

Chapter 10: The Structure and Function of DNA

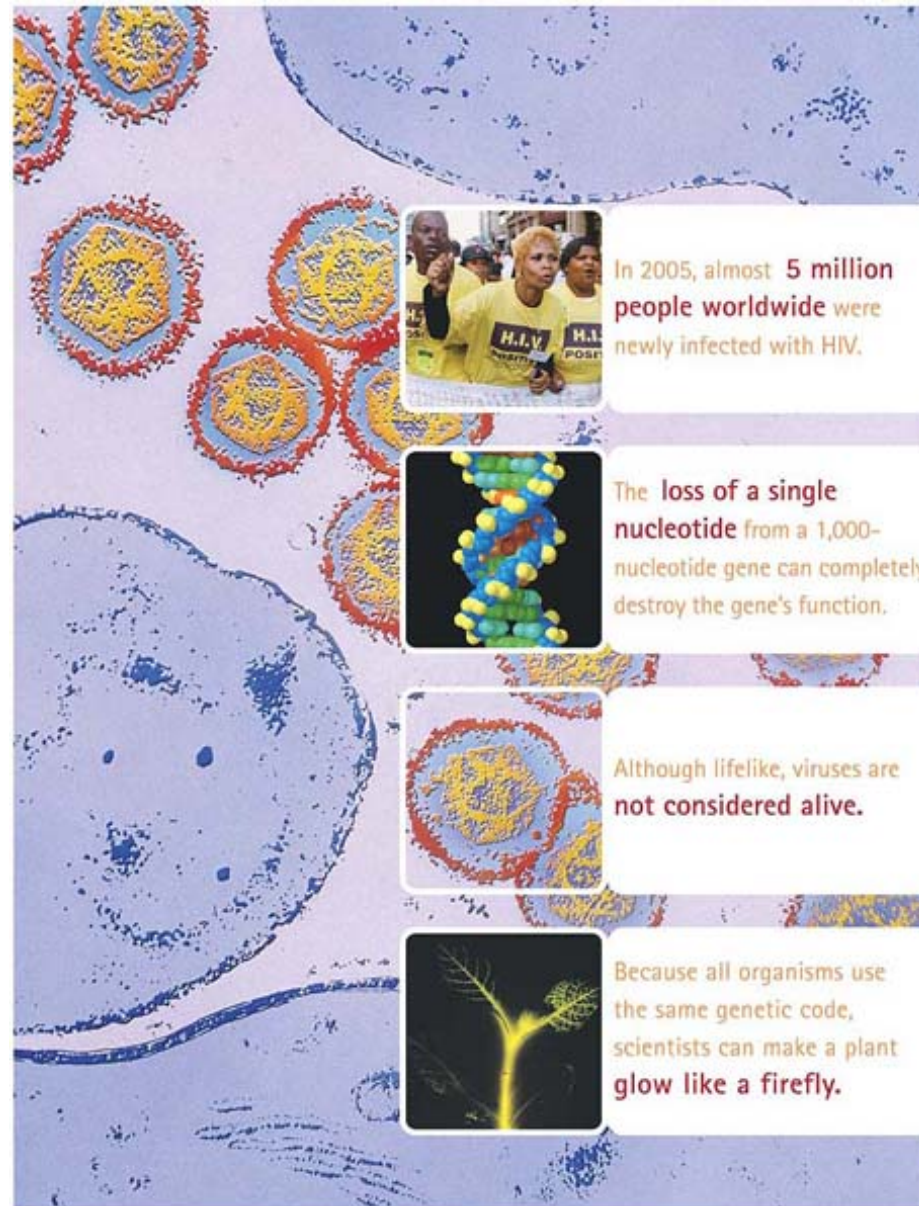
covers

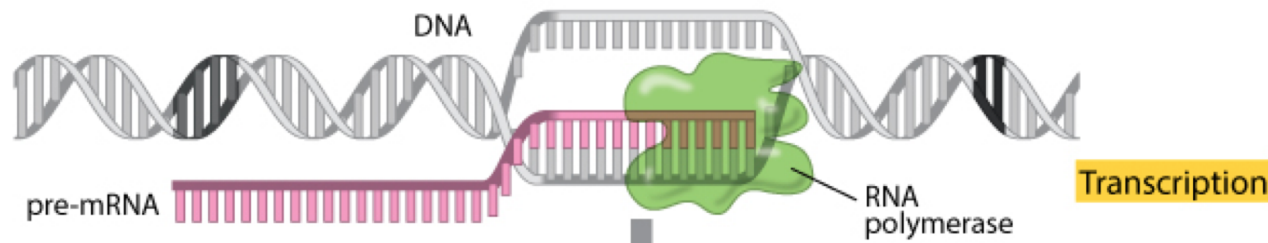
DNA replication

DNA transcription

mRNA translation

Chapter 11 covers
the regulation of gene expression





mRNA

mRNA

Translation

polypeptide

Ribosome

-NH₂

Gene expression

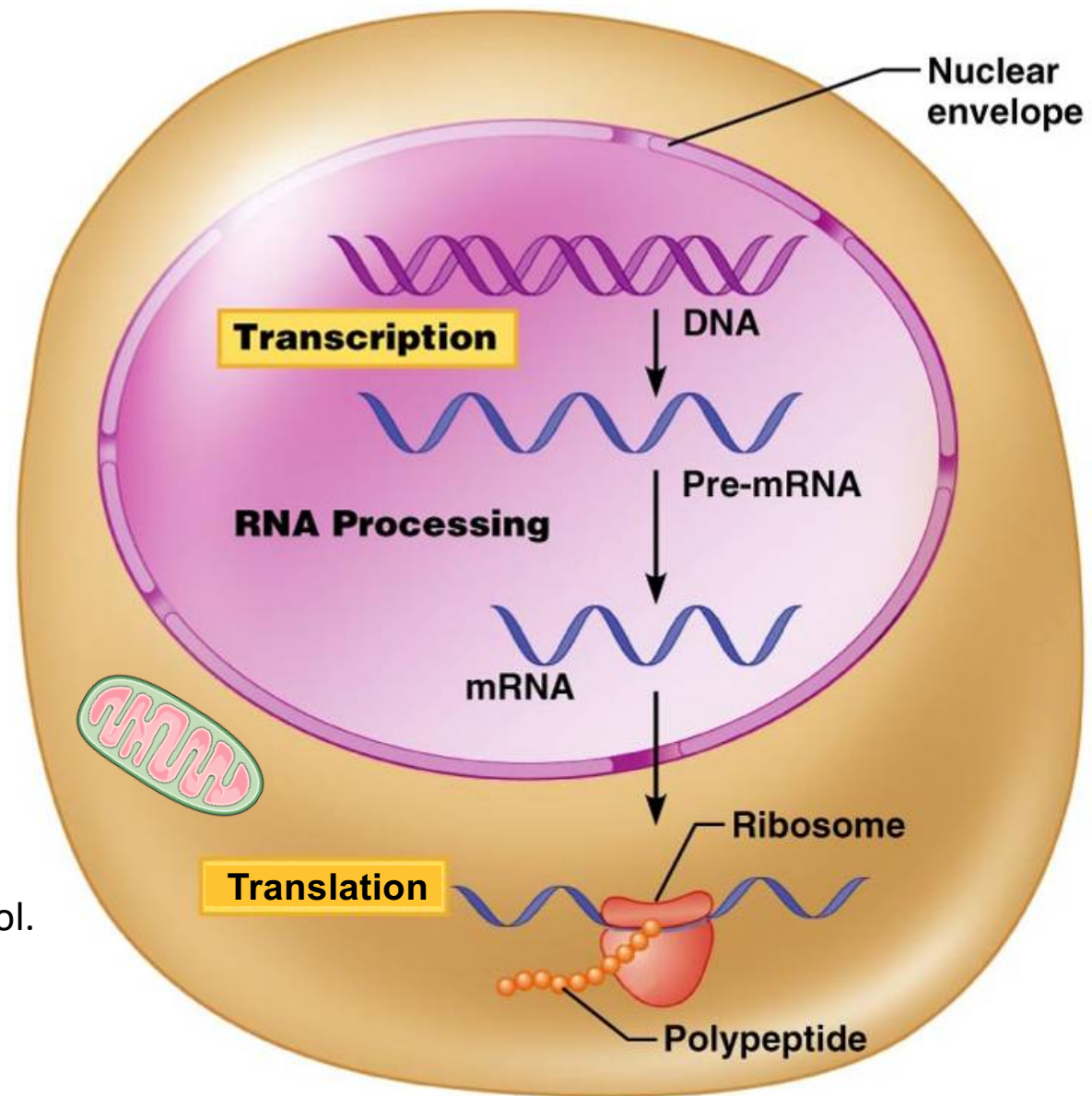


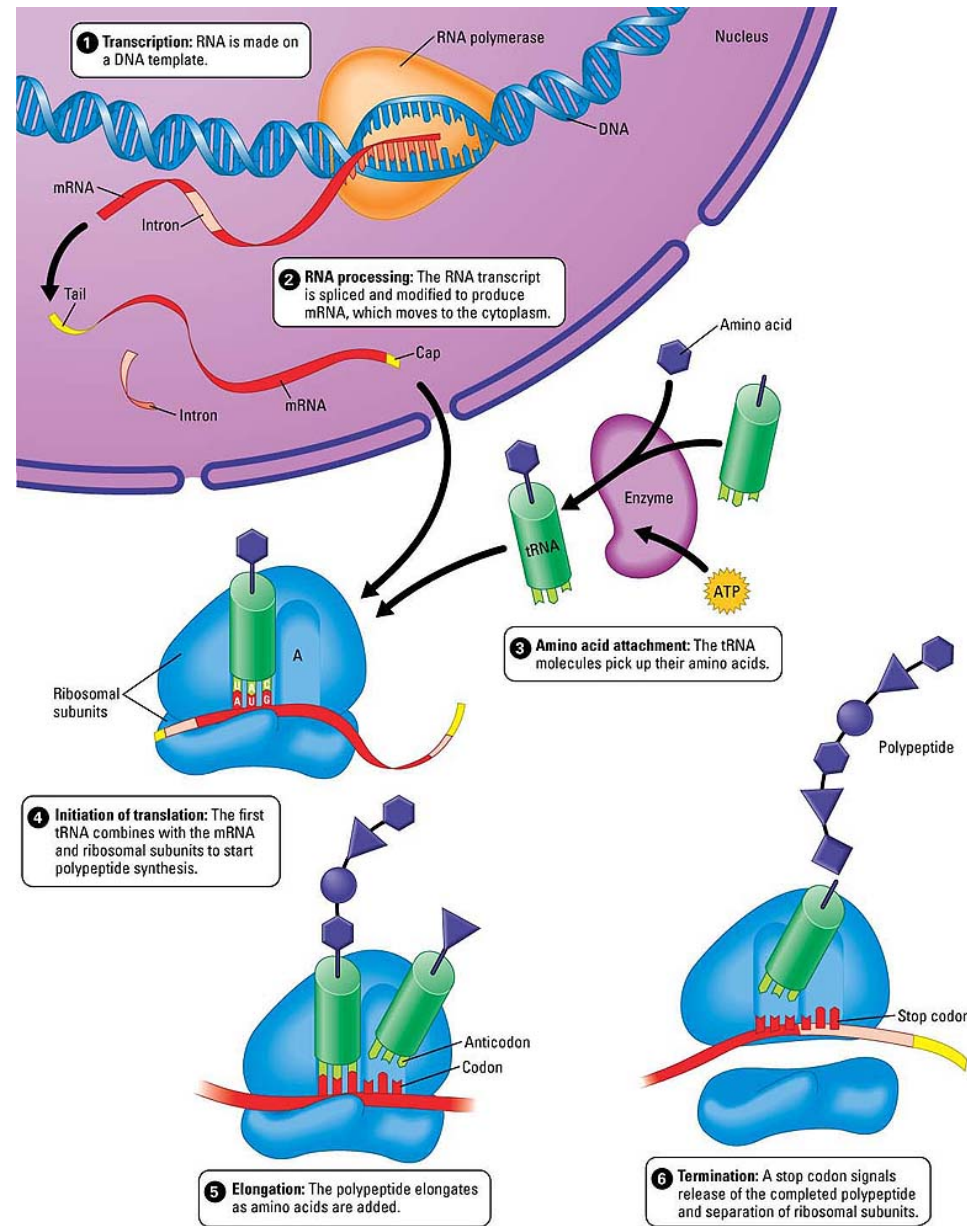
Gene expression in an eukaryotic cell:

