Transcription

RNA synthesis

Objectives

What is Transcription?

Gene structure in prokaryotes & eukaryotes

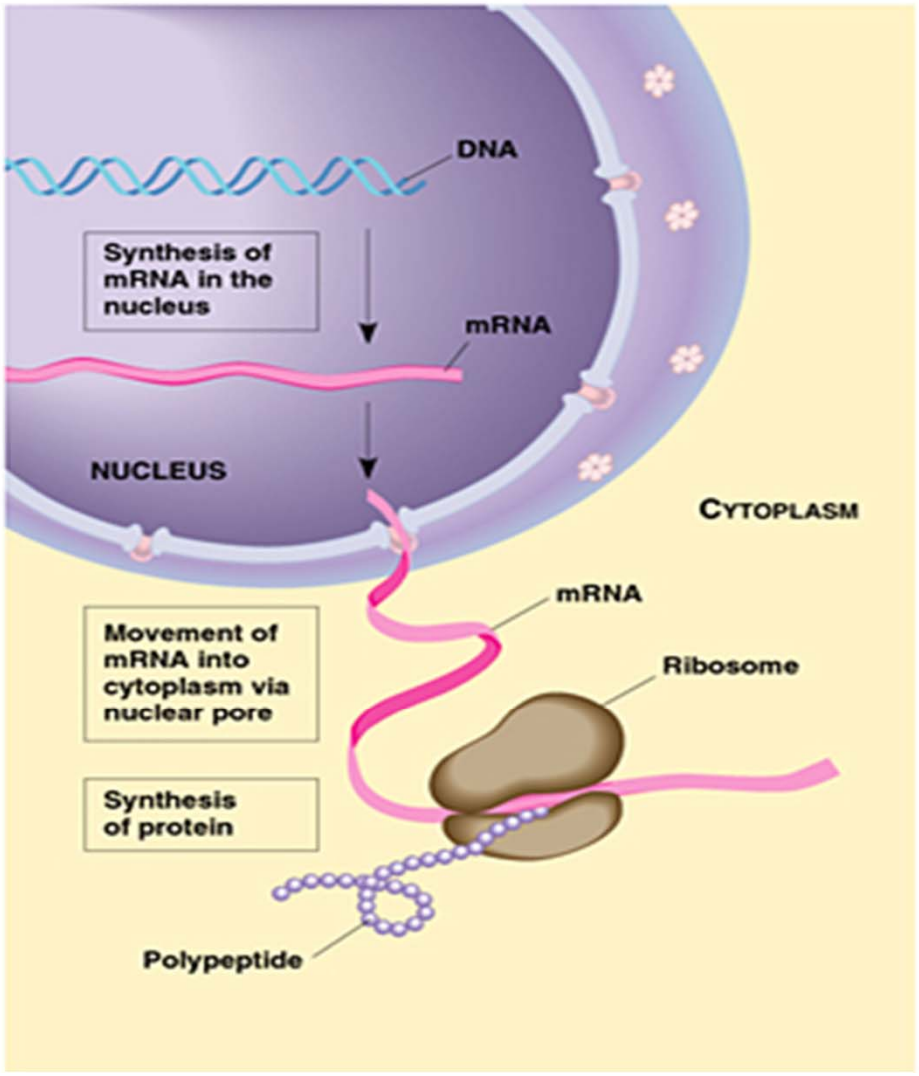
Site of Transcription

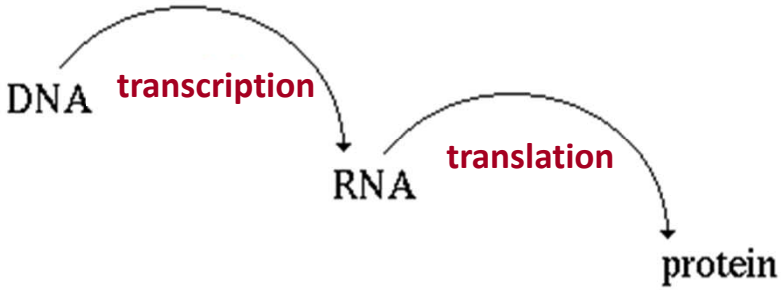
Requirements for transcription

Stages in Transcription

Need for RNA

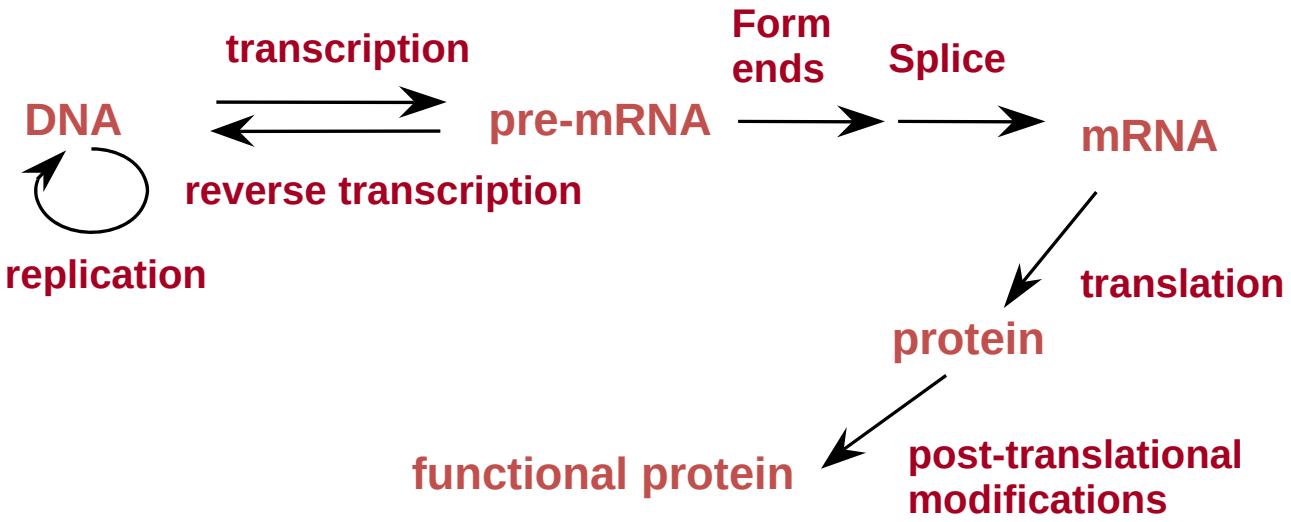
Crick's Central Dogma of Molecular Biology



