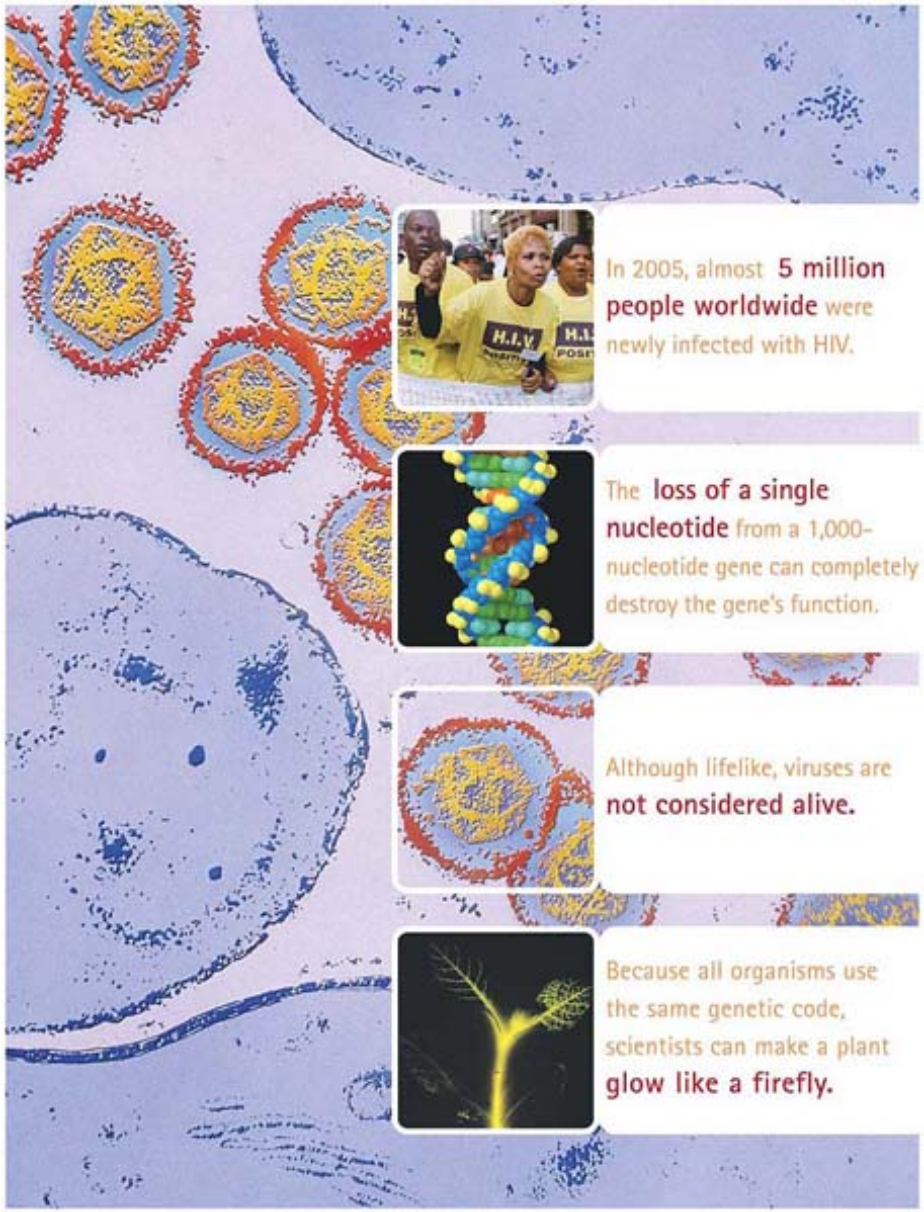
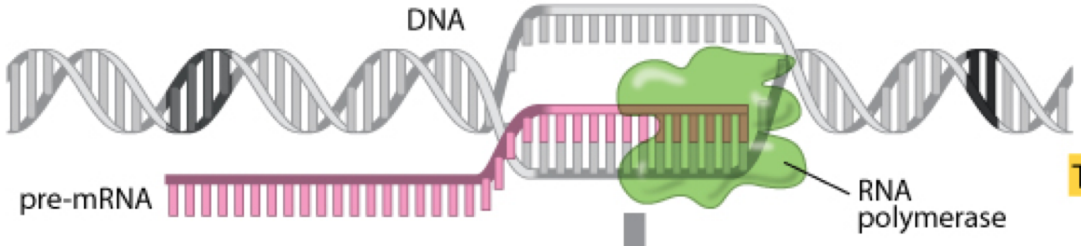
Chapter 10:
The Structure and Function of DNA

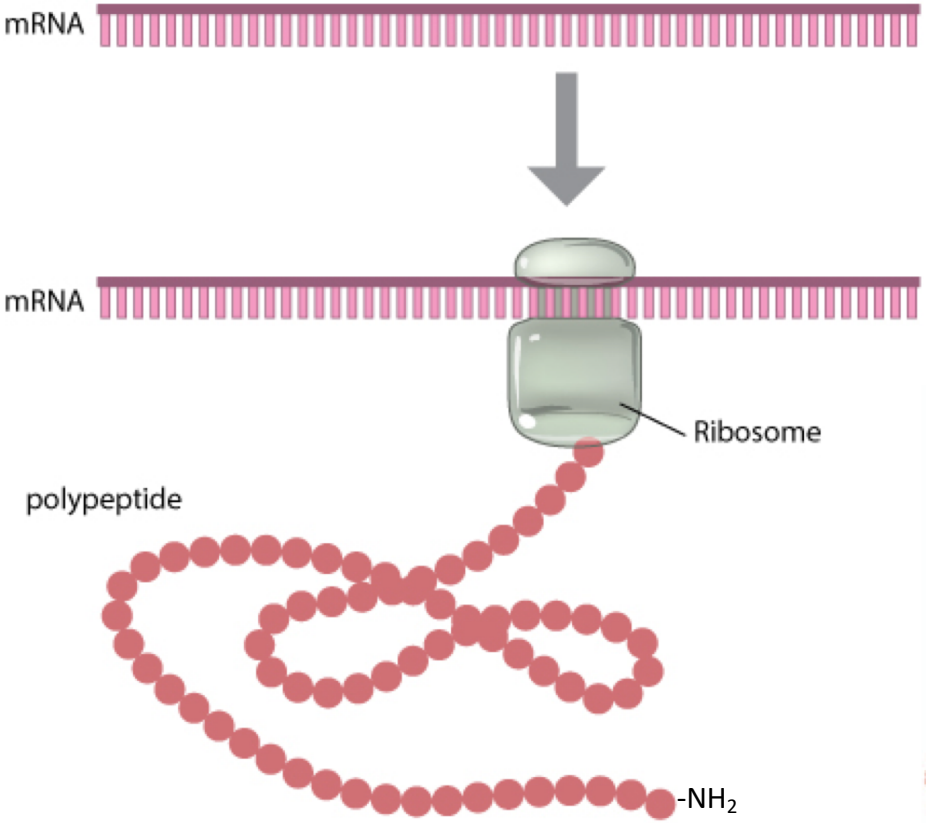
covers
- DNA replication
- DNA transcription
- mRNA translation

Chapter 11 covers
the regulation of gene expression





Transcription



Translation

Gene expression

What "tells" the RNA polymerase where to start transcription of a gene? → Promoter sequence

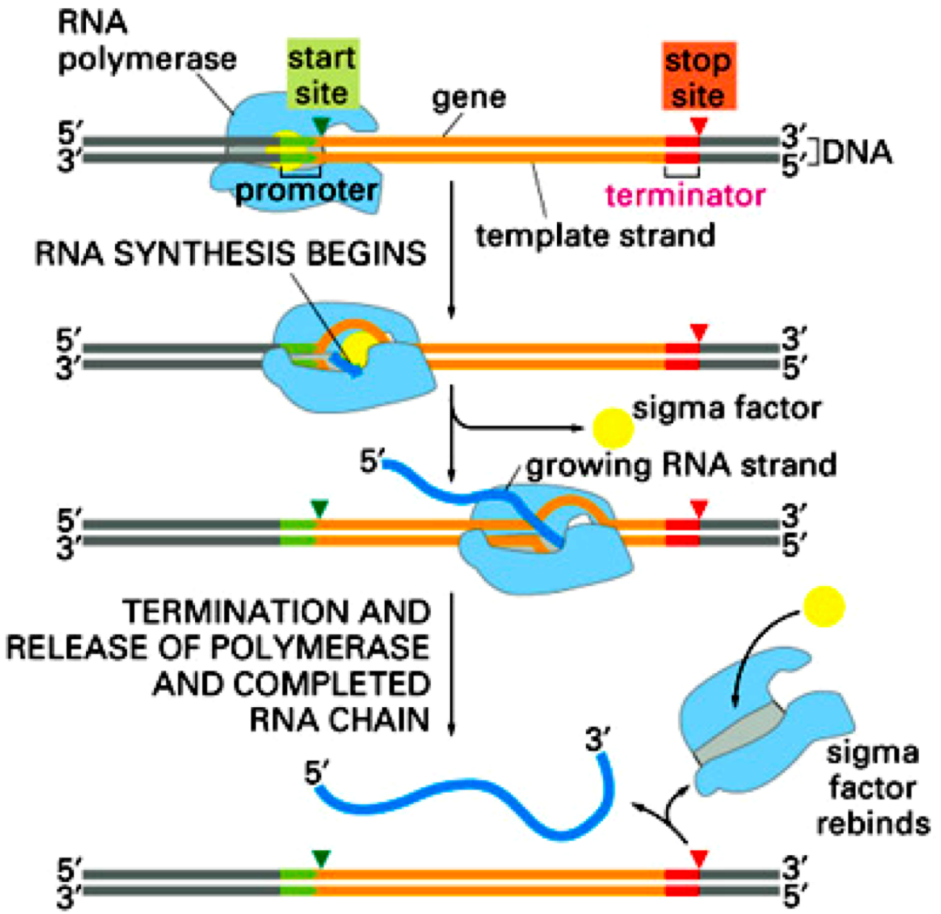
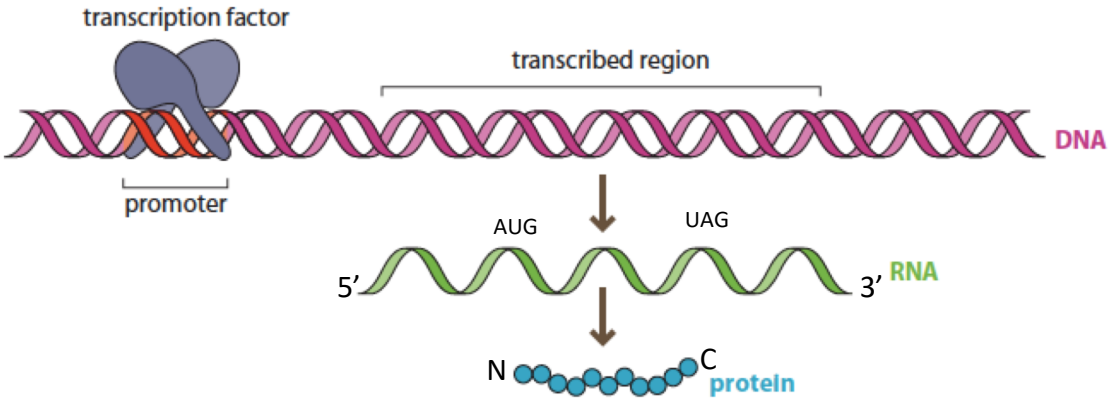


Figure shows transcription in E. coli

The enzyme RNApolymerase does not recognize promoter regions.