Eukaryotic cells are cells
with a nucleus.

Translation takes place in the cytosol.

cytosol + organites = cytoplasm





Attaching an **amino acid** to the appropriate **tRNA** requires **energy**.

Translation by ribosomes occurs in 3 steps :

- initiation
- elongation
- termination

Genetic code

GCA GCC GCG GCU	AGA AGG CGA CGC CGG CGU	GAC GAU	AAC AAU	UGC UGU	GAA GAG	CAA CAG	GGA GGC GGG GGU	CAC CAU	AUA AUC AUU	UUA UUG CUA CUC CUG CUU
Ala	Arg	Asp	Asn	Cys	Glu	Gln	Gly	His	Ile	Leu
A	R	D	N	C	E	Q	G	H	I	L

AAA AAG	AUG	UUC UUU	CCA CCC CCG CCU	AGC AGU UCA UCC UCG UCU	ACA ACC ACG ACU	UGG	UAC UAU	GUA GUC GUG GUU	UAA UAG UGA
Lys	Met	Phe	Pro	Ser	Thr	Trp	Tyr	Val	stop
K	M	F	P	S	T	W	Y	V	

Note interesting facts :

- 61 sense codons + 3 STOP codons
- Tryptophan is encoded by only 1 codon
- arginine, leucine and serine are encoded by 6 codons
- synonymous codons :
codons for the same amino acids