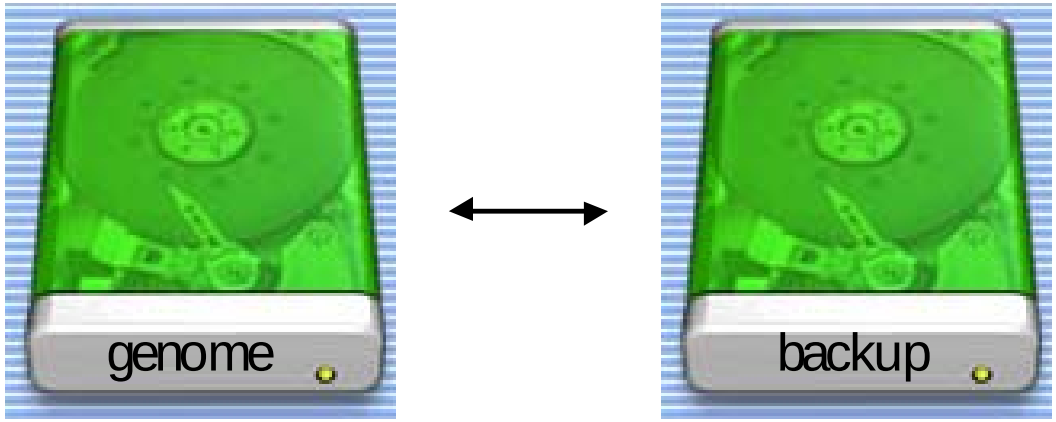


Ammendments to the Central Dogma

Flow of Genetic information is not one-way



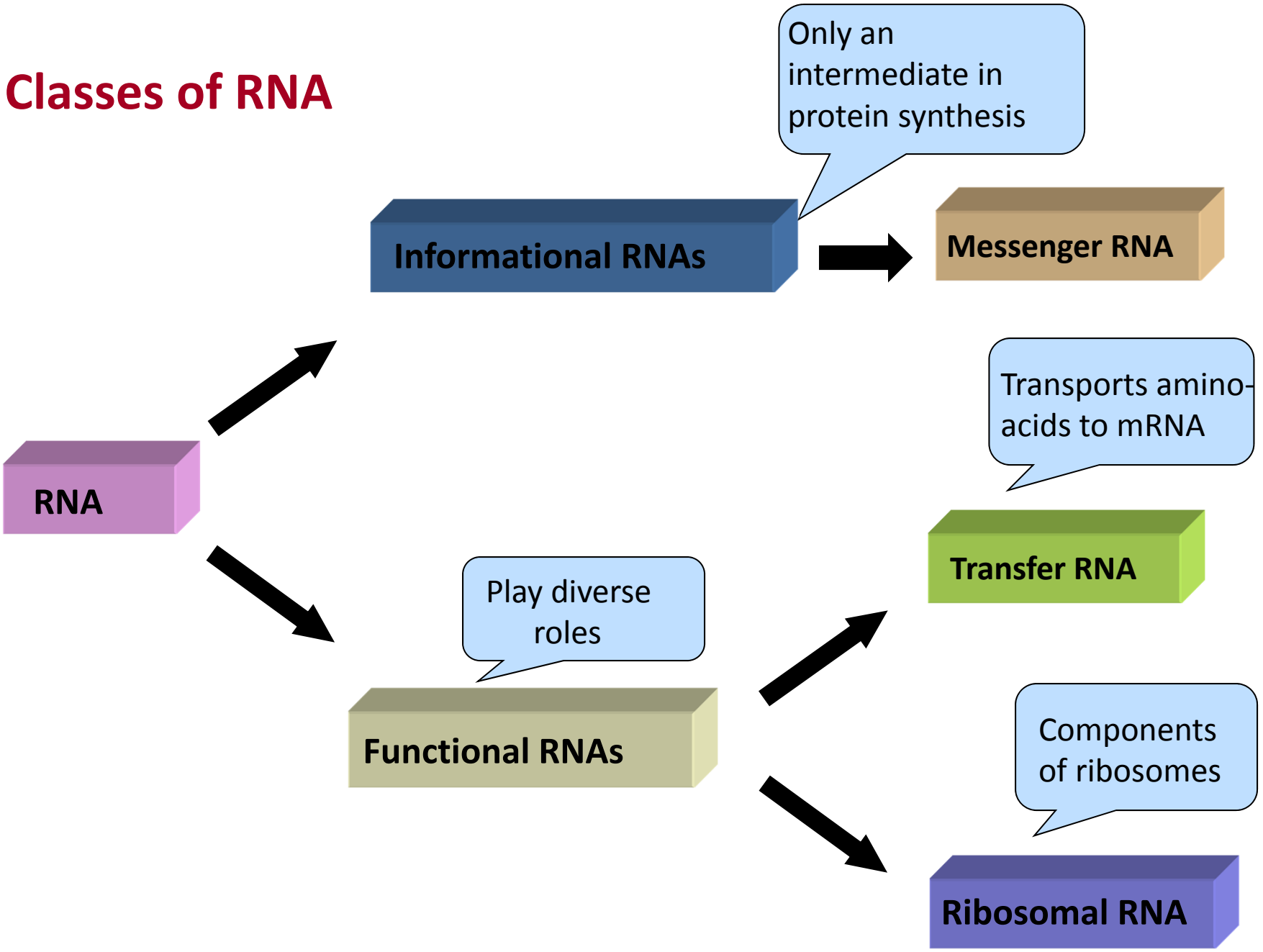
Need for an RNA intermediate



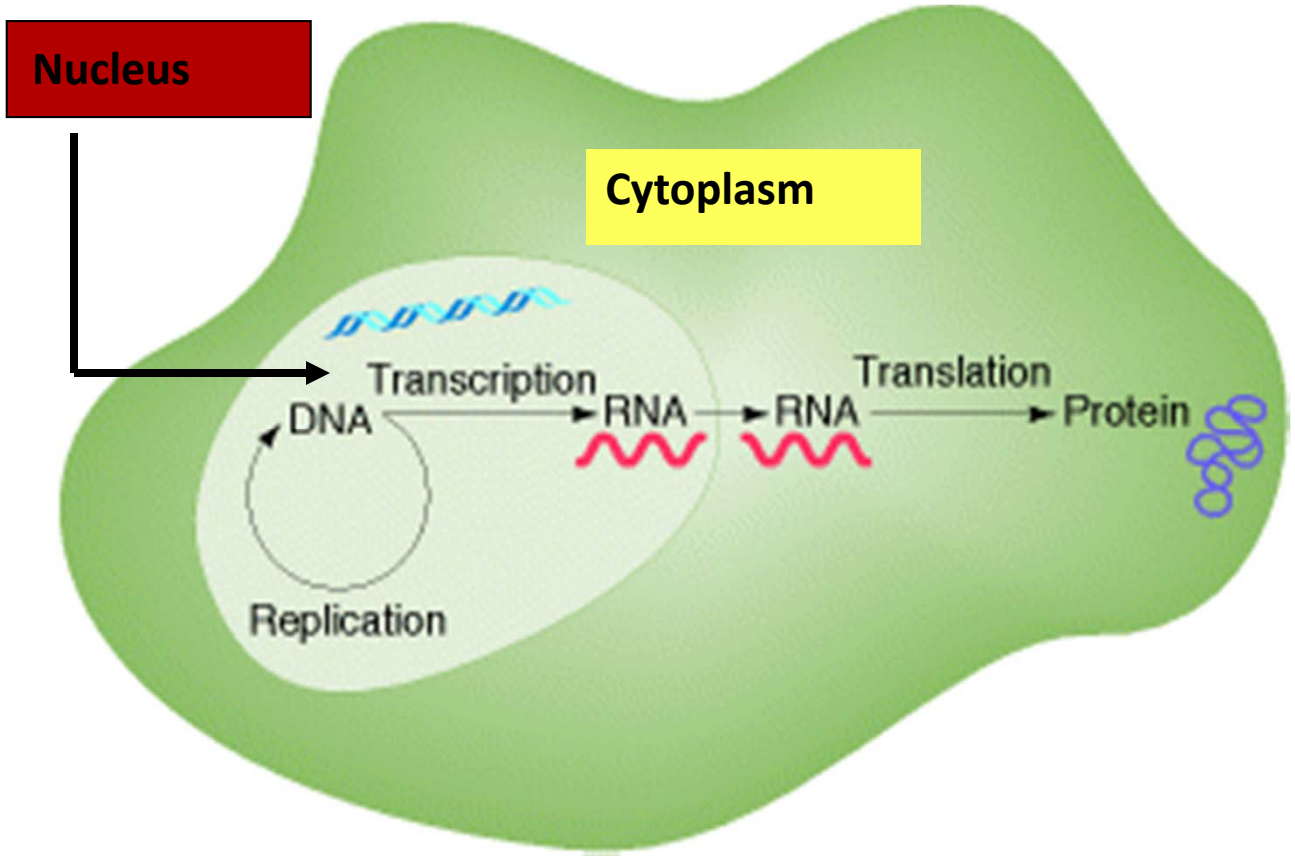
Use two nucleic acids to encode the data, one to read and one for backup

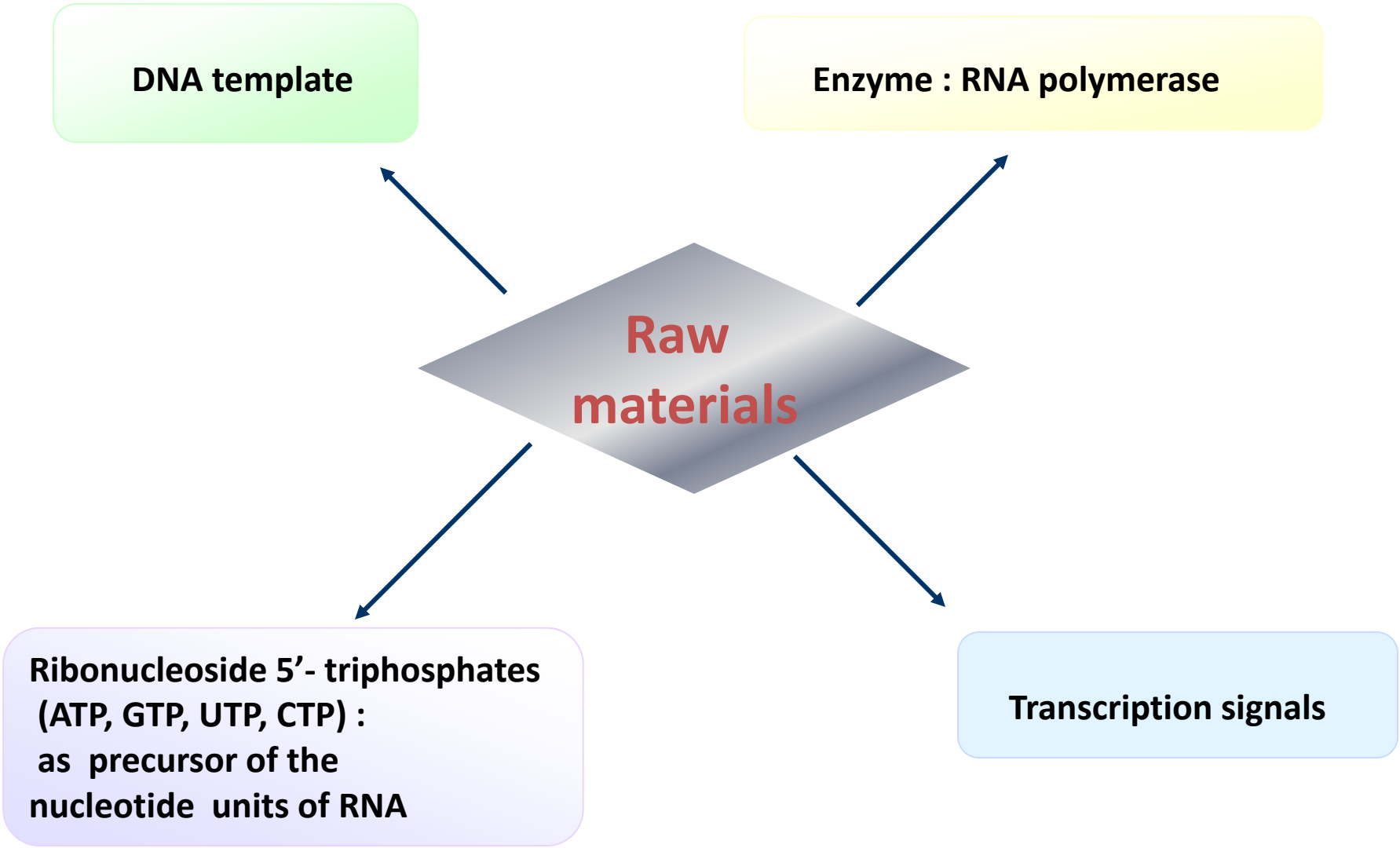
Make them complementary for error checking

