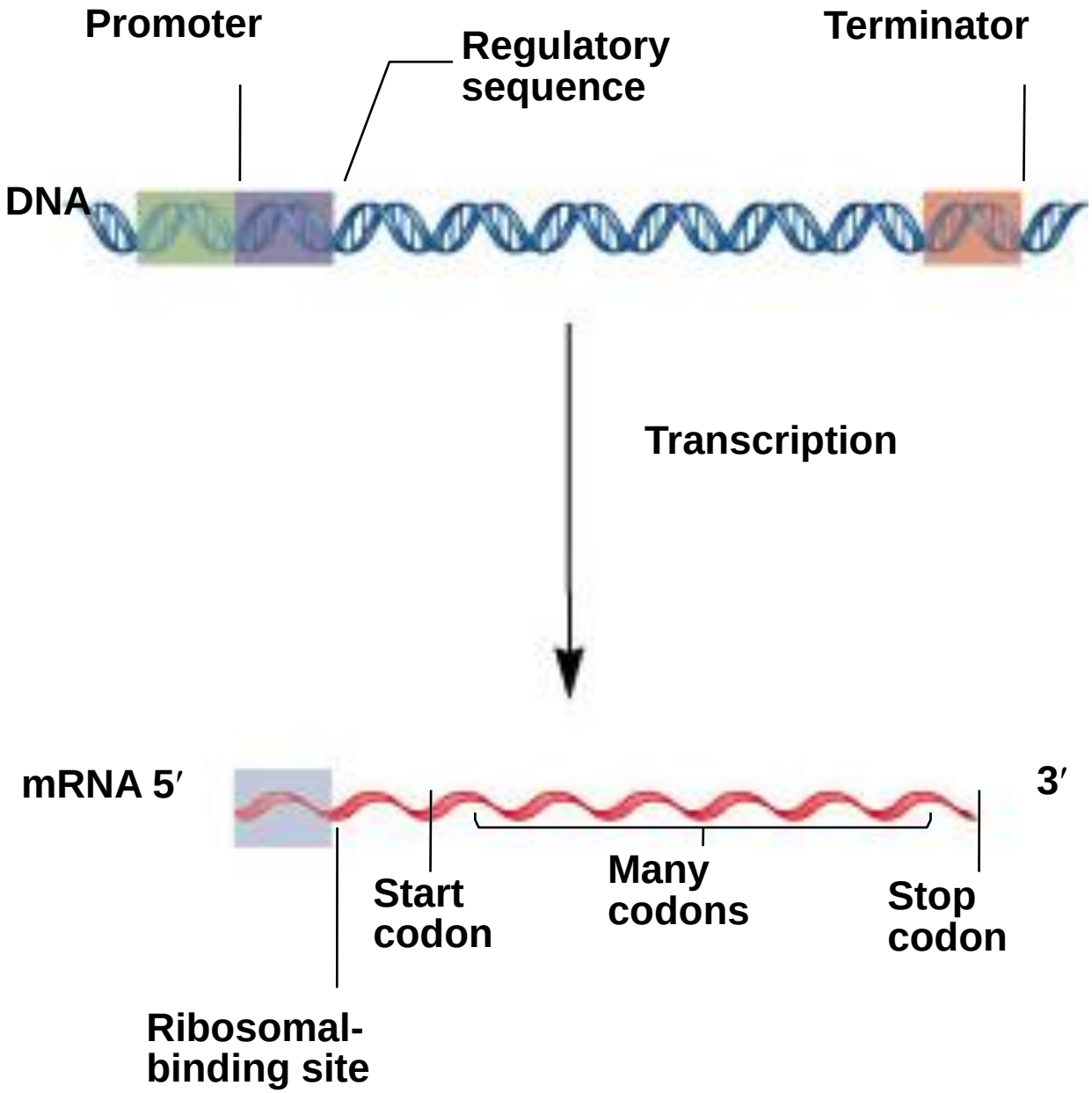
Transcription in

Prokaryotes & Eukaryotes

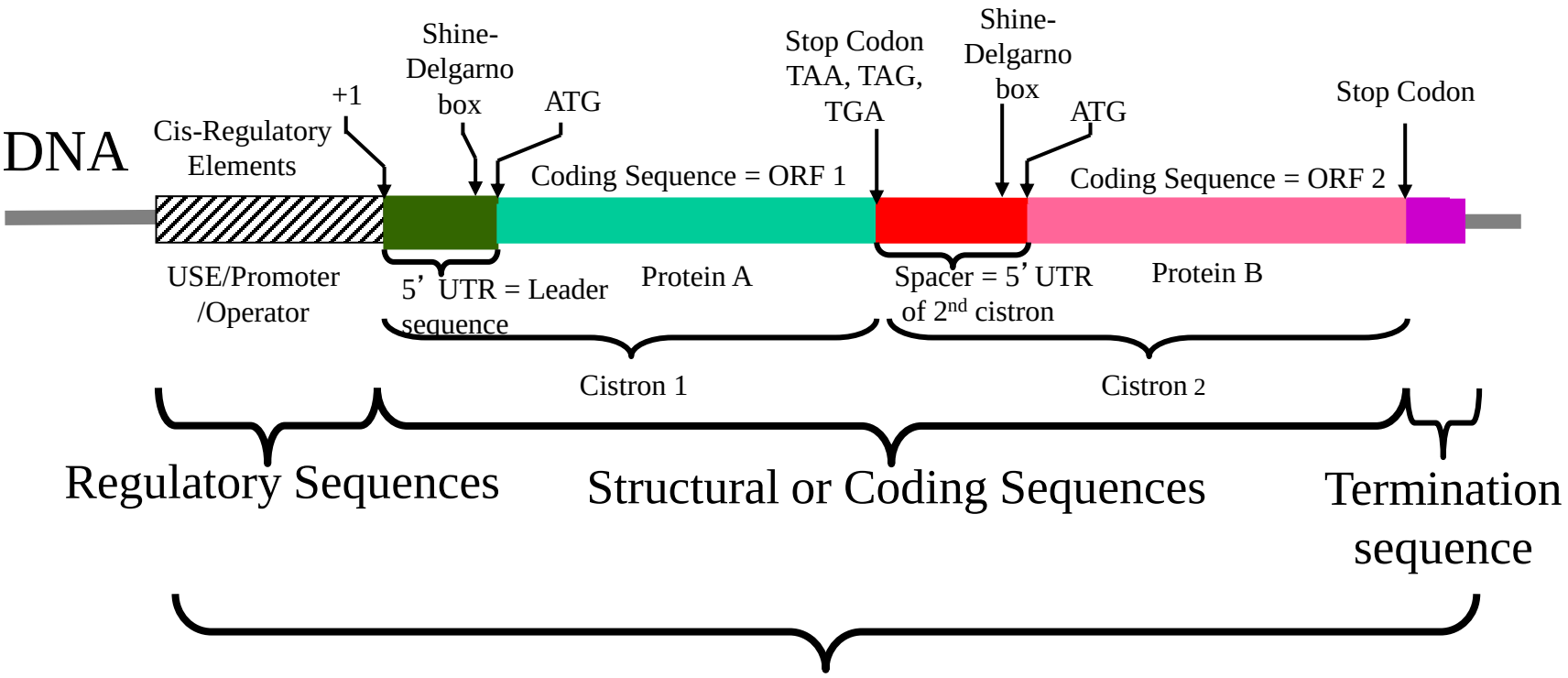
Gene Expression

- There are 4 major events that occur during the process of gene expression
  - Transcription
  - RNA processing
  - Translation
  - Protein processing