Transcription factors

· are proteins

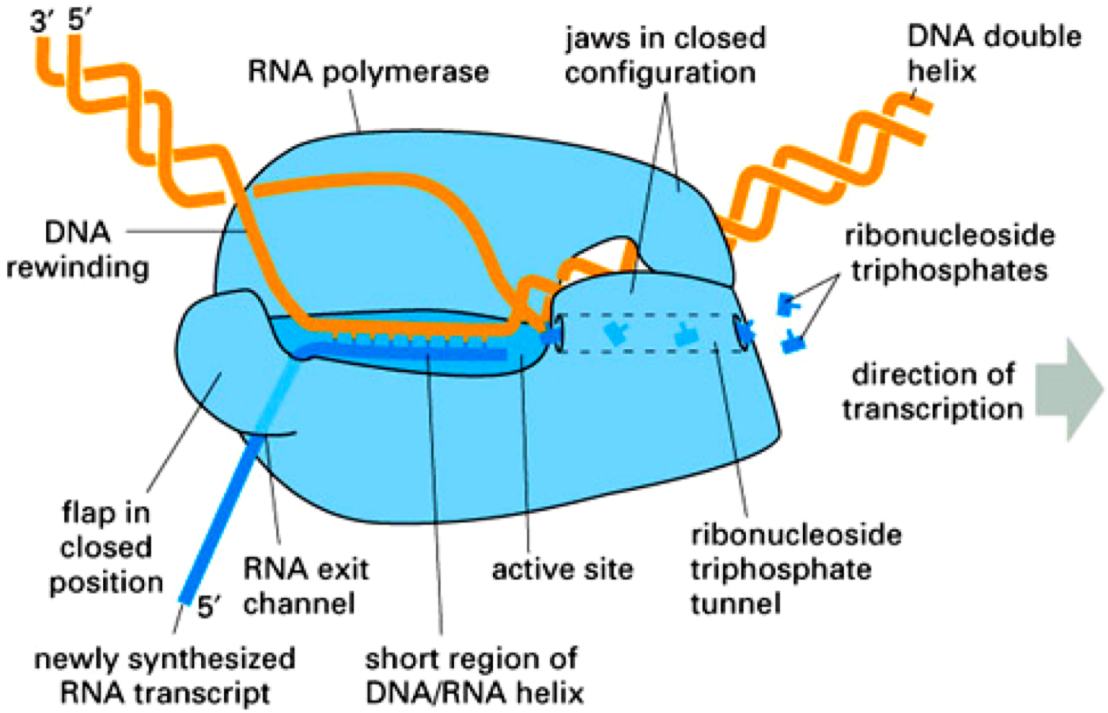
· bind ***specifically*** to certain promoters

· recruit the enzyme RNA polymerase

· position the RNApolymerase (give a direction)

RNA polymerase : an enzyme made of several polypeptides

E. coli RNA polymerase



- no need for primer
- uses ATP, CTP, GTP, UTP
- in 5' -> 3' direction
- error rate: $1/10^4$ (DNA polymerase: $1/10^7$)

All eucaryotes have 3 RNA polymerases.

A protein family

RNApol I

28S rRNA

18S rRNA

5.8S rRNA

RNApol II

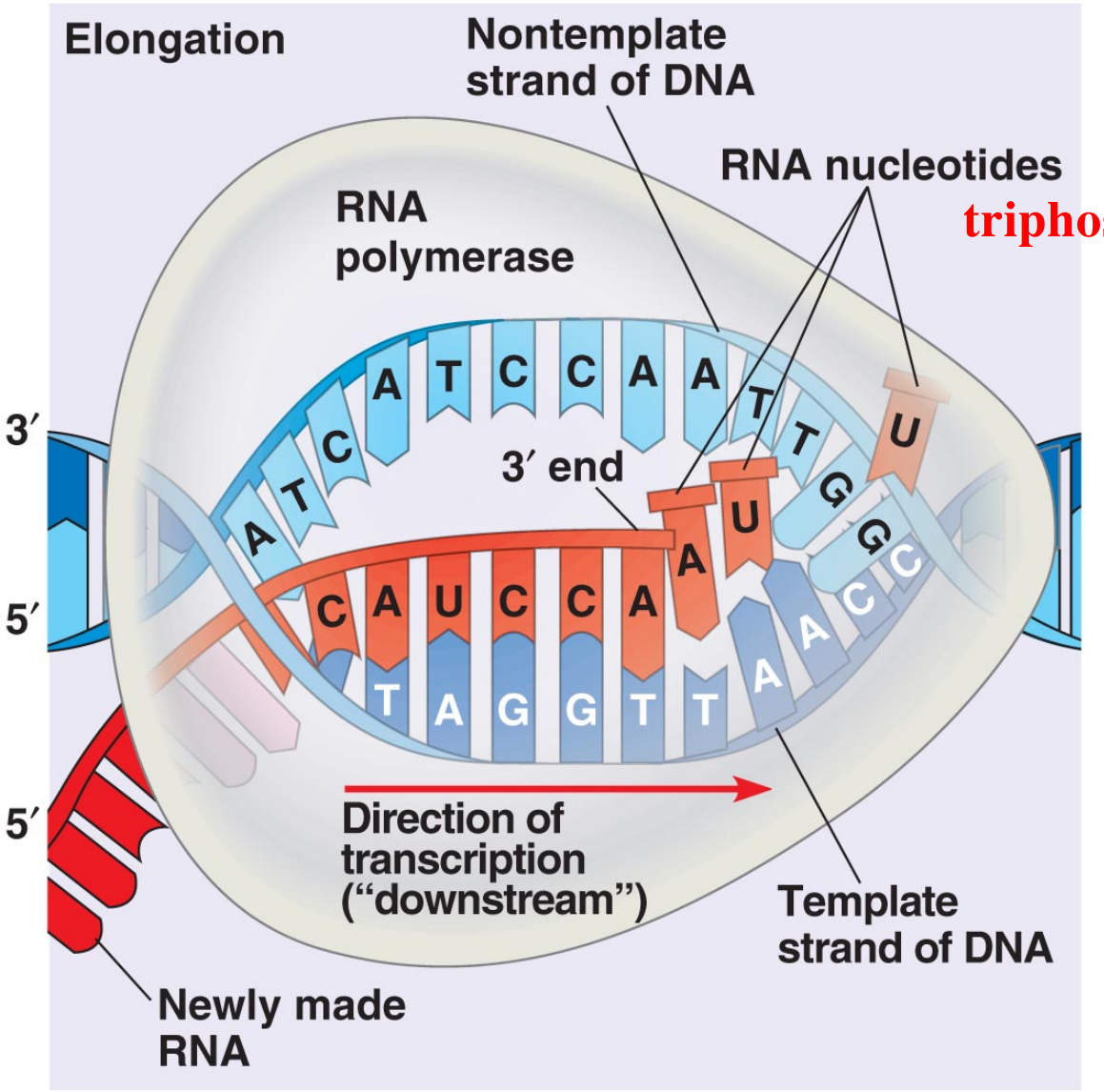
mRNA

Only RNApol II has a
C - Terminal Domaine (CTD)

