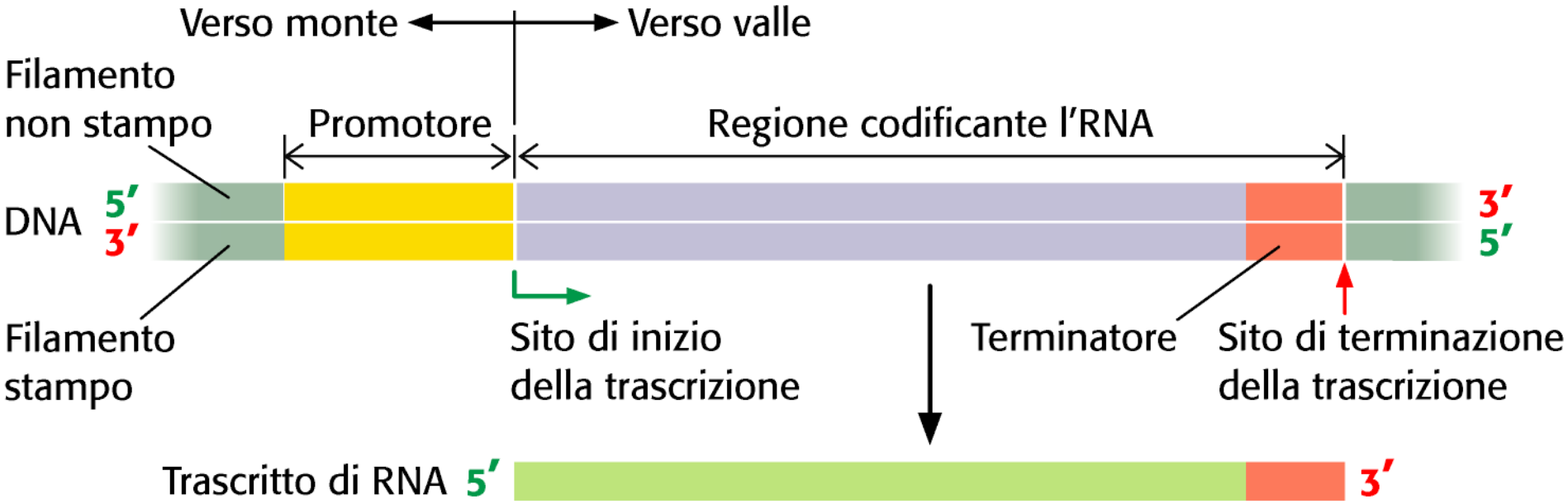
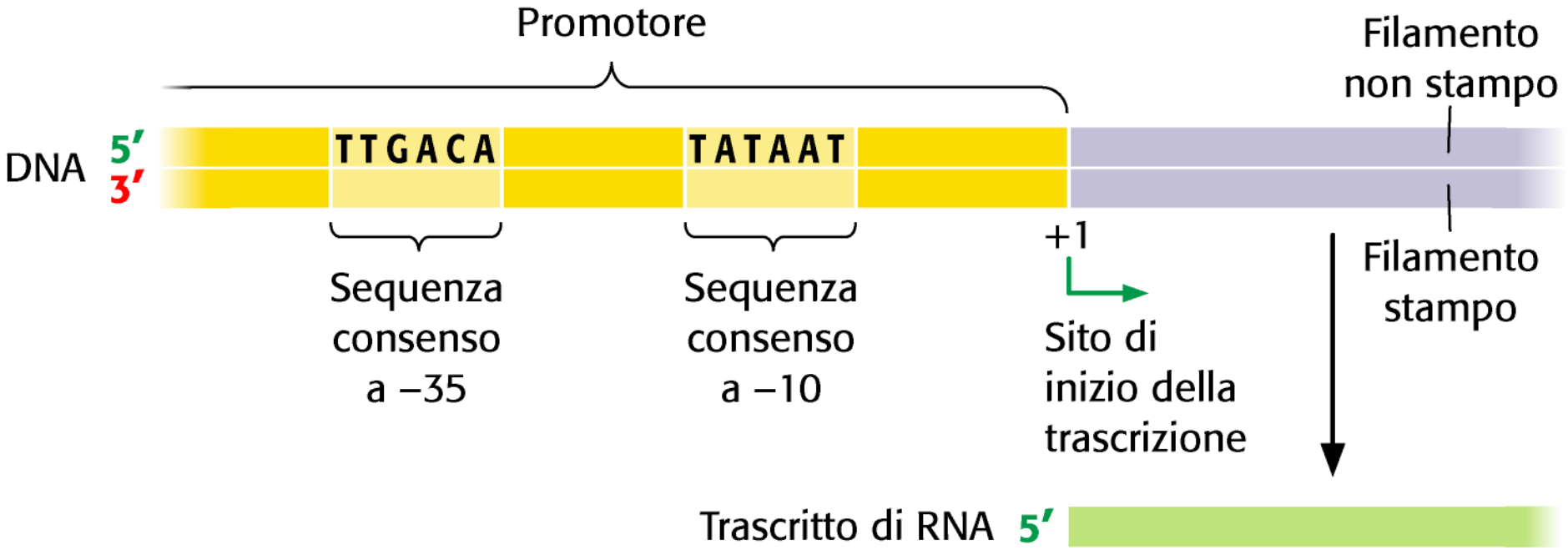
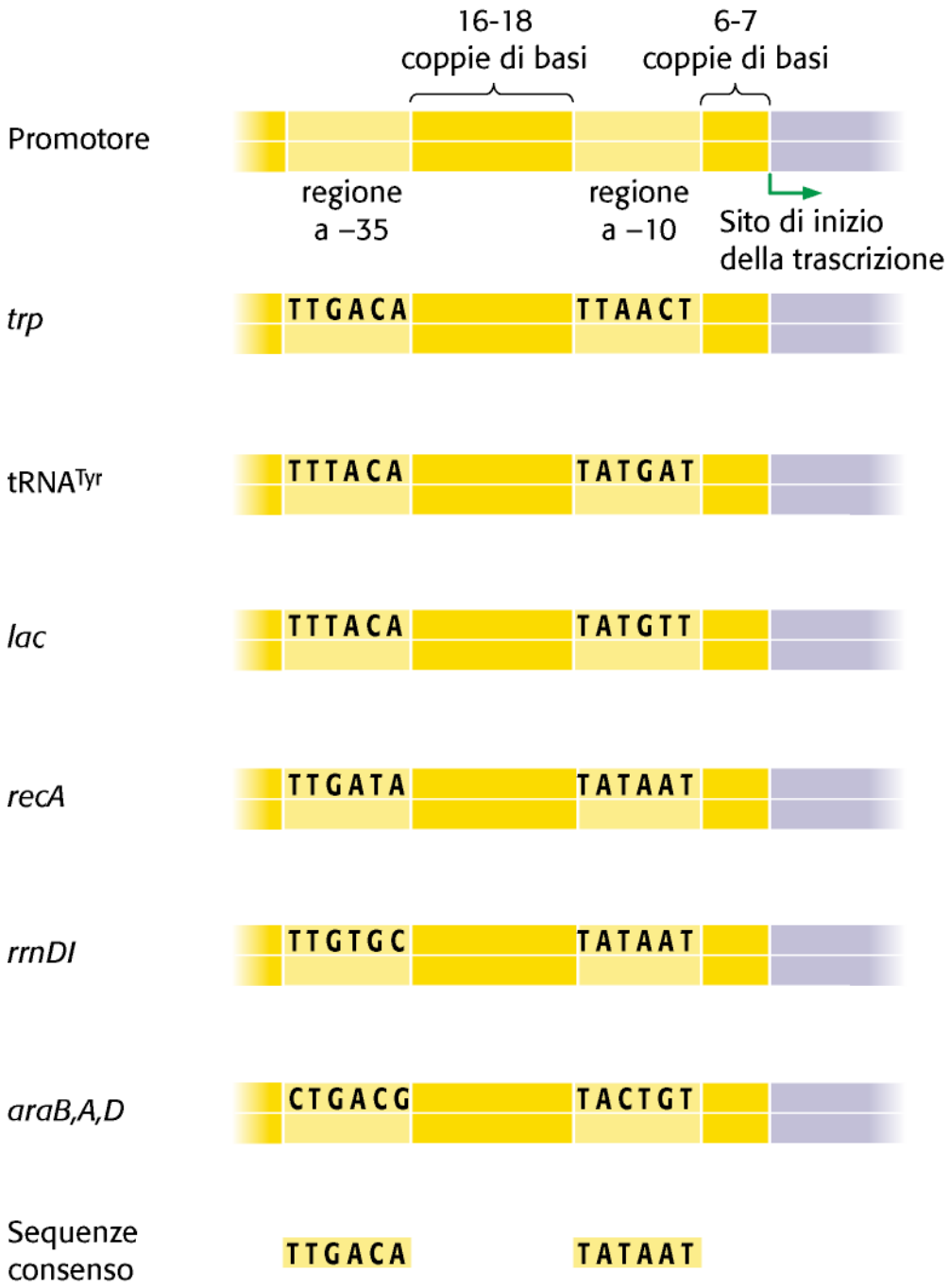
Espressione Genica I:
la Trascrizione

Fase di Inizio


Verso monte
Verso valle
Filamento non stampo
Promotore
Regione codificante l'RNA
DNA
5′
3′
3′
5′
Filamento stampo
Sito di inizio della trascrizione
Terminatore
Sito di terminazione della trascrizione
Trascritto di RNA
5′
3′


Promotore
Filamento non stampo
DNA 5′
3′
TTGACA
TATAAT
+1
Sequenza consenso a –35
Sequenza consenso a –10
Sito di inizio della trascrizione
Filamento stampo
Trascritto di RNA 5′


16-18
coppie di basi
6-7
coppie di basi
Promotore
regione
a –35
regione
a –10
Sito di inizio
della trascrizione
trp
TTGACA
TTAACT
tRNATyr
TTTACA
TATGAT
lac
TTTACA
TATGTT
recA
TTGATA
TATAAT
rrnDI
TTGTGC
TATAAT
araB,A,D
CTGACG
TACTGT
Sequenze
consenso
TTGACA
TATAAT