A Gene is a Transcription Unit

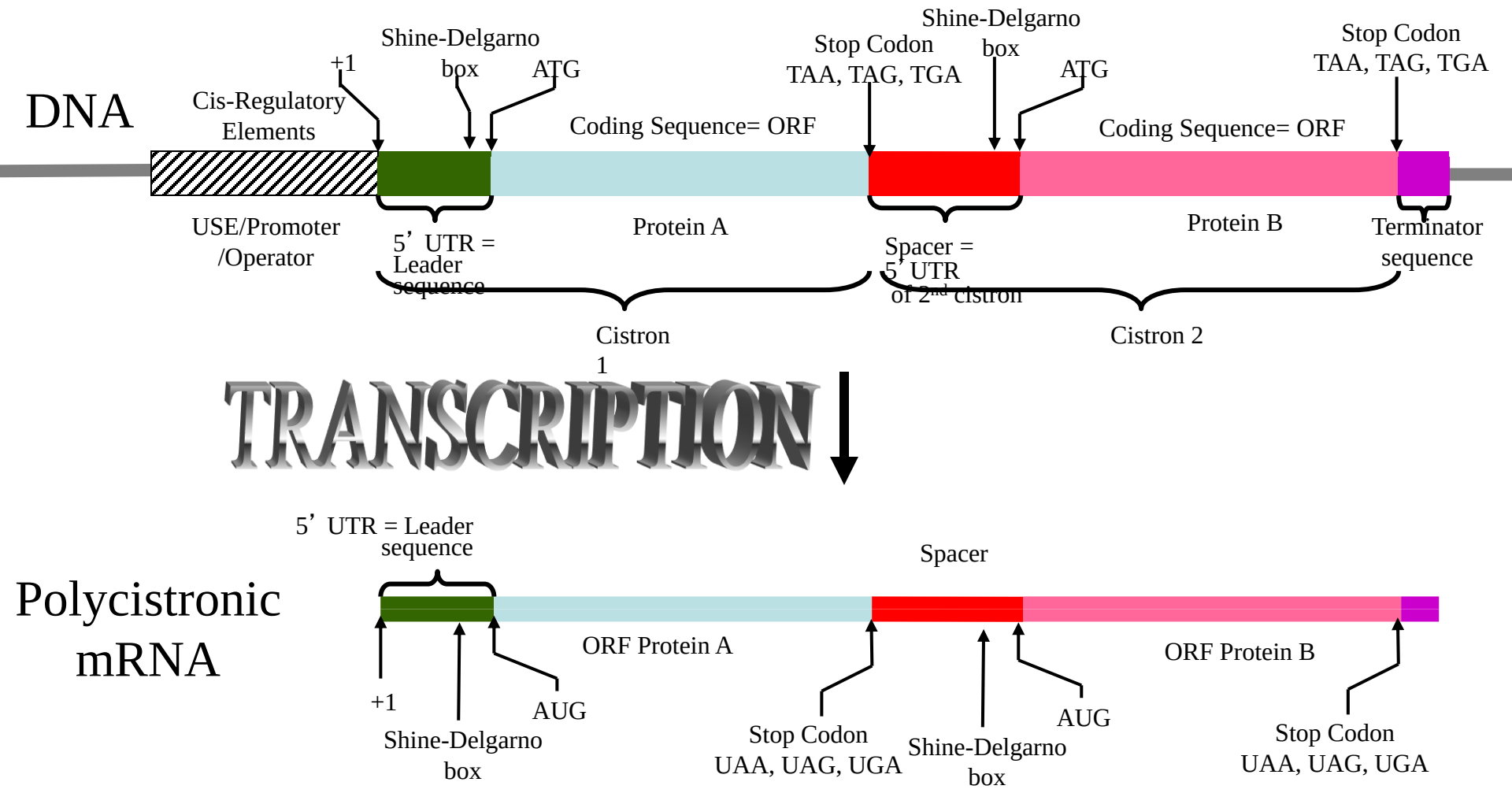


Prokaryotic Gene Structure

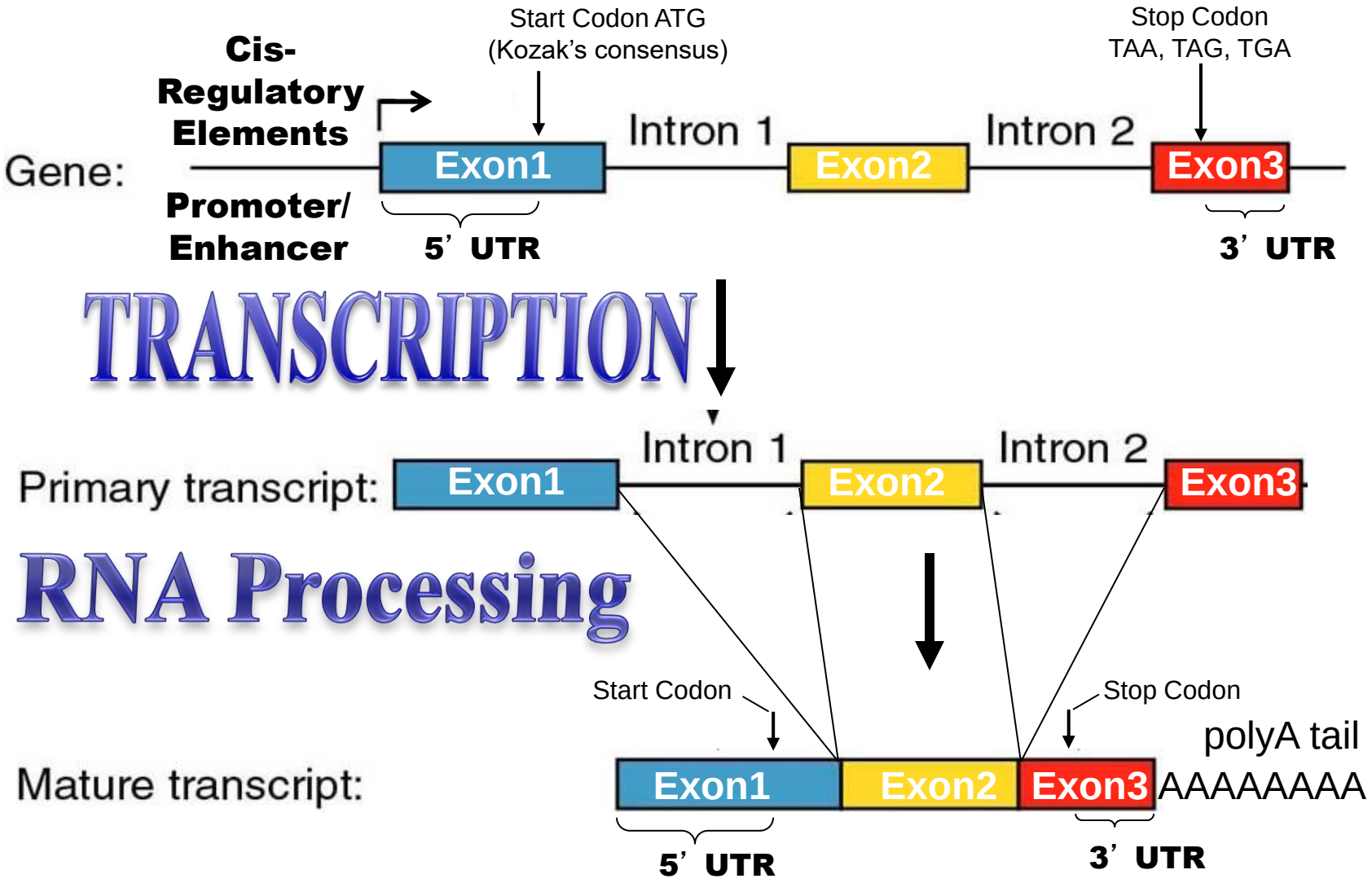


Polycistronic structure

Prokaryotic Gene Structure

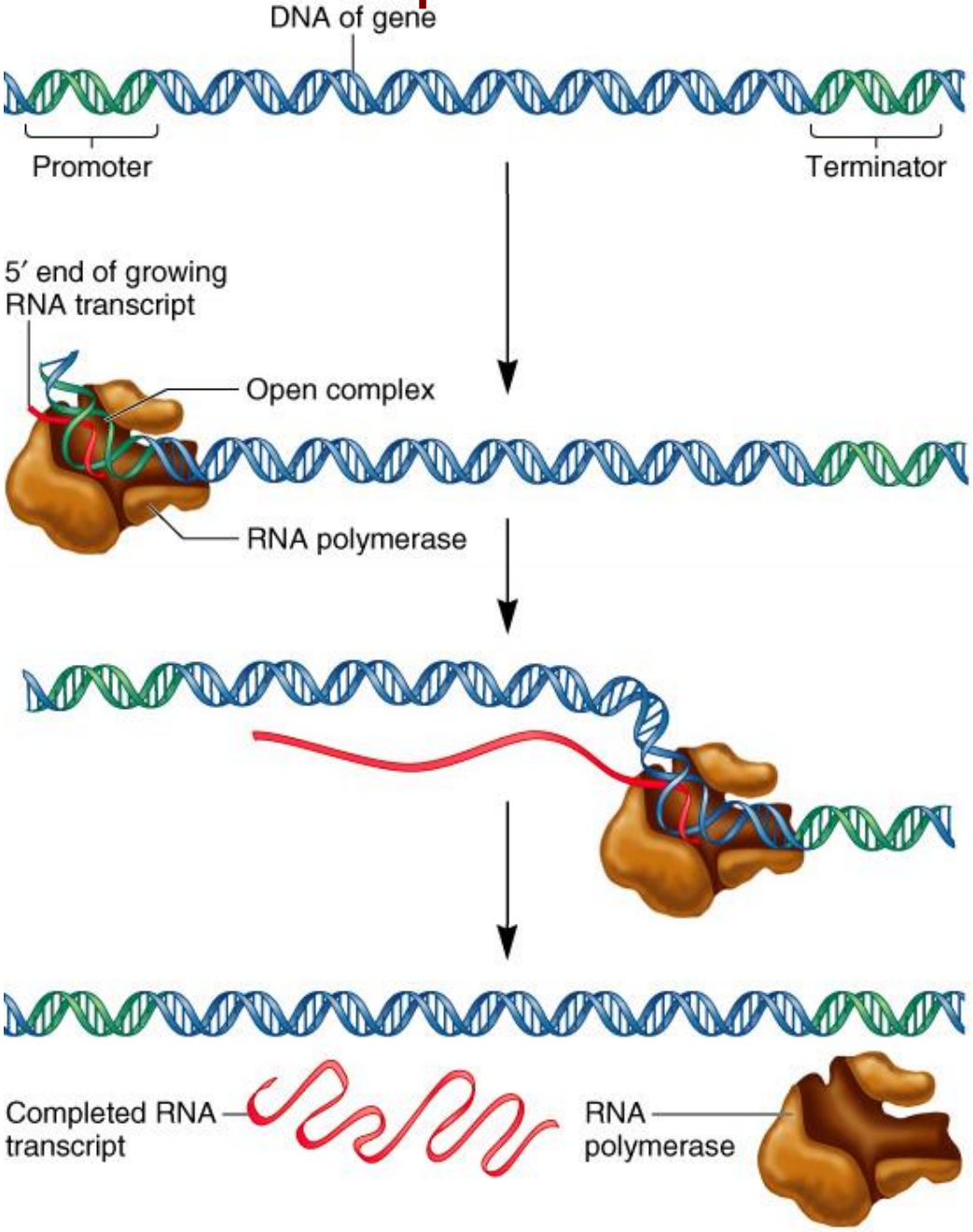


Eukaryotic Gene Structure



Monocistronic structure

Transcription Proceeds Through 3 Steps



Initiation

- **Transcription factors & RNA polymerase recognize & bind the promoter**
- **DNA adjacent to the promoter is denatured forming the open promoter complex**

Elongation

- **RNA polymerase moves along the DNA in synthesizing a RNA transcript. Synthesis is 5’→3’ – Only 1 strand of DNA is read as a template.**

