زیست شناسی مولکولی، جلسه پنجم

۱- بیان ژن

۲- ژن های کدکننده و غیرکدکننده پروتئین

۳- مراحل بیان ژن در پروکاریوت ها و یوکاریوت ها

GENE EXPRESSION

How is a gene expressed?

DNA → RNA → protein

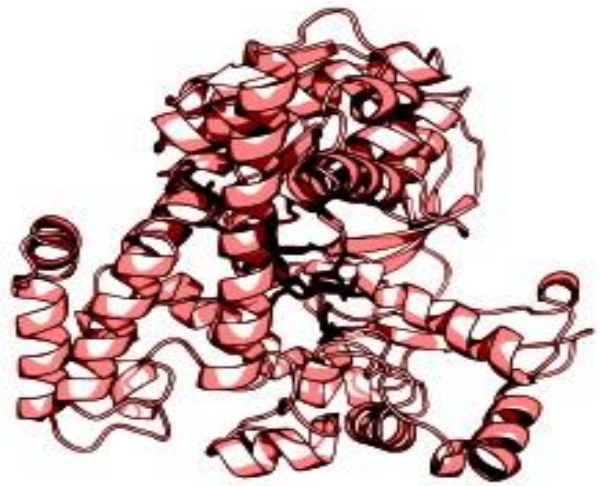
- DNA → RNA
  - Transcription
- RNA → protein
  - Translation