TRANSLATION of a messenger RNA

ribosome

growing
polypeptide

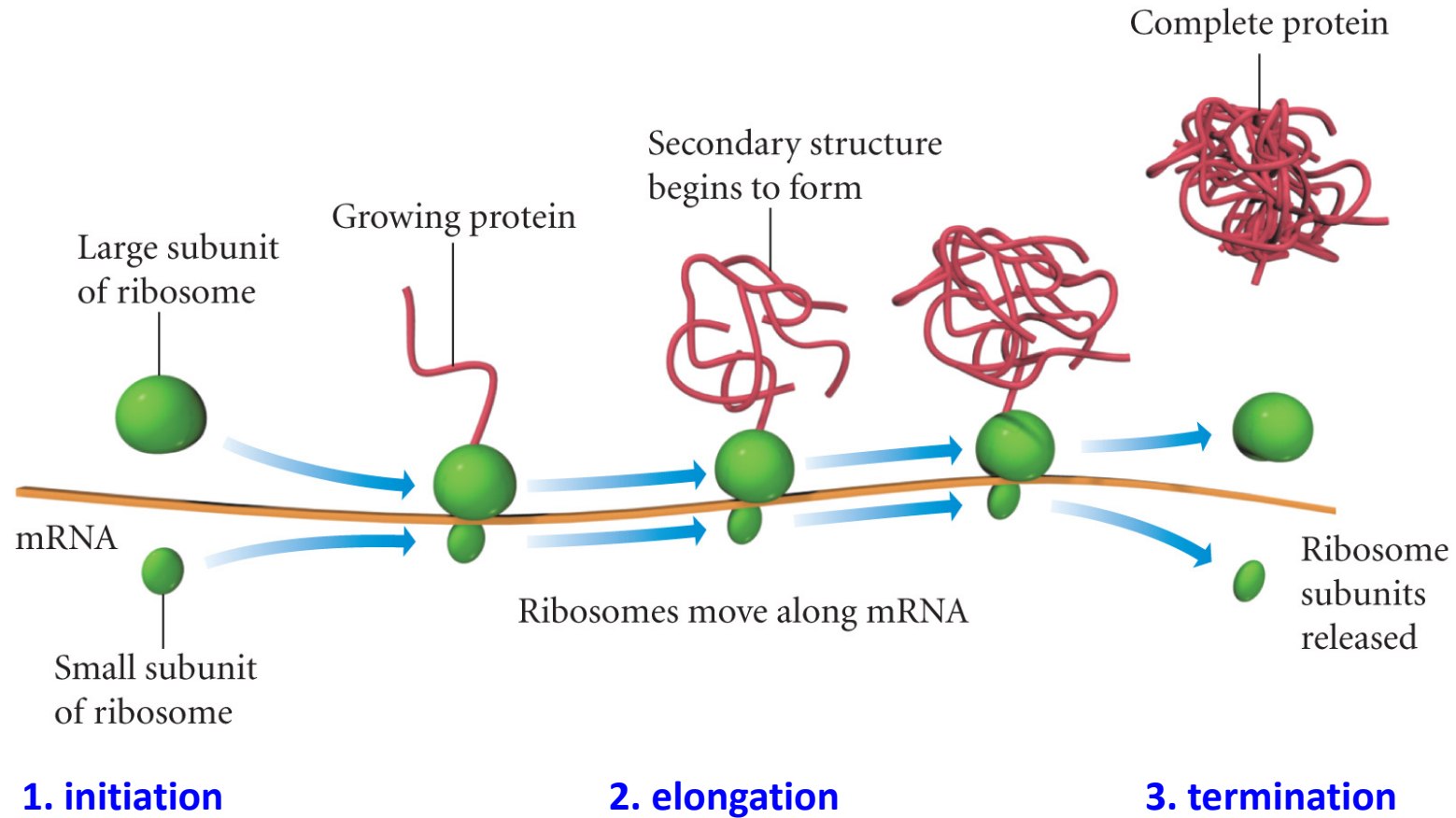
mARN
(messenger)

