Transcription: Synthesizing RNA from DNA

SBI4UP

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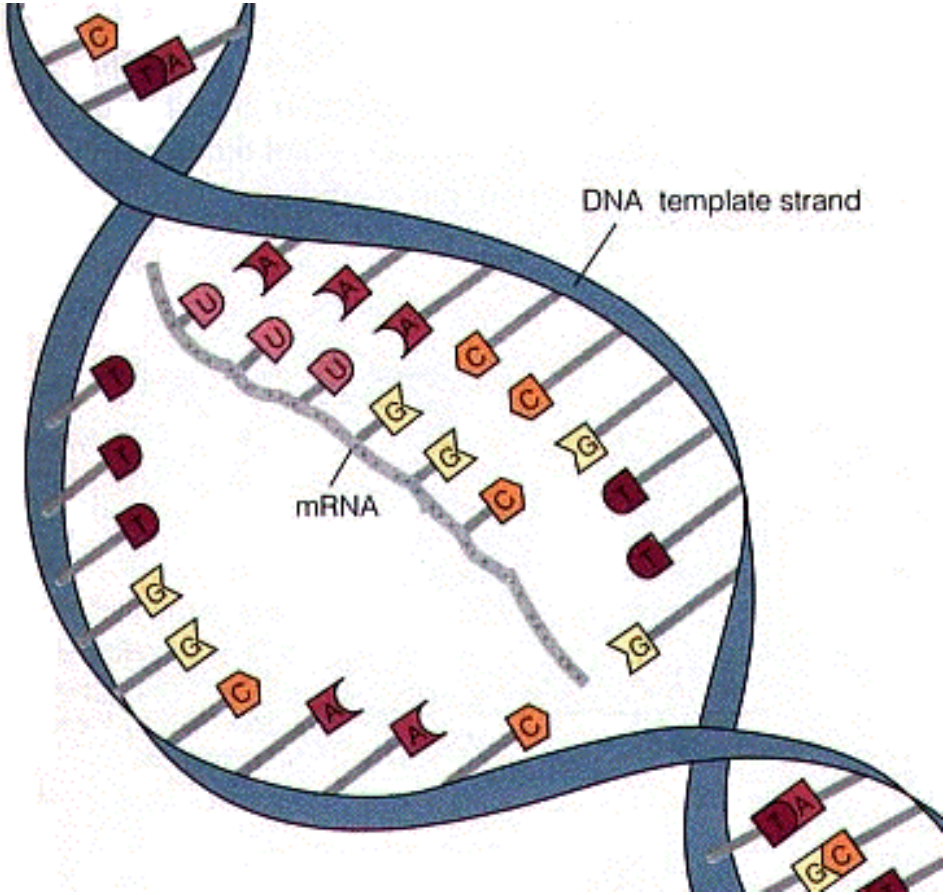
Different Forms of RNA

Table 6.3 Different RNA Molecules and Their Functions

RNA	Function
Messenger RNA (mRNA)	the template for translation
Transfer RNA (tRNA)	involved in the translation of mRNA
Ribosomal RNA (rRNA)	involved in the translation of mRNA
Small nuclear RNA (snRNA)	involved in modification of mRNA molecules
Micro RNA (miRNA)	involved in regulating gene expression
Small interfering RNA (siRNA)	involved in regulating gene expression
RNA in RNaseP	RNaseP is an enzyme; the RNA is the part of the enzyme
7S RNA	involved in targeting proteins to particular regions in eukaryotic cells
Viral RNA	found in some viral genomes

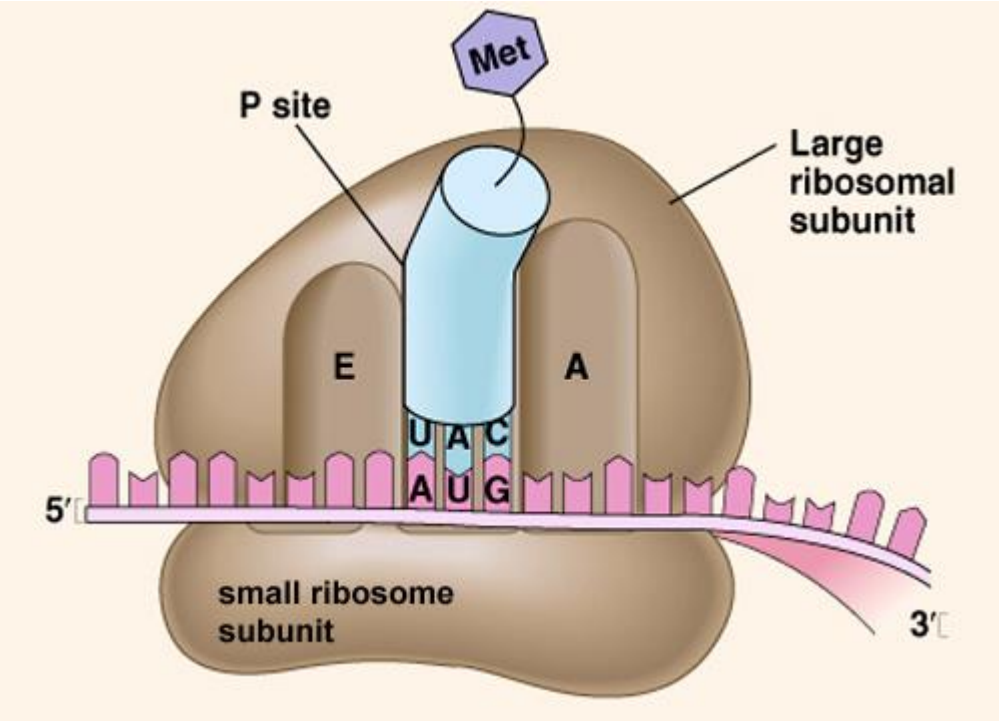
1) Messenger RNA (mRNA)