DNA

Gene

mRNA

Protein



Function

ncRNA

Function

1- Transcription

2- Post transcriptional modifications

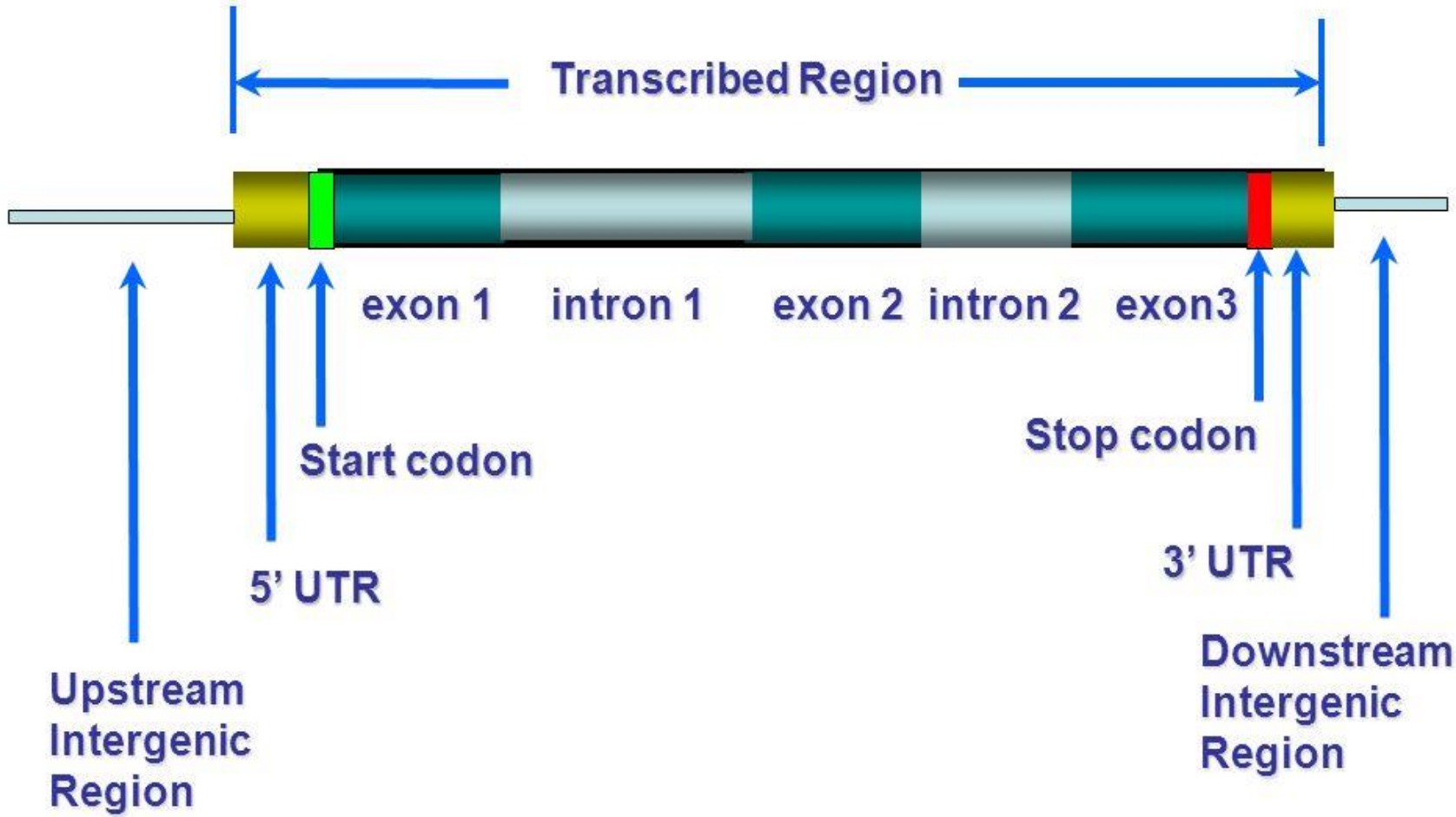
3- Translation

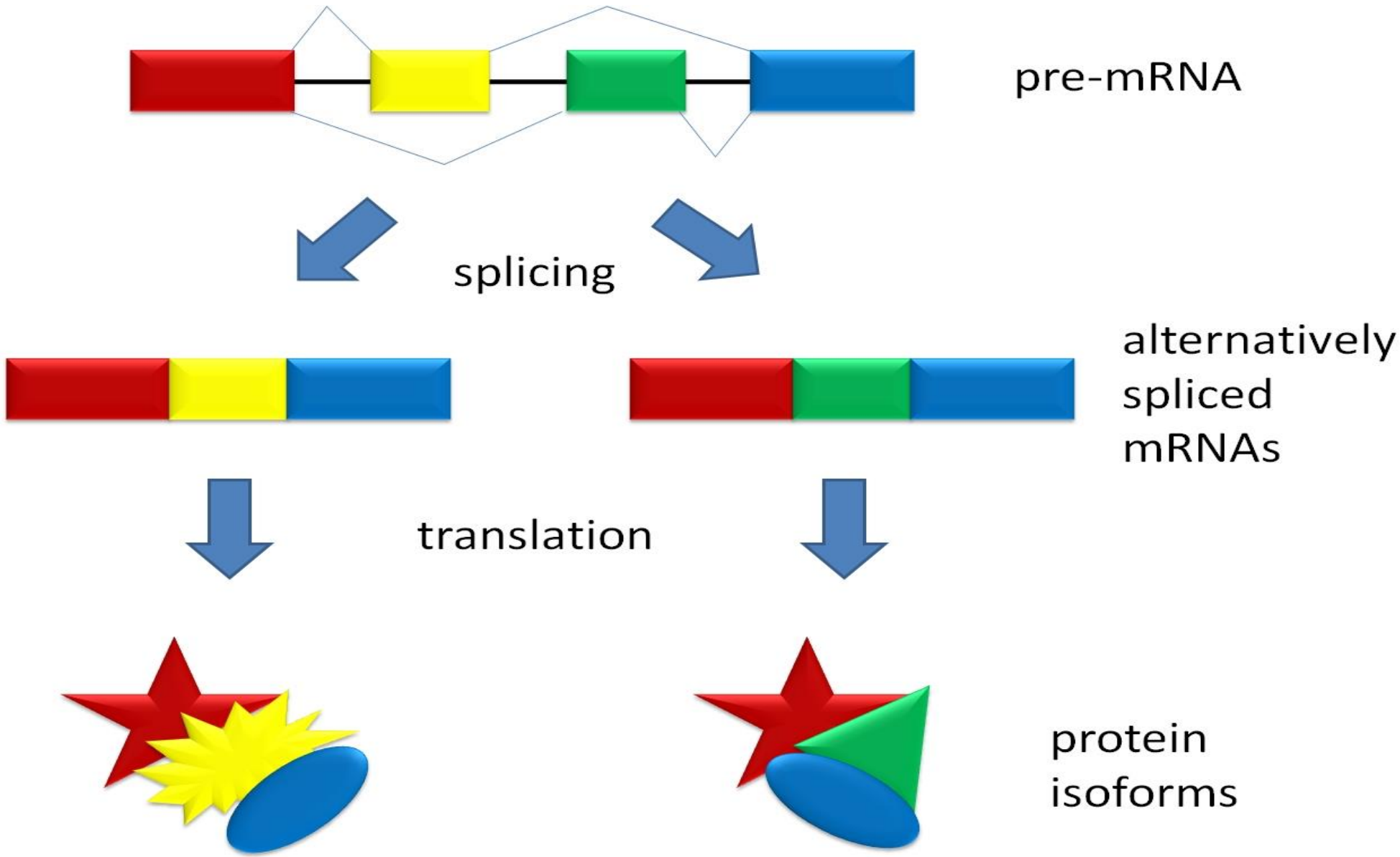
4- Post translational modifications

زیست شناسی مولکولی، جلسه ششم

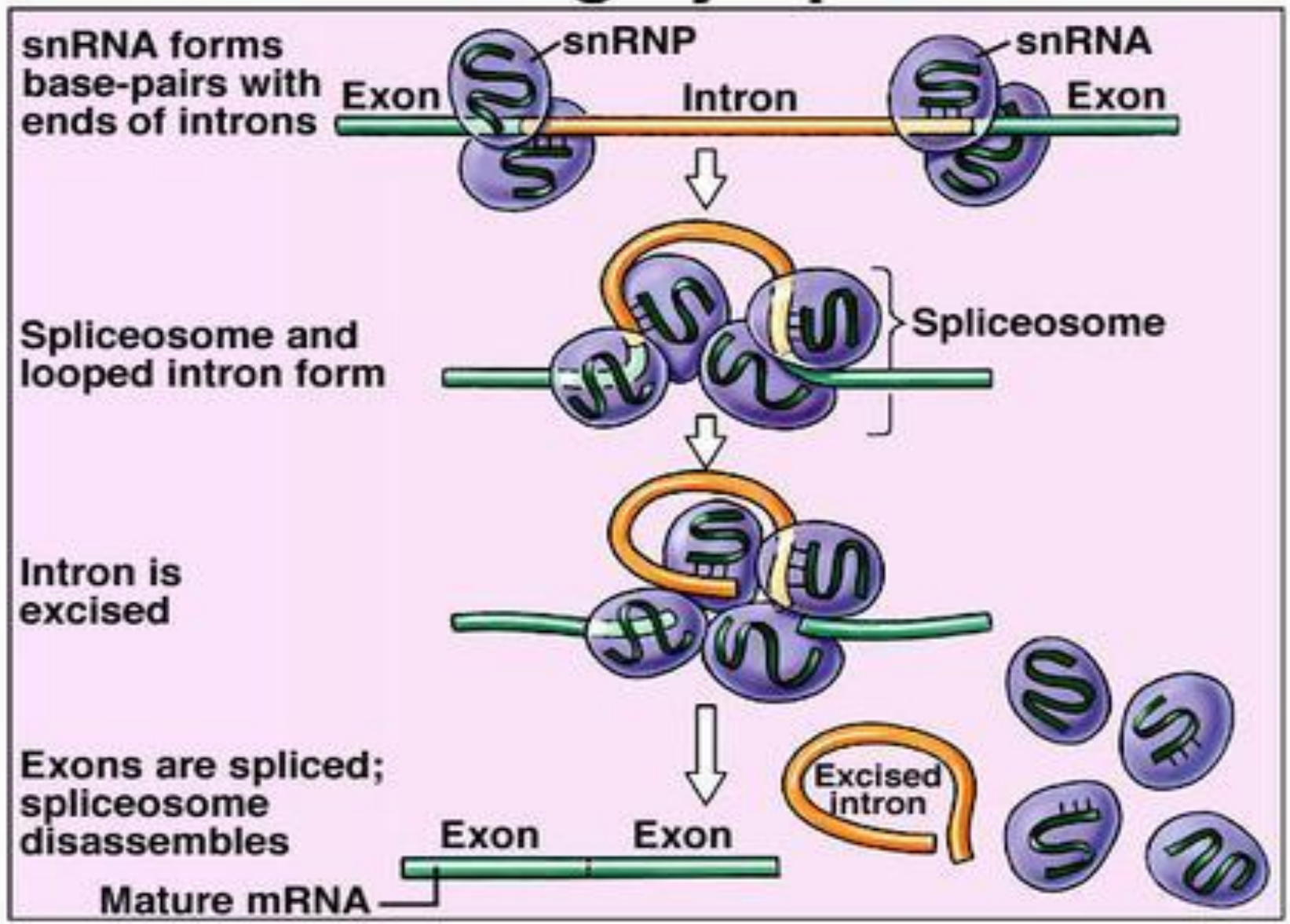