RNApol III

5S rRNA

tRNA



triphosphate

Campbell 8th

Both DNA strands can be Template for transcription

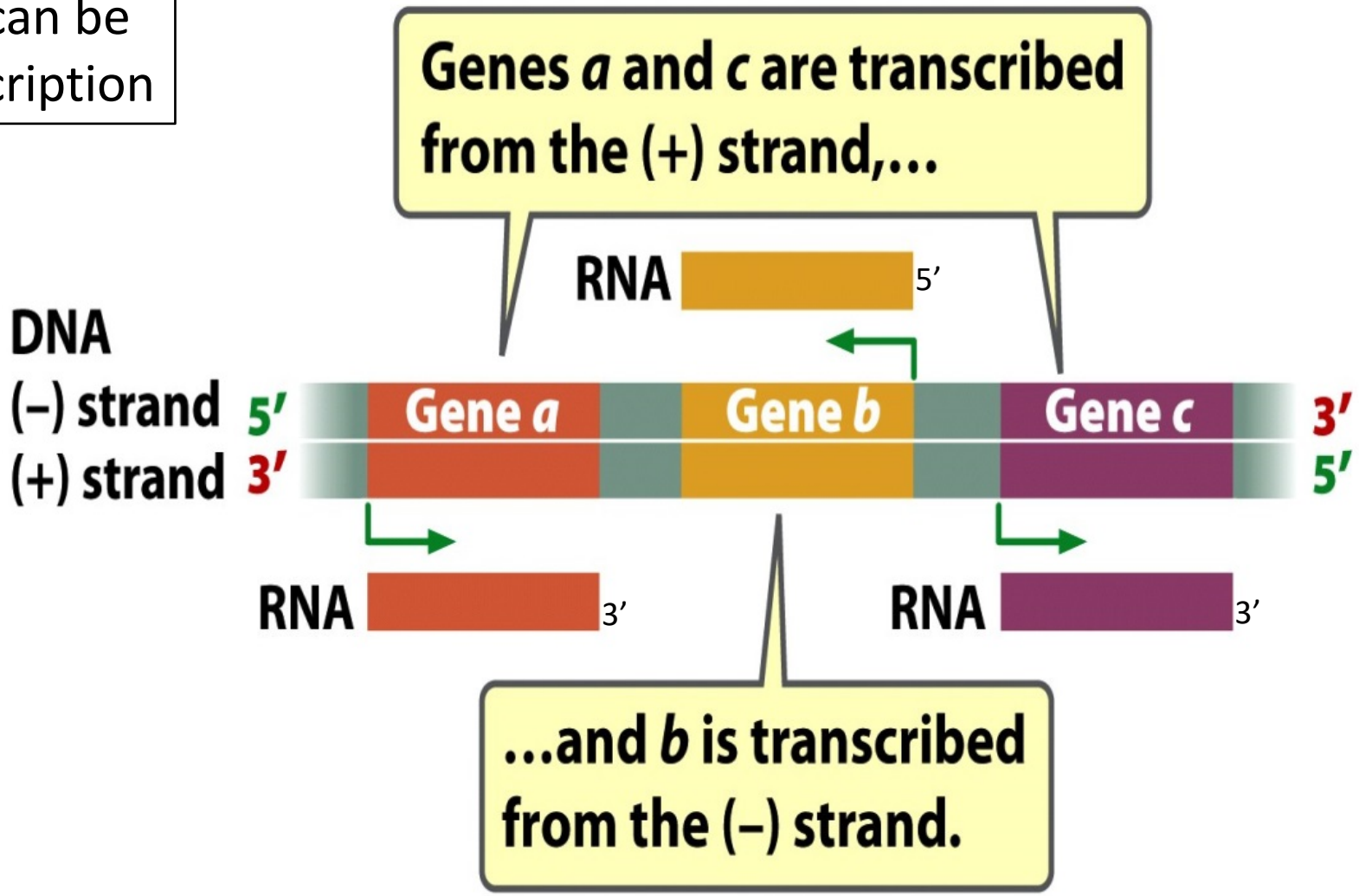
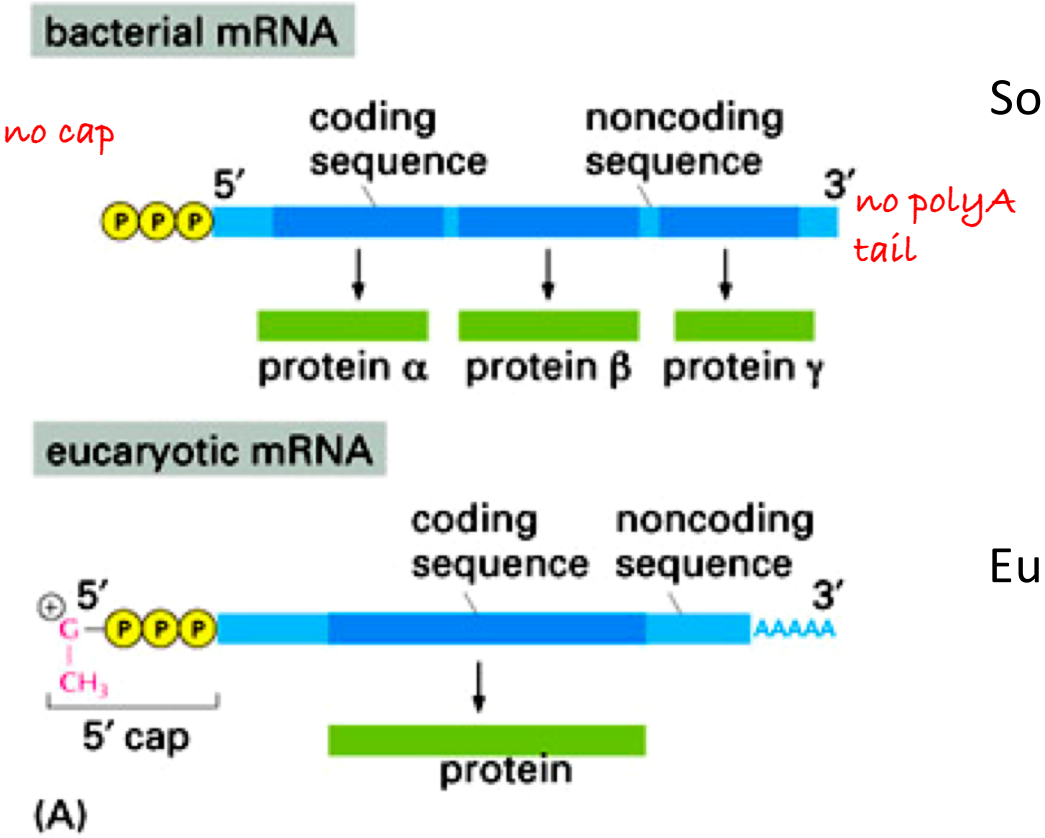


Figure 13-6
Genetics: A Conceptual Approach, Third Edition

Differences between prokaryotic and eukaryotic messengers



Some prokaryotic messengers are polycistronic.

Eukaryotic messengers are always monocistronic.

No cap No introns No polyA tail

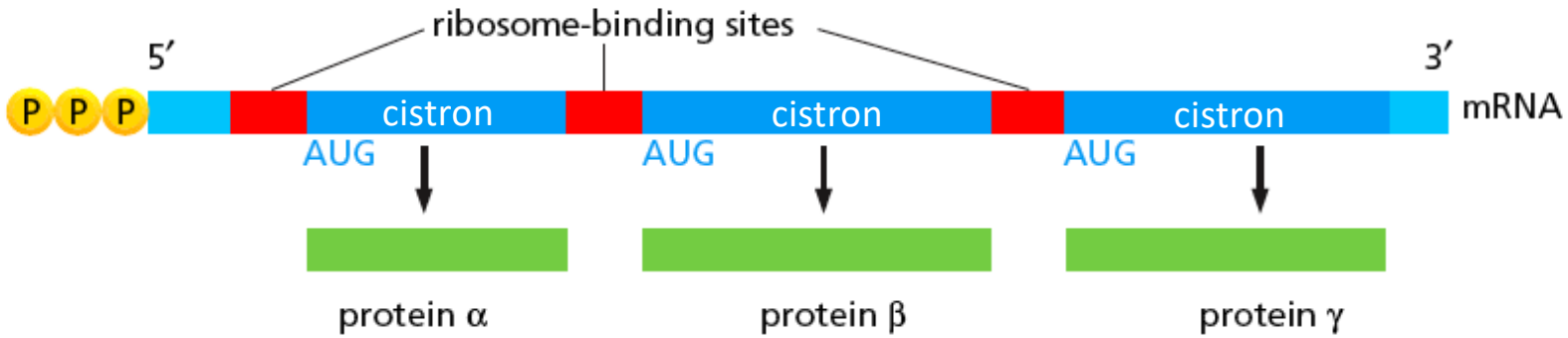


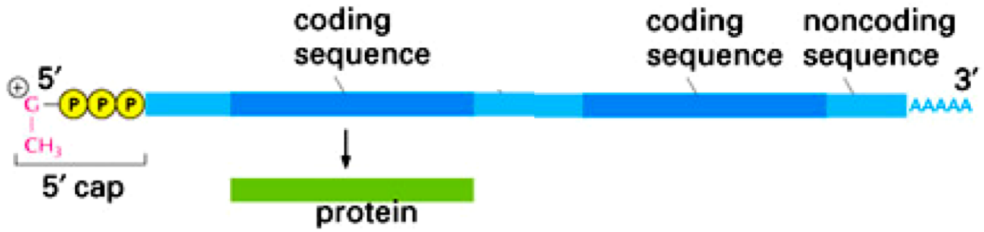
Figure 6–73 Structure of a typical bacterial mRNA molecule.

Only ~ 20% of bacterial mRNAs
are ***polycistronic***

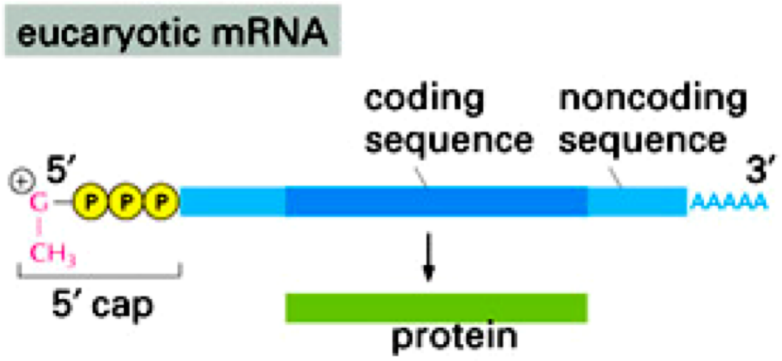
Usually proteins encoded by the same messenger work together.

Eukaryotic messengers are monocistronic.

If you engineer a bicistronic messenger only the upstream cistron is translated.