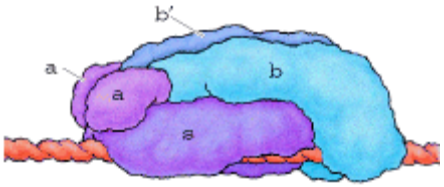
Termination

- **A termination signal is reached causing RNA polymerase to dissociated from the DNA**

Initiation

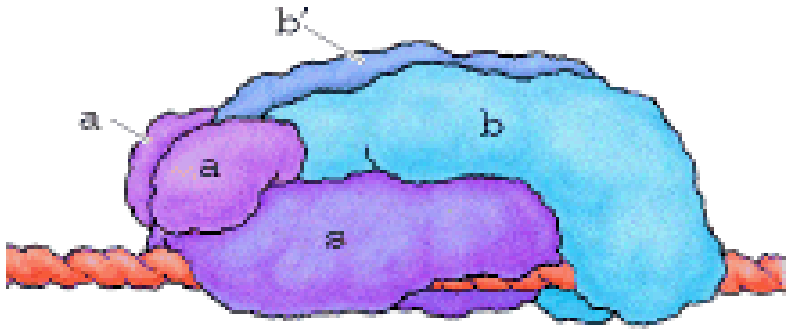
- RNA polymerase α α β β’ σ
- Transcription factors
- Promoter DNA
  - RNAP binding sites
  - Operator – repressor binding
  - Other TF binding sites

Start site of transcription is +1



Initiation

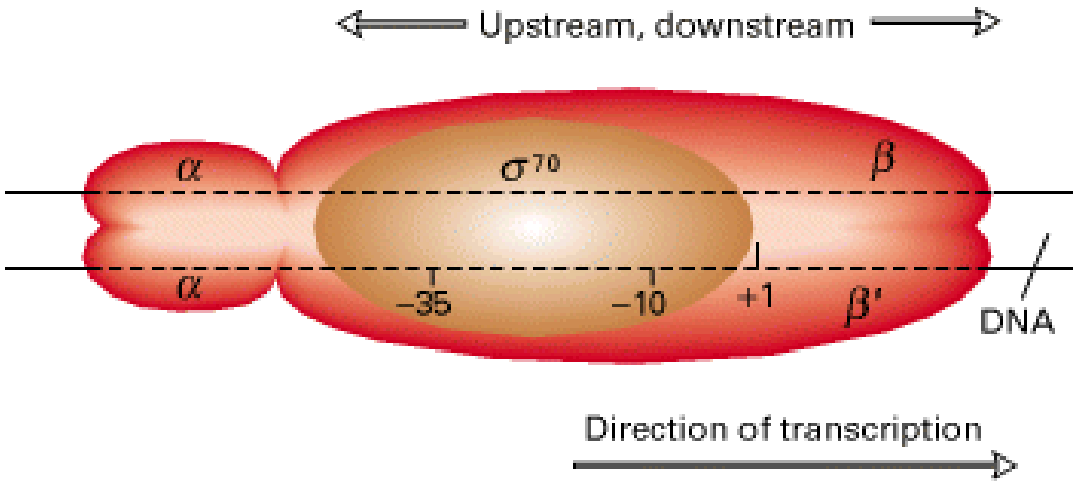
- RNA polymerase
  - 4 core subunits
  - Sigma factor (σ)- determines promoter specificity
  - Core + σ = holoenzyme
  - Binds promoter sequence
  - Catalyzes “open complex” and transcription of DNA to RNA