Scanning electron microscope

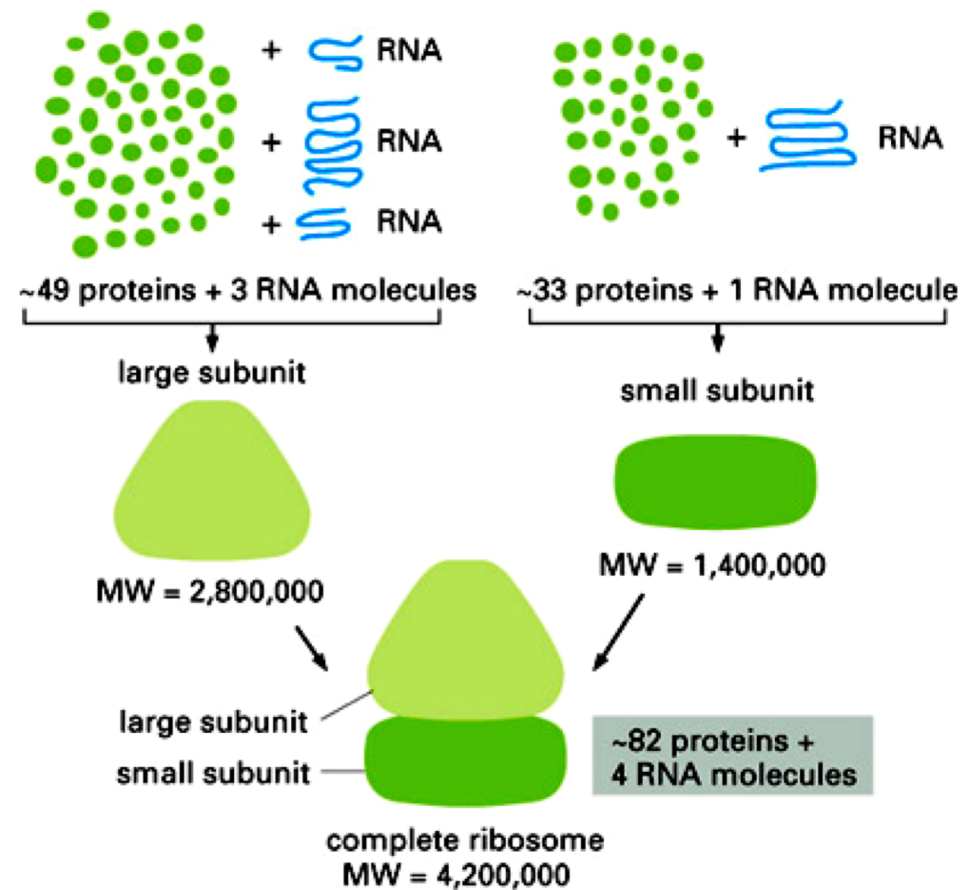


a **Synthèse de protéines** (MET, image colorisée).
On distingue les ribosomes en bleu, l'ARN messager en rose
et les protéines synthétisées en vert.

Translation



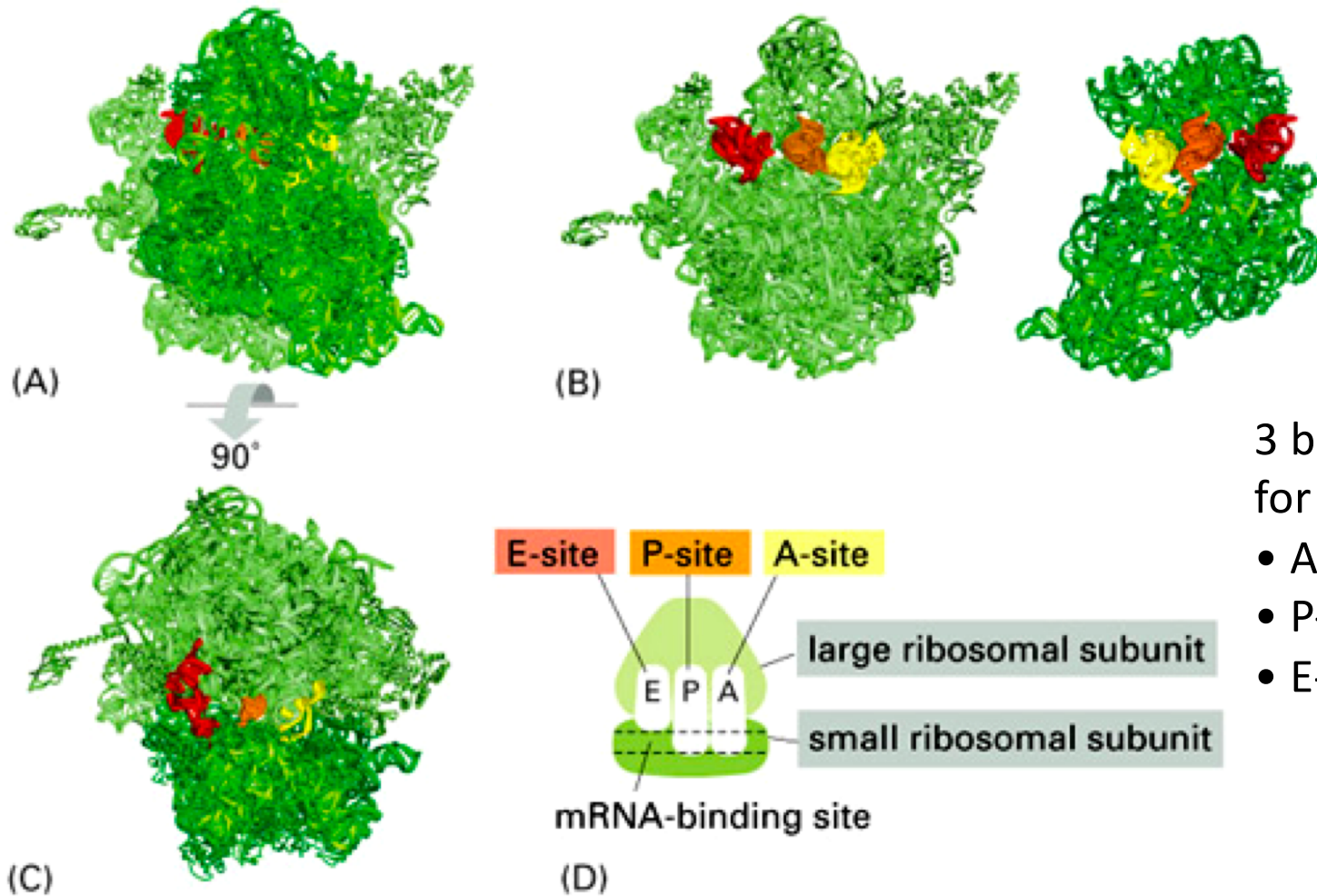
Ribosomes: made of rRNA and proteins



Eukaryotic ribosome

(prokaryotic ribosomes are similar but different enough to be specifically inhibited by **antibiotics**)