Splicing، انواع و مکانیسم های آن

Eukaryotic Gene Structure*




pre-mRNA
splicing
alternatively
spliced
mRNAs
translation
protein
isoforms

RNA Processing by Spliceosomes

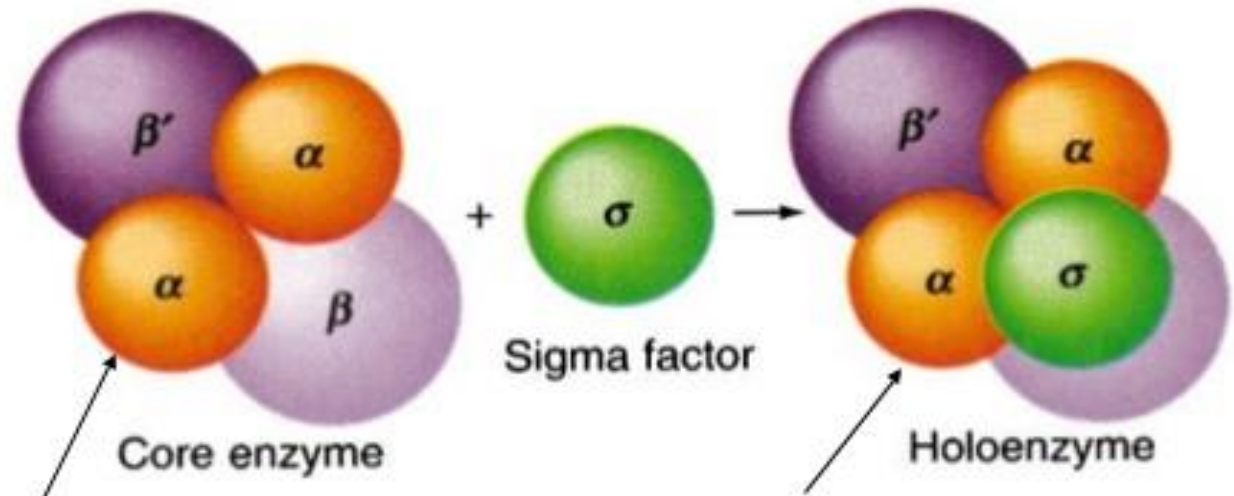


زیست شناسی مولکولی، جلسه هفتم

تنظیم بیان ژن در پروکاریوت ها

E. coli RNA polymerase