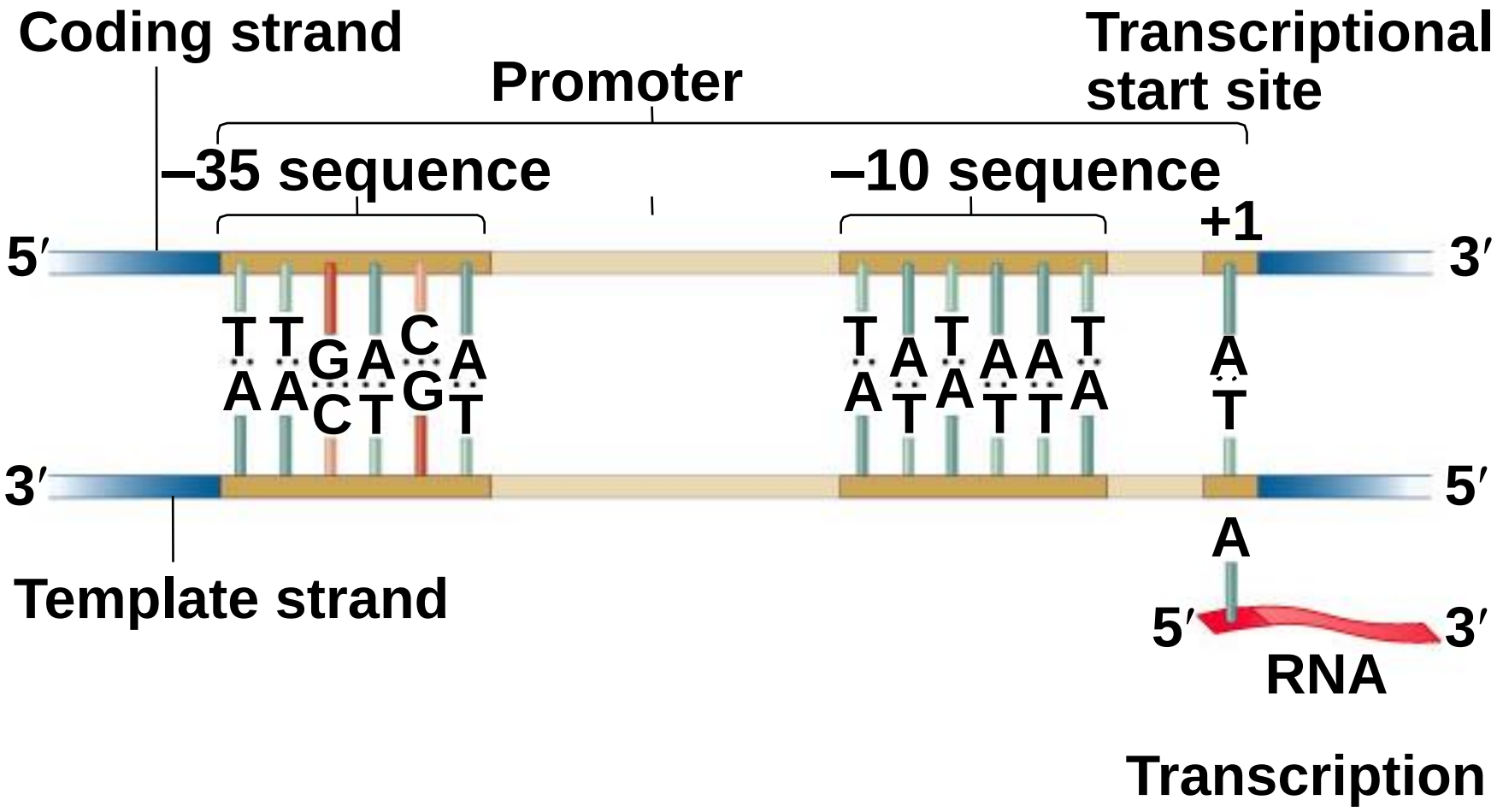
RNAP binds specific promoter sequences

- Sigma factors recognize consensus

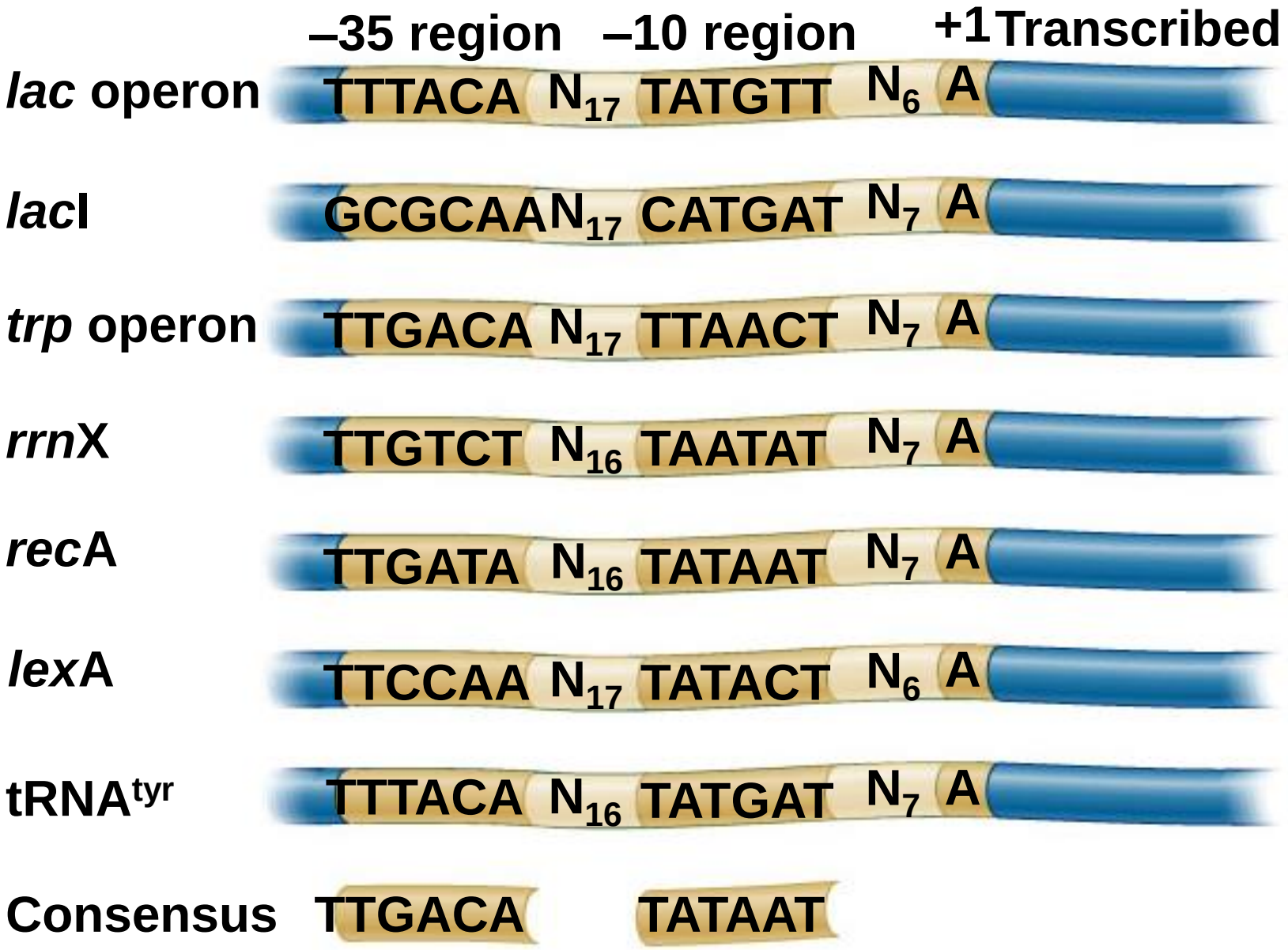
-10 and -35 sequences



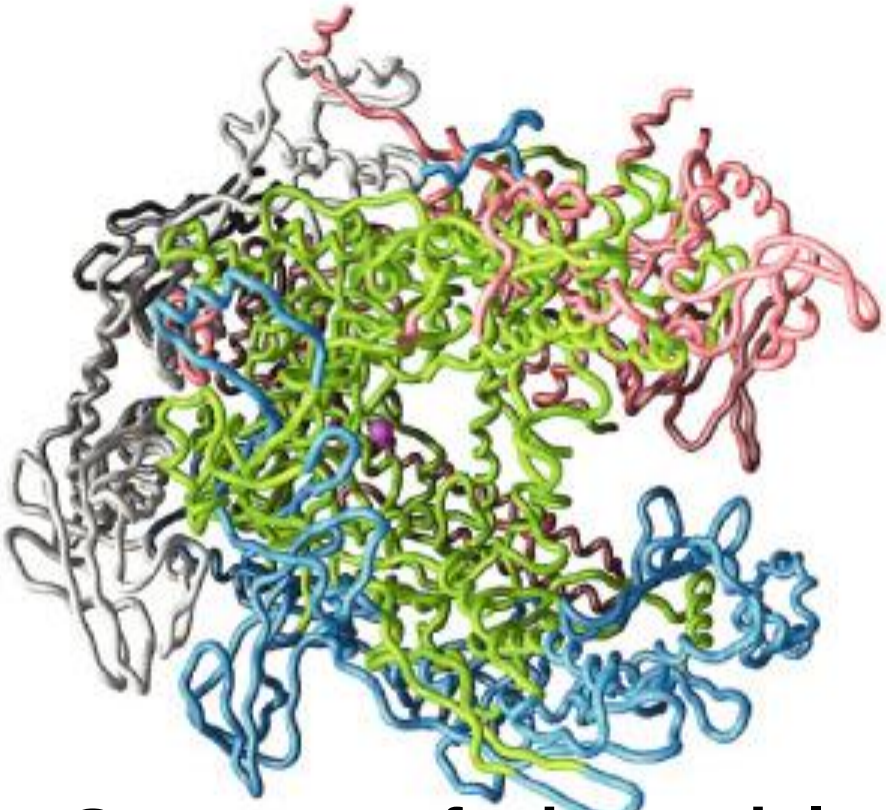
A Prokaryotic Promoter



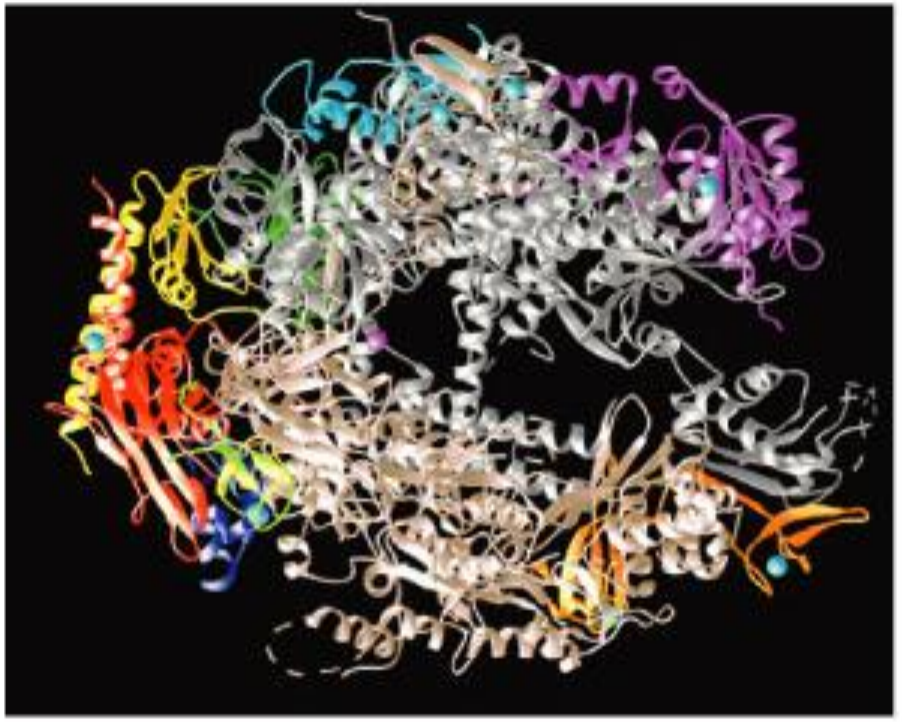
Reaching A Consensus



RNA Polymerases



Structure of a bacterial RNA polymerase



Structure of a eukaryotic RNA polymerase II

RNA Polymerases

- Differences between eukaryotes & prokaryotes
- Prokaryotes
  - 1 enzyme with 4 subunits
    - 2 α's, 1 β, & 1 β'
    - actual polymerase function
  - Sigma factors (σ)
    - recognize & bind promoter DNA sequence
- Eukaryotes
  - 3 separate holoenzymes – each has ~12 subunits
    - RNA Pol I – 28S, 18S, 5.8S rRNA
    - RNA Pol II – mRNA, snRNA
    - RNA Pol III – tRNA, 5S rRNA