In eukaryotes : processing of primary transcripts into mature messenger RNAs.



processing includes these modifications:

A. 5'-end: addition of "cap”

→ protects mRNA

→ start of translation

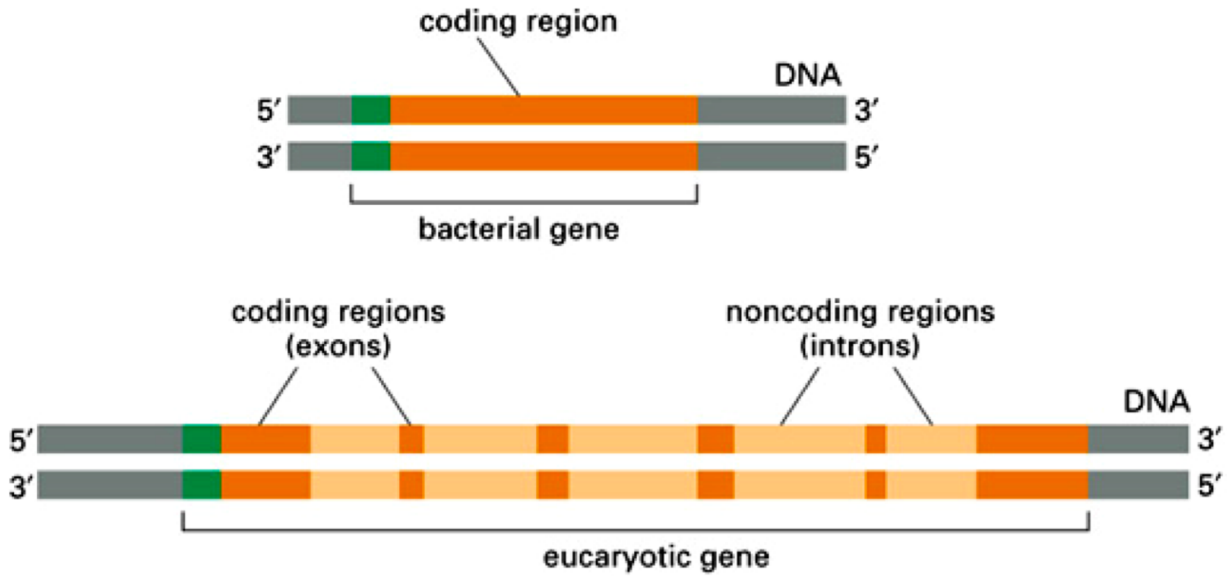
B. 3'-end: addition of AAAAA-tail

→ protects mRNA

C. removal of introns

→ splicing

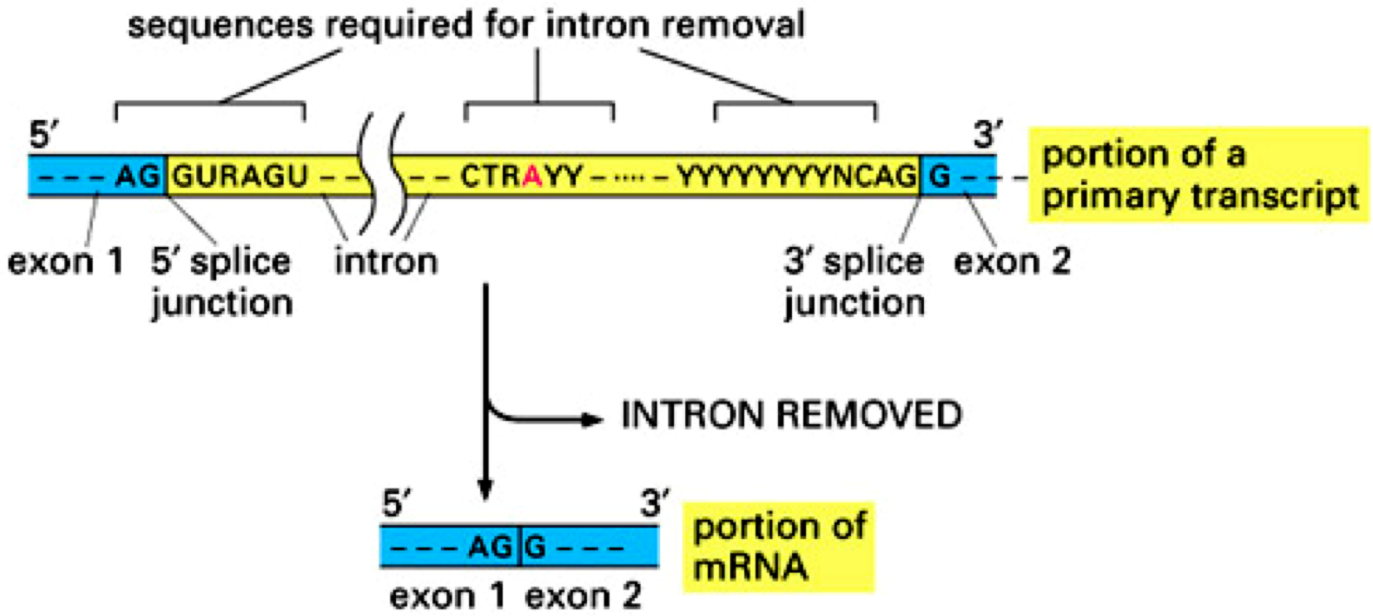
Eukaryotic genes are composed of exons and introns



Exons: sequences encoding the protein
Introns: non-coding sequences
→ Exons often encode functional domains of the protein
→ Regulatory sequences can be in introns
→ Alternative splicing possible (*see next slides*)

Correct definition of an **exon** : part of a primary transcript not eliminated by splicing. Coding or non coding has no place in the definition.

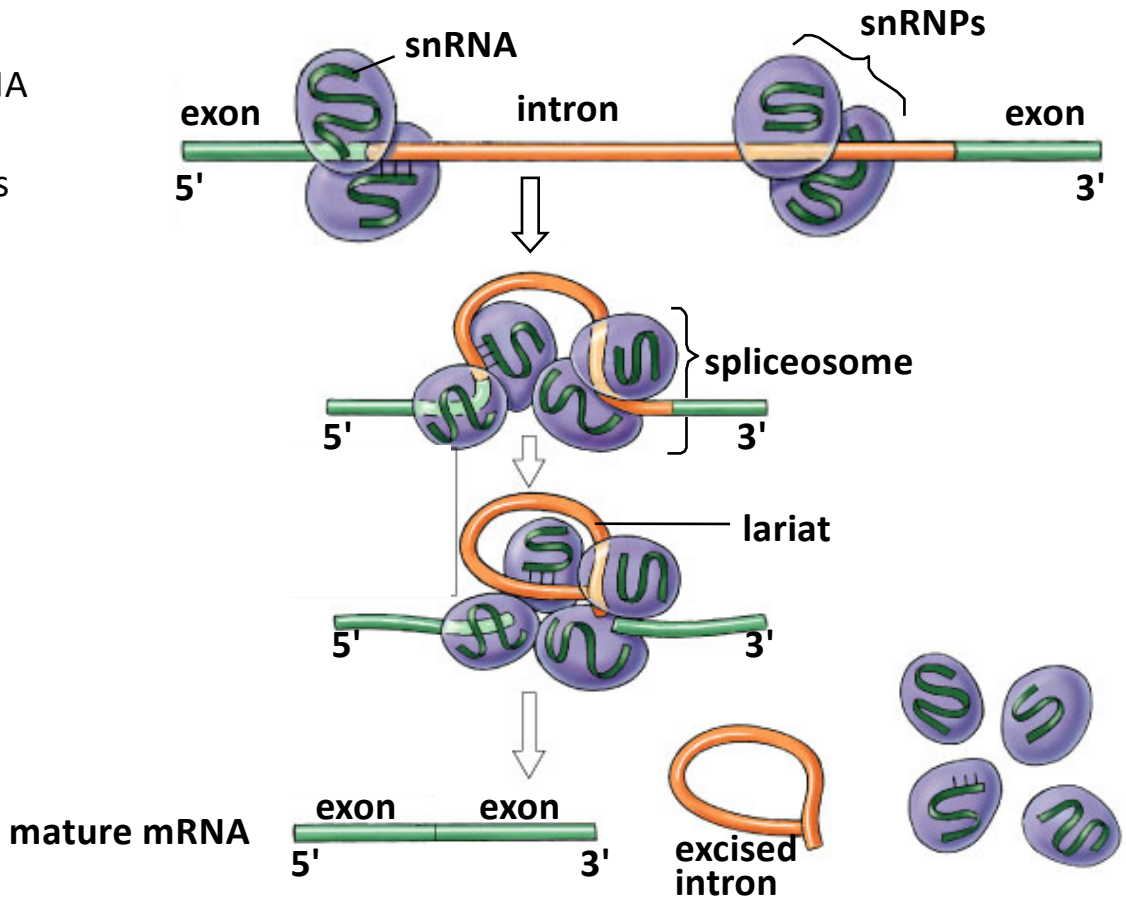
Splicing

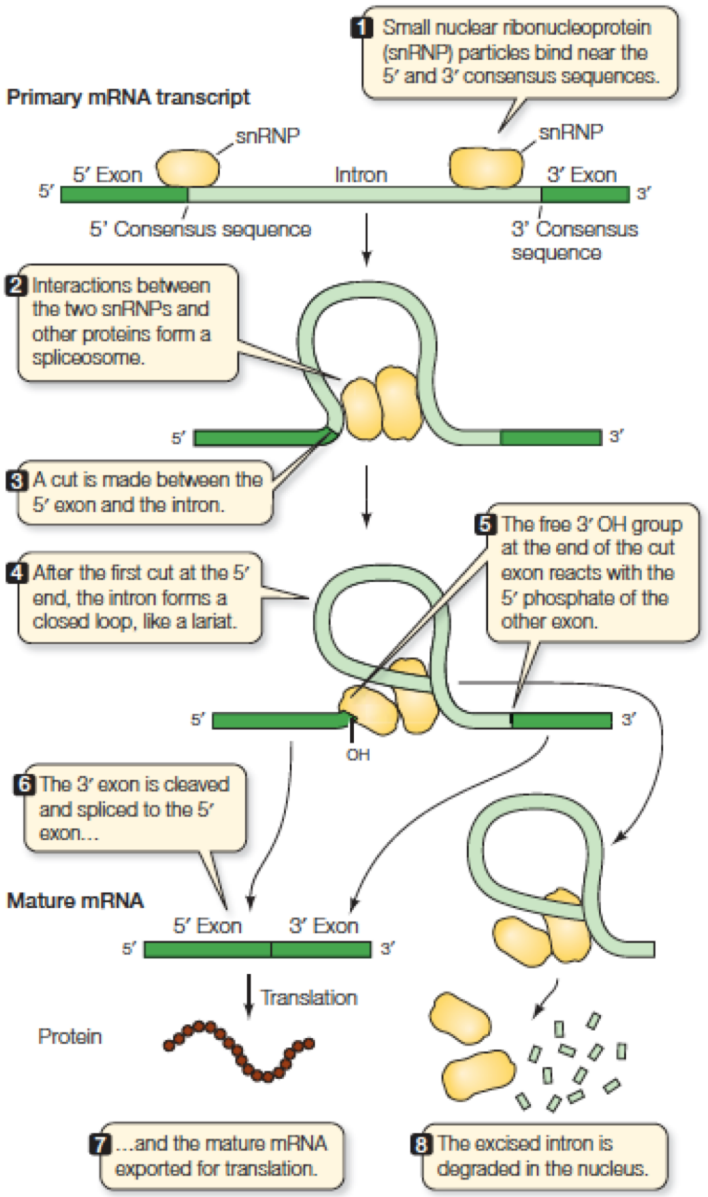

sequences required for intron removal
5′
3′
– – – AG
GURAGU – –
– – CTRAYY – ···· – YYYYYYYYNCAG
G – –
portion of a primary transcript
exon 1
5′ splice junction
intron
3′ splice junction
exon 2
INTRON REMOVED
5′
3′
– – – AG
G – – –
portion of mRNA
exon 1
exon 2