1) <u>mRNA:</u>

- One DNA strand is copied into RNA
- mRNA is a modified form of DNA
- Travels into the cytoplasm where it can be translated into a protein

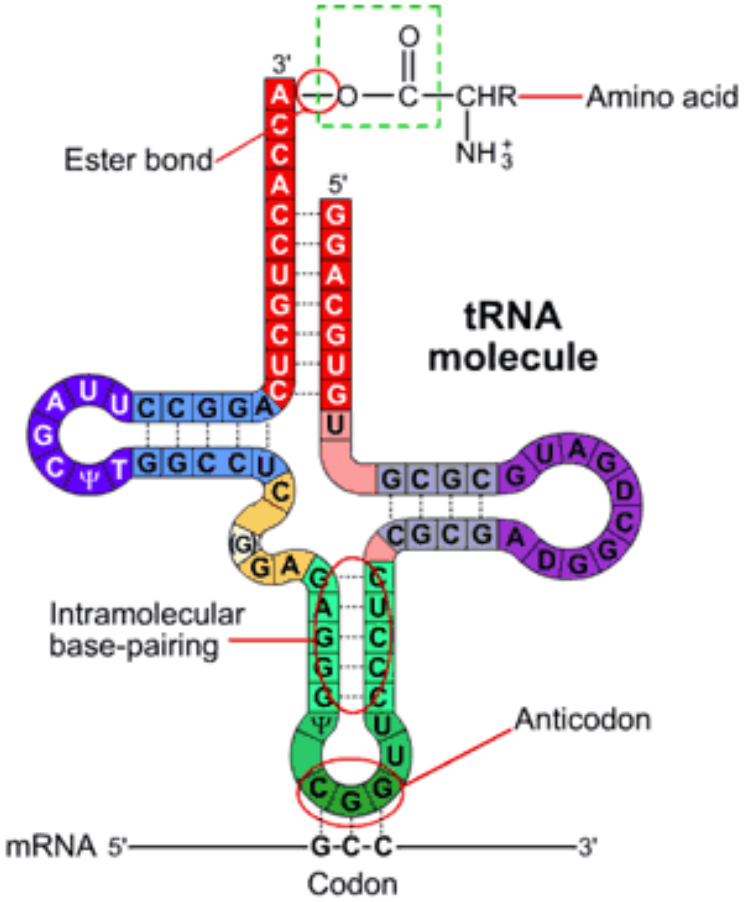
2) Ribosomal RNA (rRNA)



2) rRNA:

- Involved in the translation of mRNA into a polypeptide
- Creates a ribosome which consists of proteins and rRNA
- Catalyzes peptide bond formation between amino acids.

3) Transfer RNA (tRNA)



3) <u>tRNA:</u>

- Recognizes codons in the mRNA
- binds specific amino acids associated with each codon
- Recognizes which amino acids should be added onto the polypeptide chain

Process of Transcription

There are a total of 3 different stages involved in the process of transcription:

1) Initiation: Enzymes bind to the promoter region of the DNA strand.