  - 3 sets of basal transcription factors
    - recognize promoter DNA sequences

The Process of Transcription

- Initiation
  - Where/when most regulation of gene expression occurs
  - Different between prok:s & euk:s
- Elongation
  - Essentially same between prok:s & euk:s
  - Some regulation, more in prok:s than euk:s
- Termination
  - Different between prok:s & euk:s
  - Some regulation

Prok:s-prokaryote
Euk:s-eukaryotes

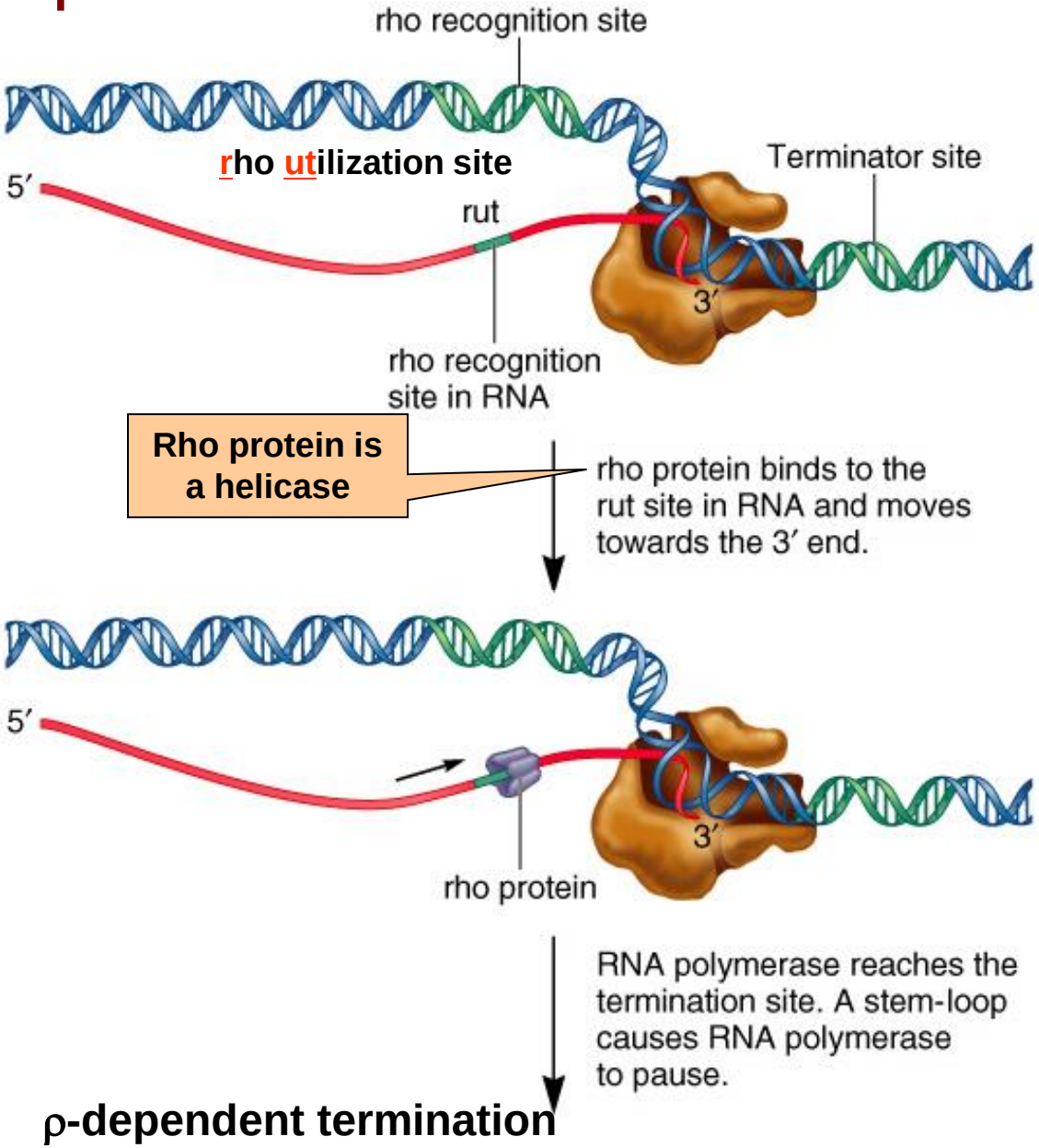
Elongation

- Once the RNA polymerase has synthesized a short stretch of RNA (~ 10 nt), transcription shifts into the elongation phase.
- This transition requires further conformational change in polymerase that leads it to grip the template more firmly.
- Functions: synthesis RNA, unwinds the DNA in front, re-anneals it behind, dissociates the growing RNA chain