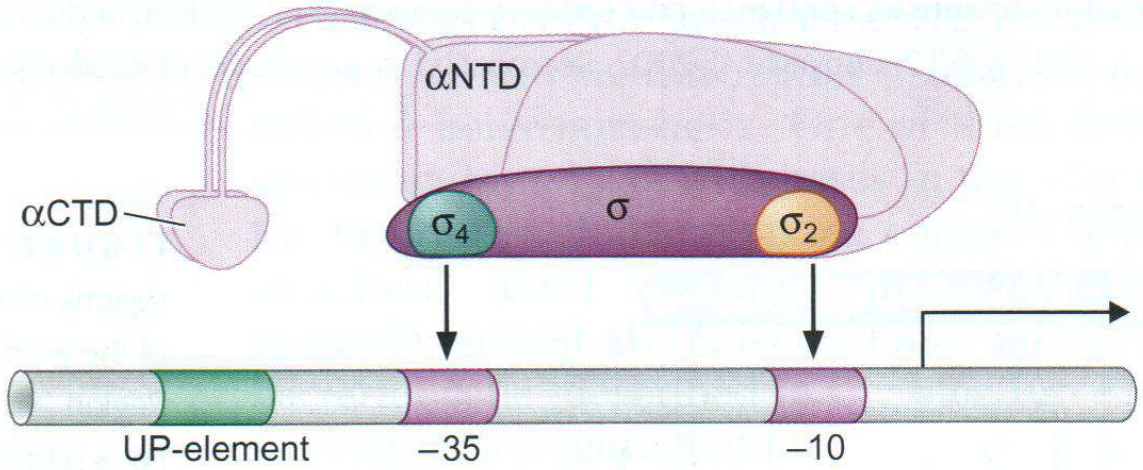
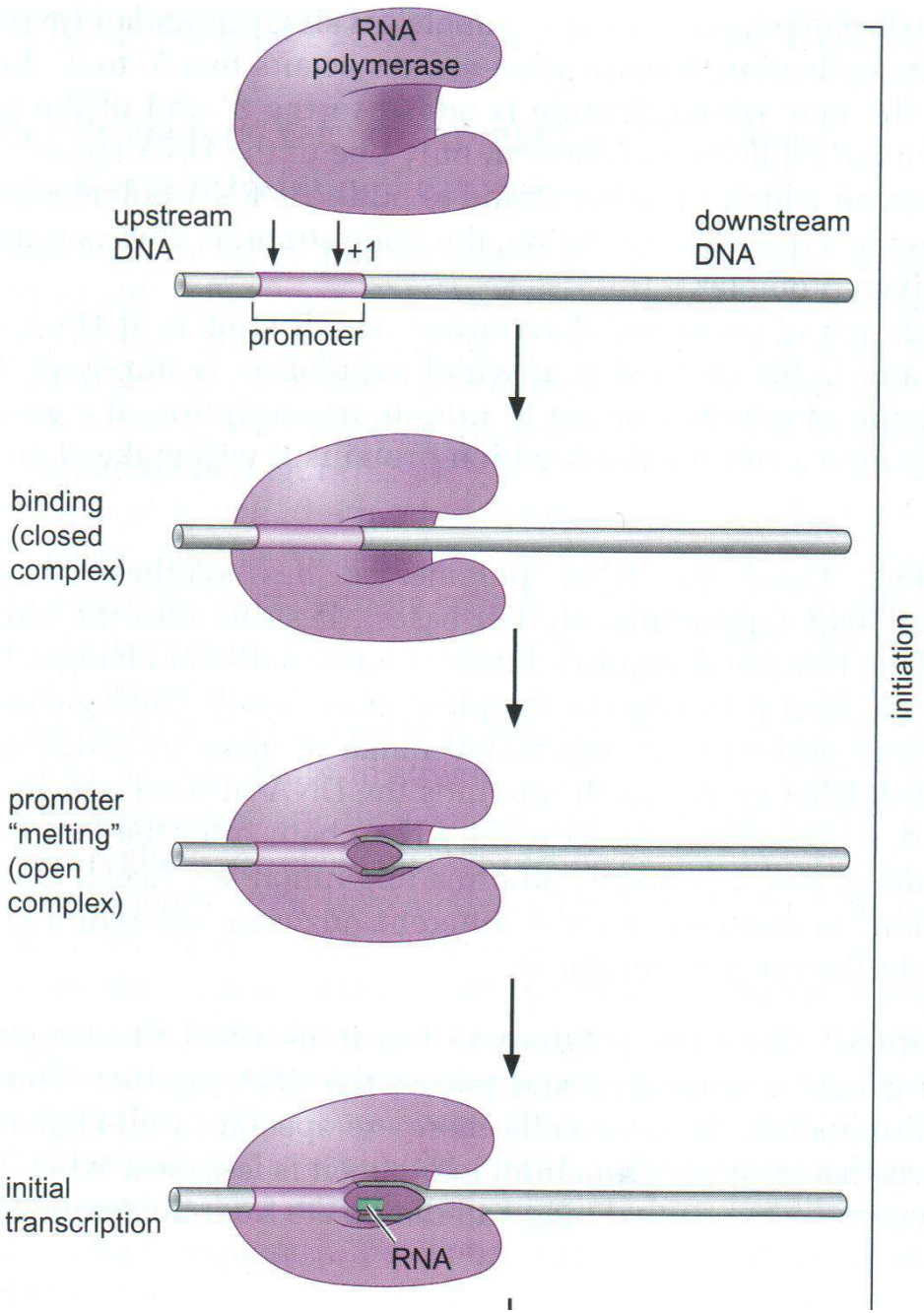
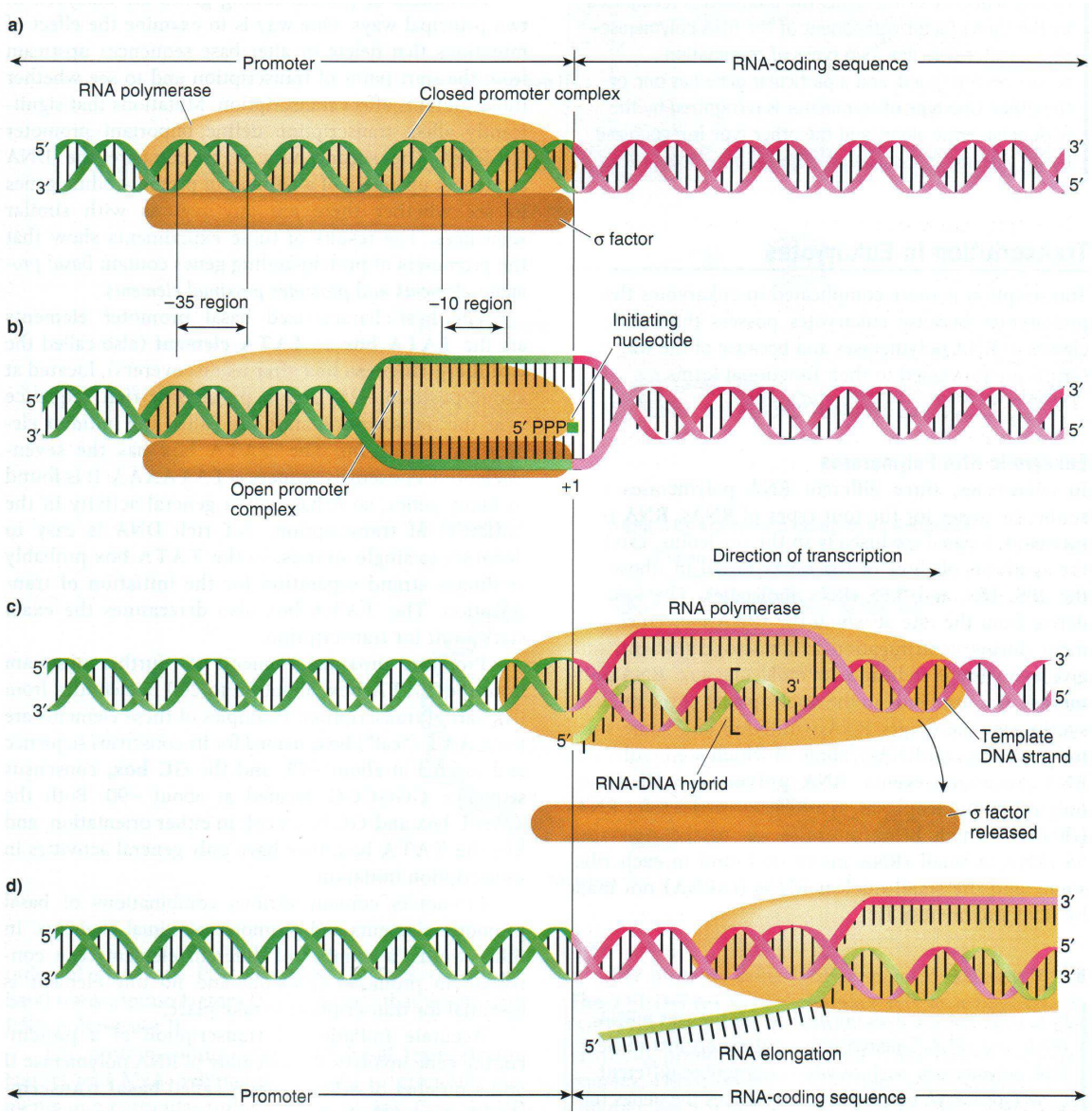
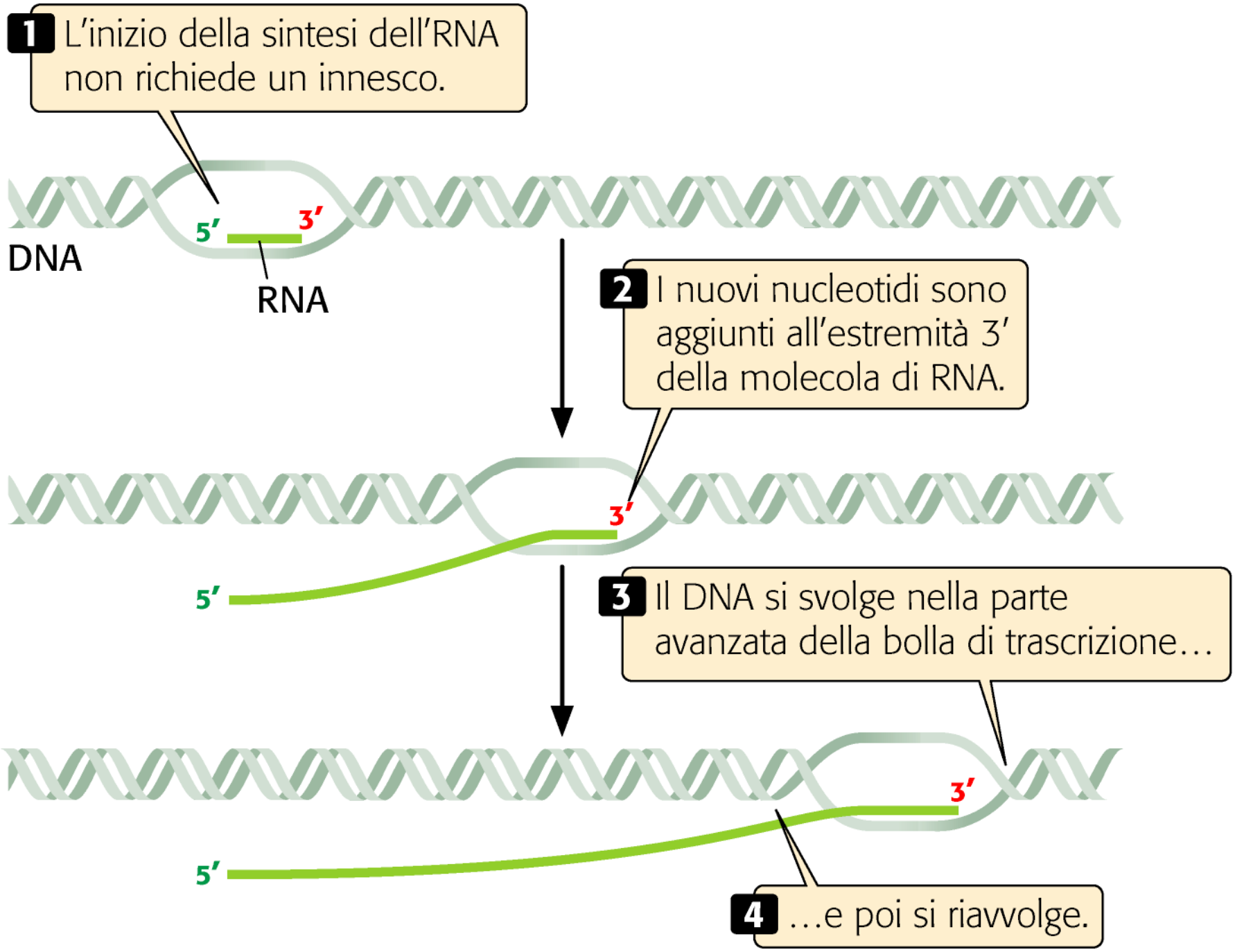


