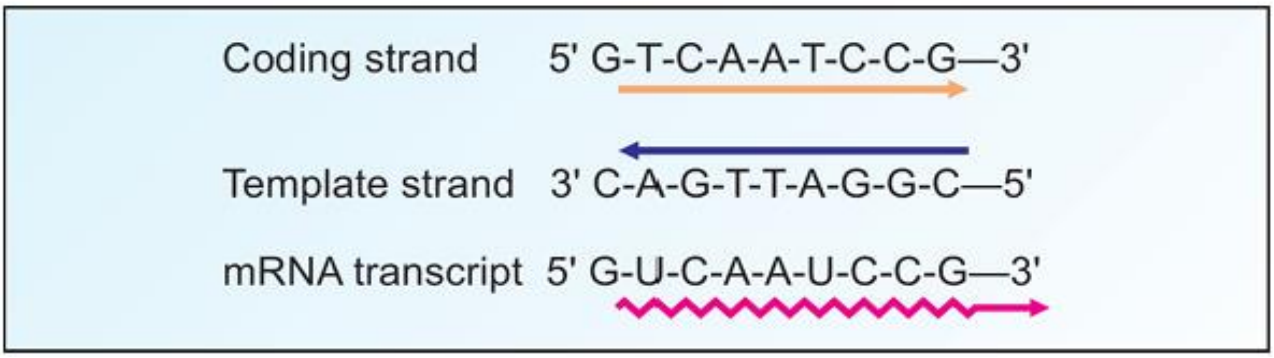
AL-MUSTAQBAL UNIVERSITY
COLLEGE OF SCIENCE
DEPARTMENT OF BIOCHEMISTRY
by ABBAS HAMZA KHUDAIR
Lec - 4

Transcription

SUMMARY

1. *Transcription is the process in which RNA is synthesized from DNA, which is carried out in 3 stages–initiation, elongation and termination.*
2. *In case of prokaryotes, a single enzyme synthesizes all the RNAs. In eukaryotes, RNA polymerase I, II and III respectively catalyse the formation of rRNAs, mRNAs and tRNAs.*
3. *The primary mRNA transcript (i.e. hnRNA) undergoes post-transcriptional modifications e.g. base modifications, splicing etc.*
4. *Reverse transcription is the process of synthesizing DNA from RNA by the enzyme reverse transcriptase.*
5. *Biosynthesis of a protein or a polypeptide is known as translation. The amino acid sequence of a protein is determined by the triplet nucleoside base sequences of mRNA, arranged as codons.*
6. *The genetic code (codons)–composed of A, G, C and U–is universal, specific, non-overlapping and degenerate. Of the 64 codons, three (UAA, UAG, UGA) are termination codons while the rest code for amino acids.*
7. *Ribosomes are the factories of protein biosynthesis. Translation involves activation of amino acids, protein synthesis proper (initiation, elongation and termination), protein folding and post-translational modifications.*
8. *The post-translational modifications include proteolytic degradation, intein splicing and covalent modifications (phosphorylation, hydroxylation, glycosylation etc.). These modifications are required to make the proteins biologically active.*
9. *The proteins synthesized in translation reach the destination to exhibit their biological activity. This is carried out by a process called protein targeting or protein sorting.*
10. *The mitochondria possess independent DNA with the machinery for transcription and translation. However, only a few proteins (around 13) are actually synthesized in the mitochondria.*





Transcription

is the process of synthesizing RNA from a DNA template. It takes place in the 5' → 3' direction. The newly synthesized mRNA [primary transcript, heterogeneous nuclear RNA (hnRNA)] is identical to the other DNA strand—the coding strand (except having uracil in place of thymine).

I.E 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. 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).

Signals for Initiation of Transcription

Promoters There are certain consensus sequences on DNA which act as start signals which may be located upstream or downstream from the start site. The RNAP attaches at the promoter site on the template DNA strand. In human beings, **about 105 transcription initiation sites are present on the entire DNA.**

Requirements

1 • **DNA** to be copied

2• **RNA polymerase**, RNAP (holoenzyme): Core enzyme (2α, 1β, 1β') + σ (sigma) factor.

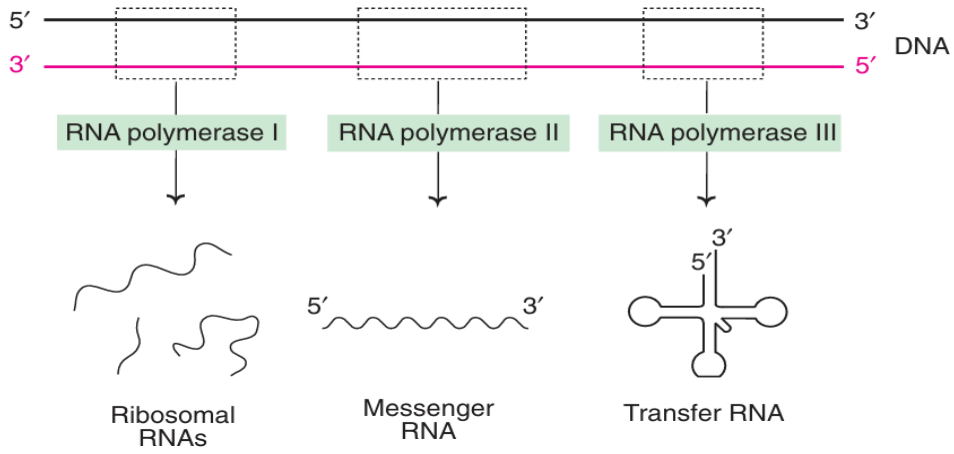
RNA polymerases

The nuclei of eukaryotic cells possess three distinct RNA polymerases .