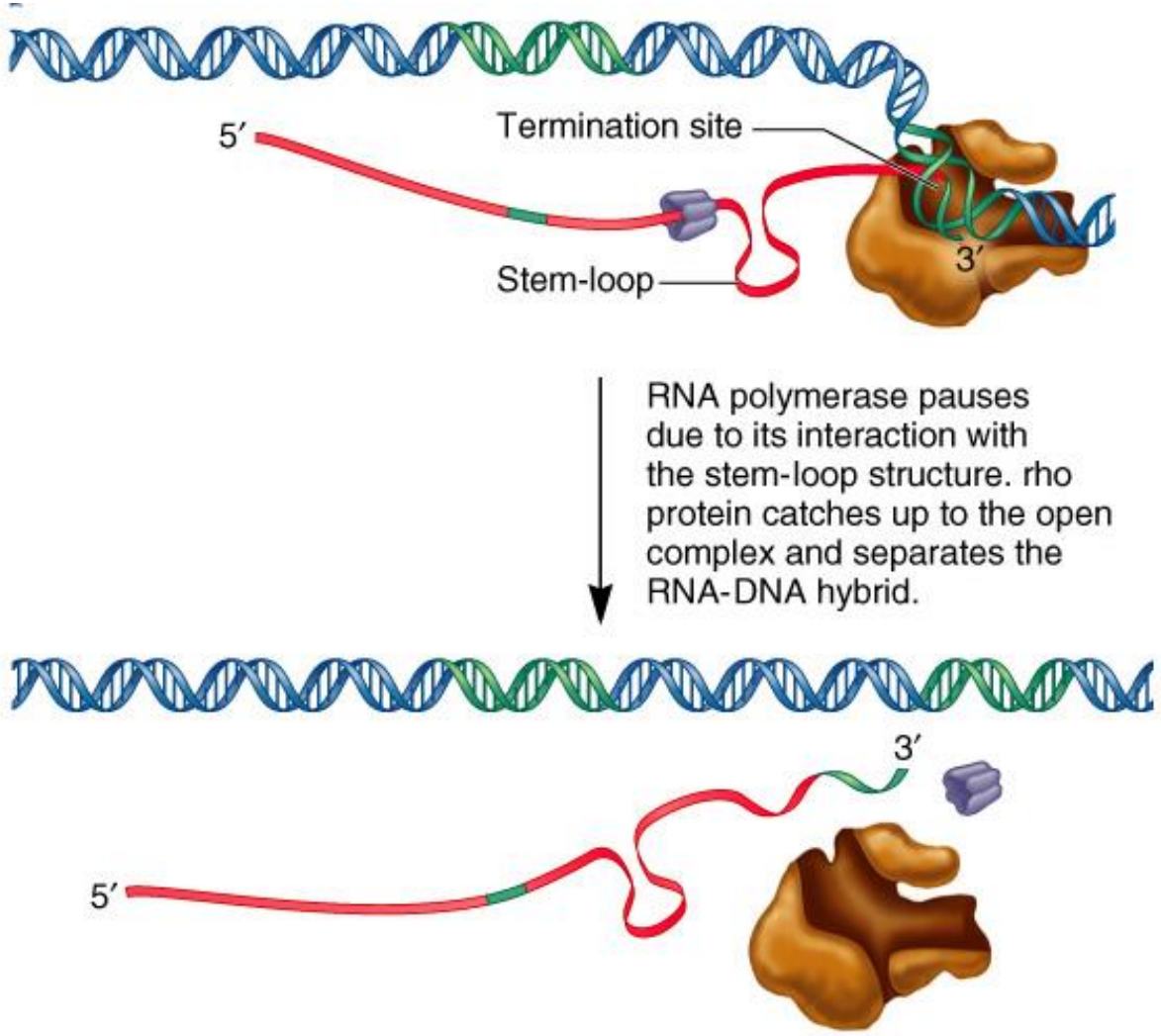
Termination

- After the polymerase transcribes the length of the gene (or genes), it will stop and release the RNA transcript.
- In some cells, termination occurs at the specific and well-defined DNA sequences called terminators. Some cells lack such termination sequences.

Rho Dependent Termination in Prokaryotes



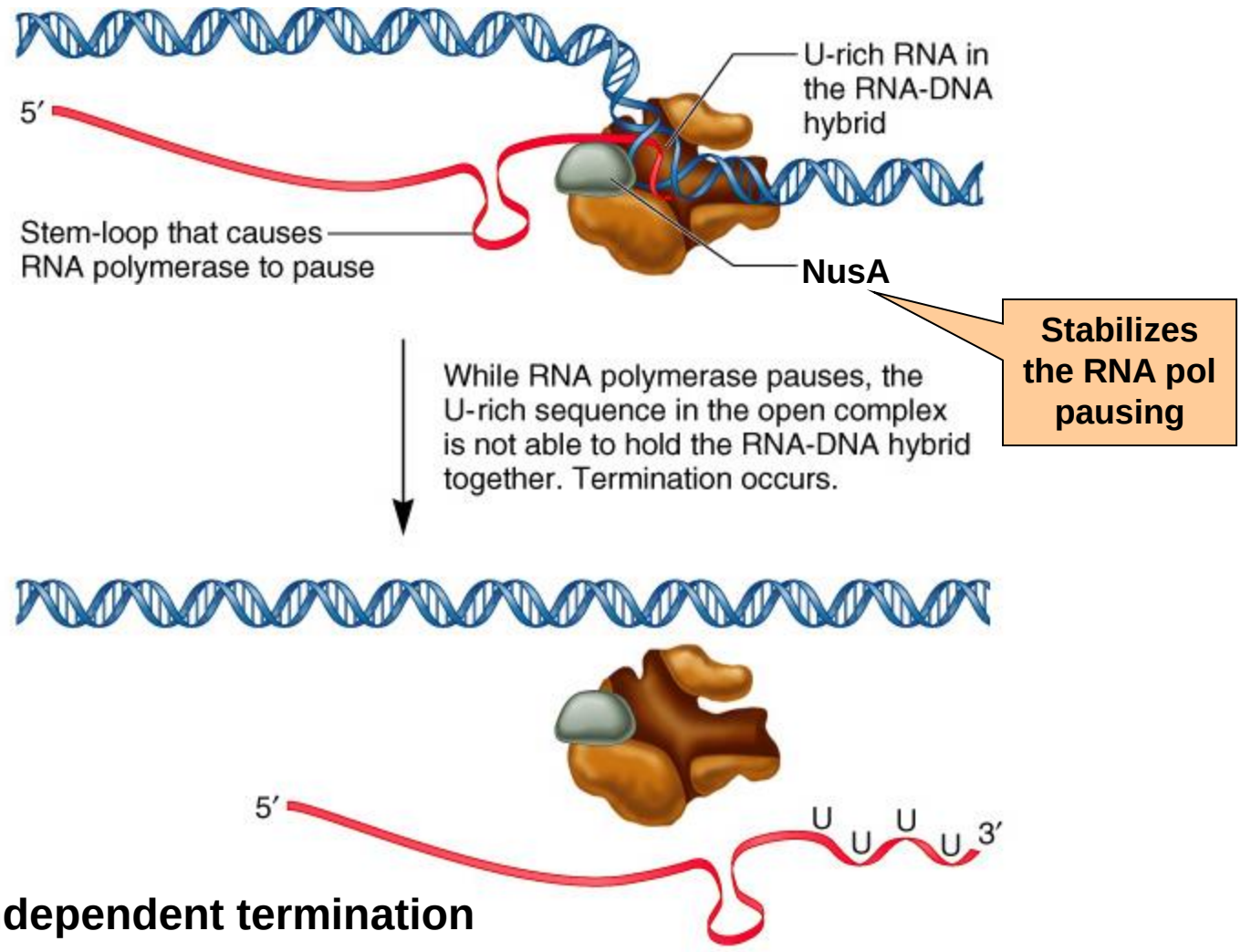
Rho Dependent Termination in Prokaryotes