2α, 1β, 1β', 1ω and σ factor



Required for polymerization activity

Required for correct initiation of transcription: ***binding to promoter***

Transcription Initiation in Prokaryotes

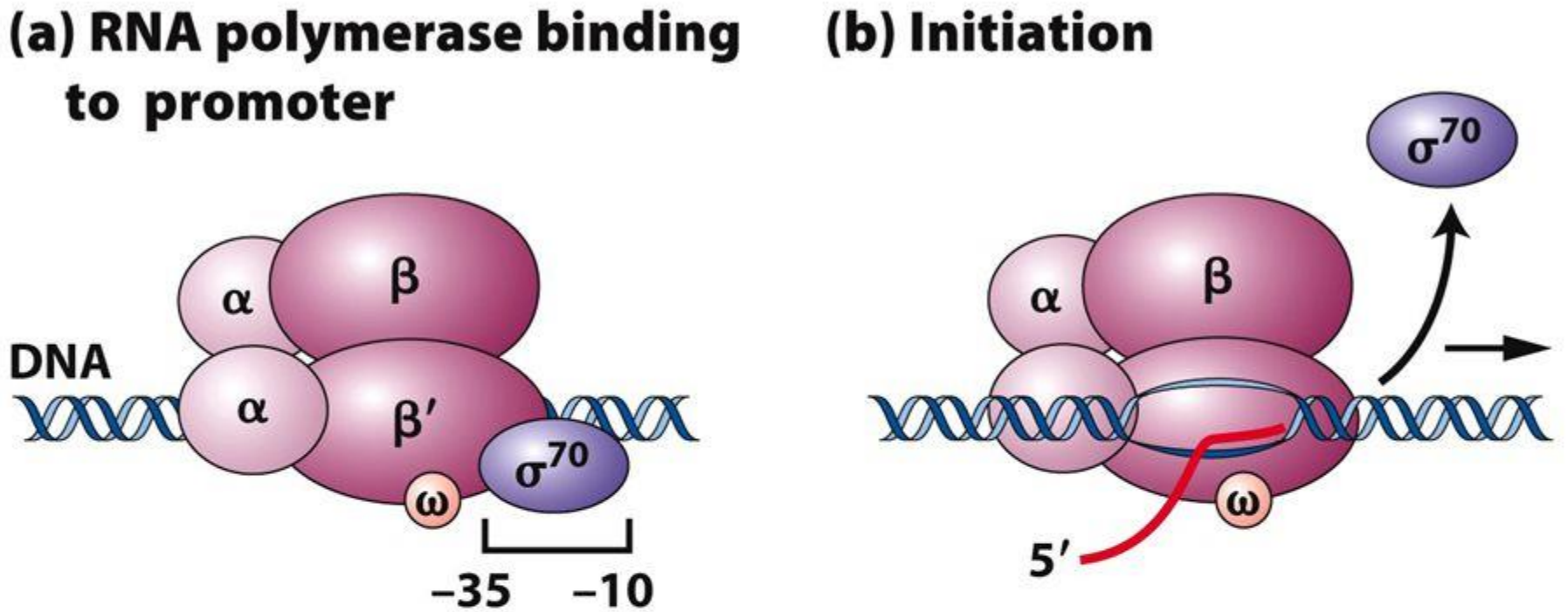


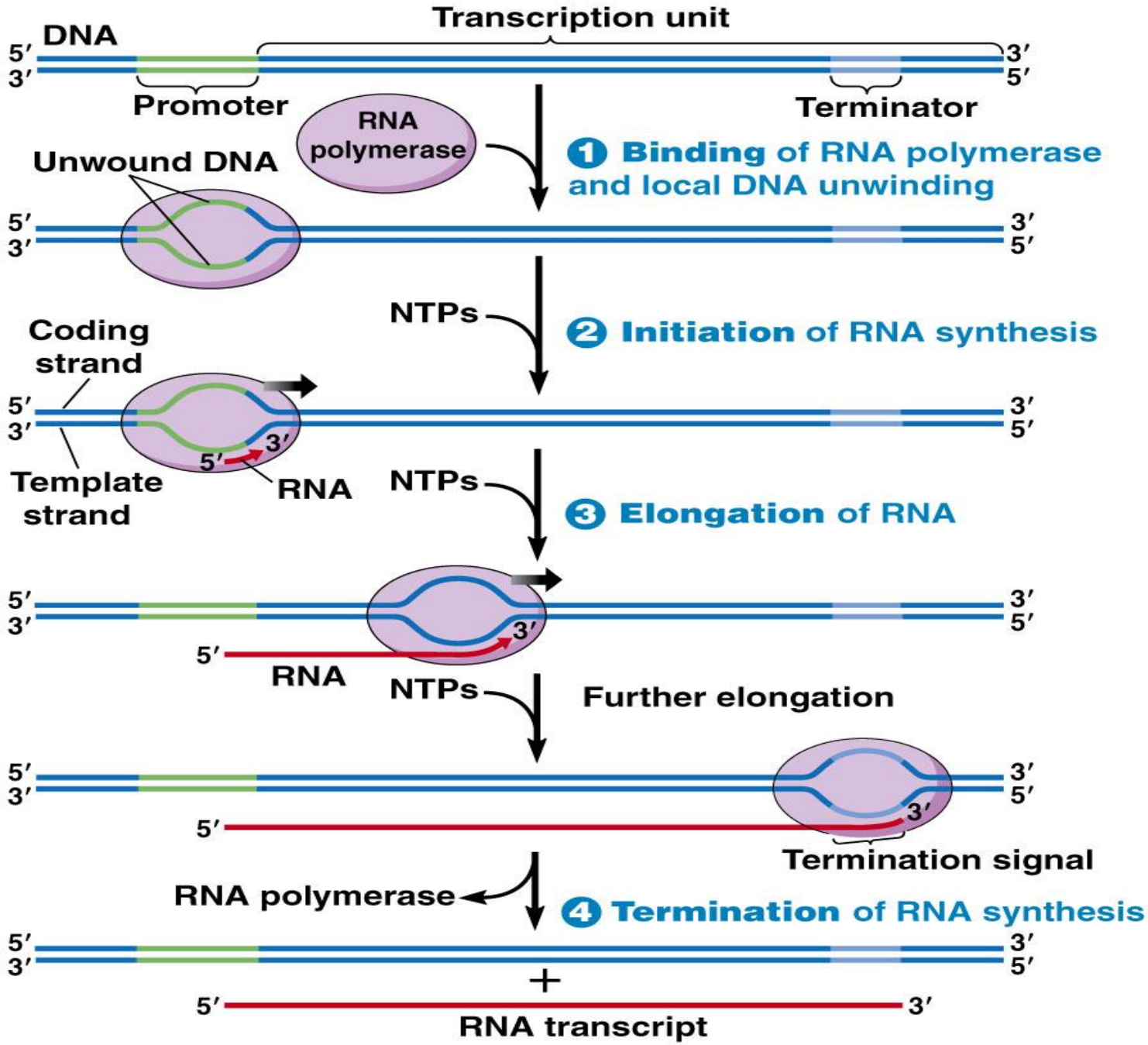
Figure 8-8
Introduction to Genetic Analysis, Tenth Edition