1. RNA polymerase I is responsible for the synthesis of precursors for the large ribosomal RNAs.

2. RNA polymerase II synthesizes the precursors for mRNAs and small nuclear RNAs.

3. RNA polymerase III participates in the formation of tRNAs and small ribosomal RNAs.



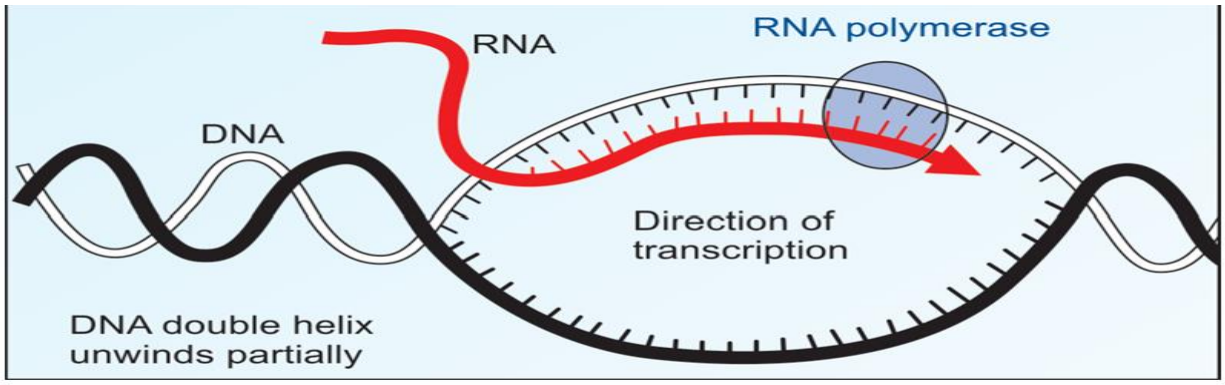
3• **Termination factor**—ρ (rho): For termination of transcription

4• **ATP**

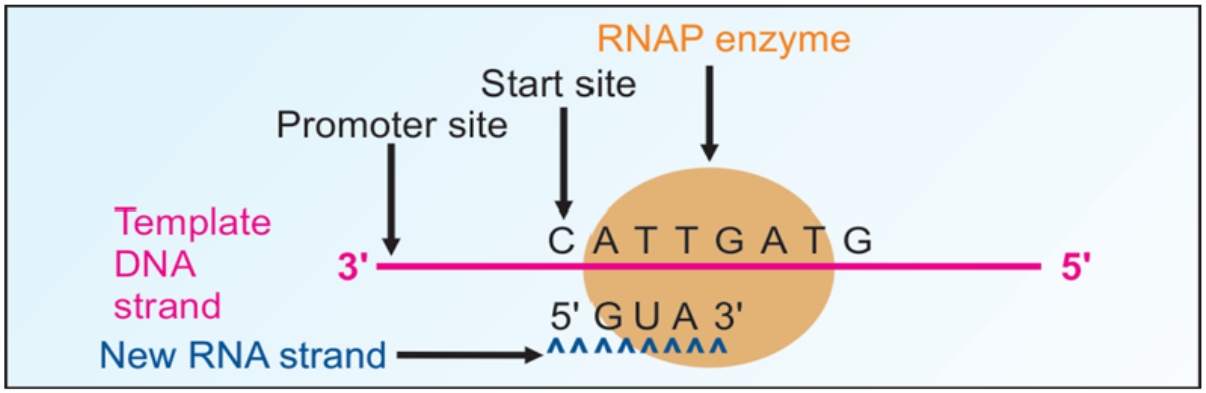
5• **Helicase**: Unwinding of DNA during transcription

6• **Topoisomerase I and II**: Remove supercoiling.