Classes of RNA



Site of Transcription : The Nucleus

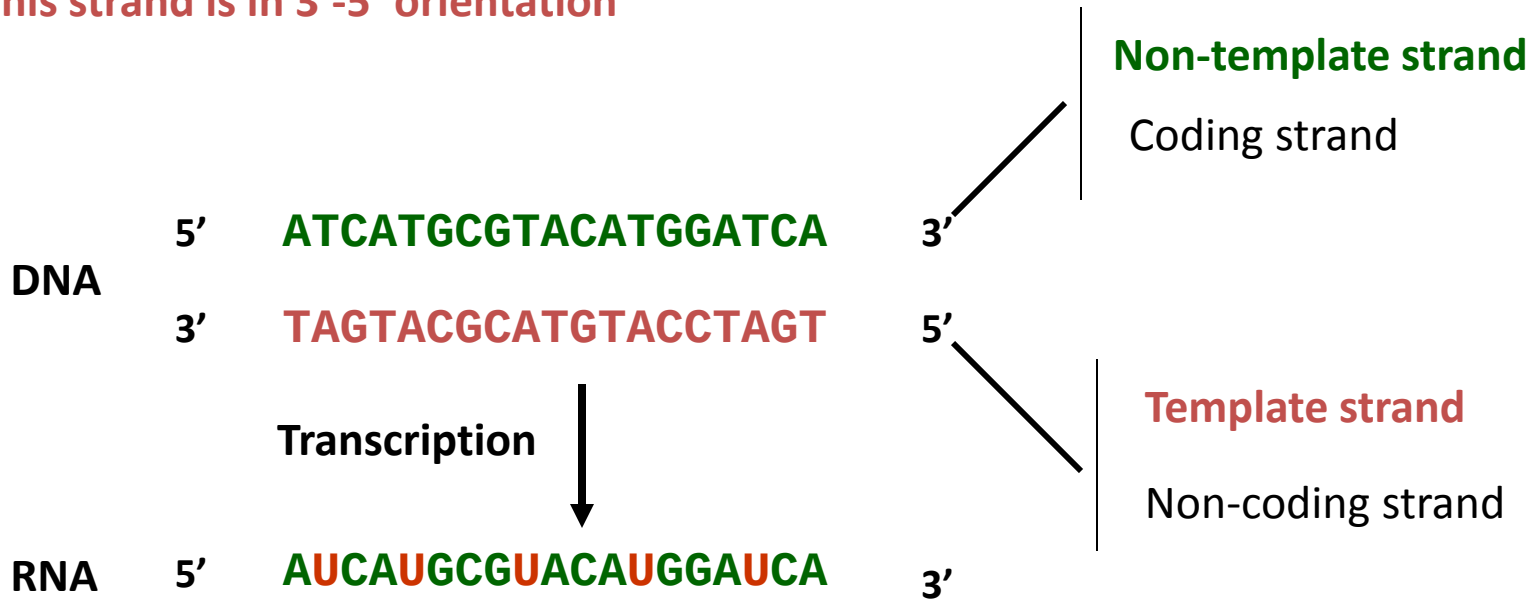



DNA template
Enzyme : RNA polymerase
Raw materials
Ribonucleoside 5'- triphosphates (ATP, GTP, UTP, CTP) : as precursor of the nucleotide units of RNA
Transcription signals

DNA template

Only one strand of the DNA of a gene is used as a template

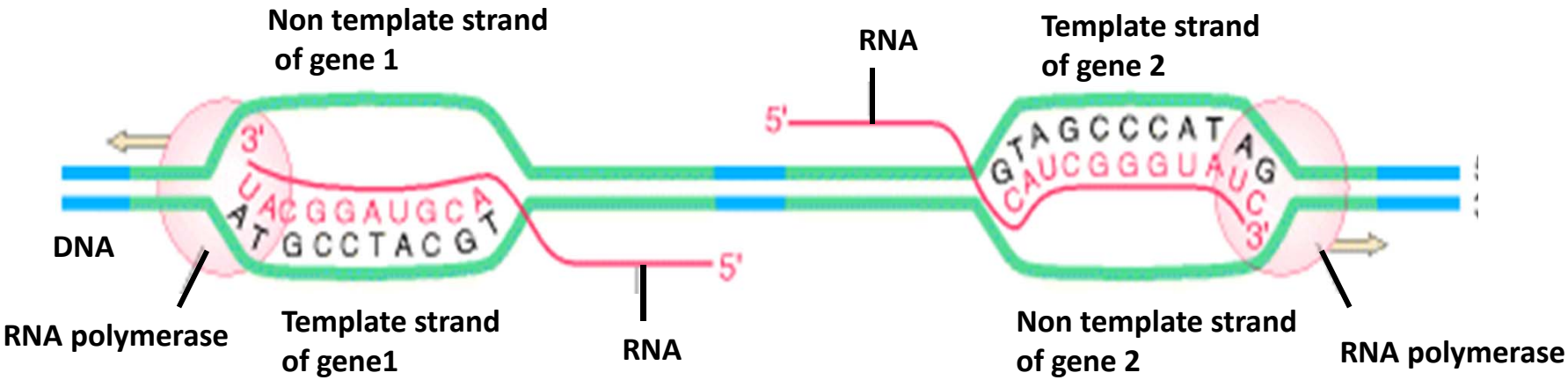
This strand is in 3’-5’ orientation



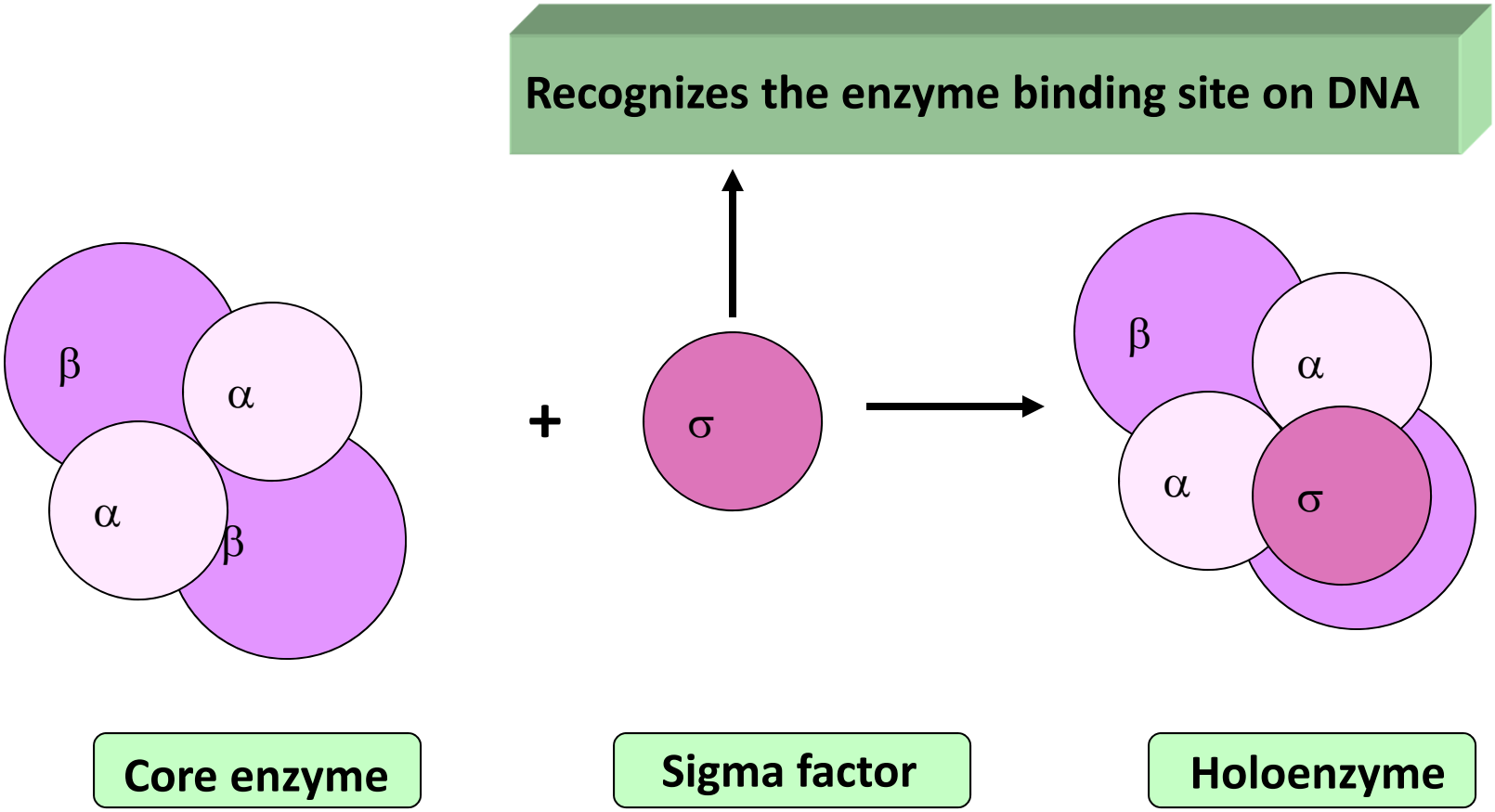
RNA transcript matches the non-template strand in direction and base sequence