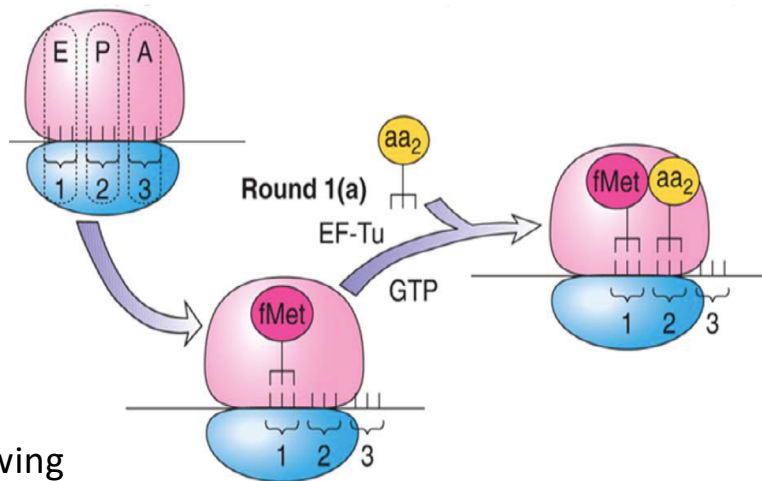
Eukaryotic ribosome



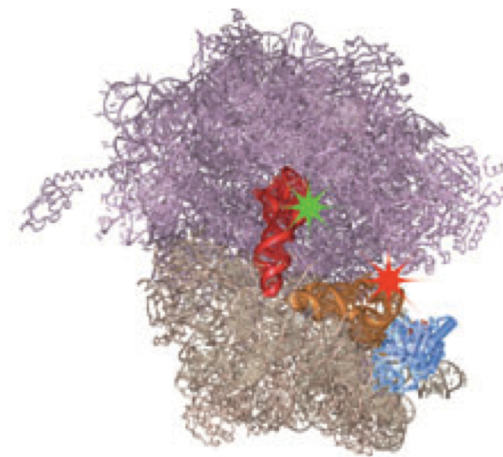
depicting
Mona Lisa



depicting
translation



Textbook drawing

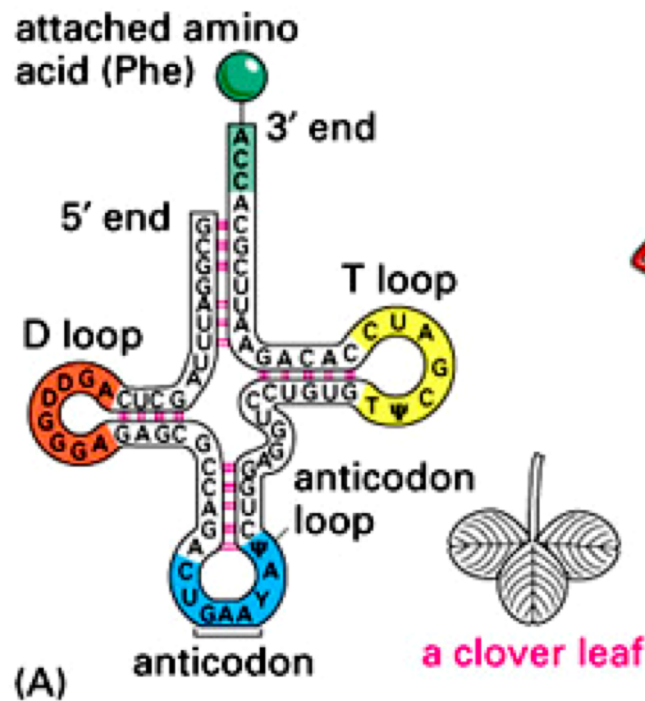


actual structure

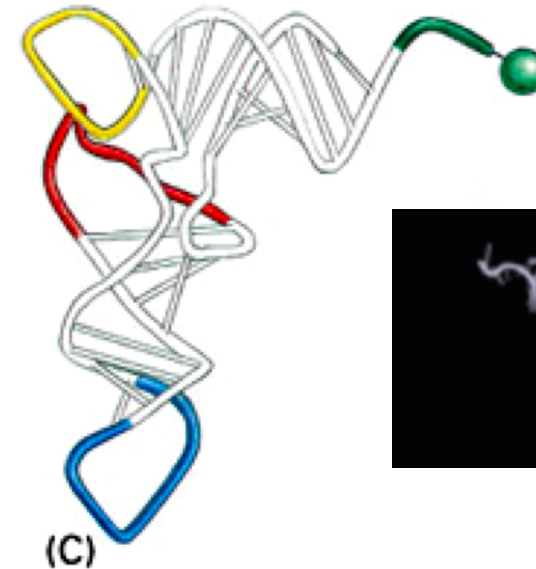
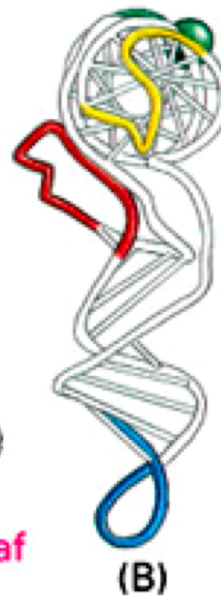
tRNA (transfer RNA): carrier of amino acids