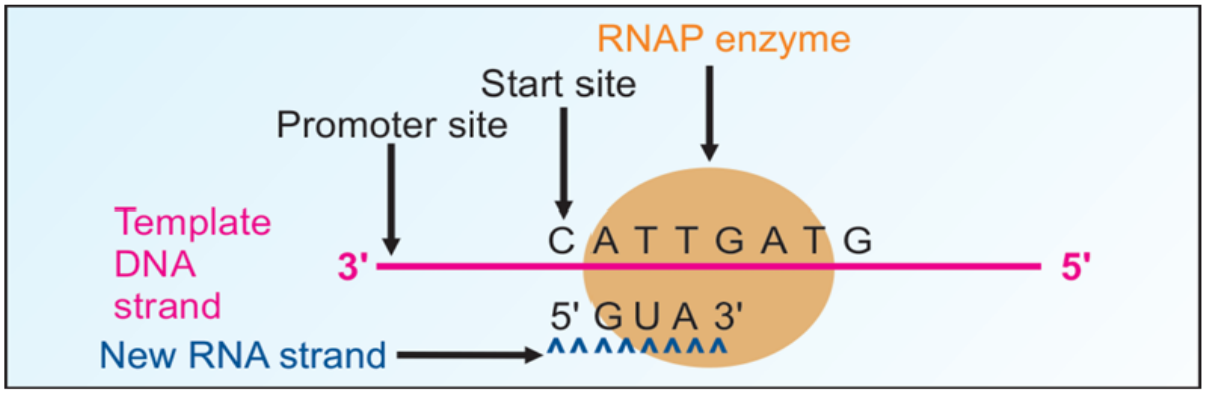
Steps in Transcription include



DNA unwinds for transcription process



Initiation of transcription



Initiation of transcription

Initiation elongation and termination.

i. Binding of RNAP to the template strand of DNA and formation of preinitiation complex: RNA polymerase (holoenzyme) binds to promoter region of DNA.

ii. Initiation of chain synthesis: The first nucleotide of RNA binds to nucleotide binding site of 'β' subunit of RNA polymerase to form 5' end of RNA. RNA polymerase moves to next base on the template strand. A corresponding nucleotide binds to RNA polymerase and phosphodiester bond is formed between the two nucleotides .

iii. Clearance of promoter: Nucleotides continue to be added**. Once RNA has 10–20 nucleotides**, RNA polymerase leaves the promoter site (promoter clearance) and moves along template strand.

iv. Elongation: After promoter clearance, elongation phase starts. New nucleotides are added to the nascent mRNA complementary to the template strand. RNA polymerase uses ribonucleotides ATP, GTP, CTP and UTP. For addition of each ribonucleotide, energy equivalent to two ATP is used .

v. Termination: Process of transcription continues until termination signal sequence is reached on the template strand of DNA.

Post-transcriptional Processing

i. The mRNA formed and released from the DNA template is known as the primary transcript. It is also known as heteronuclear mRNA or hnRNA.

ii. In mammalian system, it undergoes extensive processing to become the mature mRNA.

These modifications are:

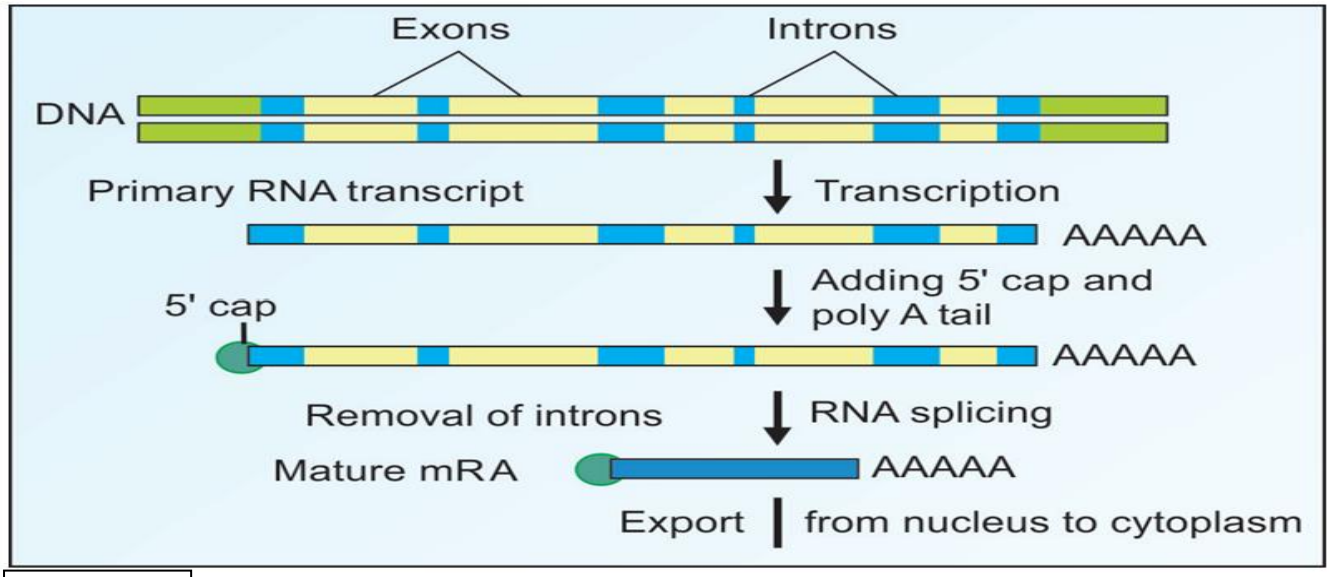
a. Poly-A tailing

b. 5’ capping

c. Methylation

d. Removal of introns

e. Splicing of exons (connect together).



Splicing process; removal of introns