Except : T’s are replaced by U’s

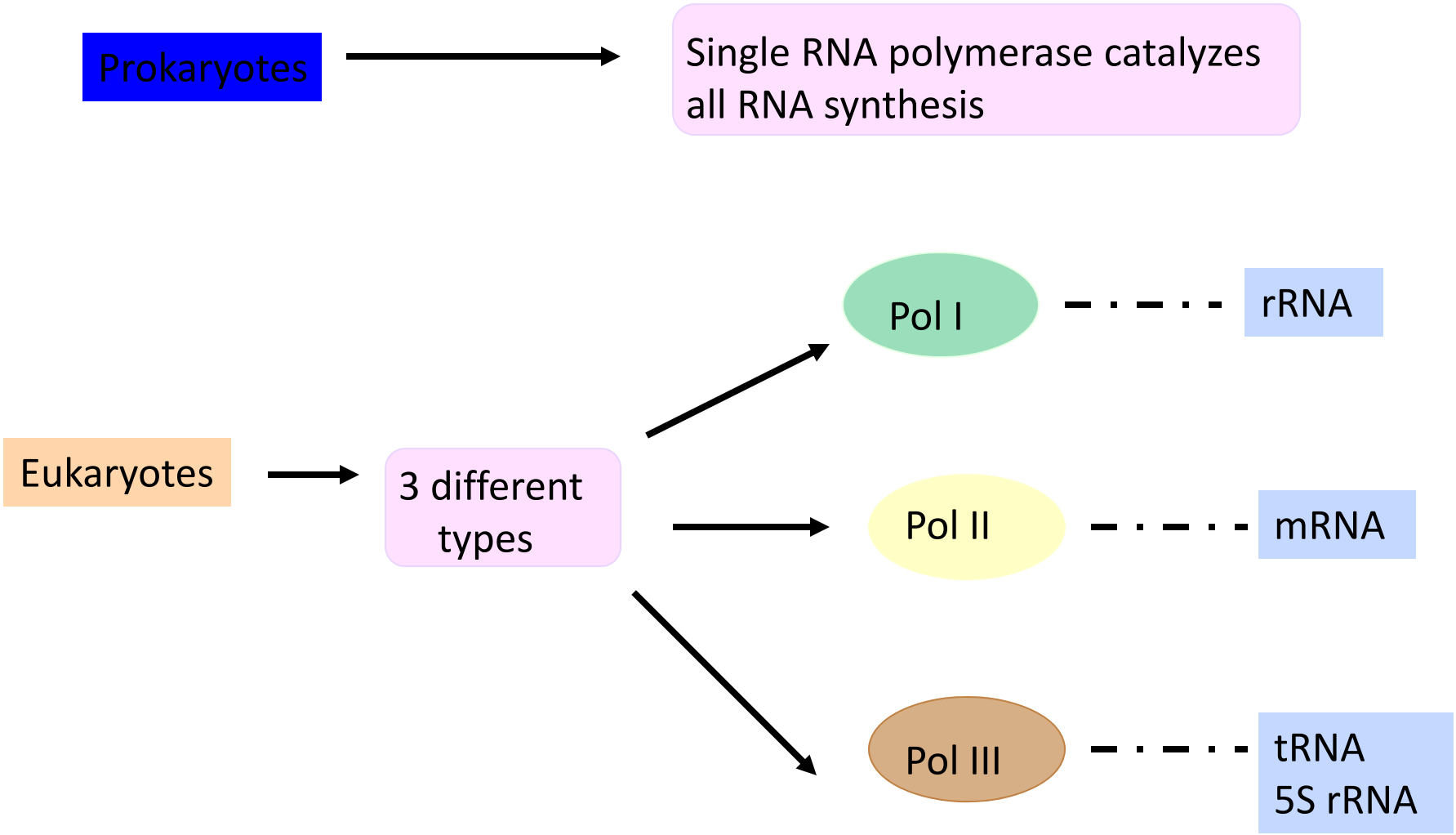
Template & Non-Template strands in two different genes