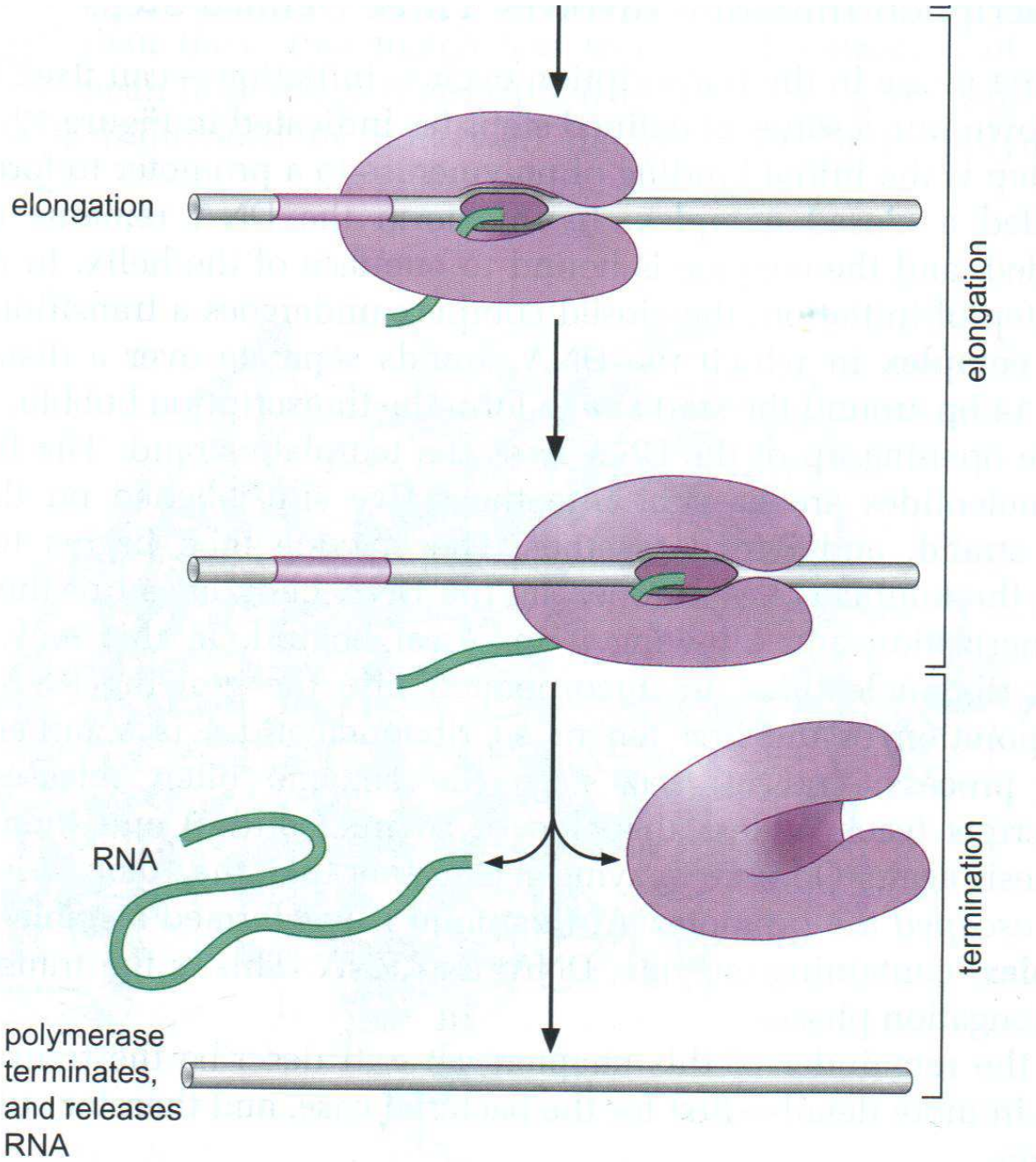
FIGURE 12-7 σ and α subunits recruit RNA polymerase core enzyme to the promoter.
The C-terminal domain of the α subunit (αCTD) recognizes the UP-element (where present), while σ regions 2 and 4 recognize the –10 and –35 regions respectively (see Figure 12-6). In this figure, RNA polymerase is shown in a rather different schematic form than presented in earlier figures. This form is particularly useful for indicating surfaces that touch DNA and regulating proteins and we use it again in some figures in Chapter 16 when we consider regulation of transcription in bacteria.


RNA
polymerase
upstream
DNA
+1
downstream
DNA
promoter
binding
(closed
complex)
promoter
"melting"
(open
complex)
initial
transcription
RNA
initiation

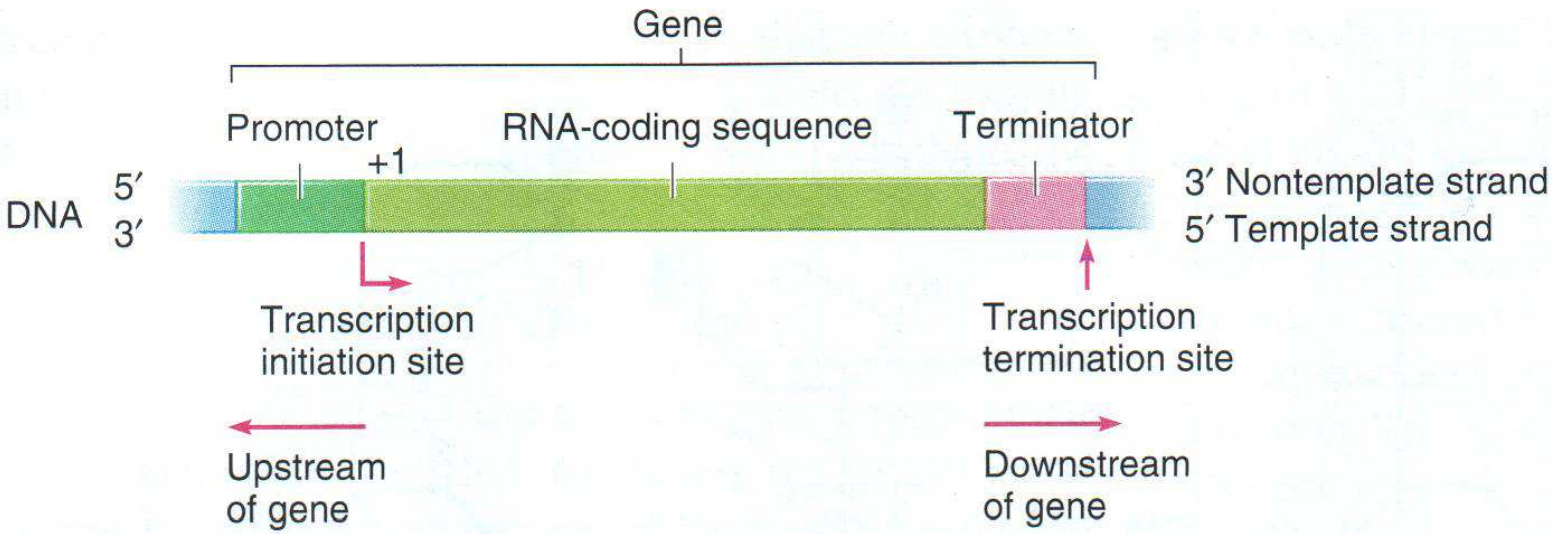

a)
Promoter
RNA-coding sequence
RNA polymerase
Closed promoter complex
5′
3′
3′
5′
σ factor
−35 region
−10 region
b)
Initiating nucleotide
5′
3′
5′ PPP
3′
5′
Open promoter complex
+1
Direction of transcription
c)
RNA polymerase
5′
3′
3′
5′
3′
5′
Template DNA strand
RNA-DNA hybrid
σ factor released
d)
5′
3′
3′
5′
3′
5′
RNA elongation
Promoter
RNA-coding sequence