Splicing

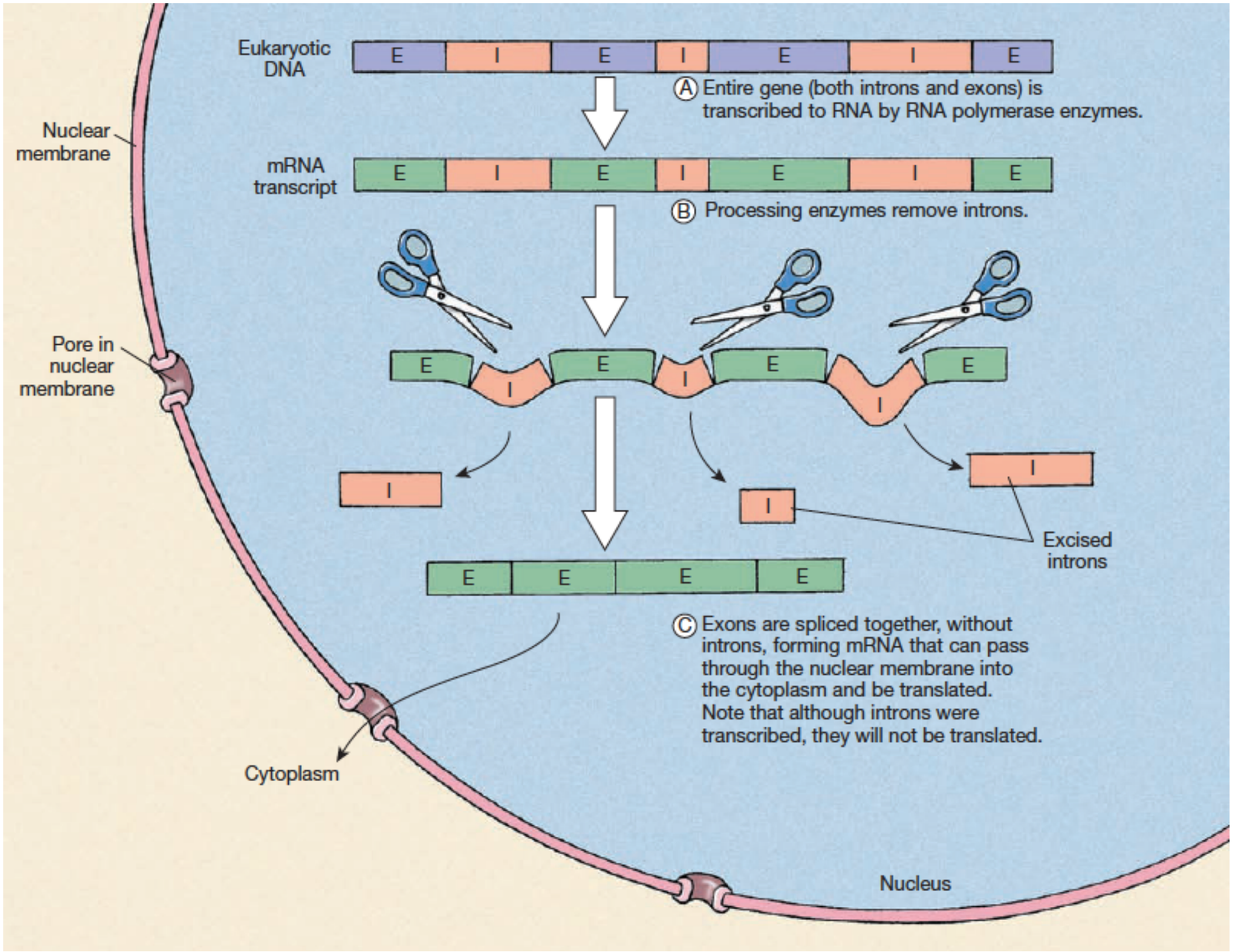
snRNA : small nuclear RNA

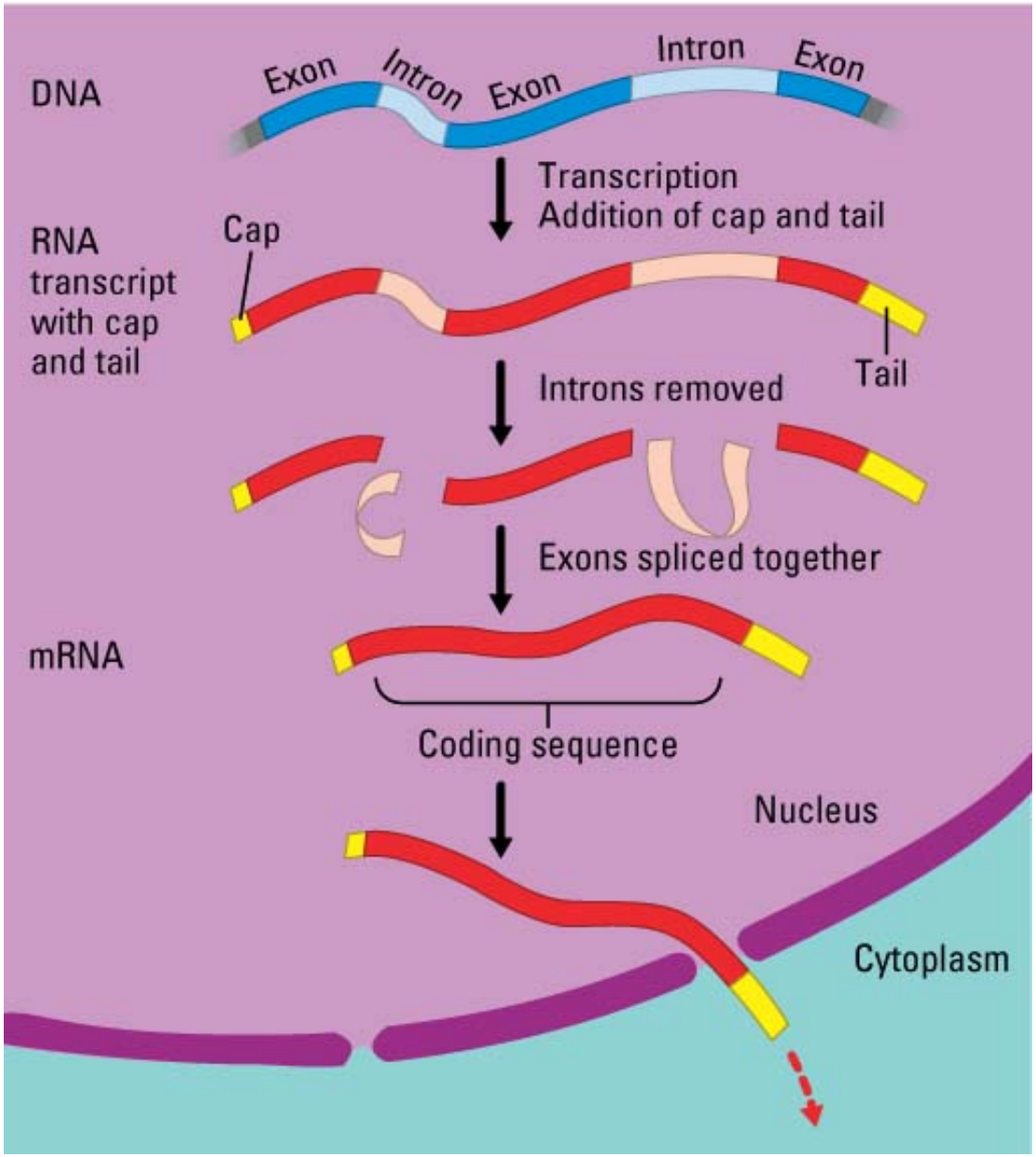
snRNP : snRNA + proteins





Introns are degraded
→ nucleotids are recycled


Eukaryotic DNA
E
I
E
I
E
I
E
Ⓐ Entire gene (both introns and exons) is transcribed to RNA by RNA polymerase enzymes.
Nuclear membrane
mRNA transcript
Ⓑ Processing enzymes remove introns.
Pore in nuclear membrane
Excised introns
Ⓒ Exons are spliced together, without introns, forming mRNA that can pass through the nuclear membrane into the cytoplasm and be translated. Note that although introns were transcribed, they will not be translated.
Cytoplasm
Nucleus