Enzyme RNA Polymerase (Prokaryotes) : Structure

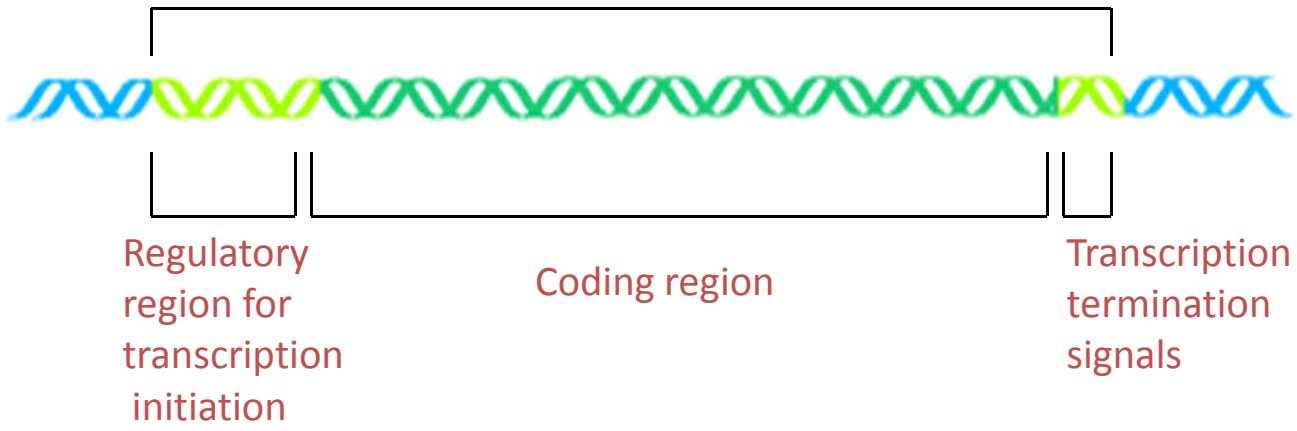


Types of RNA Polymerases

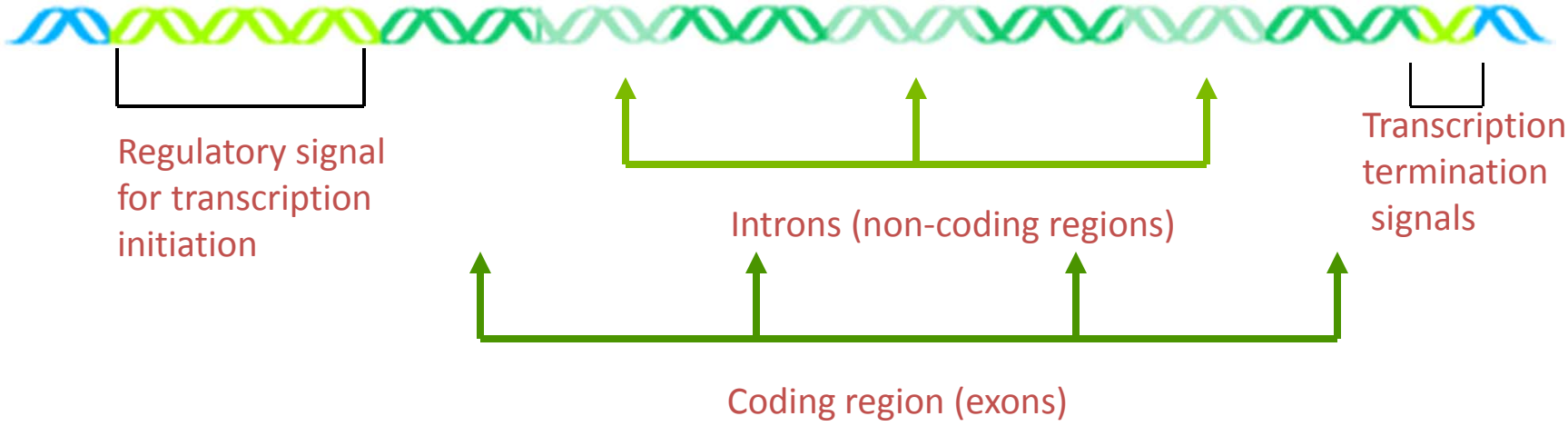


Gene Structure

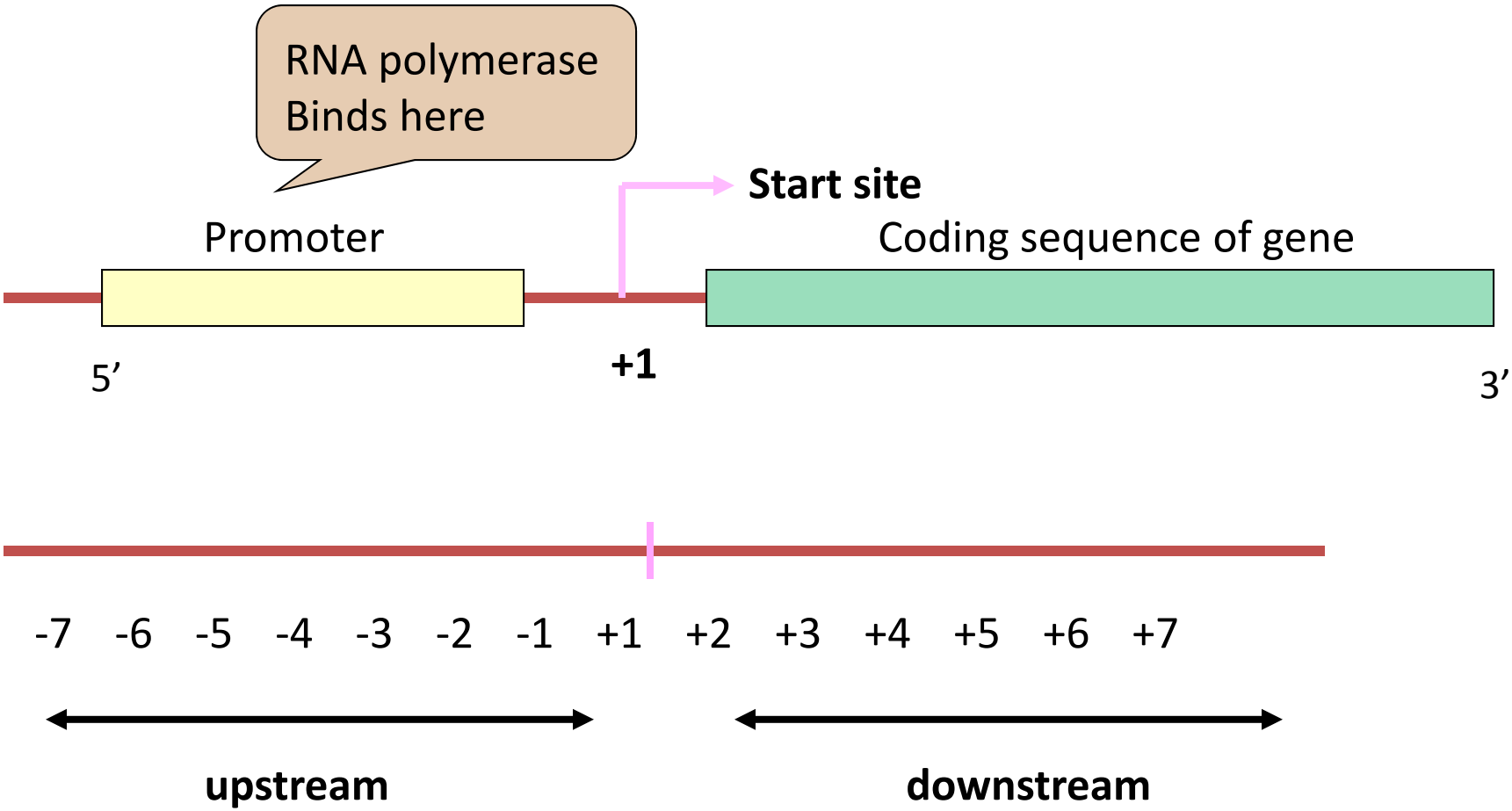
Prokaryotic gene



Eukaryotic gene



Transcription signals - Promoters



Transcription signals - Promoters

Prokaryotes:

-10 sequence and -35 sequence ("Pribnow" box recognized by the holoenzyme)

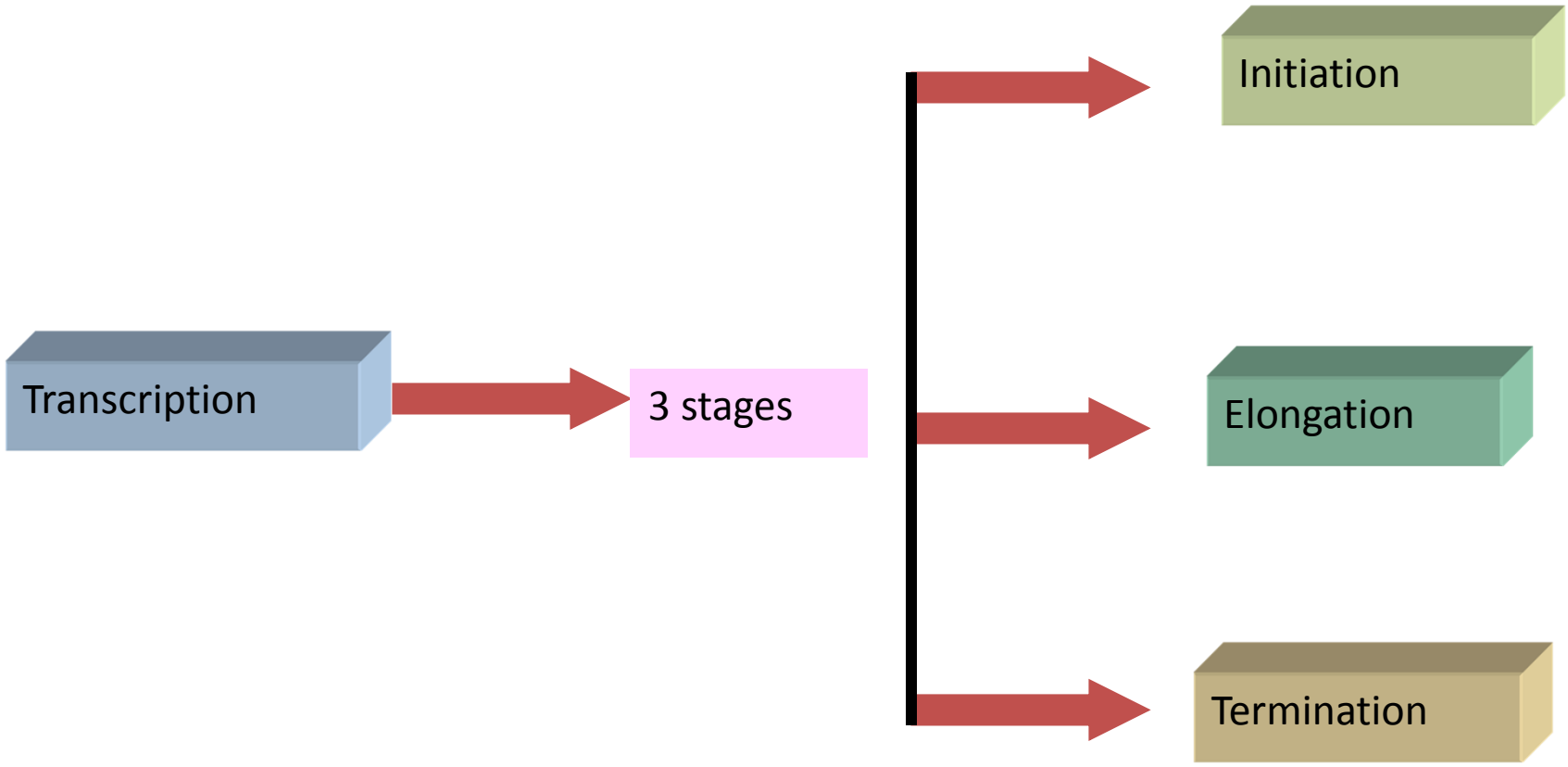
-35 -10
5'------TTGACA----------TATAAT------Start site-