σ subunit positions RNA polymerase for correct initiation.

Upon initiation of transcription, σ subunit dissociates.

Transcription of Prokaryotes

- **Initiation phase**: RNA-pol recognizes the promoter and starts the transcription.
- **Elongation phase**: the RNA strand is continuously growing.
- **Termination phase**: the RNA-pol stops synthesis and the nascent RNA is separated from the DNA template.



OPERON in gene regulation of prokaryotes:

Definition: **a few genes that are controlled collectively by one promoter**

Its structure: **Each Operon is consisted of few structural genes(cistrons) and**

some cis-acting element such as promoter (P) and operator (O).

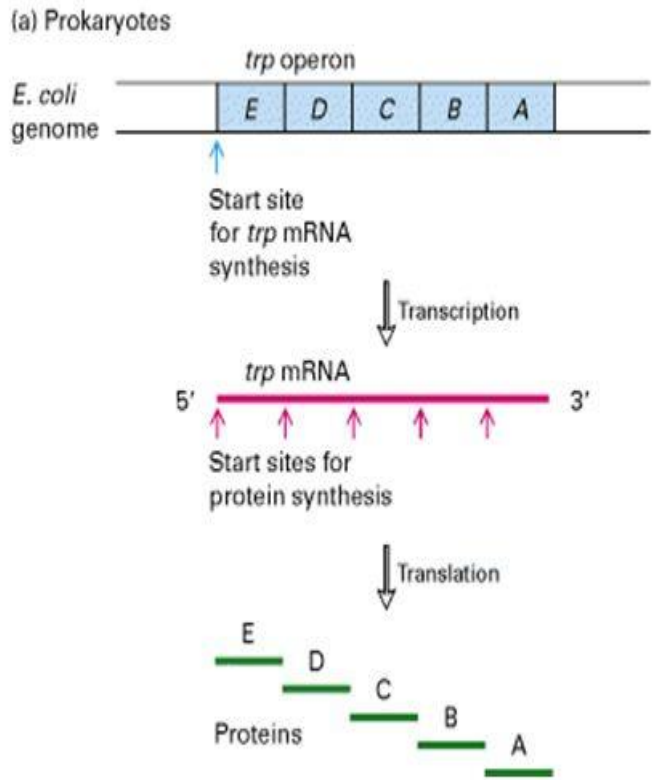
Its regulation: **There are one or more regulatory gene outside of the Operon that produce trans-acting factors such as repressor or activators.**

Classification:

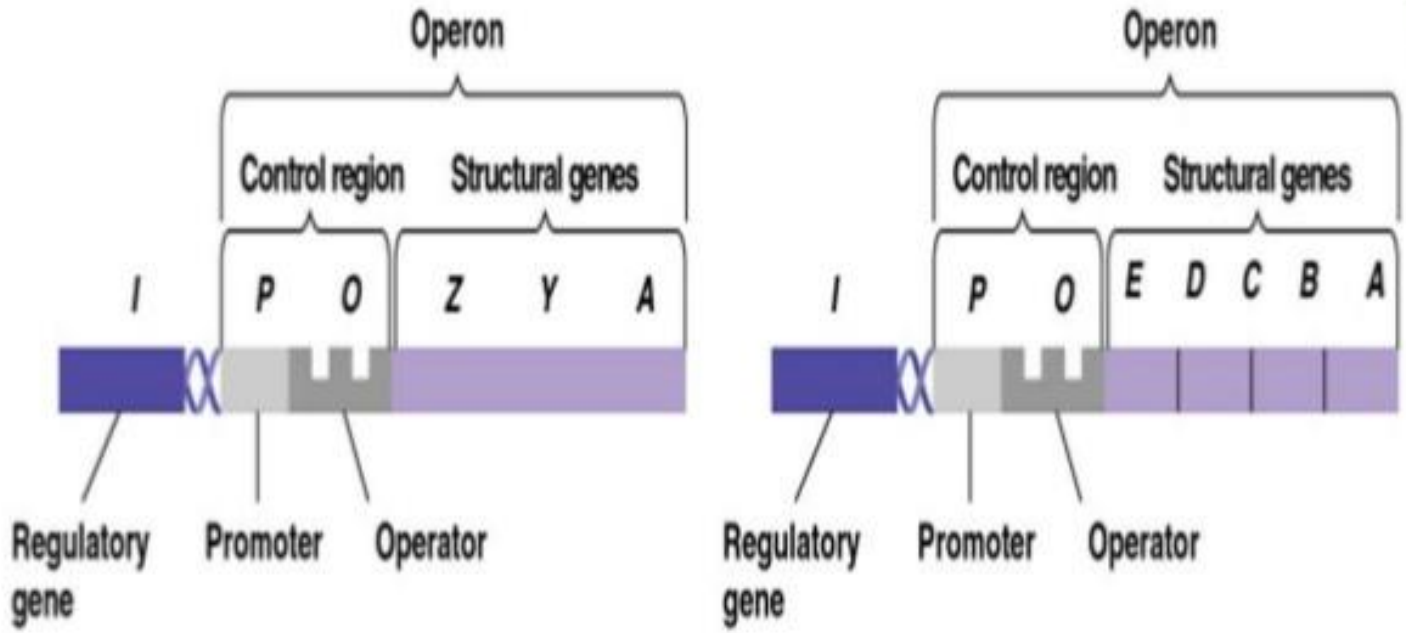
1- Catabolic (inducible) such as Lac OPERON
2- Anabolic (repressible) such as ara OPERON
3- Other types