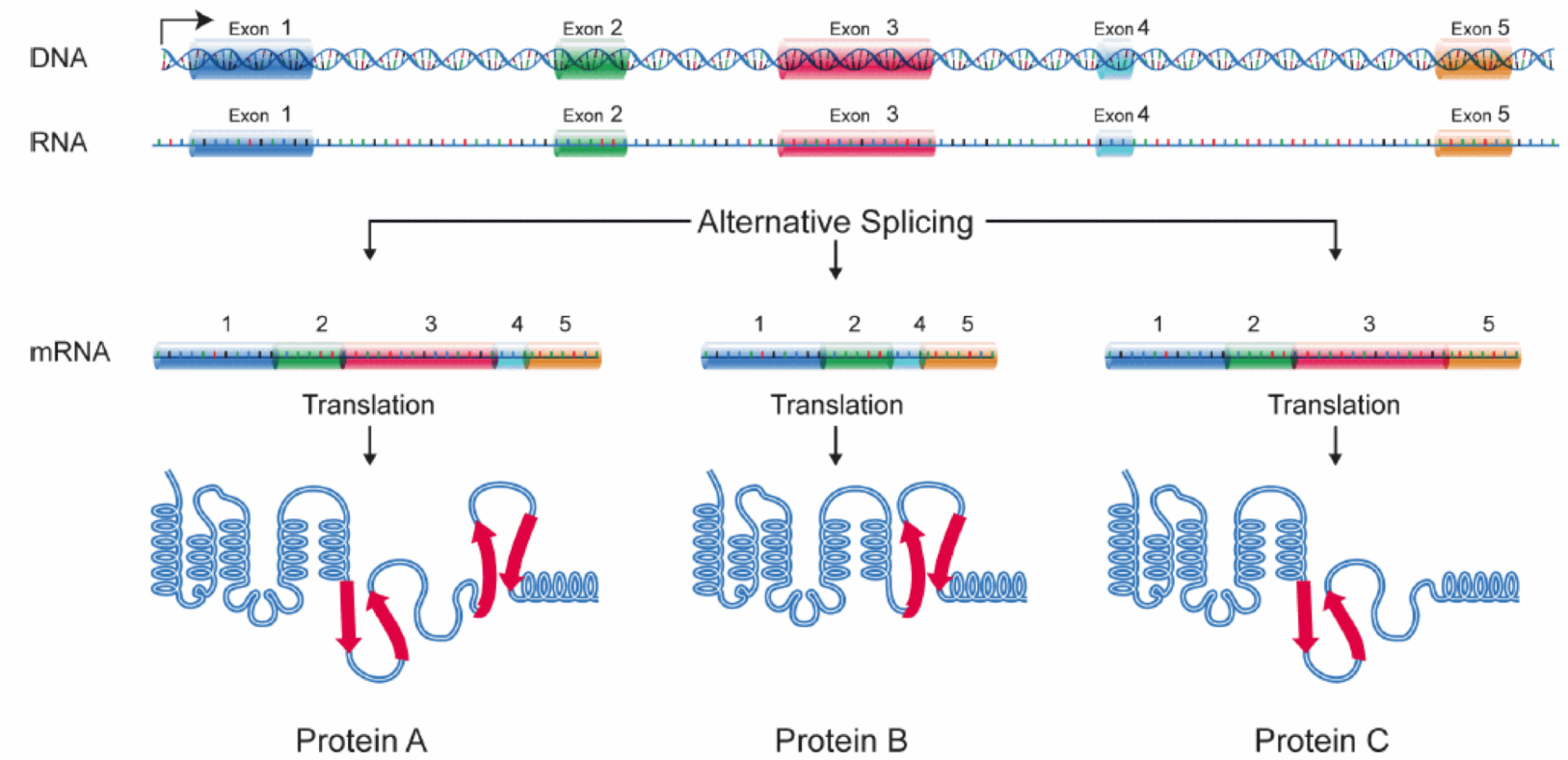


5’-end first

Essential Biology
Fig 10.14

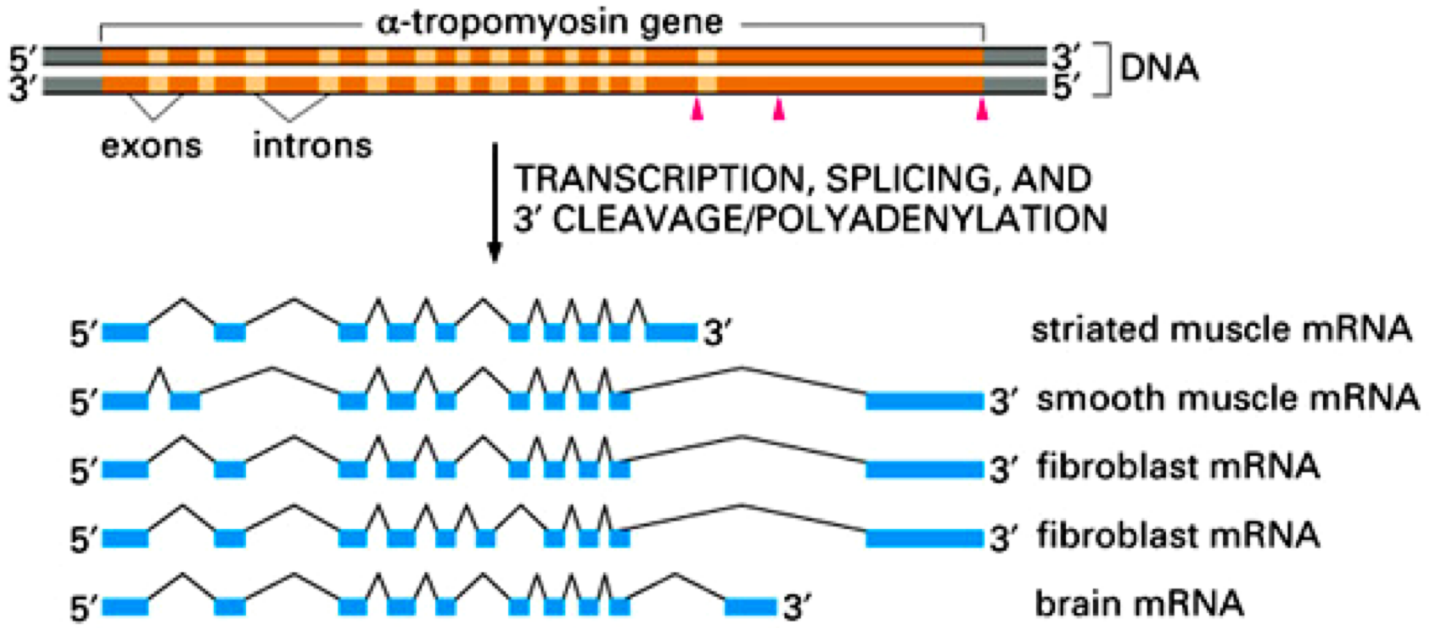
Alternative splicing

General idea



RNA splicing can create different mRNAs from 1 primary RNA

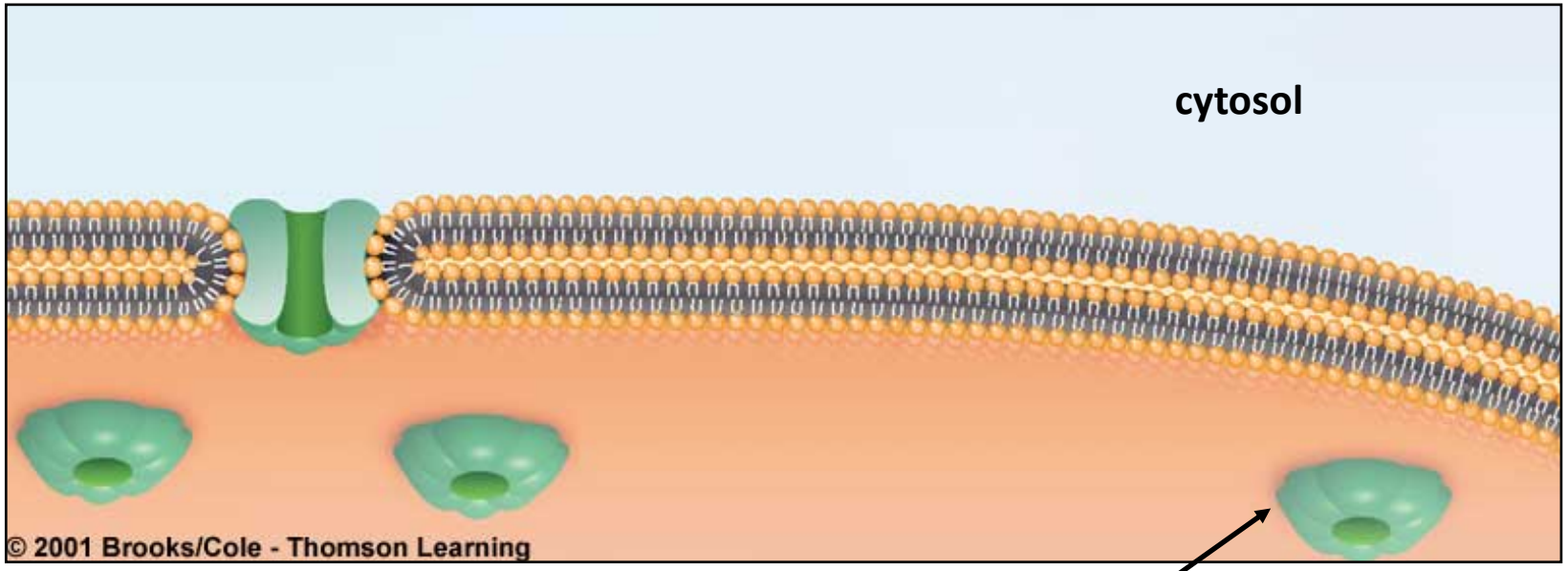
→ **alternative splicing**



Nuclear envelope and nuclear pores.

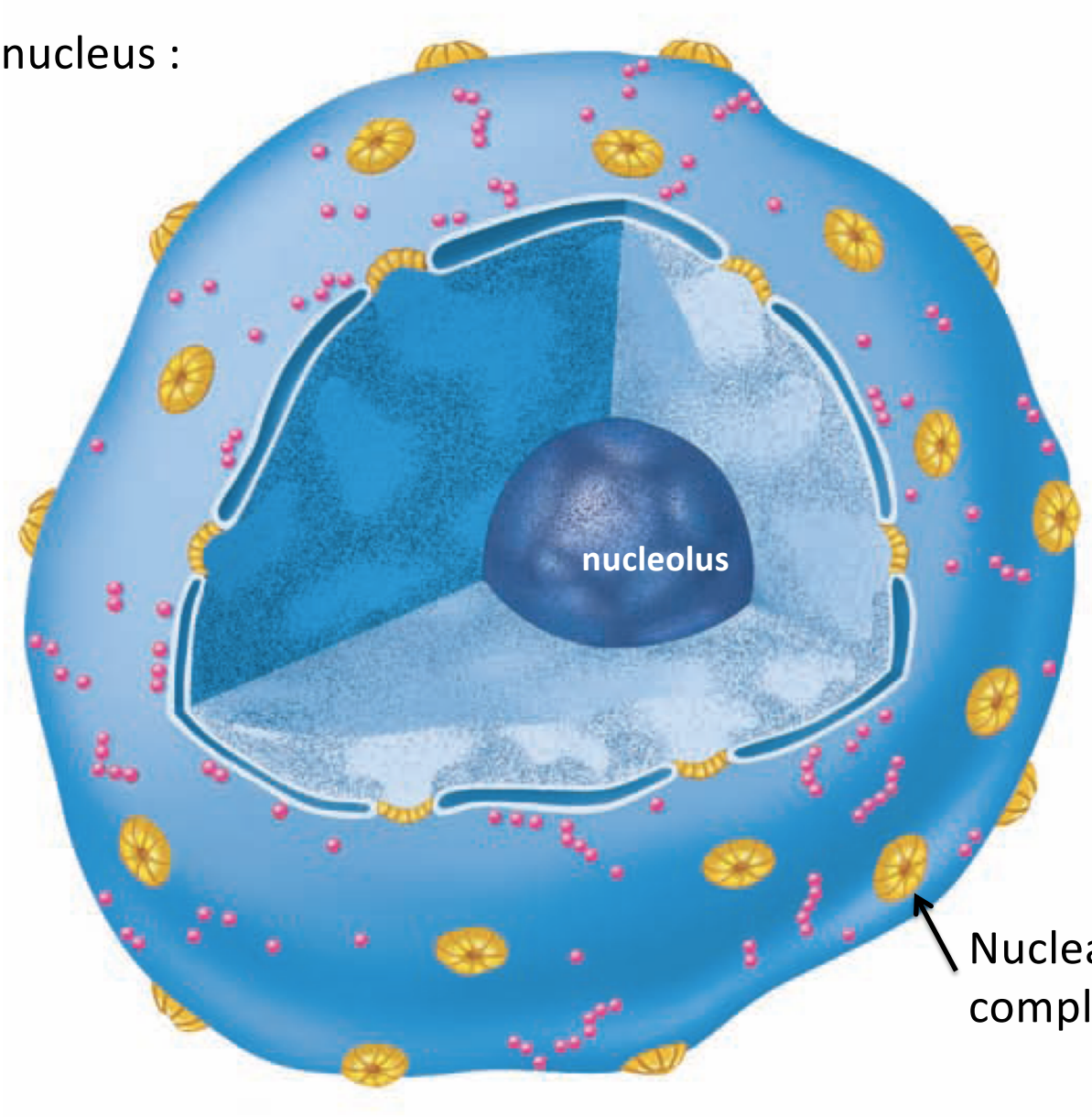
2 membranes :