Eukaryotes:
-35, -75, and -90 sequences

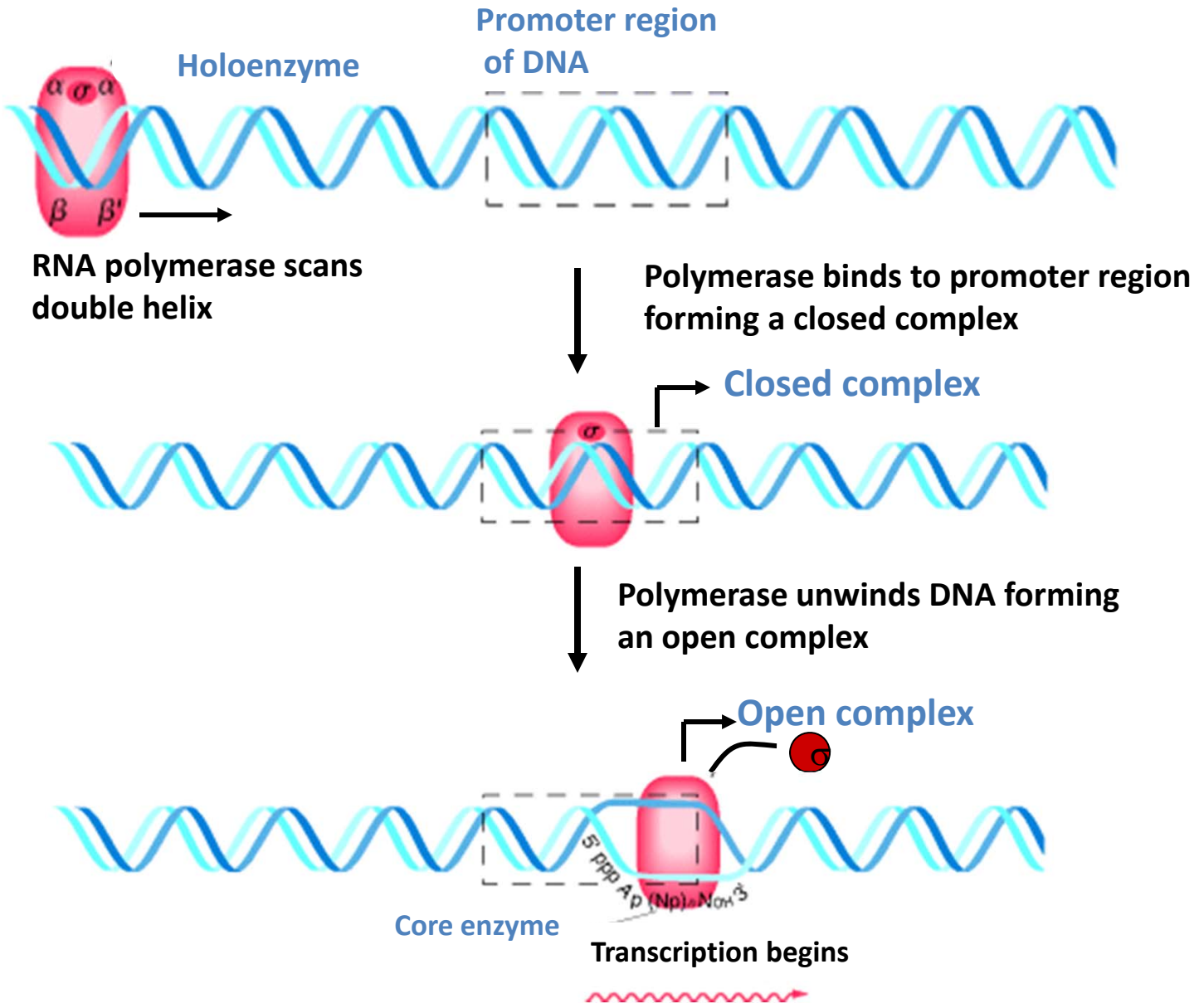
-90 -75 -35
5'-----GCGCGC-----CAAT-------TATAAT--------Start site

GC Box CAAT Box TATA Box

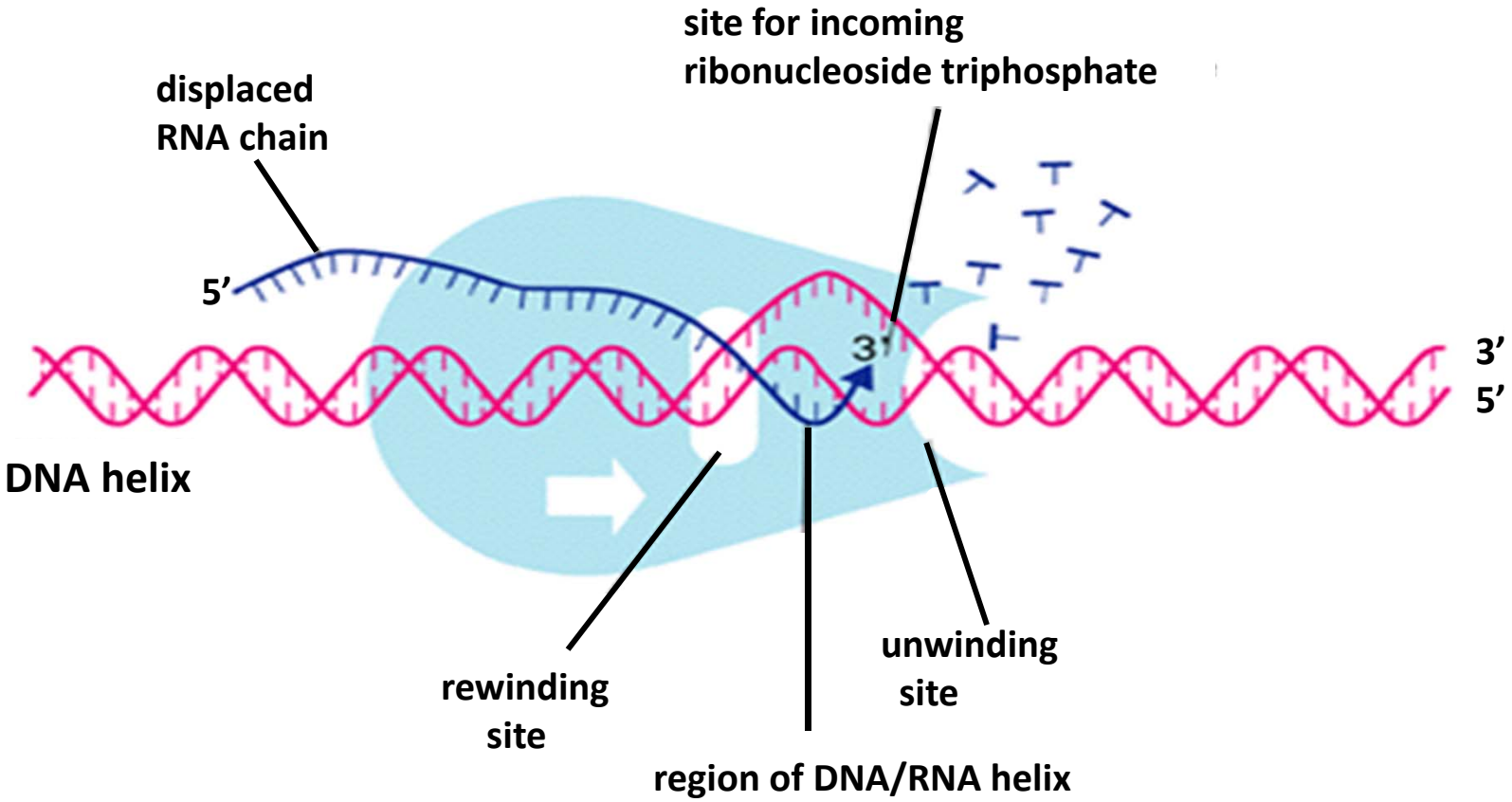
Transcription : The Process



Initiation


Promoter region
of DNA
Holoenzyme
α σ α
β β'
RNA polymerase scans
double helix
Polymerase binds to promoter region
forming a closed complex
Closed complex
σ
Polymerase unwinds DNA forming
an open complex
Open complex
σ
5' ppp A p (Np)n OH 3'
Core enzyme
Transcription begins