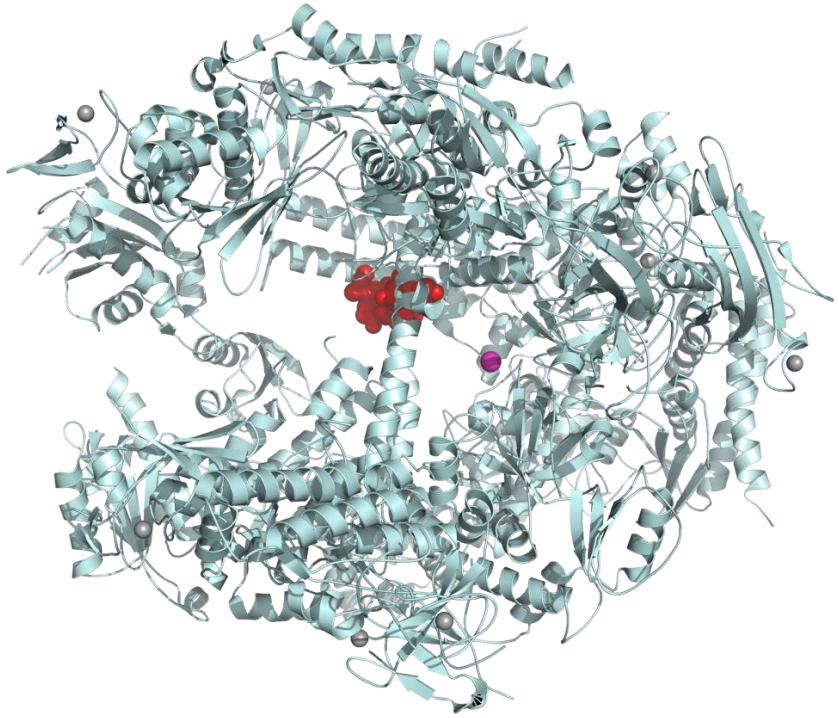
2) Elongation: the enzyme machinery continues synthesizing the mRNA strand while using the DNA strand as a template

3) Termination: a nucleotide sequence on the DNA indicates the end of transcription

1) **INITIATION**
2) Elongation
3) Termination

1) Initiation

RNA polymerase is the enzyme used to synthesize an RNA strand while using DNA as a template. Unlike DNA polymerase, it does not require a primer.

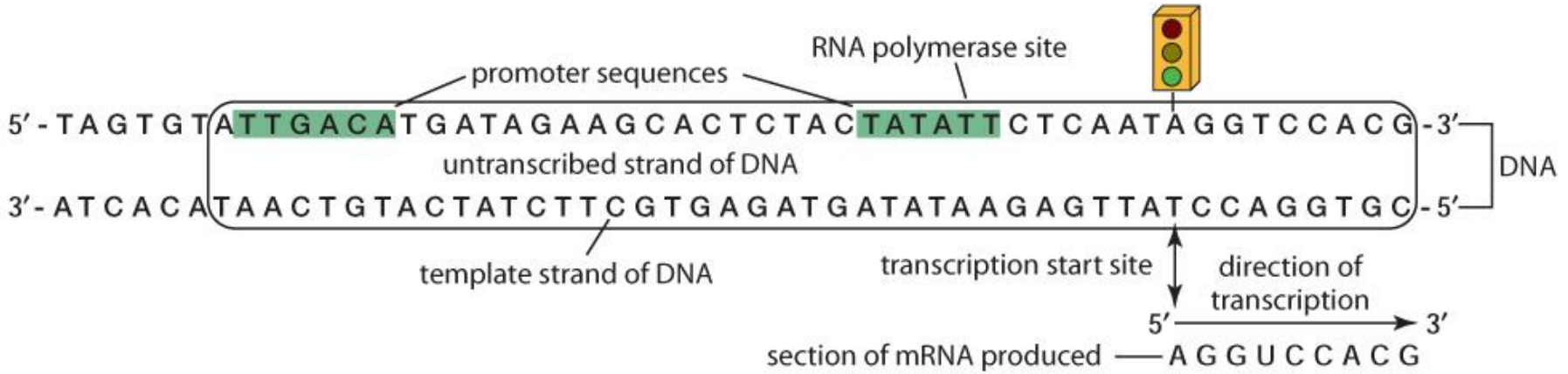


RNA polymerase binds to a promoter region on the DNA sequence.

Promoter: *sequence of nucleotides that indicated where the RNA polymerase should bind.*