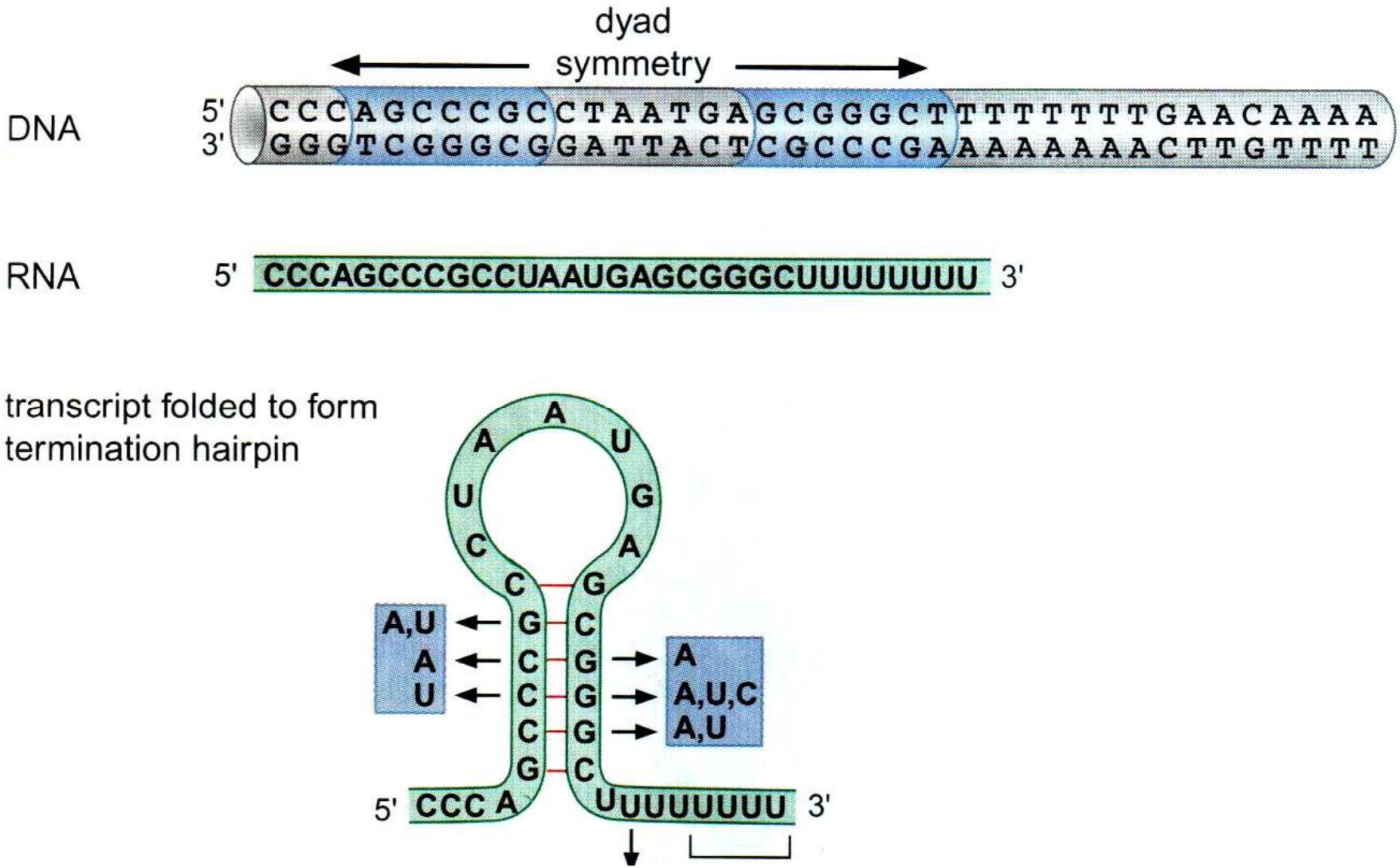
Fase di Elongazione

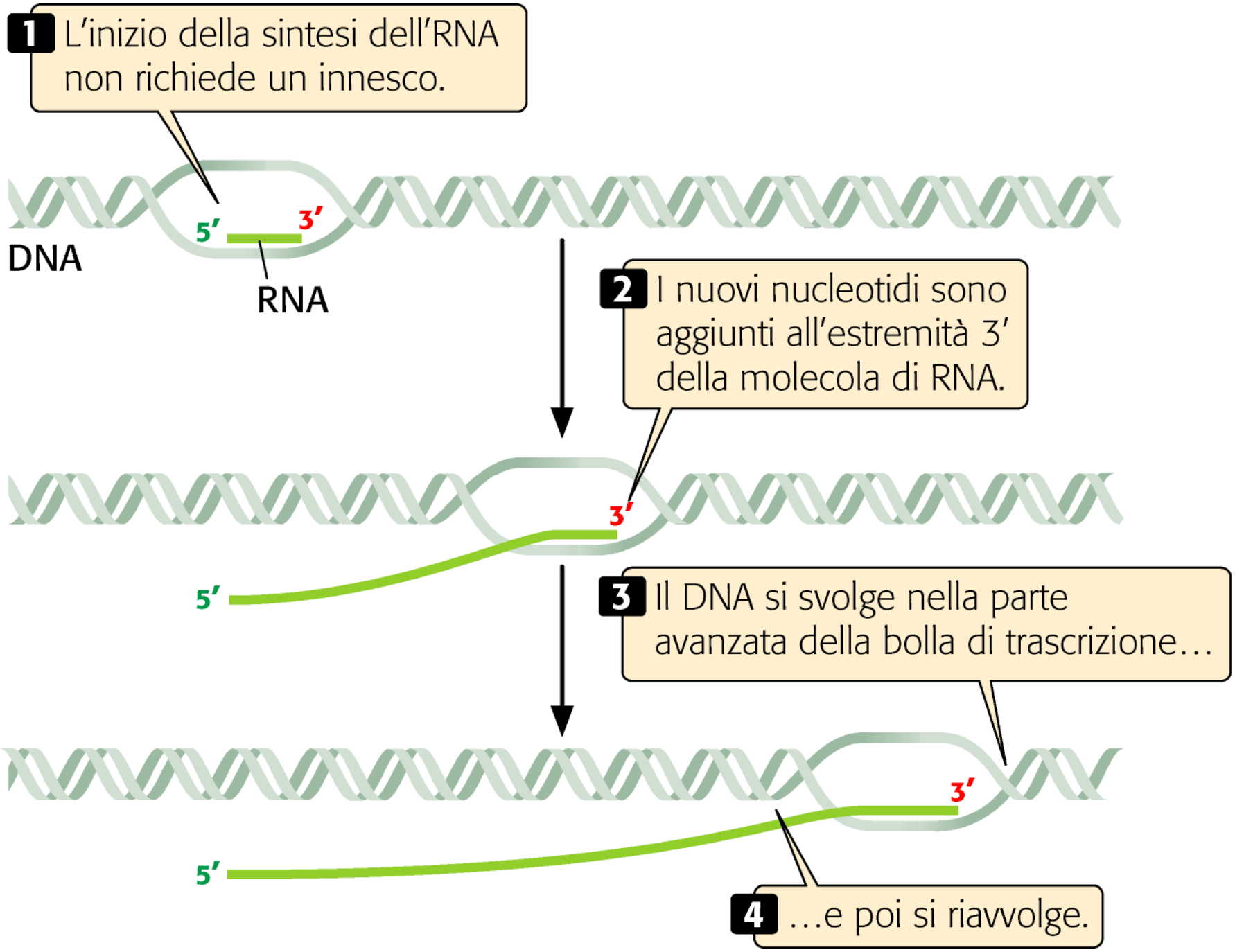

1 L'inizio della sintesi dell'RNA non richiede un innesco.
5′
3′
DNA
RNA
2 I nuovi nucleotidi sono aggiunti all'estremità 3′ della molecola di RNA.
3′
5′
3 Il DNA si svolge nella parte avanzata della bolla di trascrizione…
3′
5′
4 …e poi si riavvolge.

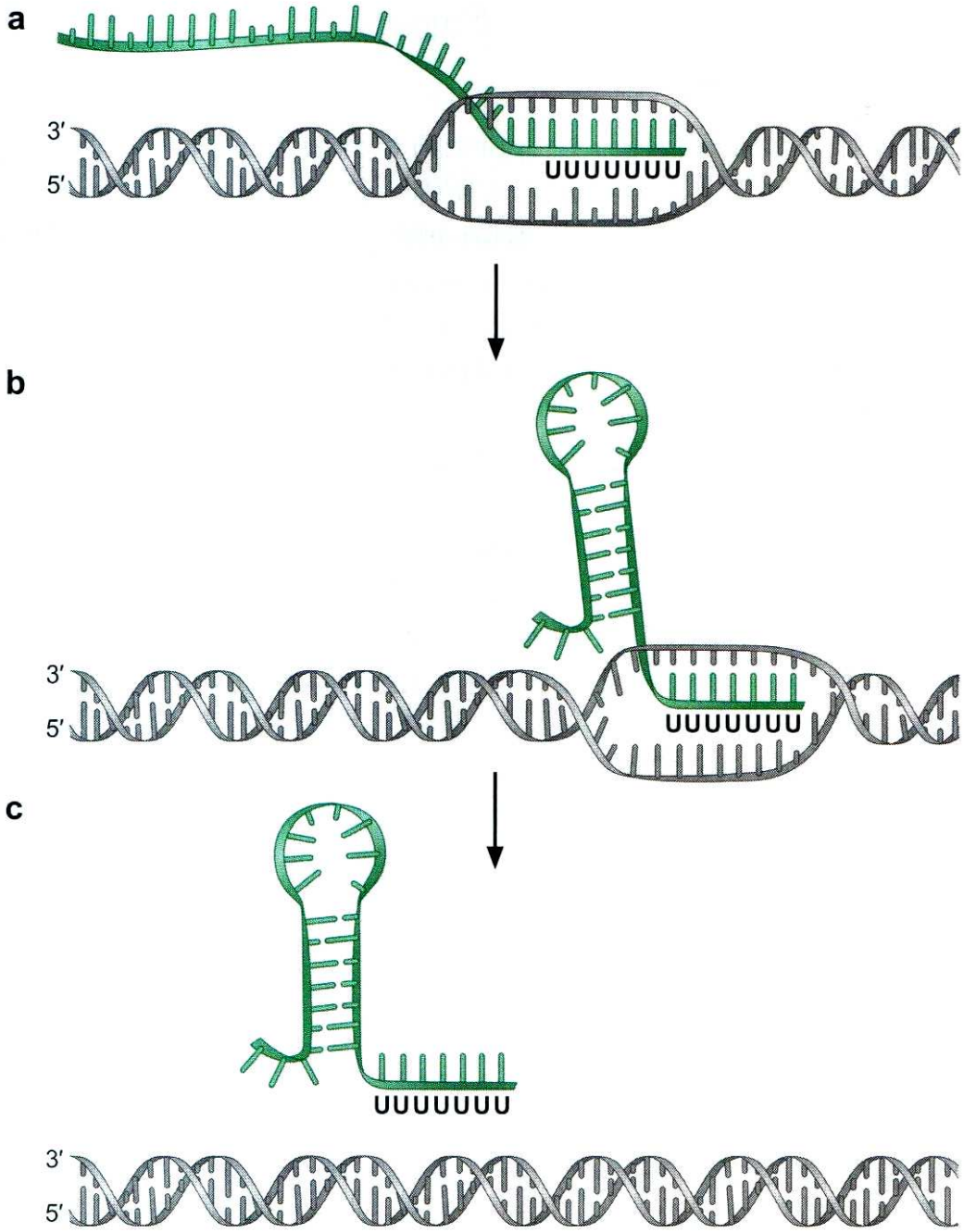

elongation
elongation
RNA
termination
polymerase
terminates,
and releases
RNA

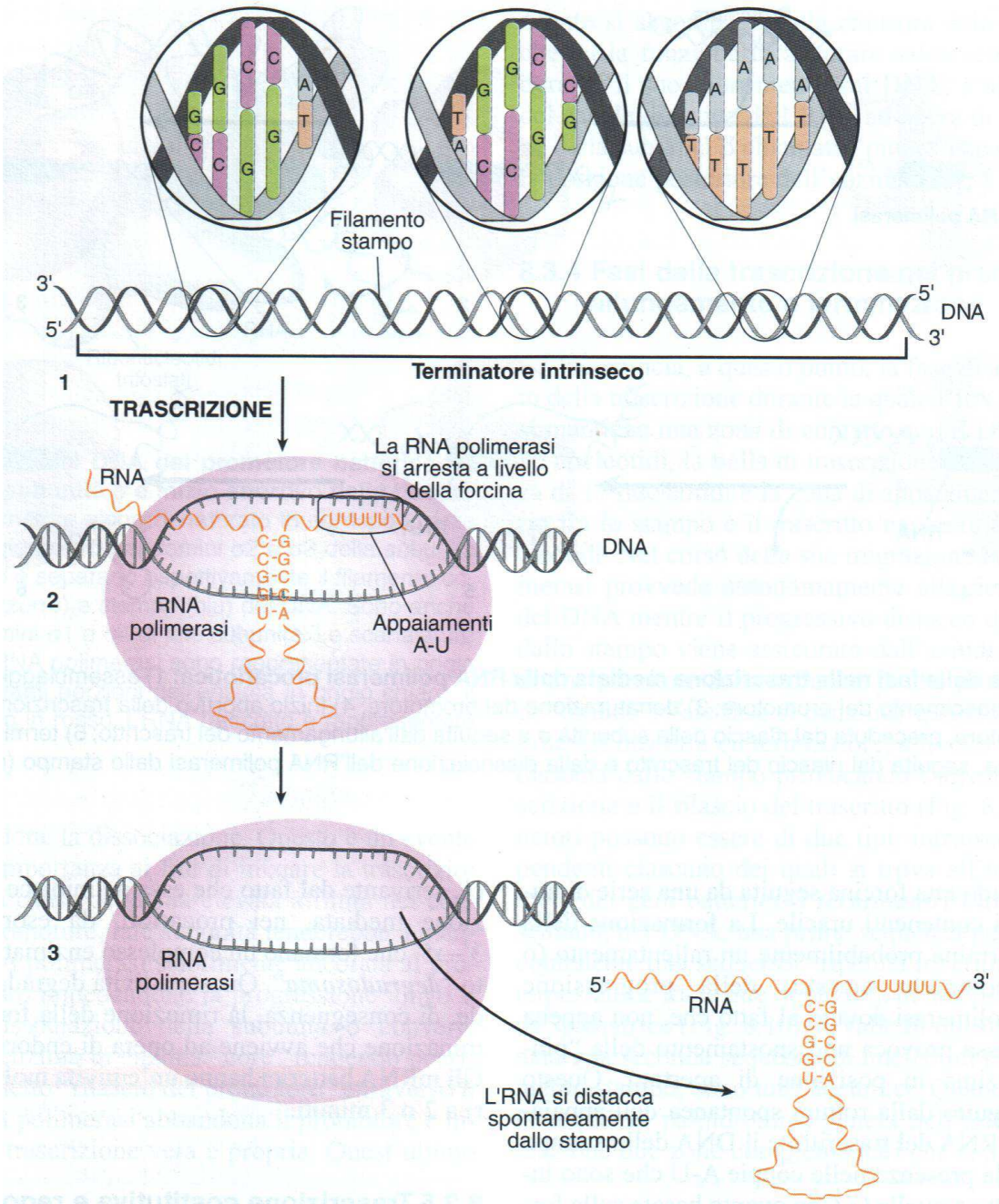
Fase di Termine

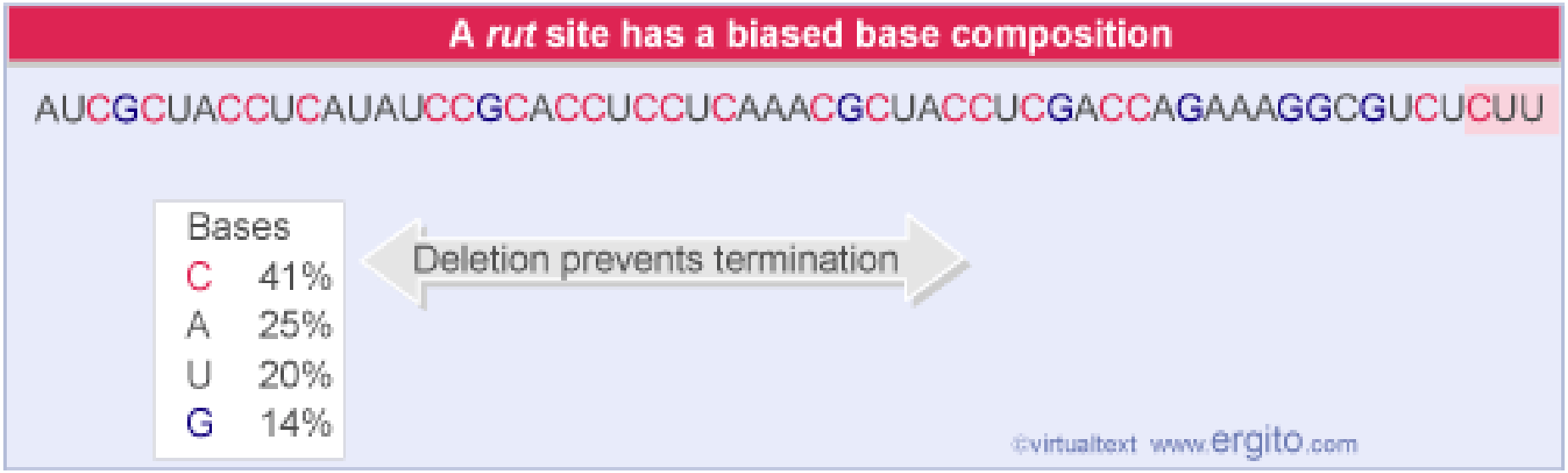

Gene
Promoter
RNA-coding sequence
Terminator
+1
DNA
5′
3′
3′ Nontemplate strand
5′ Template strand
Transcription initiation site
Transcription termination site
Upstream of gene
Downstream of gene