Prokaryotic Transcription

- Operons
  Groups of related genes transcribed by the same promoter
- Polycistronic RNA
- Multiple genes transcribed as ONE TRANSCRIPT
- No nucleus, so transcription and translation can occur simultaneously



GENERAL STRUCTURE OF AN OPERON



1 **Structure of the operon.** The operon consists of the promoter (*P*), and operator (*O*) sites, and structural genes which code for the protein. The operon is regulated by the product of the regulatory gene (*I*).

Types of operon

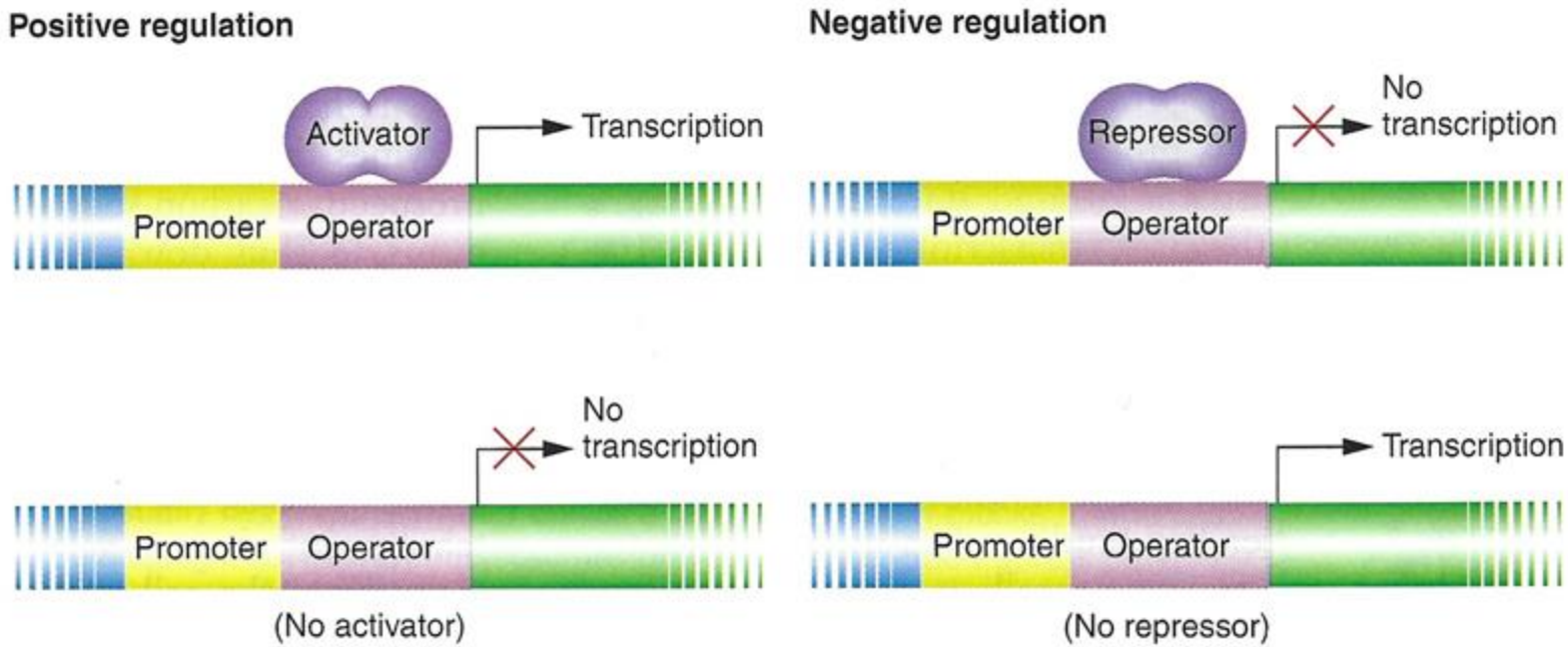
➢**Inducible operons:**

- They include genes that encode for enzymes that take part in metabolic pathways.
- The expression of the gene is controlled by the substrate.
- Example is the "Lac Operon".

➢**Repressible operons:**

- They include genes that encode for enzymes involved in biosynthetic pathways.
- The expression of the gene is controlled by the end-product of the pathway.
- Example is the "Trp Operon".