- inner nuclear membrane
- outer nuclear membrane
- perinuclear space (between the 2 membranes)



Nuclear pore made of proteins

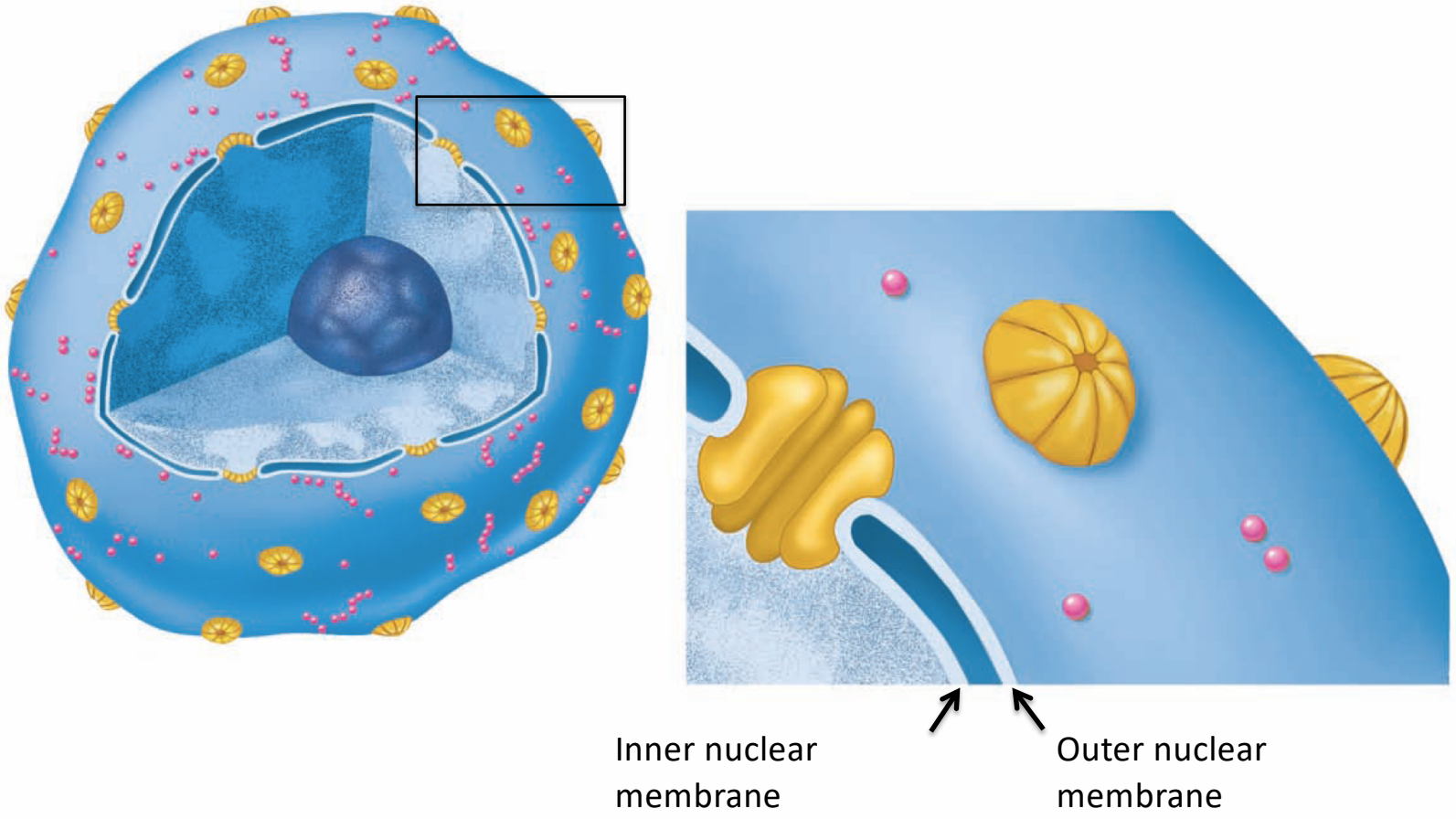
The cell nucleus :

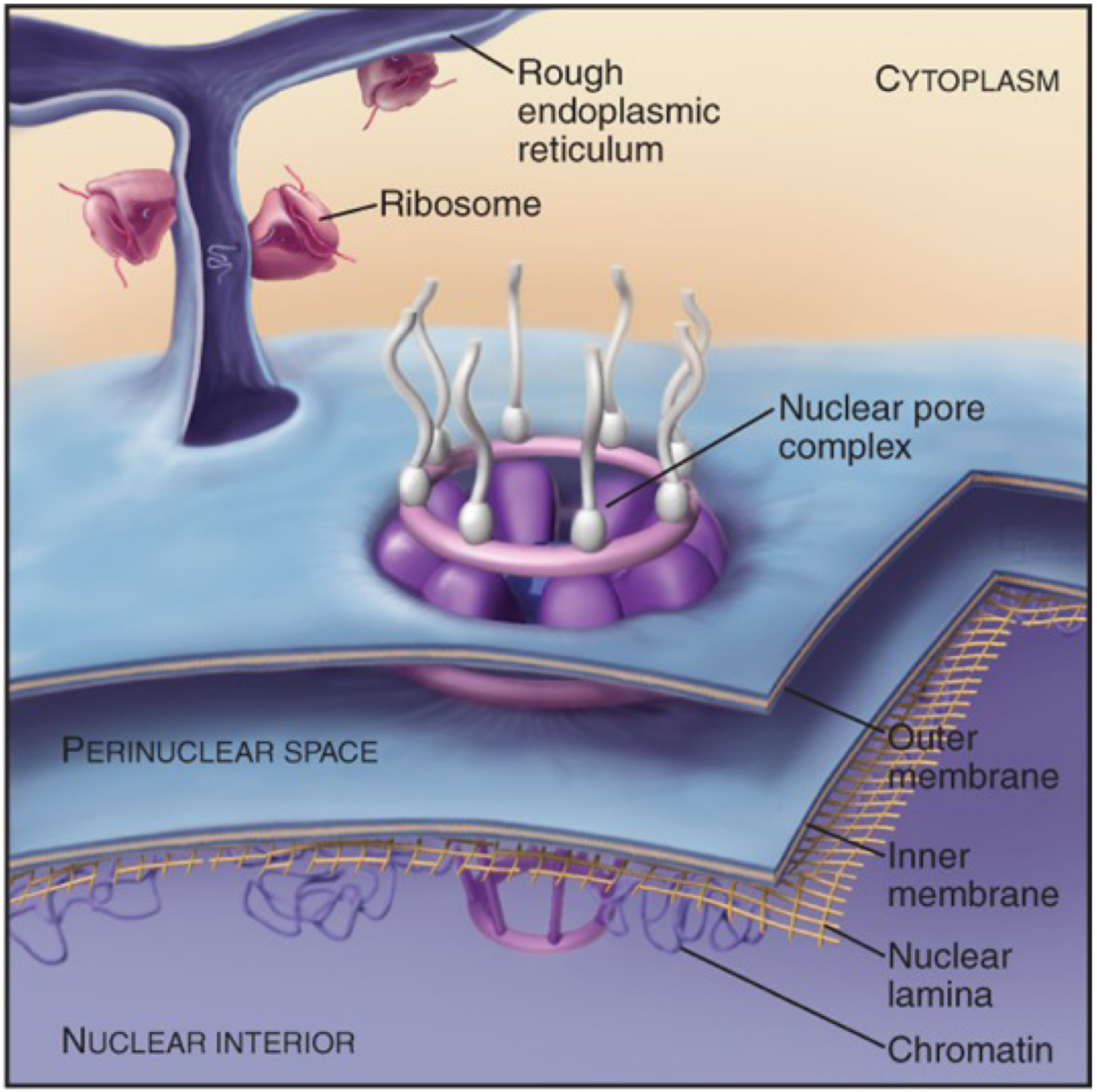


Note the heterogenous nuclear content :