1) **INITIATION**
2) Elongation
3) Termination

1) Initiation



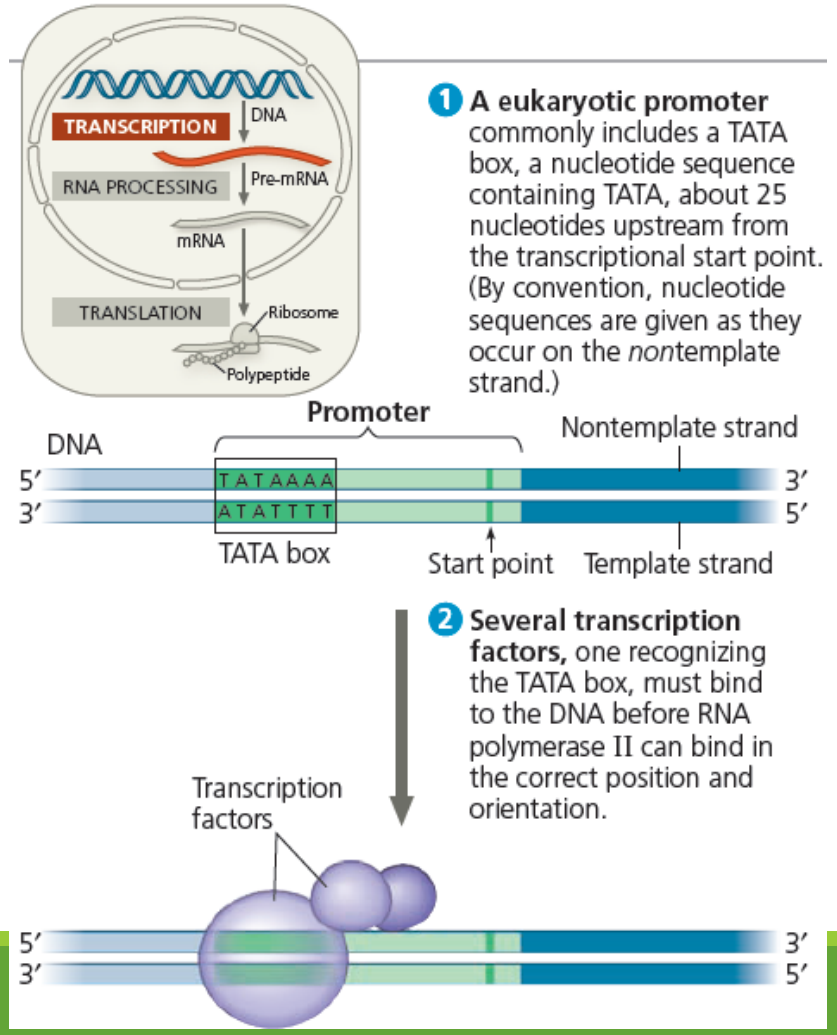
The promoter regions tells RNA polymerase:

a) where to begin transcription

b) which of the two DNA strands needs to be transcribed

1) **INITIATION**
2) Elongation
3) Termination

1) Initiation (Eukaryotic Cells ONLY)



In eukaryotic cells, there are various RNA polymerases.

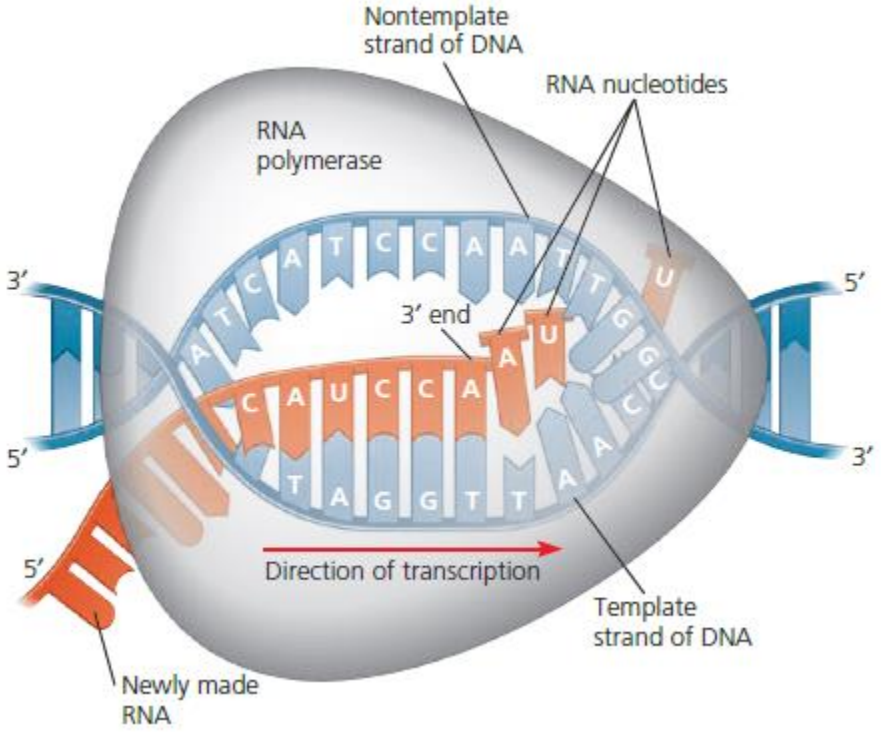
RNA polymerase II bind to the promoter region when different transcription factors bind.

Prokaryotic cells only have one RNA polymerase and do not require transcription factors to bind.