Formation of an Open Complex



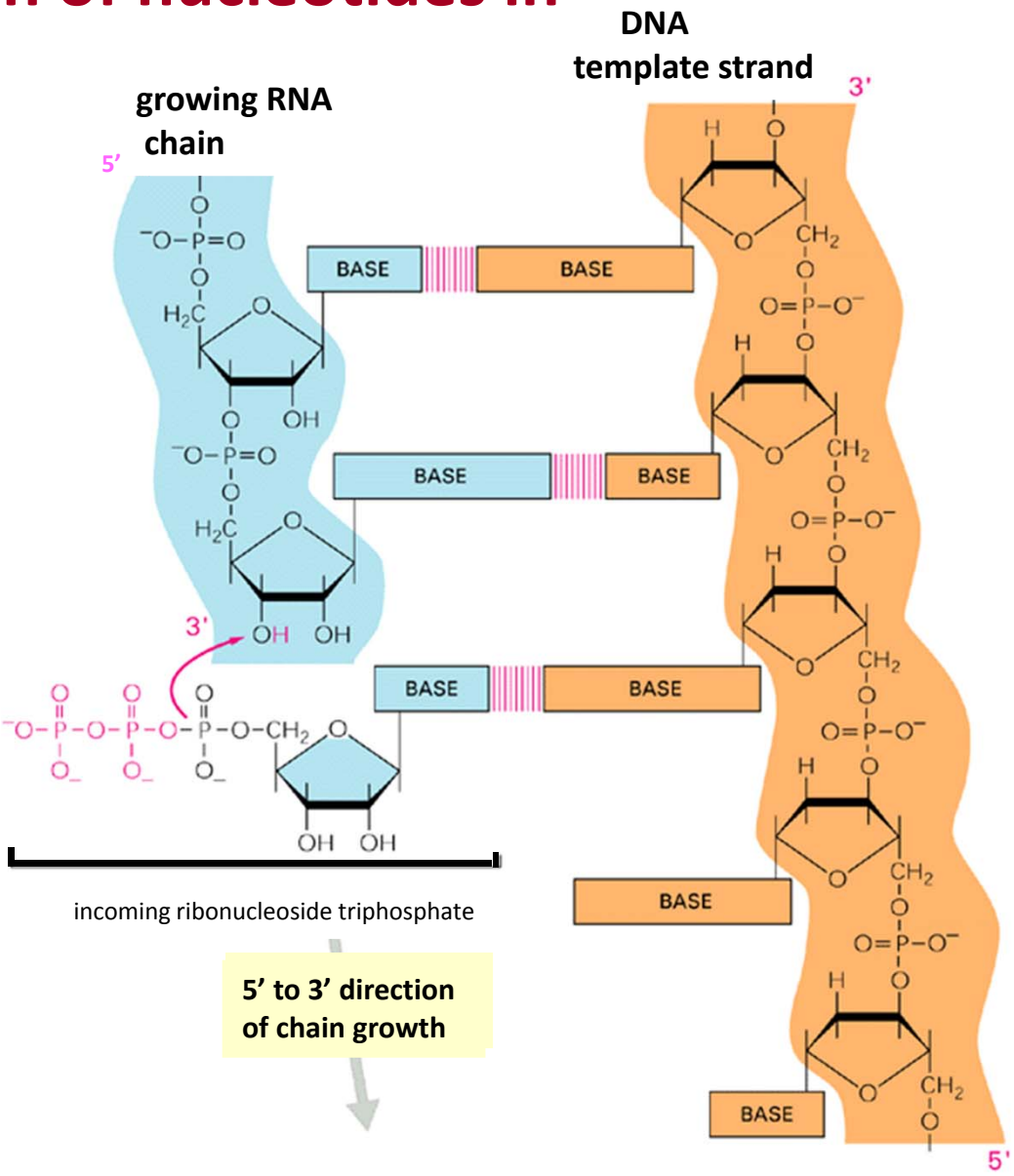
A moving RNA polymerase molecule continuously:

unwinds the DNA helix ahead of the polymerization site

rewinds the 2 DNA strands behind this site

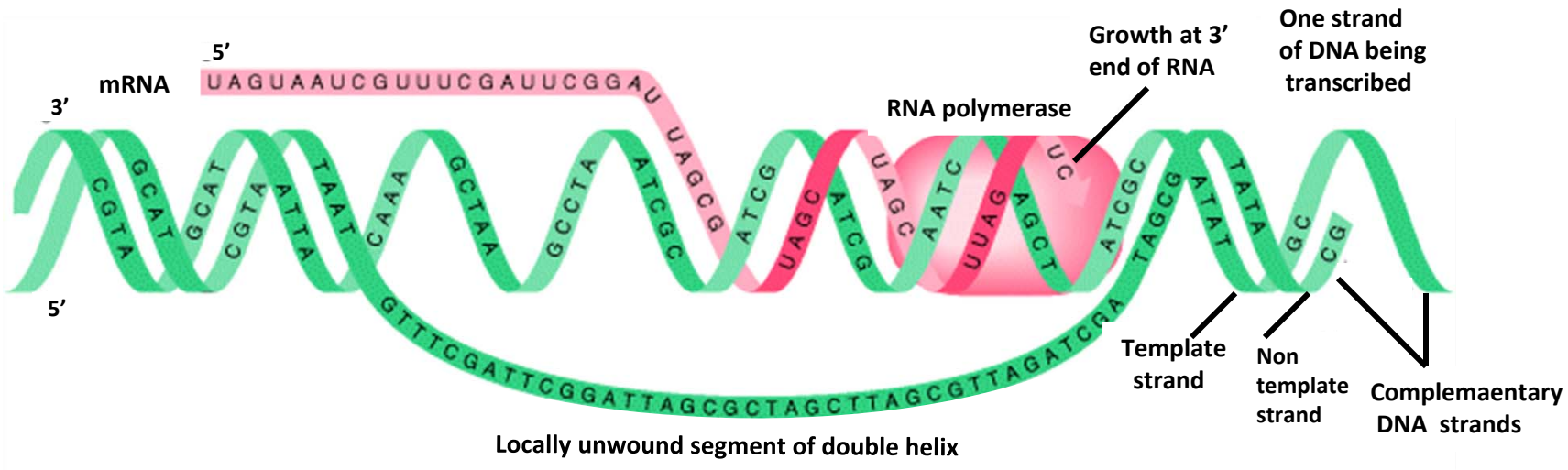
Sequential addition of nucleotides in 5’-3’ direction

The RNA chain grows by the formation of a bond between the 3’ hydroxyl end of the growing strand & a nucleotide triphosphate



Elongation

RNA strand is synthesized in the 5’ - 3’ direction from a single stranded region of DNA



Termination

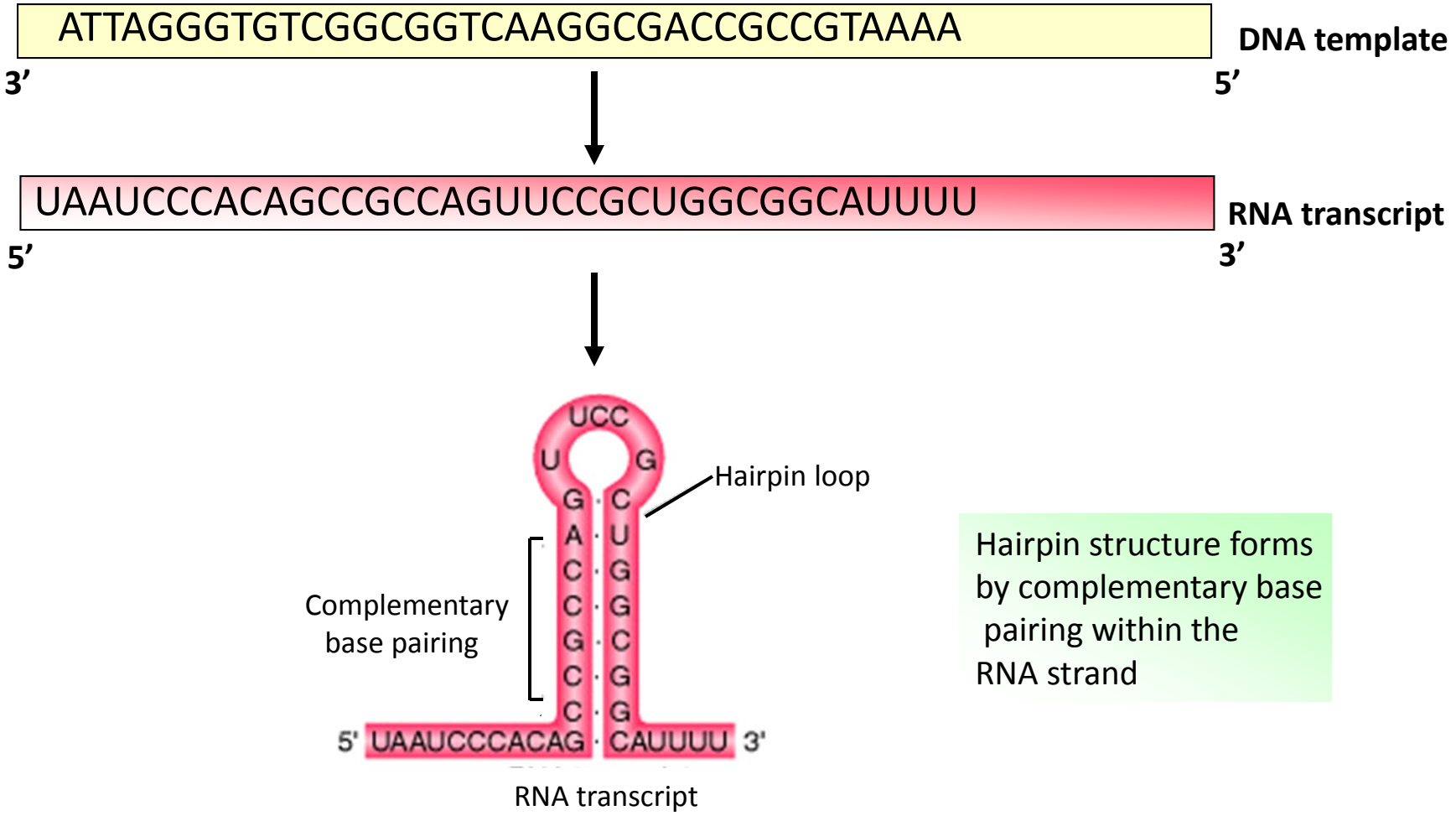
Specific nucleotide sequences in the DNA act as chain termination signals