Positive and negative regulation



زیست شناسی مولکولی، جلسه هشتم

تنظیم بیان ژن در یوکاریوتها

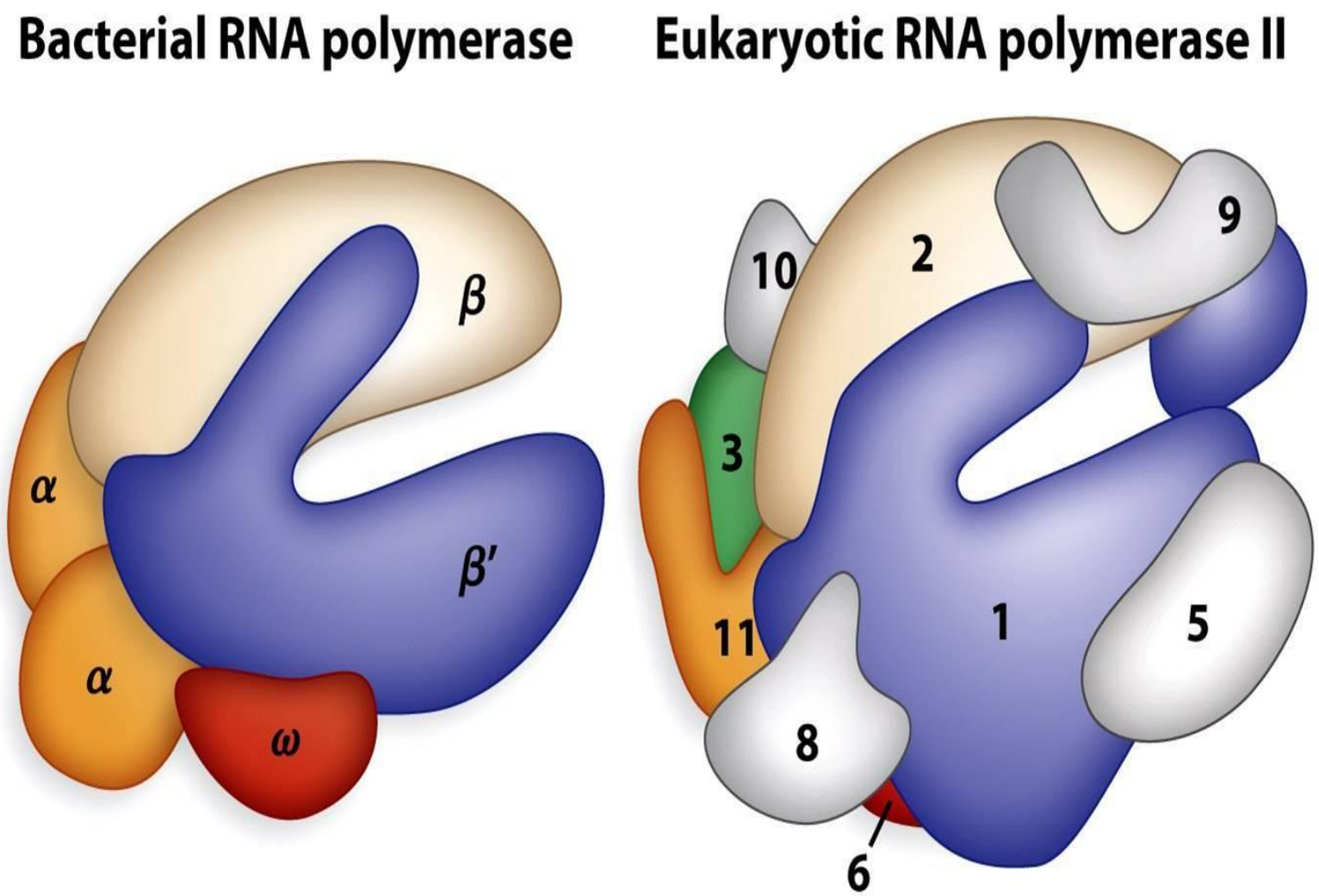


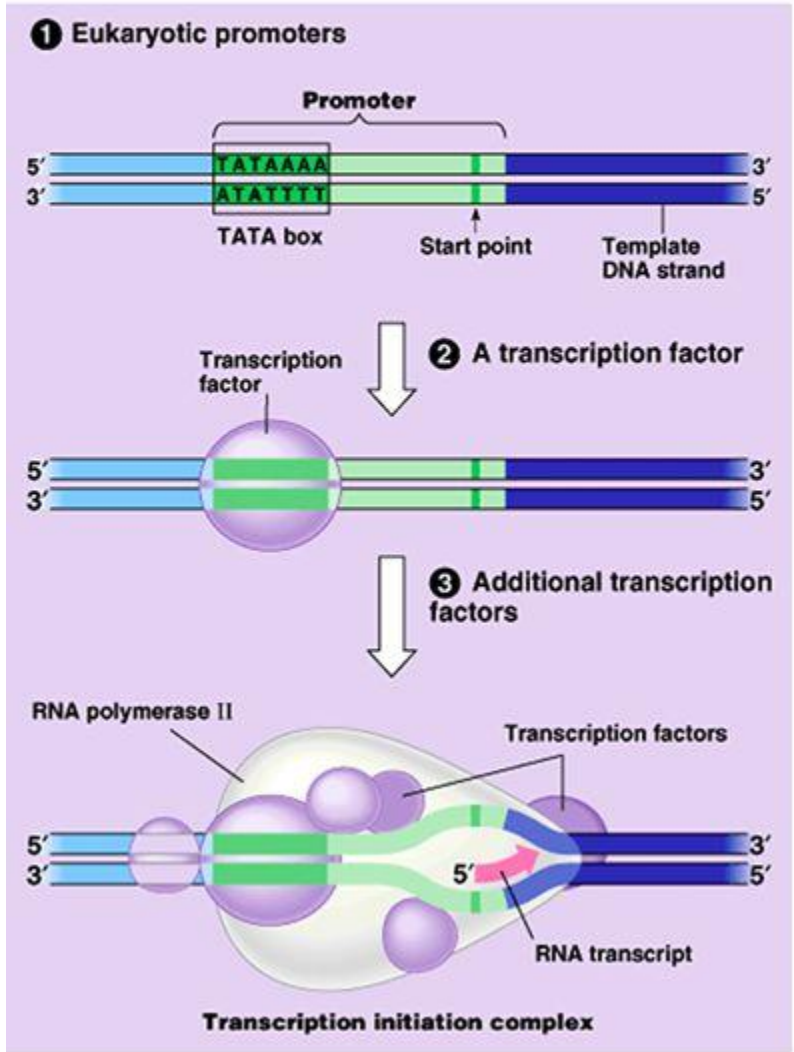
Figure 15-21
Molecular Biology: Principles and Practice