Secondary structure

base pairing



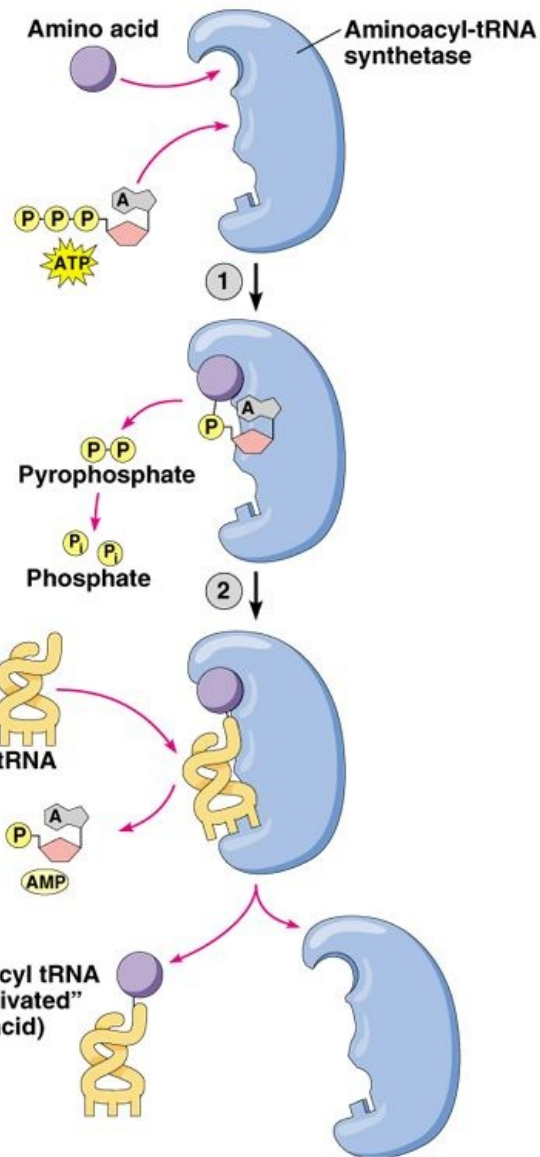
Tertiary structure



Primary structure



There are unusual bases : ψ , D , I



Attaching a specific amino acid
to a tARN

Only 1 enzyme
for a 2-step reaction

The accuracy of translation depends mainly on these enzymes.
There are 20 enzymes, one for each amino acid.

Energy :



Initiation of translation (in eukaryotes)