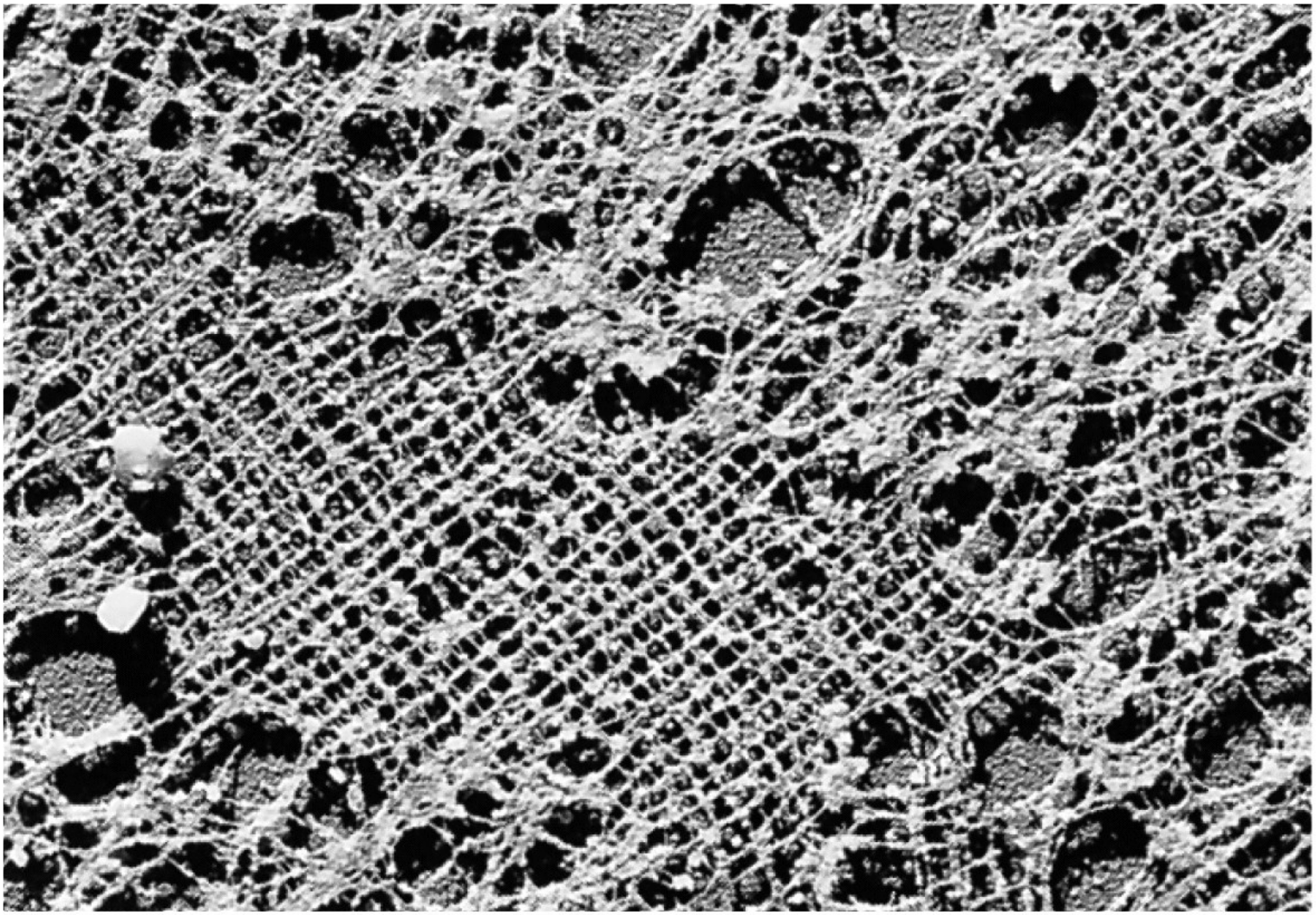
- euchromatin
- heterochromatin

The nuclear enveloppe





Nuclear lamina

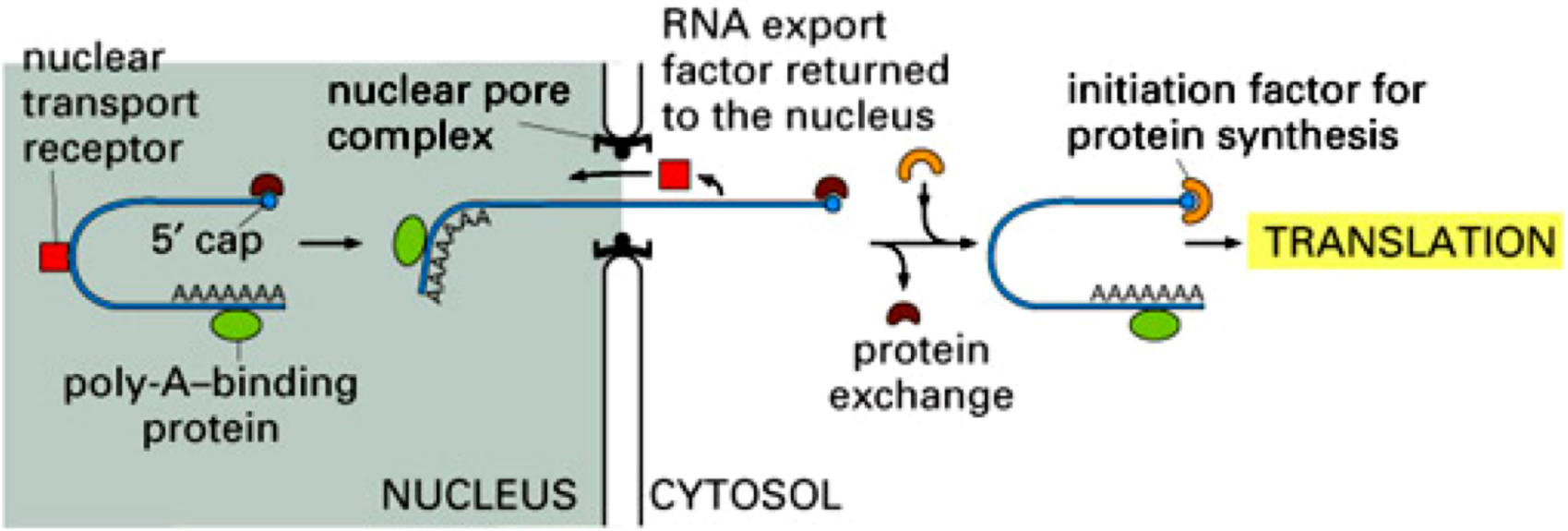


The nuclear lamina

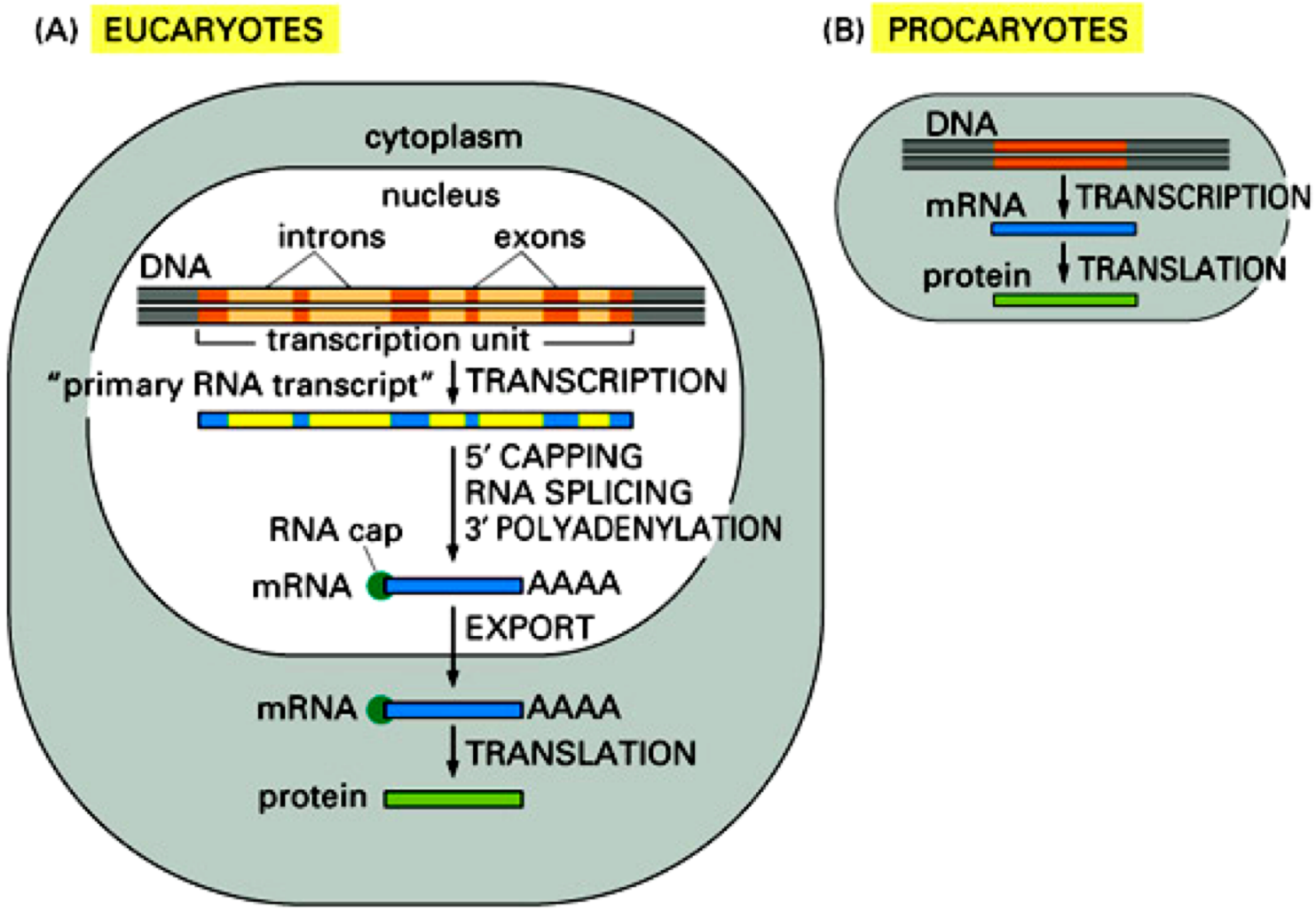
1 μm

mRNA nuclear export

a complex process



Only fully spliced RNA are exported


(A) EUCARYOTES
cytoplasm
nucleus
introns
exons
DNA
transcription unit
"primary RNA transcript"
TRANSCRIPTION
5′ CAPPING
RNA SPLICING
3′ POLYADENYLATION
RNA cap
mRNA
AAAA
EXPORT
mRNA
AAAA
TRANSLATION
protein
(B) PROCARYOTES
DNA
mRNA
TRANSCRIPTION
protein
TRANSLATION