Eukaryotic RNA Polymerases

- Three DNA dependent RNA polymerases:
  RNA Pol I, II, and III
- All 3 are big, multimeric proteins (500-700 kD)
- All have 2 large subunits with sequences similar to β and β' in E. coli RNA polymerase, so catalytic site may be conserved
- All interact with general transcription factors-GTFs
- RNA Pol II is most sensitive to α-amanitin

Enzyme	Location	Product
RNA Polymerase I	Nucleolus	rRNA
RNA Polymerase II	Nucleoplasm	mRNA
RNA Polymerase III	Nucleoplasm	tRNA
mt RNA Polymerase	Mitochondria	mtRNA

Eukaryotic Transcription



1. **Initiation** – Transcription factors adhere to the TATA box in the promoter signaling RNA Polymerase II to attach. Additional transcription factors attach and the transcription initiation complex is formed. Enhancers/silencers

2. **Elongation** – RNA Polymerase II unzips the DNA and pairs the template with complementary mRNA nucleotides.

3. **Termination** – RNA Polymerase II reaches the polyadenylation (AAUAAA) sequence and releases the pre-mRNA.

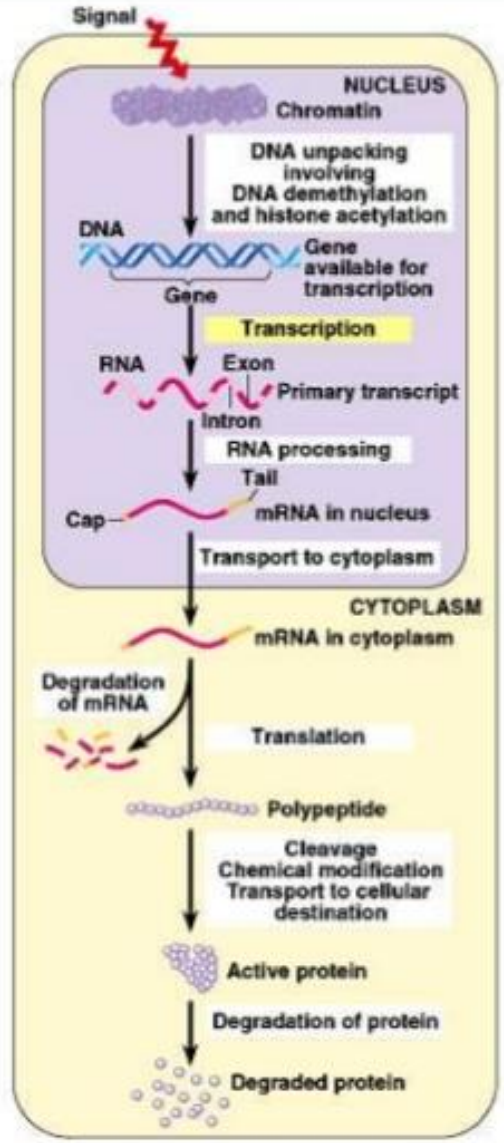
transcription

*Gene expression is most often regulated at transcription

Table 28.1: Difference between Prokaryotes and Eukaryotes Transcription	
Prokaryotic Transcription	**Eukaryotic Transcription**
Polycistronic type of transcription	Monocistronic type of transcription
Occurs in cytoplasm	Occurs in nucleus
Coupled transcription –translation process occurs	Coupled transcription –translation process not occurs.
Single type of RNA Polymerase required for synthesis of all type of RNA	Three different type of RNA Polymerase required for synthesis of all type of RNA
No need of any transcription factor for initiation.	Its require transcription factor for initiation
RNA Polymerase are made up by 5 subunits	RNA Polymerase are made by 10-15 subunits

Points of control

- The control of gene expression can occur at any step in the pathway from gene to functional protein
  1. packing/unpacking DNA
  2. transcription
  3. mRNA processing
  4. mRNA transport
  5. translation
  6. protein processing
  7. protein degradation



Regulation of gene expression

Prokaryotes

- Mainly at transcriptional level
- Sets of genes transcribed together (polycistronic)
- E.g. *lac* operon and *trp* operon in bacteria

Eukaryotes

- Other levels of regulation inlcude posttranscriptional and posttranslational regulation
- Each gene transcribed independently (monocistronic)