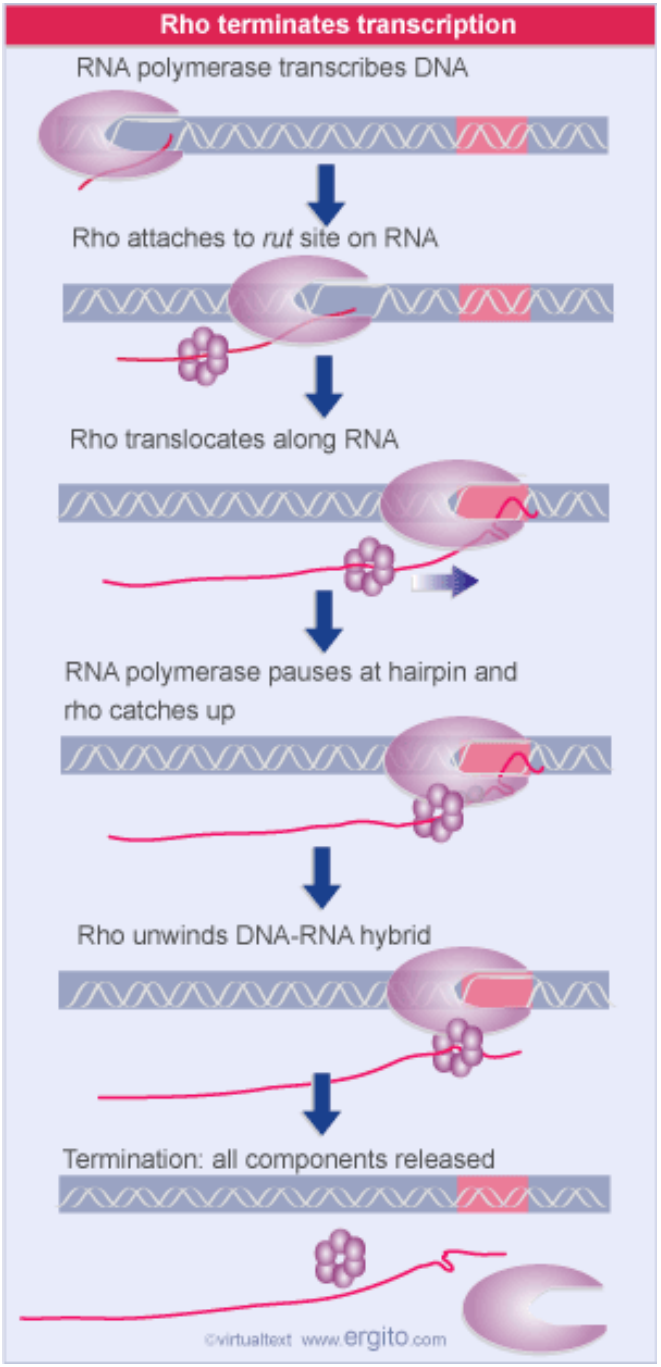

dyad
symmetry
DNA
5'
3'
CCCAGCCCGCCTAATGAGCGGGCTTTTTTTTTGAACAAAA
GGGTCGGGCGGATTACTCGCCCGAAAAAAAACTTGTTTT
RNA
5'
CCCAGCCCGCCUAAUGAGCGGGCUUUUUUUU
3'
transcript folded to form
termination hairpin
A,U
A
U
A
U
C
A
U
G
A
C
G
C
G
C
G
C
G
C
G
C
G
A
A,U,C
A,U
5'
CCC A
UUUUUUUU
3'

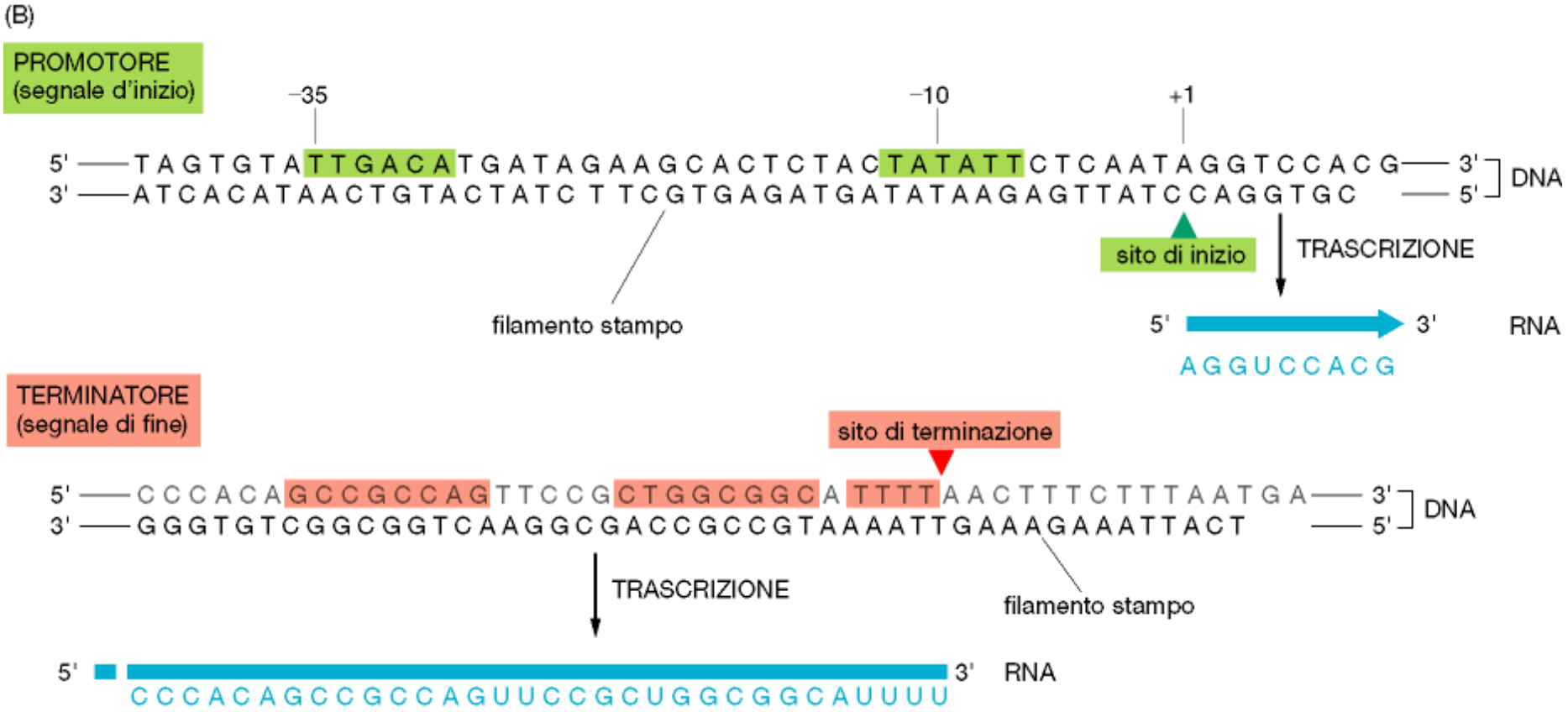

1 L'inizio della sintesi dell'RNA non richiede un innesco.
5′
3′
DNA
RNA
2 I nuovi nucleotidi sono aggiunti all'estremità 3′ della molecola di RNA.
3′
5′
3 Il DNA si svolge nella parte avanzata della bolla di trascrizione…
3′
5′
4 …e poi si riavvolge.


a
3′
5′
UUUUUUU
b
3′
5′
UUUUUUU
c
UUUUUUU
3′
5′


Filamento stampo
3'
5'
5'
3'
DNA
Terminatore intrinseco
1
TRASCRIZIONE
La RNA polimerasi si arresta a livello della forcina
RNA
DNA
UUUUU
C-G
C-G
G-C
G-C
U-A
2
RNA polimerasi
Appaiamenti A-U
3
RNA polimerasi
5'
RNA
UUUUU
3'
C-G
C-G
G-C
G-C
U-A
L'RNA si distacca spontaneamente dallo stampo


A rut site has a biased base composition
AUCGCUACCUCAUAUCCGCACCUCCUCAAACGCUACCUCGACCAGAAAGGCGUCUCUU
Bases
C 41%
A 25%
U 20%
G 14%
Deletion prevents termination
©virtualtext www.ergito.com


Rho terminates transcription
RNA polymerase transcribes DNA
Rho attaches to *rut* site on RNA
Rho translocates along RNA
RNA polymerase pauses at hairpin and rho catches up
Rho unwinds DNA-RNA hybrid
Termination: all components released
©virtualtext www.ergito.com


(B)
PROMOTORE
(segnale d'inizio)
−35
−10
+1
5' TAGTGTATTGACATGATAGAAGCACTCTACTATATTCTCAATAGGTCCACG 3'
3' ATCACATAACTGTACTATC T TCGTGAGATGATATAAGAGTTATCCAGGTGC 5'
DNA
sito di inizio
TRASCRIZIONE
filamento stampo
5' 3' RNA
AGGUCCACG
TERMINATORE
(segnale di fine)
sito di terminazione
5' CCCACAGCCGCCAGTTCCGCTGGCGGCATTTTAACTTTCTTTAATGA 3'
3' GGGTGTCGGCGGTCAAGGCGACCGCCGTAAAATTGAAAGAAATTACT 5'
DNA
TRASCRIZIONE
filamento stampo
5' 3' RNA
CCCACAGCCGCCAGUUCCGCUGGCGGCAUUUU

Tipi di RNA

- RNA messaggero mRNA
- RNA ribosomale rRNA
- RNA transfer tRNA

Table 7–1 Types of RNA Produced in Cells

TYPE OF RNA	FUNCTION
mRNAs	code for proteins
rRNAs	form part of the structure of the ribosome and participate in protein synthesis
tRNAs	used in protein synthesis as adaptors between mRNA and amino acids

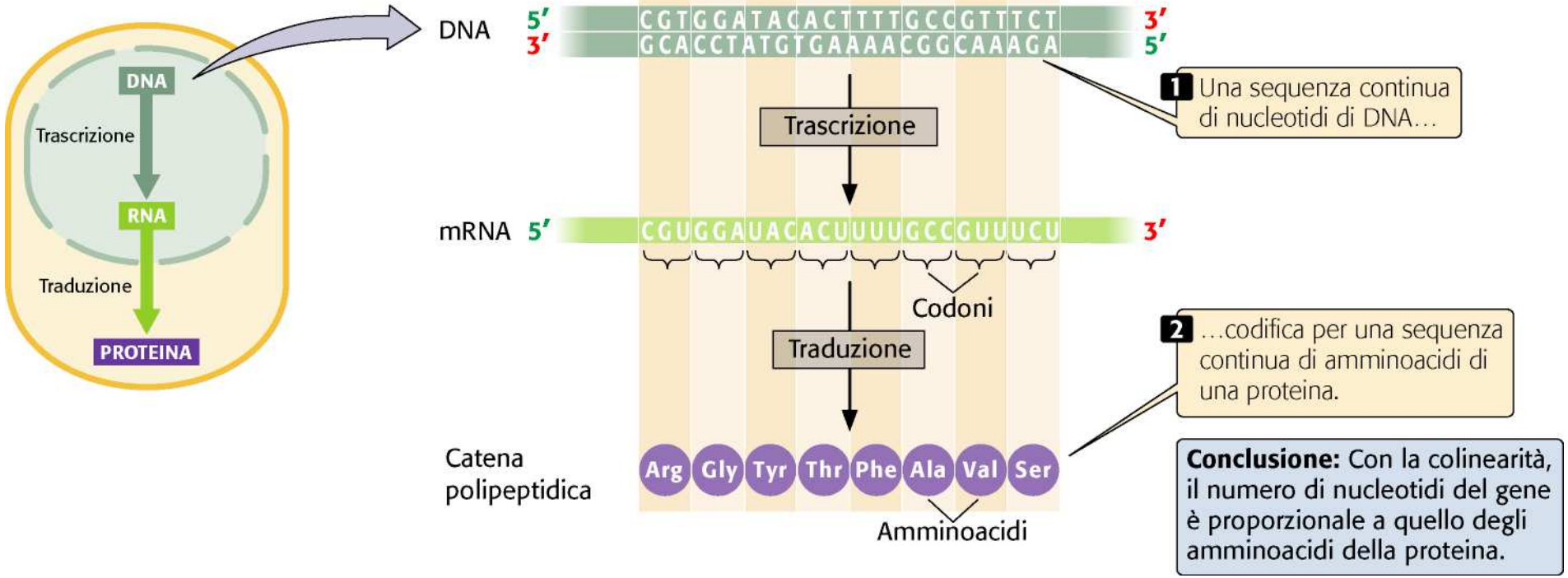

DNA
Trascrizione
RNA
Traduzione
PROTEINA
DNA
5′
3′
CGTGGATACACTTTTGCCGTTTCT
GCACCTATGTGAAAACGGCAAAGA
3′
5′
1 Una sequenza continua di nucleotidi di DNA…
Trascrizione
mRNA
5′
CGUGGAUACACUUUUGCCGUUUCU
3′
Codoni
Traduzione
Catena polipeptidica
Arg
Gly
Tyr
Thr
Phe
Ala
Val
Ser
Amminoacidi
2 …codifica per una sequenza continua di amminoacidi di una proteina.
Conclusione: Con la colinearità, il numero di nucleotidi del gene è proporzionale a quello degli amminoacidi della proteina.