1) Initiation
2) **ELONGATION**
3) Termination

2) Elongation

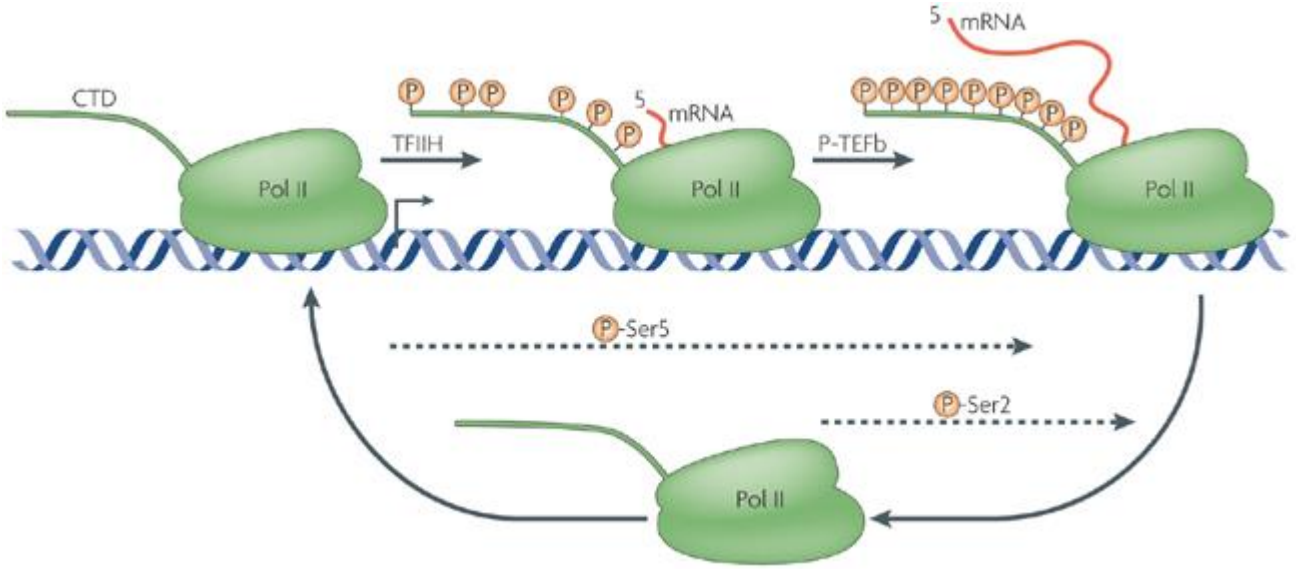
RNA polymerase unwinds the DNA strand and exposes 10 – 20 nucleotides at a time. New nucleotides are added to the 3’ end of the growing RNA strand.



RNA polymerase travels in the 5’ to 3’ direction. The uracil nucleotide base pairs with the adenine nucleotide on the template strand.

1) Initiation
2) **ELONGATION**
3) Termination

2) Elongation

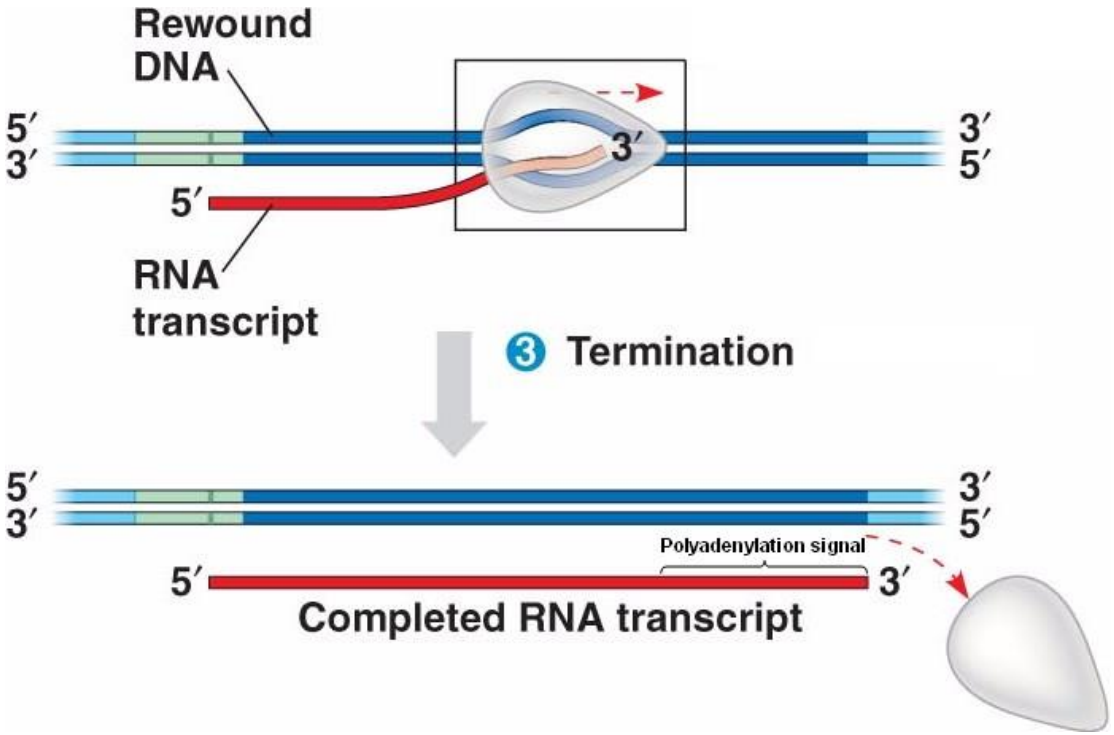


As the RNA polymerase is travelling along the template strand, a new RNA polymerase may bind to the promoter region and begin to synthesize another new mRNA strand.

1) Initiation
2) Elongation
3) **TERMINATION**

3) Termination

There is a specific nucleotide sequence on the template strand that indicates that the process of transcription should be terminated.