ρ-dependent termination

Rho Independent Termination in Prokaryotes

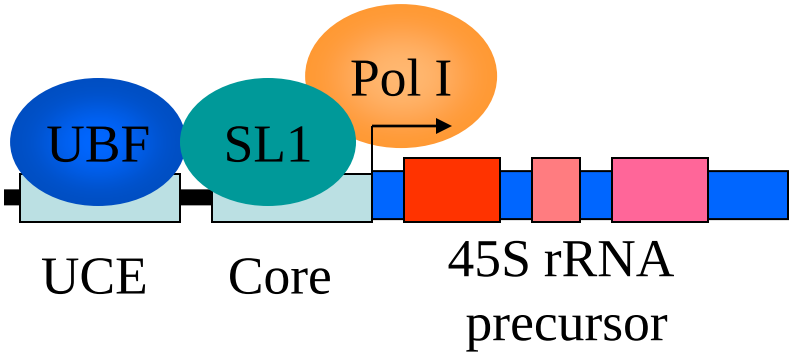
- ρ-independent termination requires two sequences in the RNA
  - A stem-loop structure upstream of 7-9 U residues



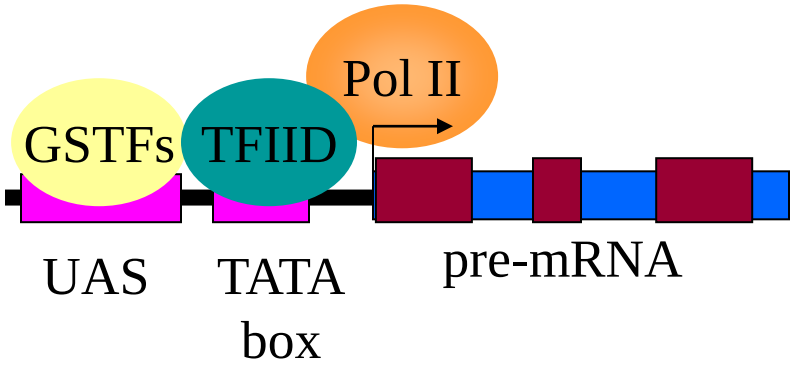
ρ-independent termination

Eukaryotic Promoters

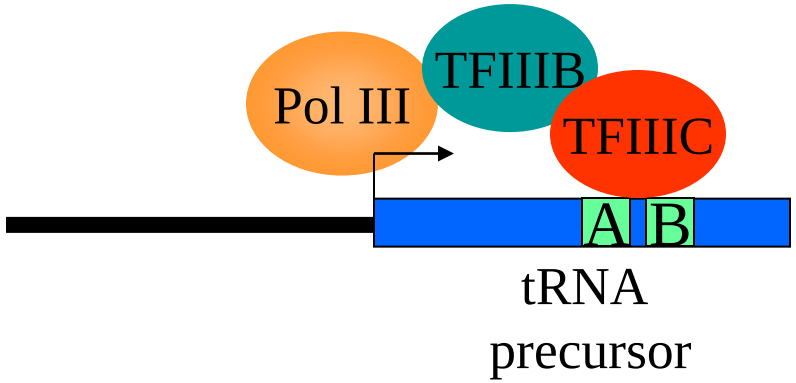
- RNA Pol I
  - rRNA precursor



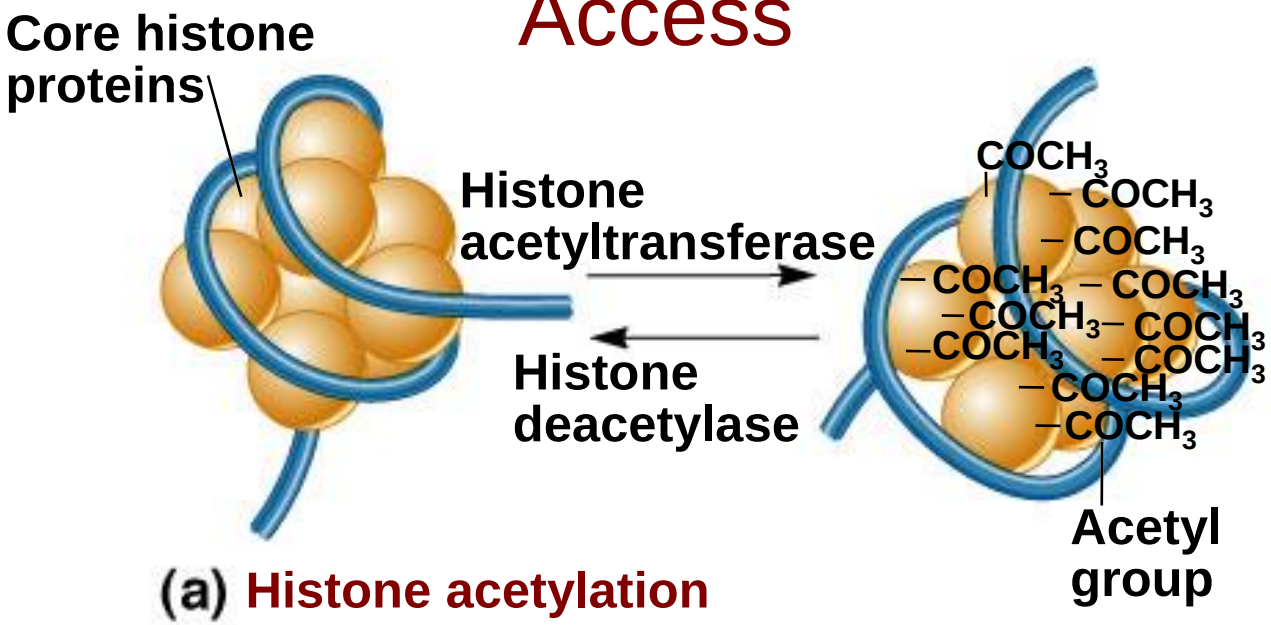
- RNA Pol II
  - mRNAs, U6 snRNA



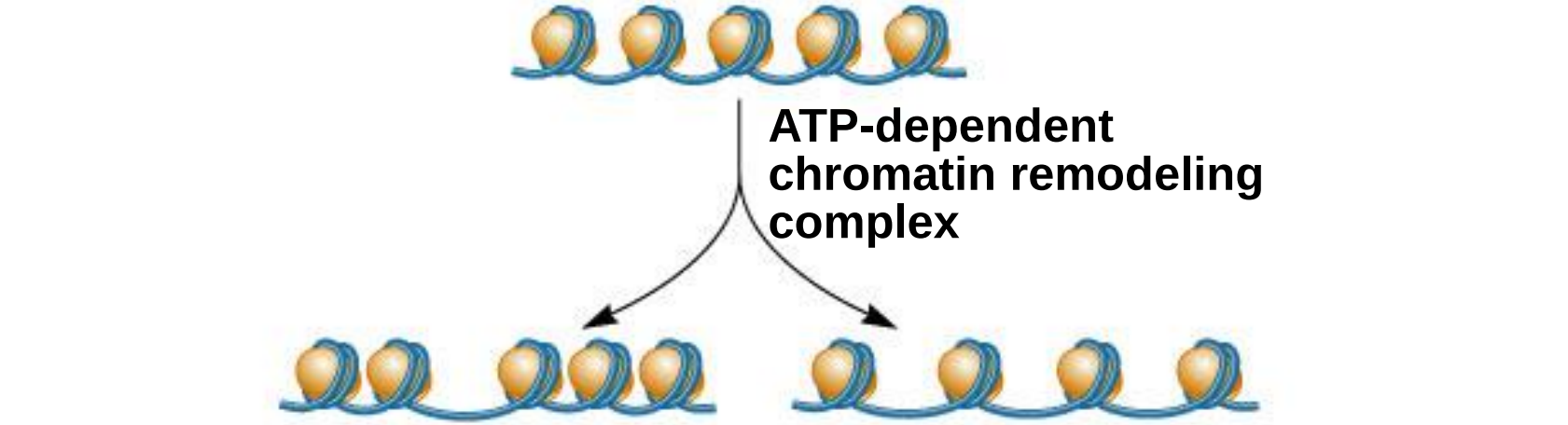
- RNA Pol III
  - tRNA, 5S rRNA, U1-U5 snRNAs