Table 7–1 Types of RNA Produced in Cells

TYPE OF RNA	FUNCTION
mRNAs	code for proteins
rRNAs	form part of the structure of the ribosome and participate in protein synthesis
tRNAs	used in protein synthesis as adaptors between mRNA and amino acids

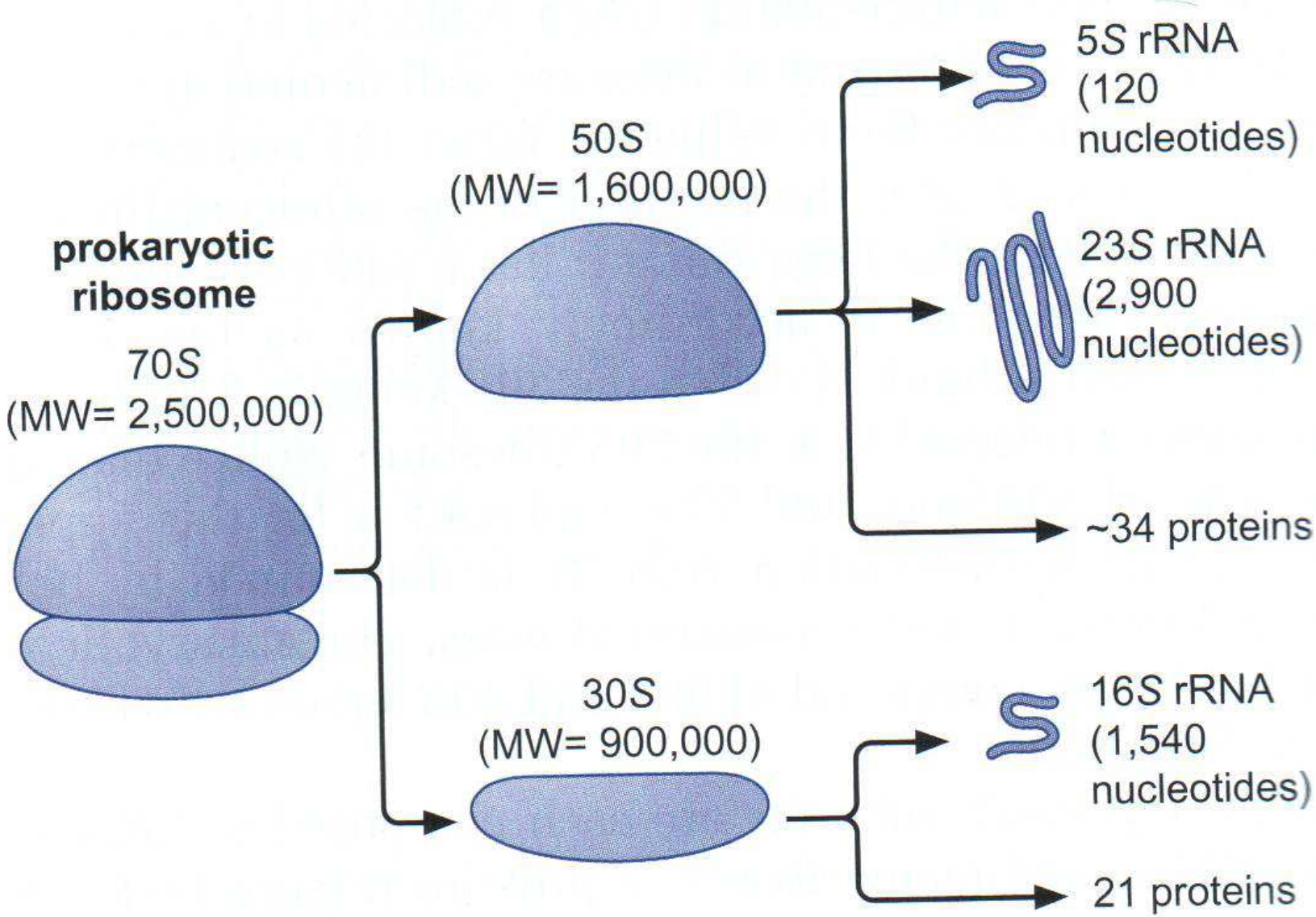
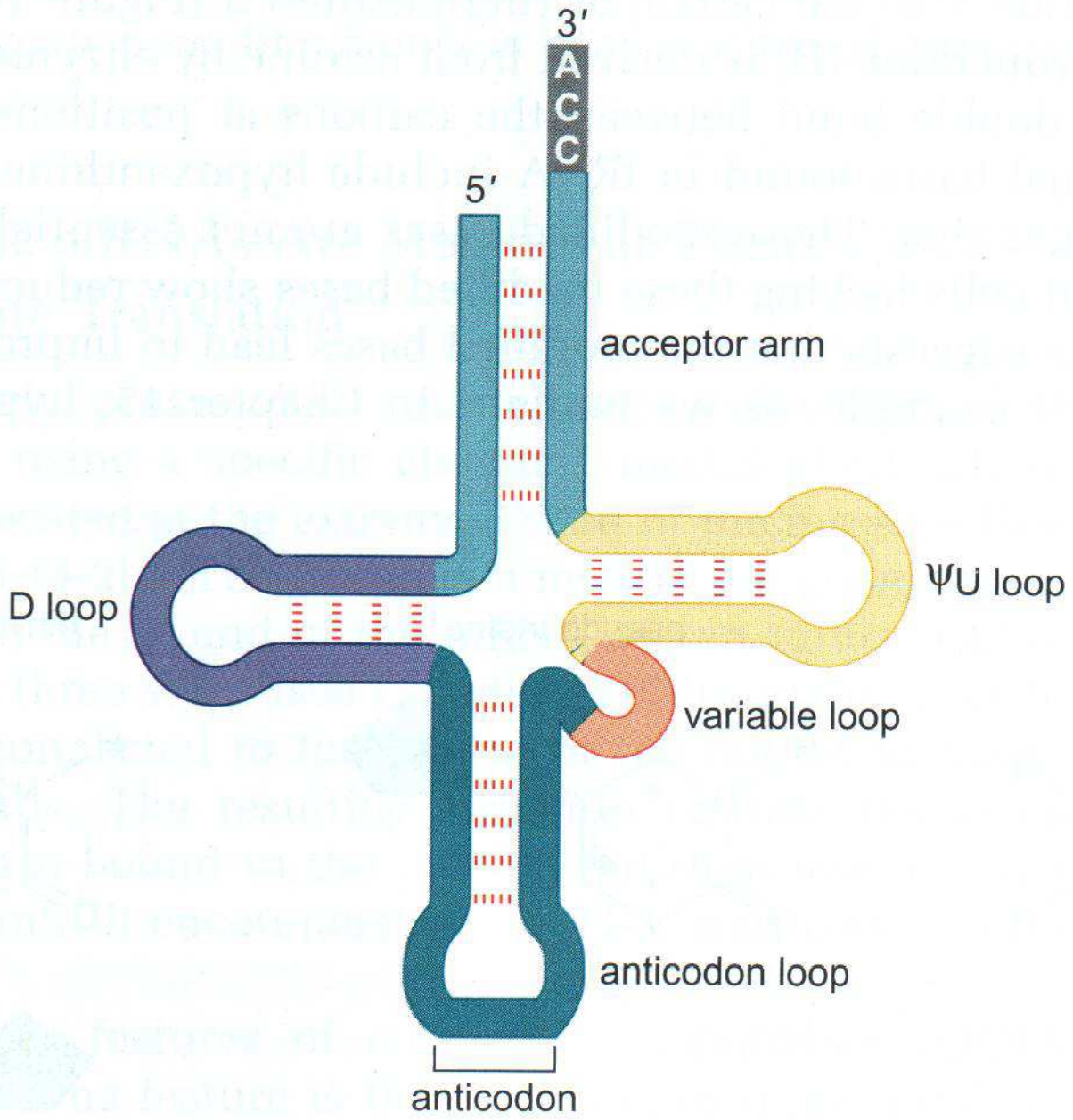

prokaryotic ribosome
70S
(MW= 2,500,000)
50S
(MW= 1,600,000)
30S
(MW= 900,000)
5S rRNA
(120
nucleotides)
23S rRNA
(2,900
nucleotides)
~34 proteins
16S rRNA
(1,540
nucleotides)
21 proteins

Table 7–1 Types of RNA Produced in Cells

TYPE OF RNA	FUNCTION
mRNAs	code for proteins
rRNAs	form part of the structure of the ribosome and participate in protein synthesis
tRNAs	used in protein synthesis as adaptors between mRNA and amino acids


3′
A
C
C
5′
acceptor arm
D loop
ΨU loop
variable loop
anticodon loop
anticodon

La Trascrizione negli Eucarioti

RNA Polimerasi eucariotiche

- RNA Pol I — 28S, 18S, 5.8S rRNA
- RNA Pol II — mRNA; alcuni snRNA
- RNA Pol III — tRNA; 5S rRNA; altri snRNA