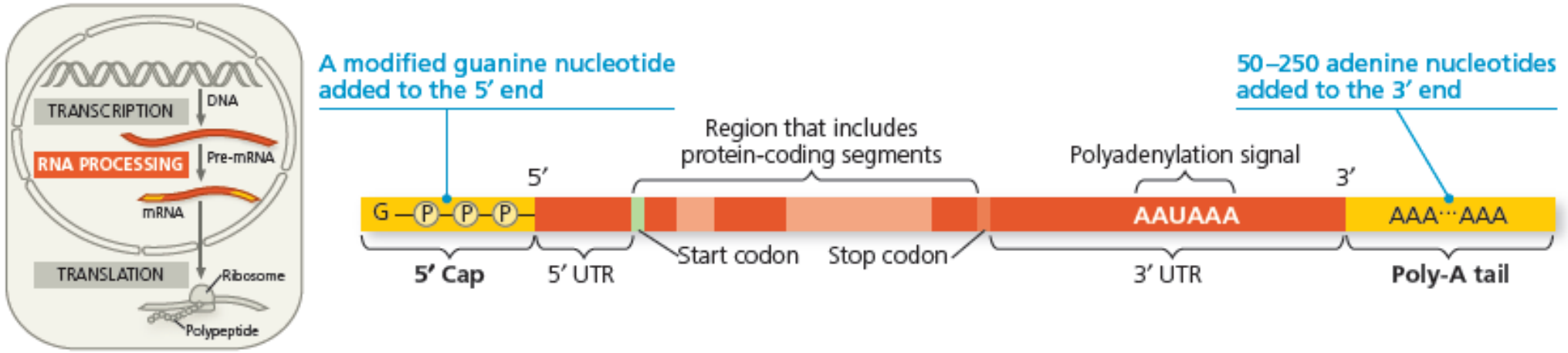


By the time the RNA polymerase has reached the terminator sequence the DNA strands are unwound.

1) Initiation
2) Elongation
3) **TERMINATION**

3) Termination

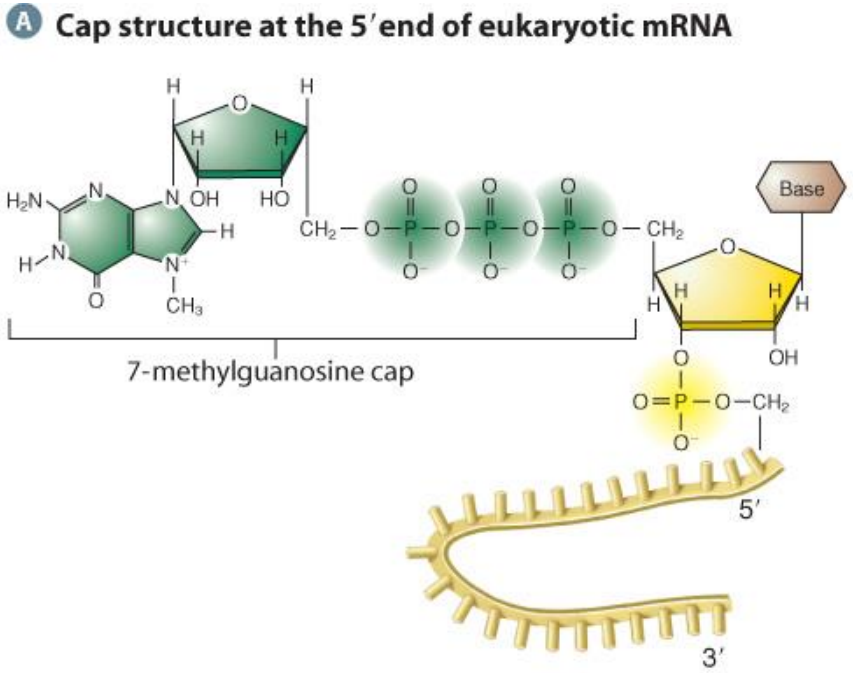
RNA polymerase continues to transcribe even once the mRNA is synthesized. The polymerase continues to transcribe until it reaches the ***polyadenylation signal (AAUAAA).***