Chromatin Structure Affects Promoter Access

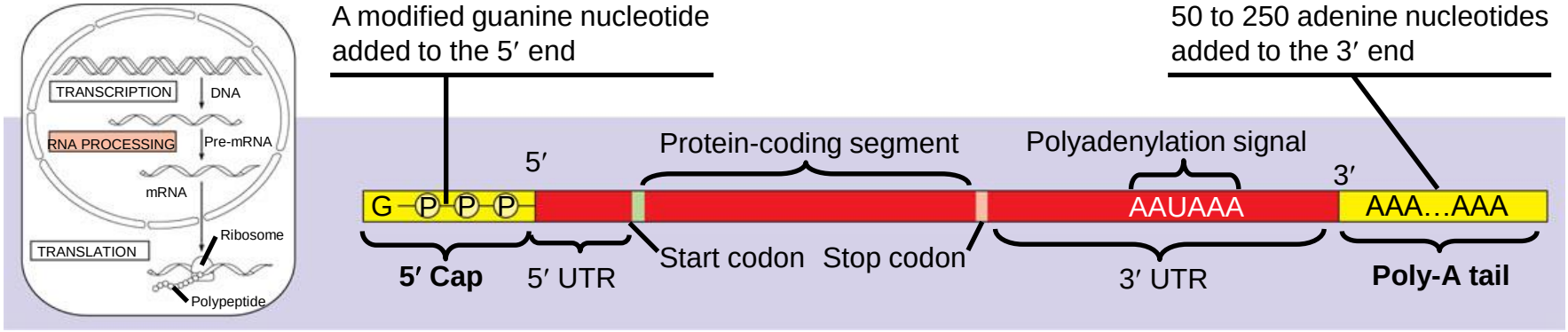


(a) Histone acetylation

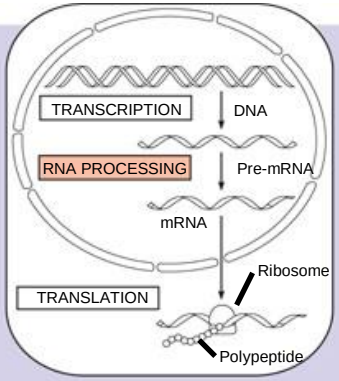


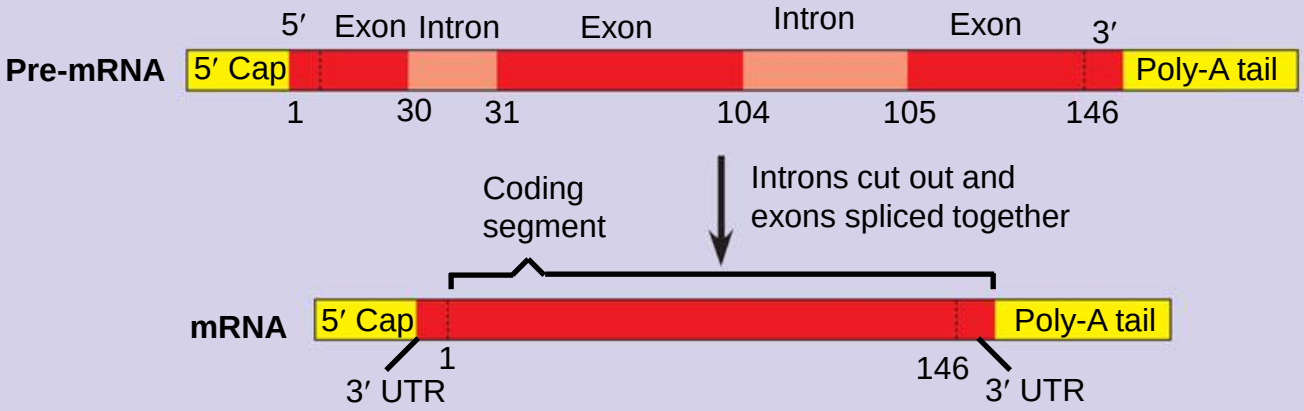
(b) Chromatin remodeling

RNA processing: addition of the 5′ cap and poly-A tail

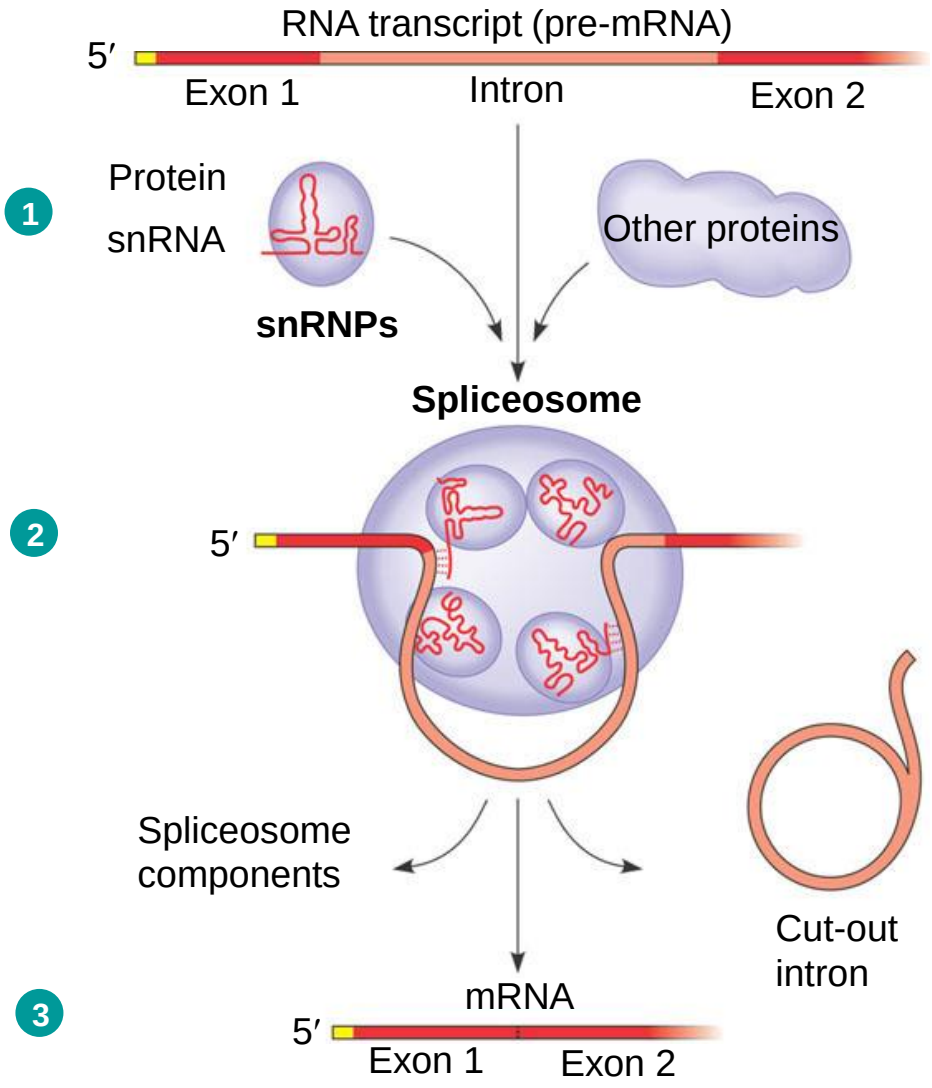


RNA processing: RNA splicing





The roles of snRNPs and spliceosomes in pre-mRNA splicing



Regulation of Translation