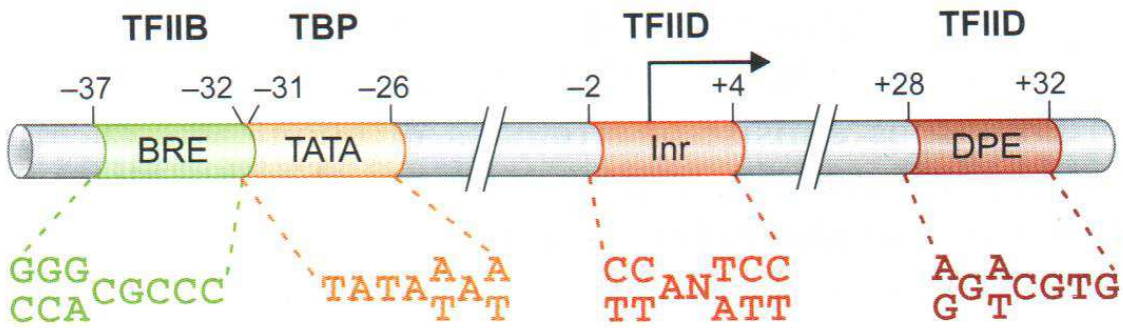
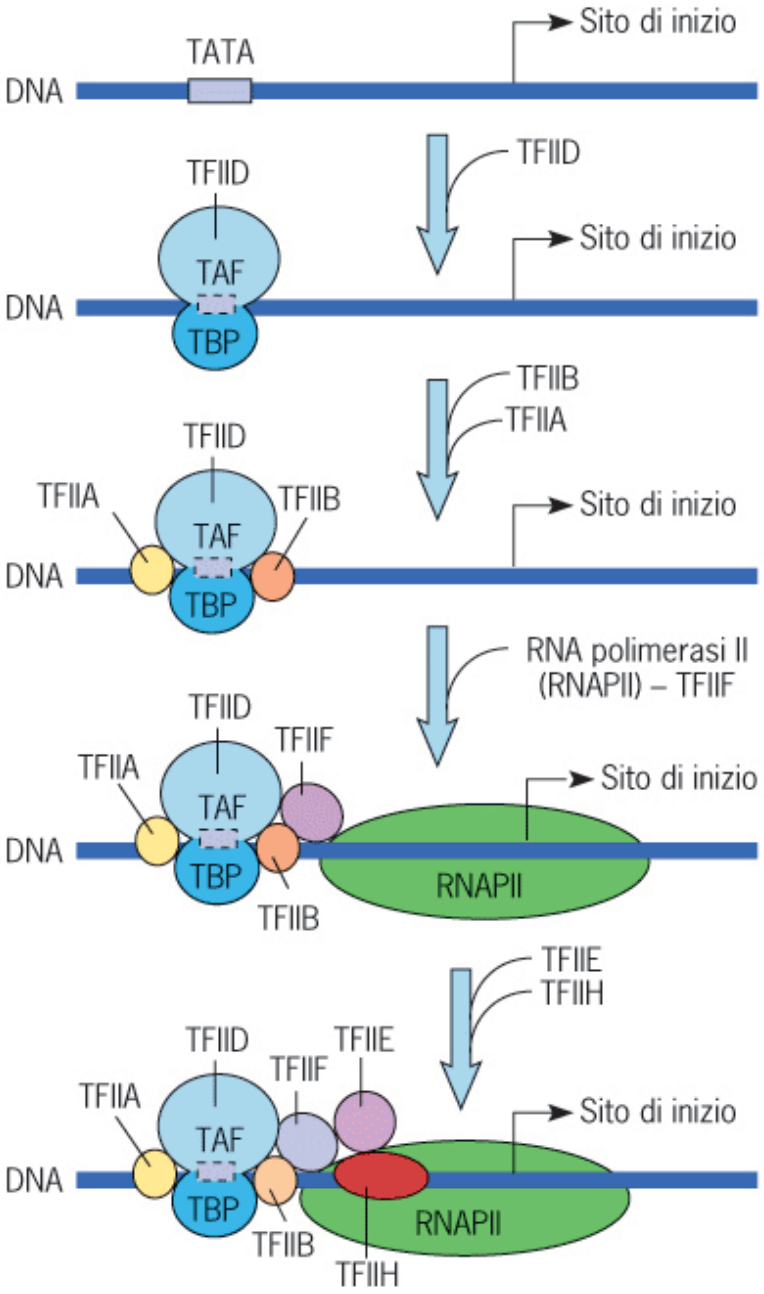
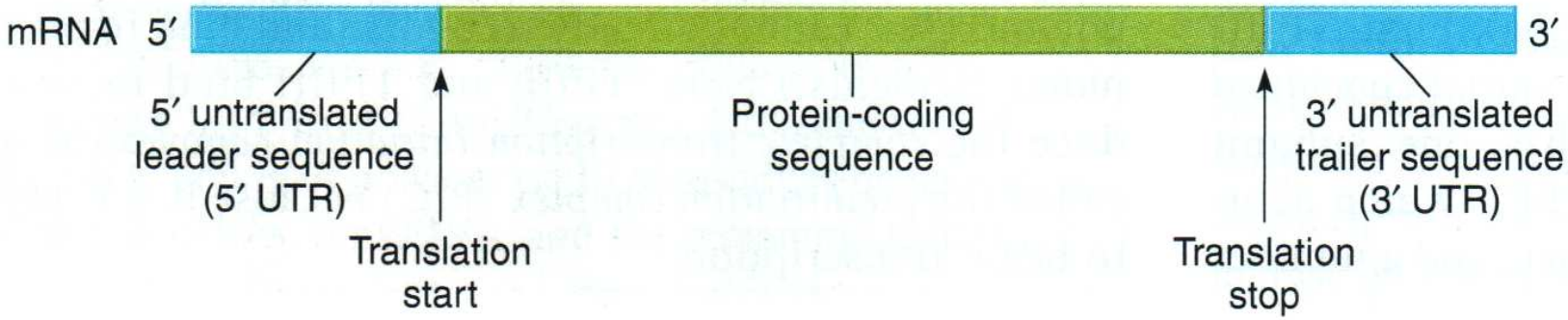
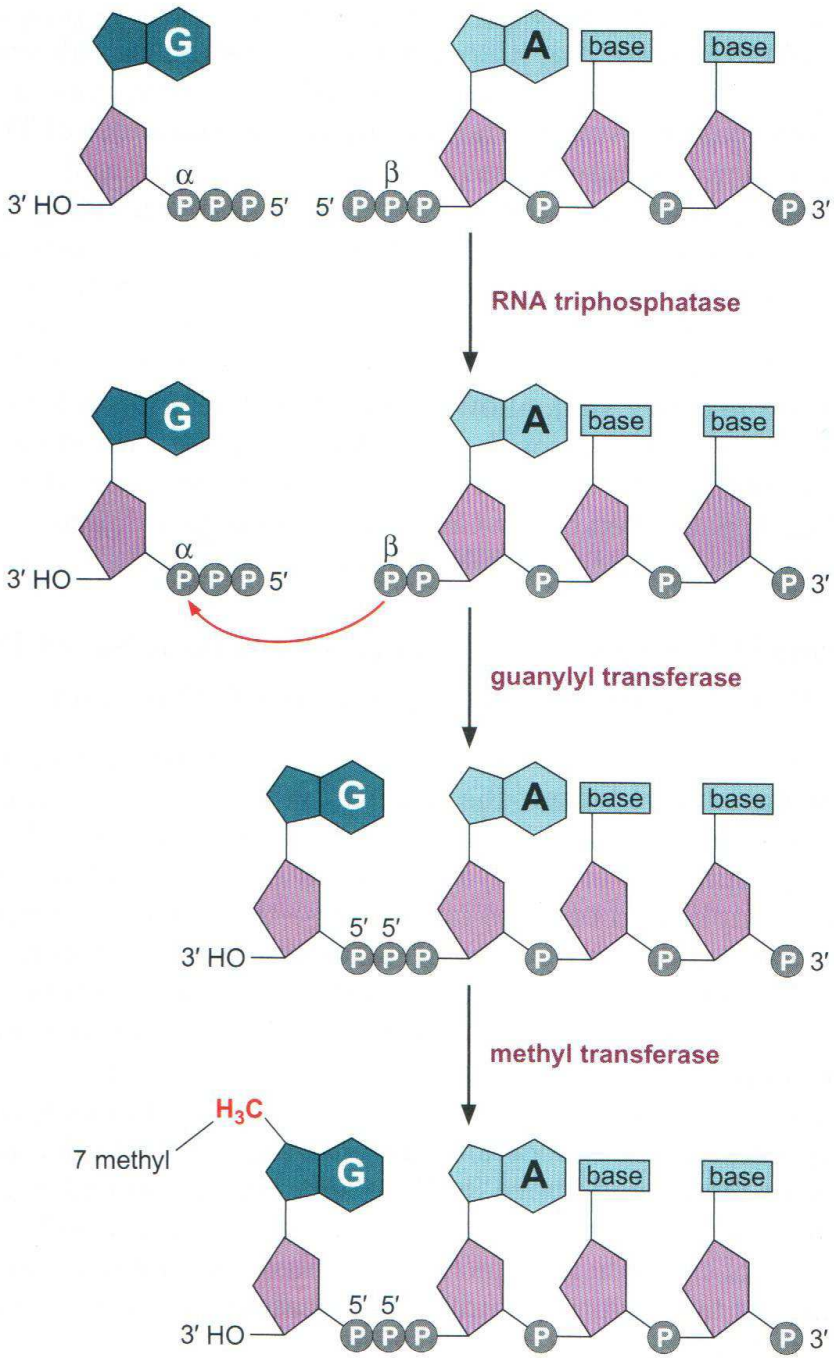


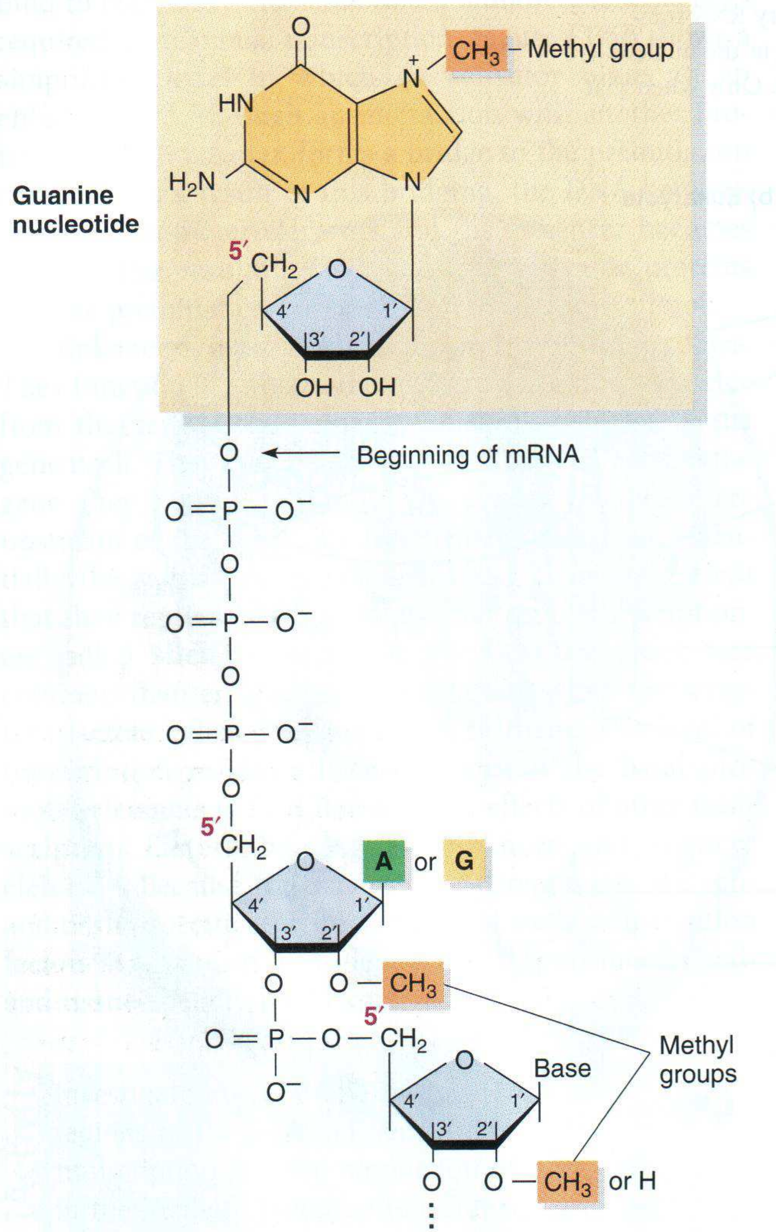
FIGURE 12-12 Pol II core promoter. The figure shows the positions of various DNA elements relative to the transcription start site (indicated by the arrow above the DNA). These elements, described in the text, are as follows: BRE (TFIIB recognition element); TATA (TATA Box); Inr (initiator element); and DPE (downstream promoter element). Also shown (below) are the consensus sequence for each element (determined in the same way as described for the bacterial promoter elements, see Box 12-1); and (above) the name of the general transcription factor that recognizes each element. (Source: Butler J.E.F. et al. 2002. *Genes and Development* 16: 2583–2592, Fig. 1.)