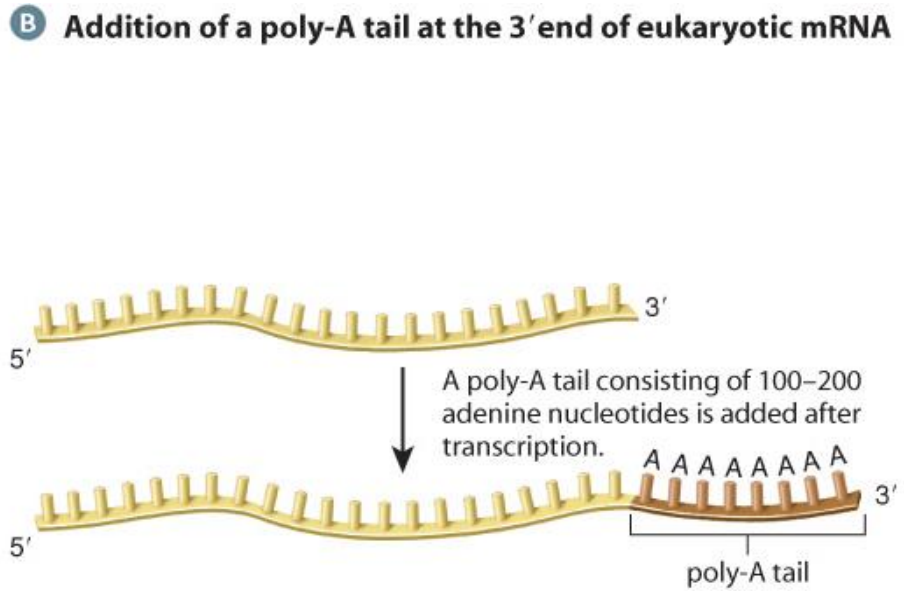


Enzymes cleave the polymerase complex 10-35 nucleotides downstream of the polyadenylation signal.

Modification in Eukaryotic mRNA

There are two modification that need to be made to the pre-mRNA before it leaves the nucleus.





1) Addition of a 5' cap – covalent linkage of G nucleotides to the 5' end of the mRNA

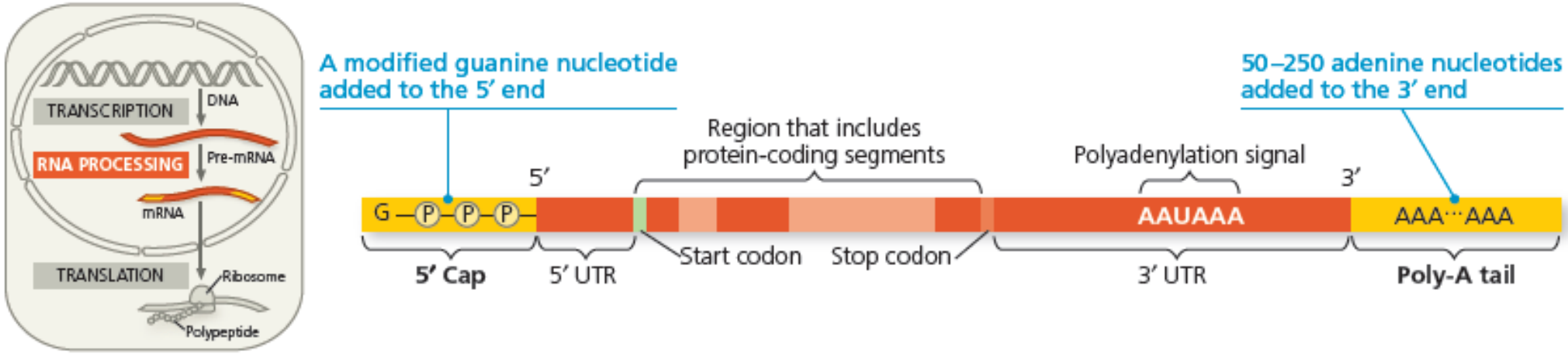
2) Addition of a 3' poly-A-tail – covalent linkage of a series of 'A' nucleotides to the 3' end of the mRNA.

Benefits of Modifications

1) Facilitate the transport of the mRNA into the cytoplasm

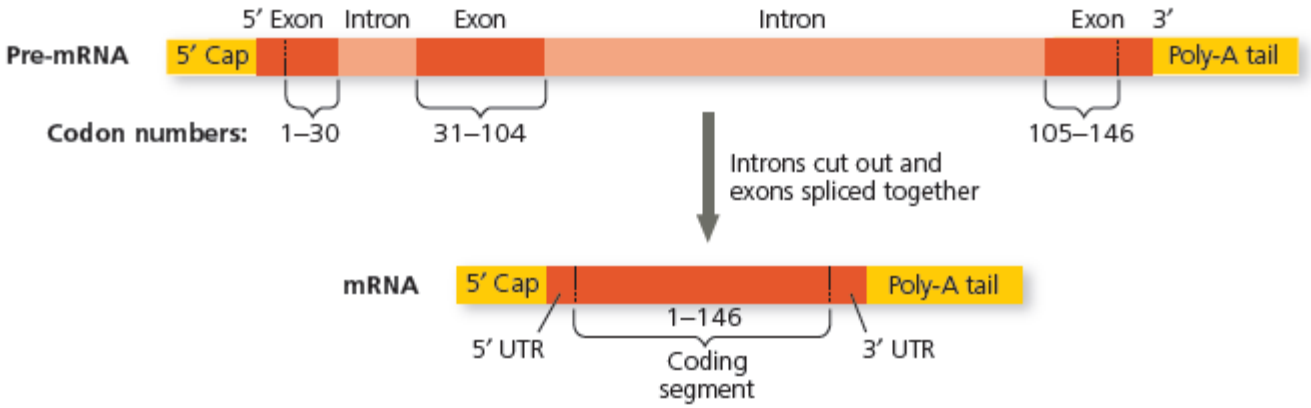
2) Protect the mRNA from degradation by enzymes

3) Enables ribosomes to bind to the 5’ end and begin the process of translation



RNA Splicing

The average length of an mRNA is about 8000 nucleotides long, but only 1200 nucleotides are required to make a protein. There are many noncoding strands of nucleotides that are not required to make the protein.