Two main mechanisms for termination

RNA strand released from the DNA template

Polymerase released from the DNA template

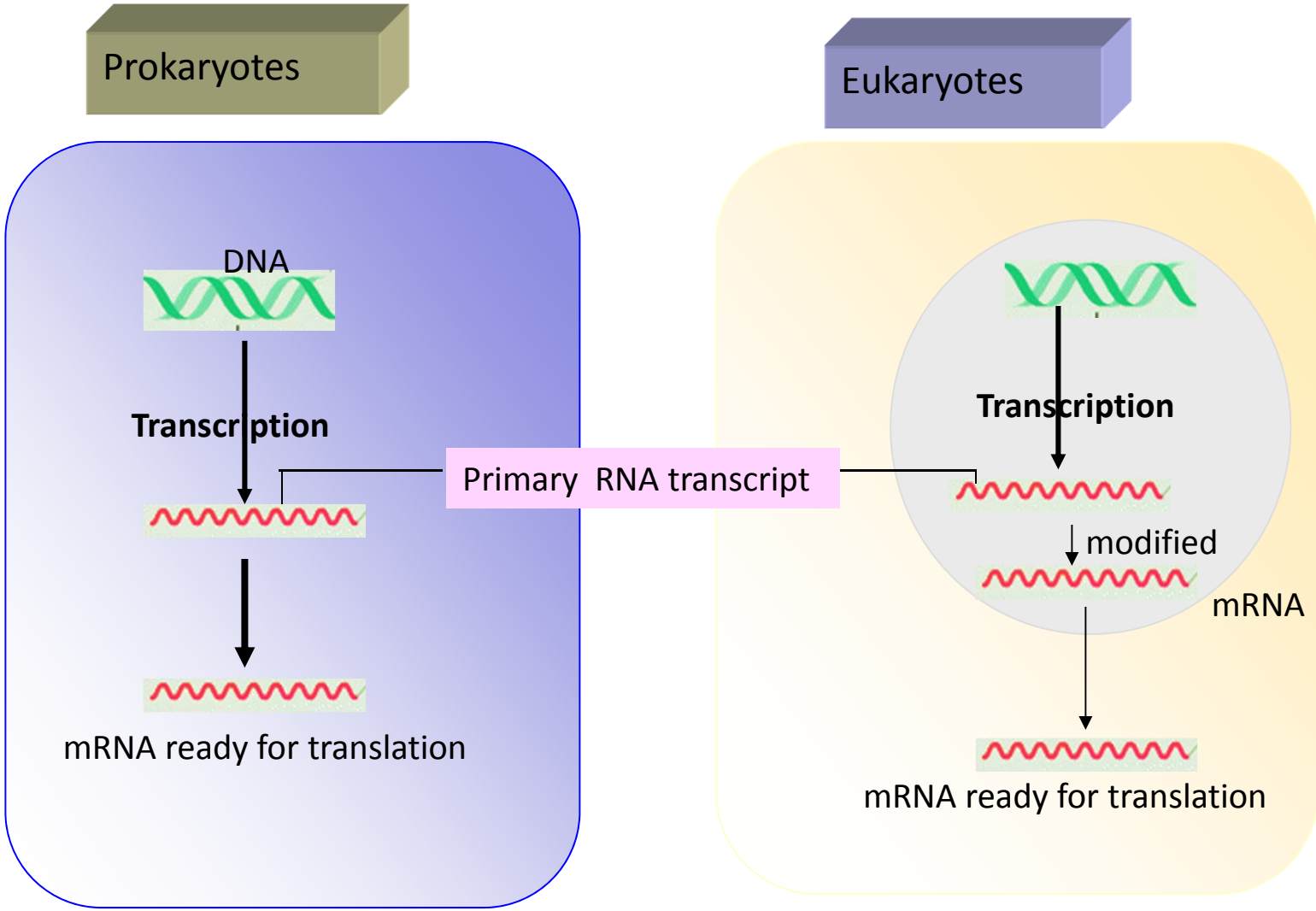
(a) Terminator sequences consist of about 40 bp, ending in a GC rich stretch followed by a run of four or more A's on the template strand



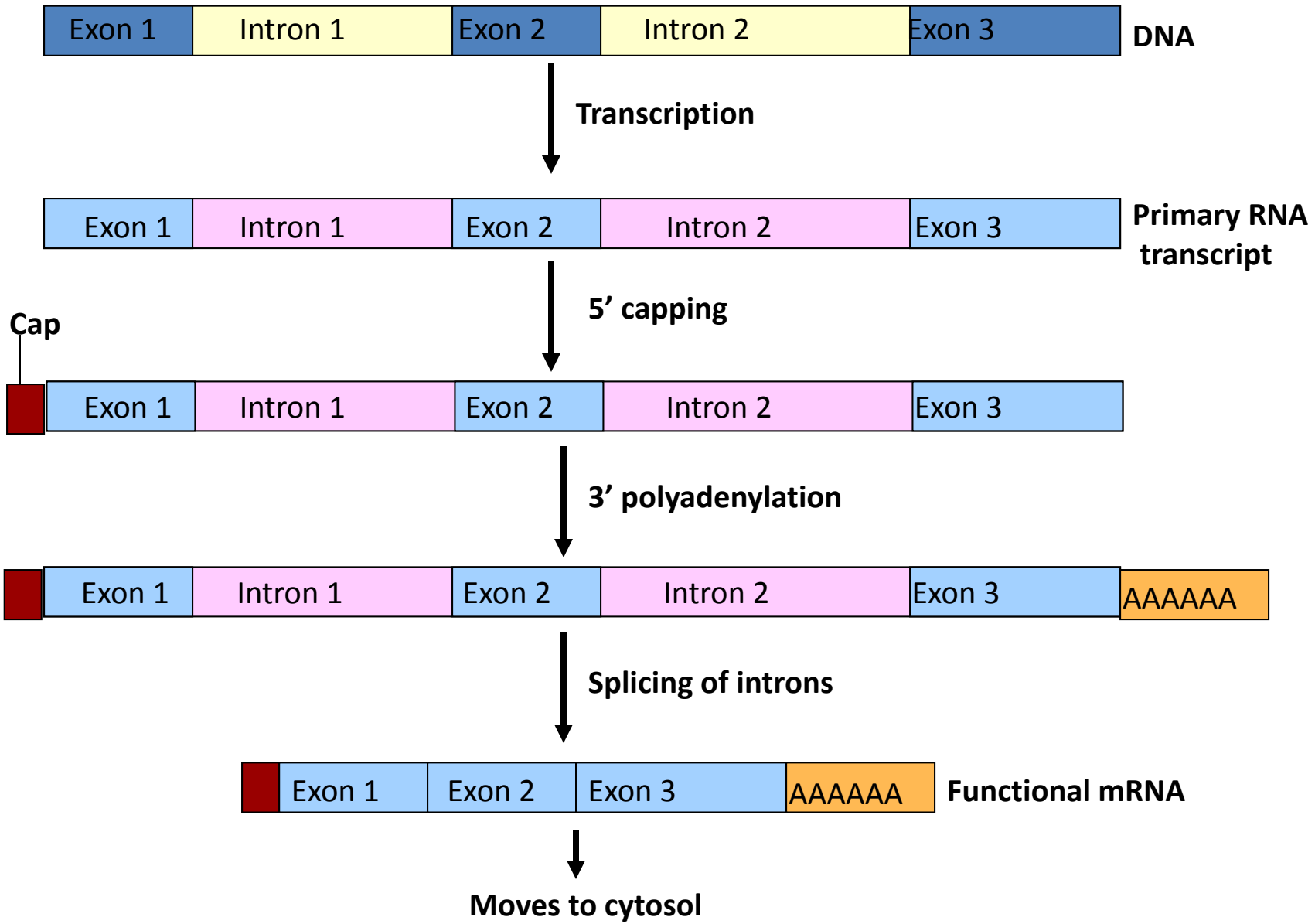
Hairpin structure forms by complementary base pairing within the RNA strand

(b) Mediated by protein : rho factor

Post termination



Processing of primary transcript in eukaryotes



Summary

Transcription : Synthesis of RNA from DNA in the nucleus