TATA
Sito di inizio
DNA
TFIID
TAF
TBP
TFIIA
TFIIB
TFIIF
TFIIE
TFIIH
RNA polimerasi II
(RNAPII) – TFIIF
RNAPII

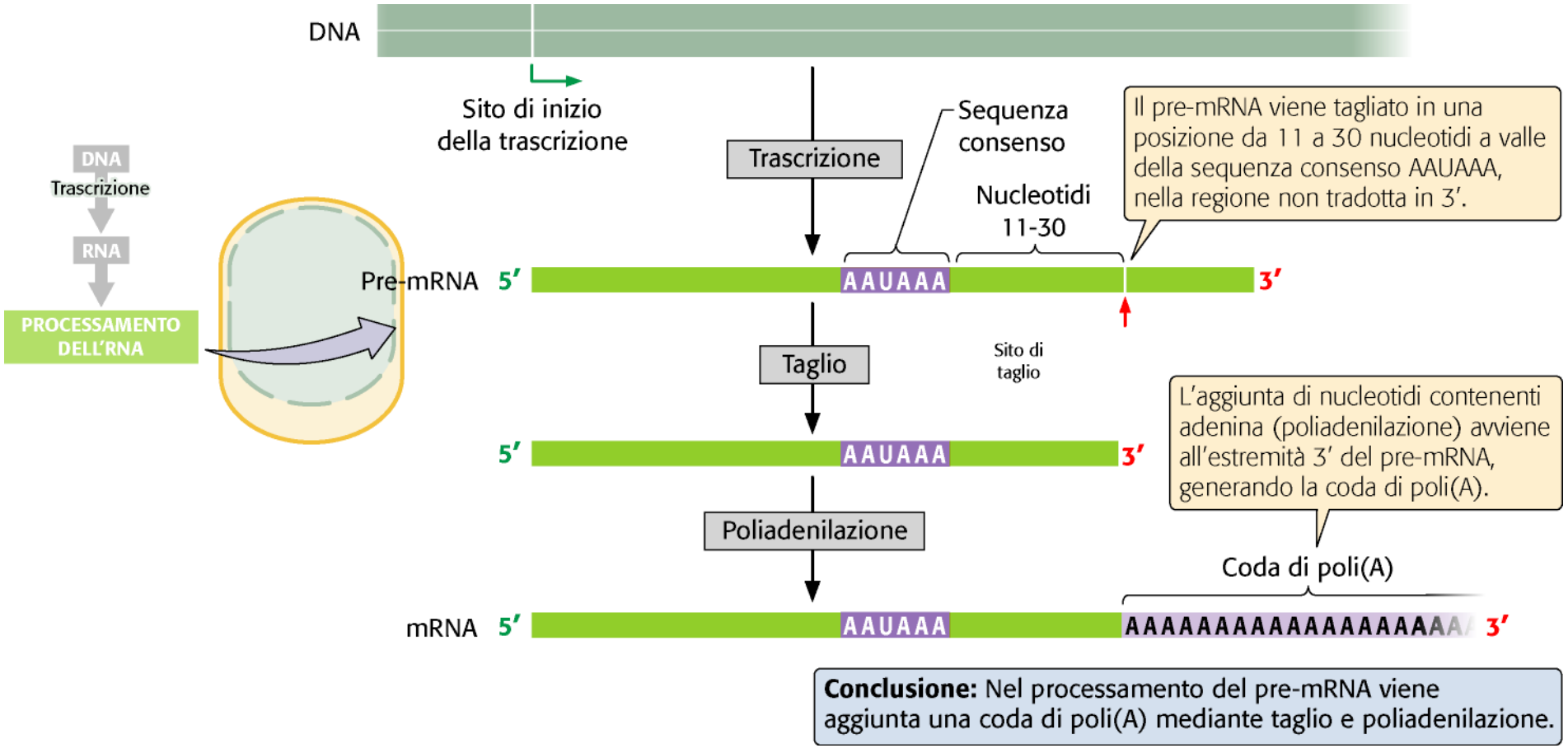
(b)

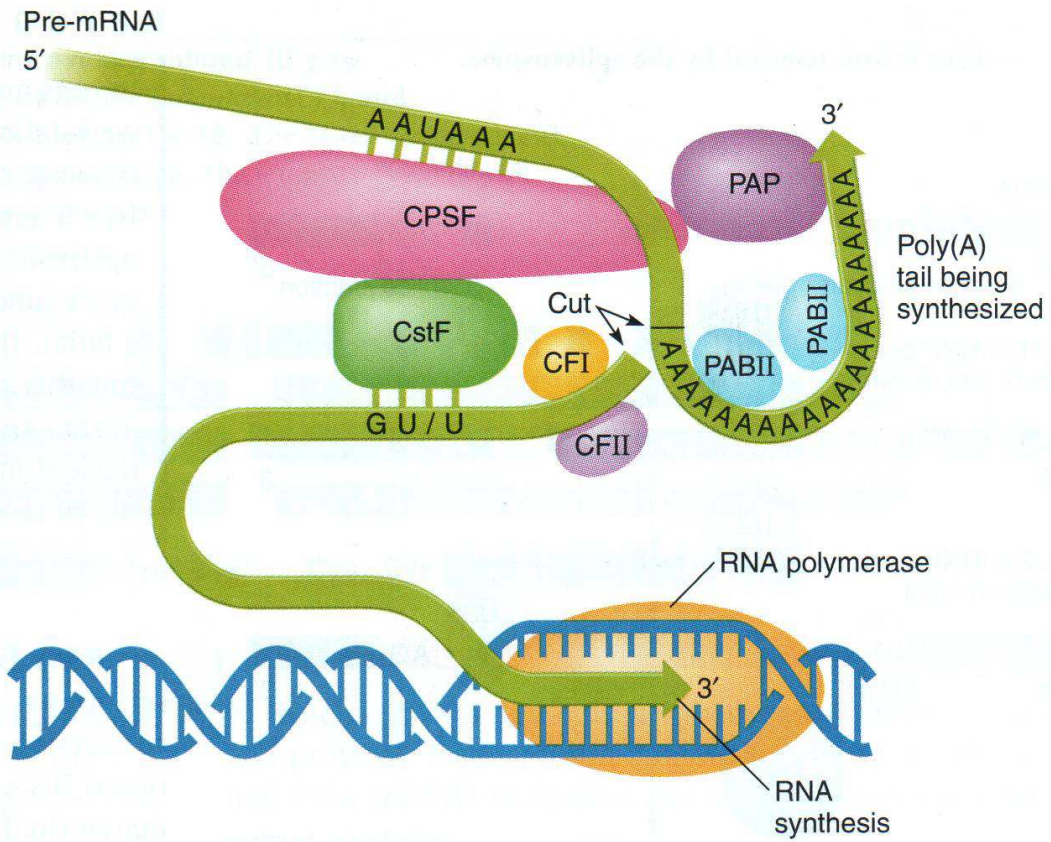

mRNA
5′
3′
5′ untranslated
leader sequence
(5′ UTR)
Translation
start
Protein-coding
sequence
Translation
stop
3′ untranslated
trailer sequence
(3′ UTR)

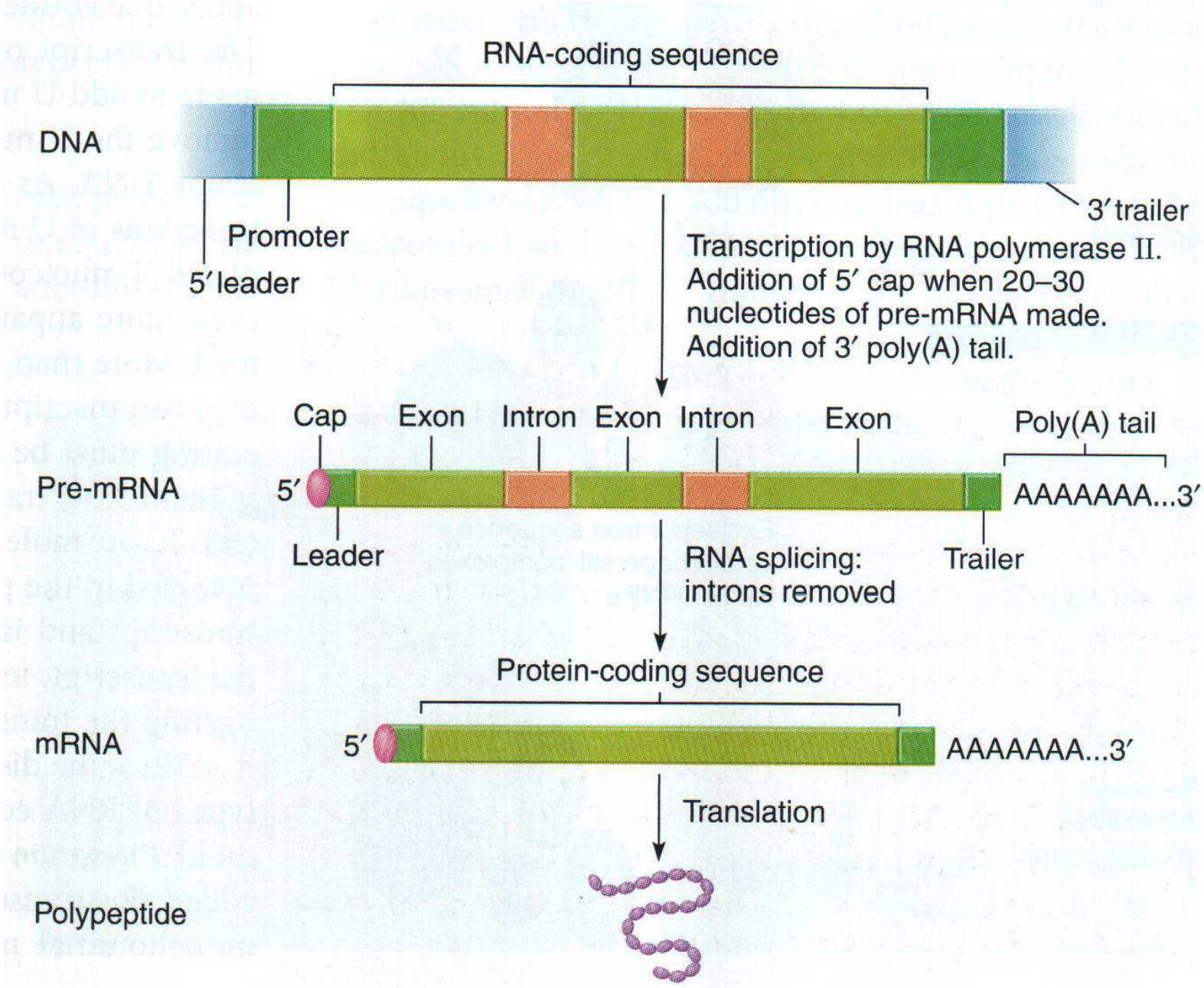

G
A
base
base
3′ HO
α
P P P 5′
5′ P P P
β
P P 3′
RNA triphosphatase
guanylyl transferase
5′ 5′
methyl transferase
H3C
7 methyl



Guanine nucleotide
O
HN
H2N
N
N+
N
CH3
Methyl group
5′
CH2
O
4′
1′
3′
2′
OH
OH
O
Beginning of mRNA
O=P–O−
O
O=P–O−
O
O=P–O−
O
5′
CH2
O
A
or
G
4′
1′
3′
2′
O
O – CH3
5′
O=P–O–CH2
O−
O
Base
4′
1′
3′
2′
Methyl groups
O
O – CH3
or H


DNA
Trascrizione
RNA
PROCESSAMENTO DELL'RNA
DNA
Sito di inizio della trascrizione
Trascrizione
Sequenza consenso
Nucleotidi 11-30
Il pre-mRNA viene tagliato in una posizione da 11 a 30 nucleotidi a valle della sequenza consenso AAUAAA, nella regione non tradotta in 3′.
Pre-mRNA 5′ AAUAAA 3′
Taglio
Sito di taglio
5′ AAUAAA 3′
L'aggiunta di nucleotidi contenenti adenina (poliadenilazione) avviene all'estremità 3′ del pre-mRNA, generando la coda di poli(A).
Poliadenilazione
Coda di poli(A)
mRNA 5′ AAUAAA AAAAAAAAAAAAAAAAAAAA 3′
Conclusione: Nel processamento del pre-mRNA viene aggiunta una coda di poli(A) mediante taglio e poliadenilazione.


Pre-mRNA
5′
A A U A A A
CPSF
CstF
CFI
CFII
G U / U
Cut
PAP
3′
PABII
PABII
A A A A A A A A A A A A A A A A A A A A
Poly(A)
tail being
synthesized
RNA polymerase
3′
RNA
synthesis


RNA-coding sequence
DNA
3′ trailer
Promoter
5′ leader
Transcription by RNA polymerase II.
Addition of 5′ cap when 20–30
nucleotides of pre-mRNA made.
Addition of 3′ poly(A) tail.
Cap
Exon
Intron
Exon
Intron
Exon
Poly(A) tail
Pre-mRNA
5′
AAAAAAA...3′
Leader
Trailer
RNA splicing:
introns removed
Protein-coding sequence
mRNA
5′
AAAAAAA...3′
Translation
Polypeptide