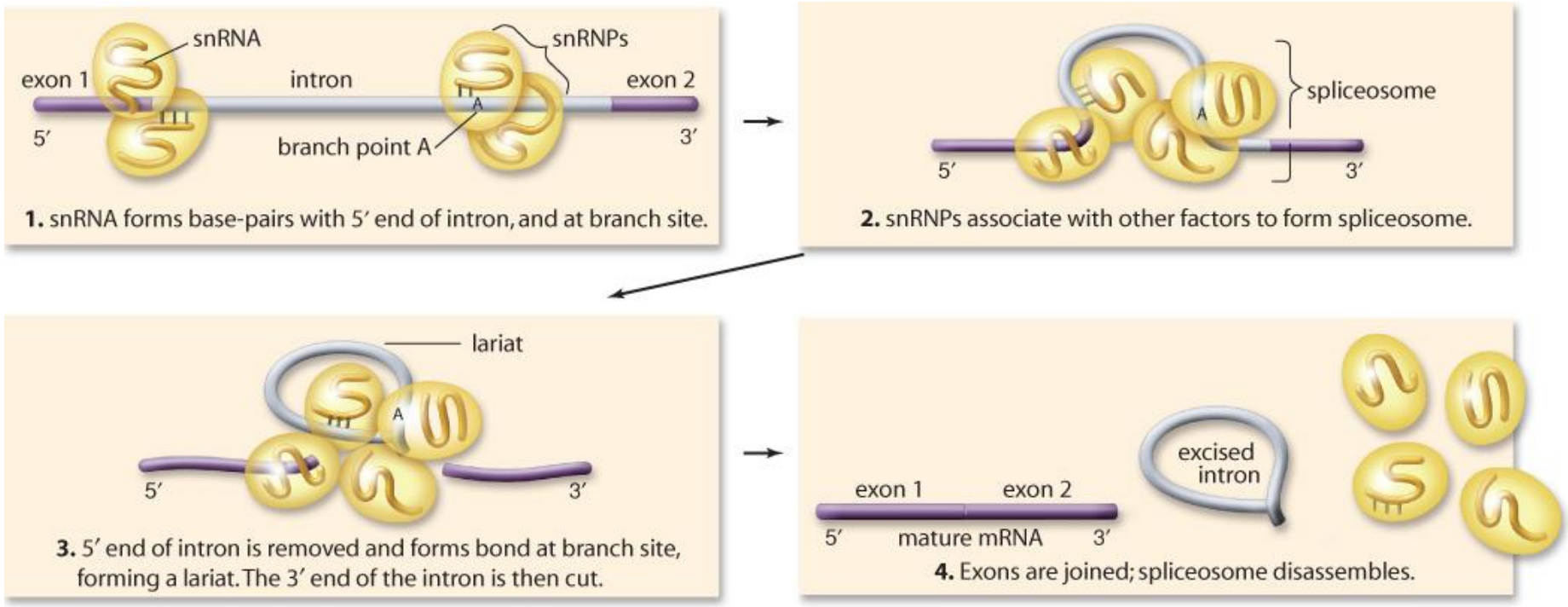


Introns: noncoding sequences not required for protein synthesis

Exons: coding sequences required for protein synthesis

RNA Splicing

There are small signals between the introns and exons that indicate where splicing should occur. snRNA (small nuclear RNA) and other proteins form a complex at the signal and splice out the introns.



Checking for Understanding

Like DNA replication, the first major step in transcription is

A) Binding of the transcription factors

B) Elongation

C) The usage of RNA primers

D) Recognition of the promoter sites

E) unwinding of the double helix

Checking for Understanding

Which statement about RNA polymerase is true?

A) RNA polymerase has proofreading function

B) RNA polymerase works in a 3’ to 5’ direction

C) During initiation of transcription, RNA polymerase binds to the promoter region

D) RNA polymerase transcribes both strands of DNA at the same time

E) RNA polymerase uses the sense strand of DNA as a template

Checking for Understanding

The parts of genes that are transcribed into mRNA but are later removed are called

A) exons

B) spliceosomes

C) introns

D) peptides

E) mutations

Checking for Understanding

To facilitate the movement of mRNA form the nucleus into the cytoplasm, what is added to the 3’ end of mRNA?

A) a cap of modified nucleotides

B) modified tRNA molecules

C) ribosomes

D) a poly-A tail

E) Transcription Factors

Homework

Textbook: p.256 # 4,5,6,7, 9 & 10