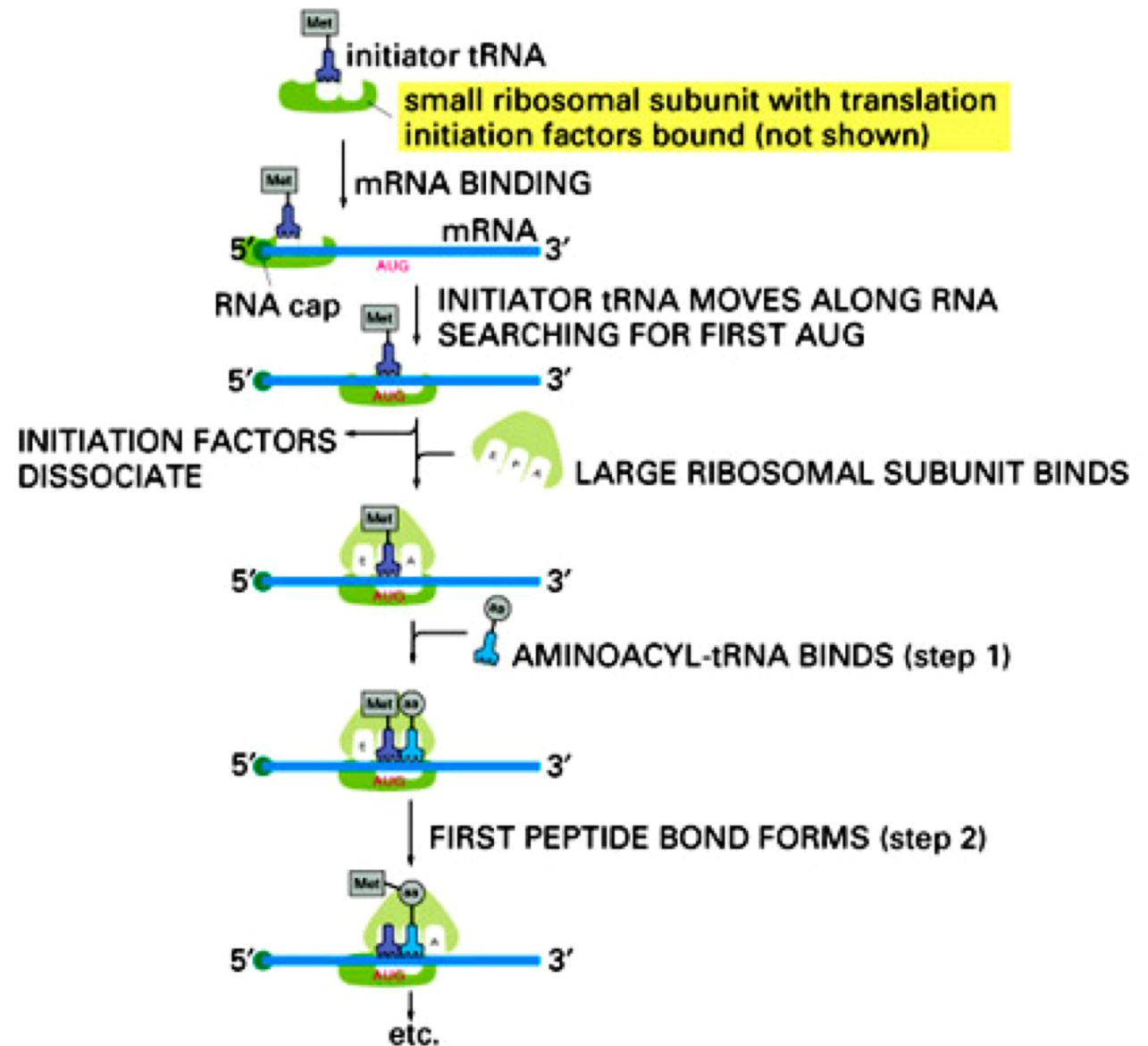
→ determines the **reading-frame**

1. small subunit + initiator tRNA
(with Met)

-> bind to cap

2. "scan" for first AUG
= Met

3. large subunit joins



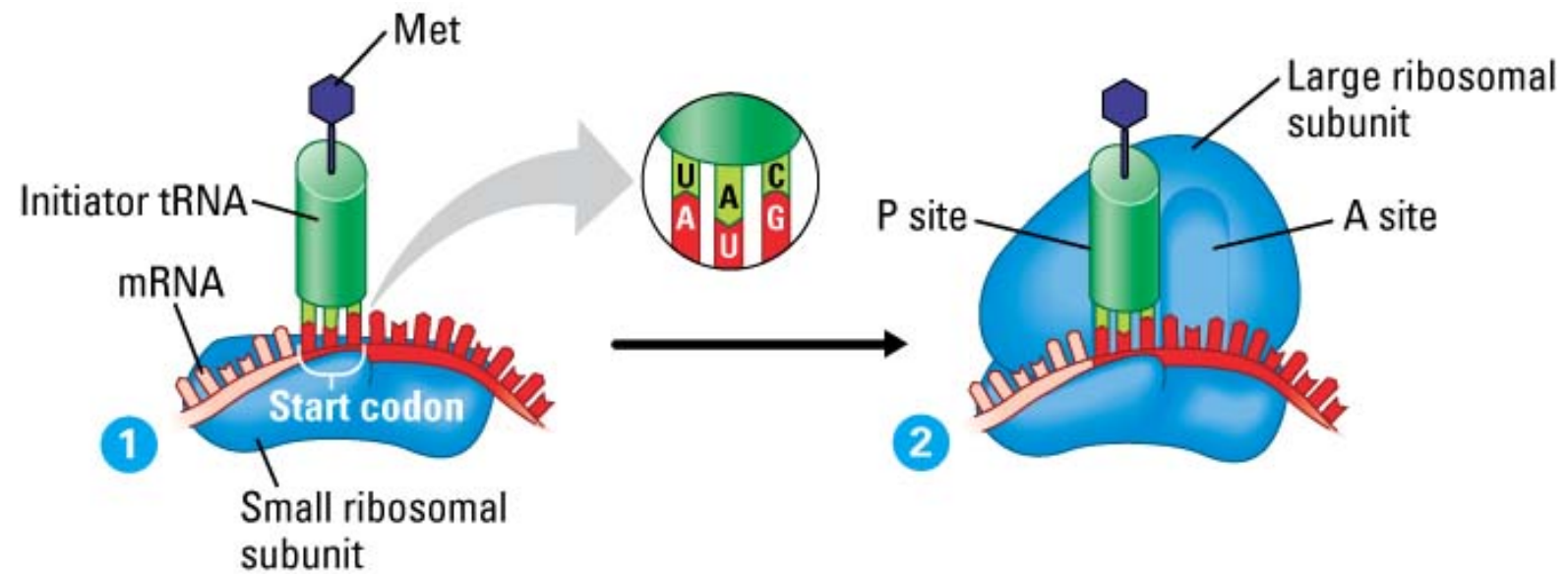


Figure 10.18 The initiation of translation

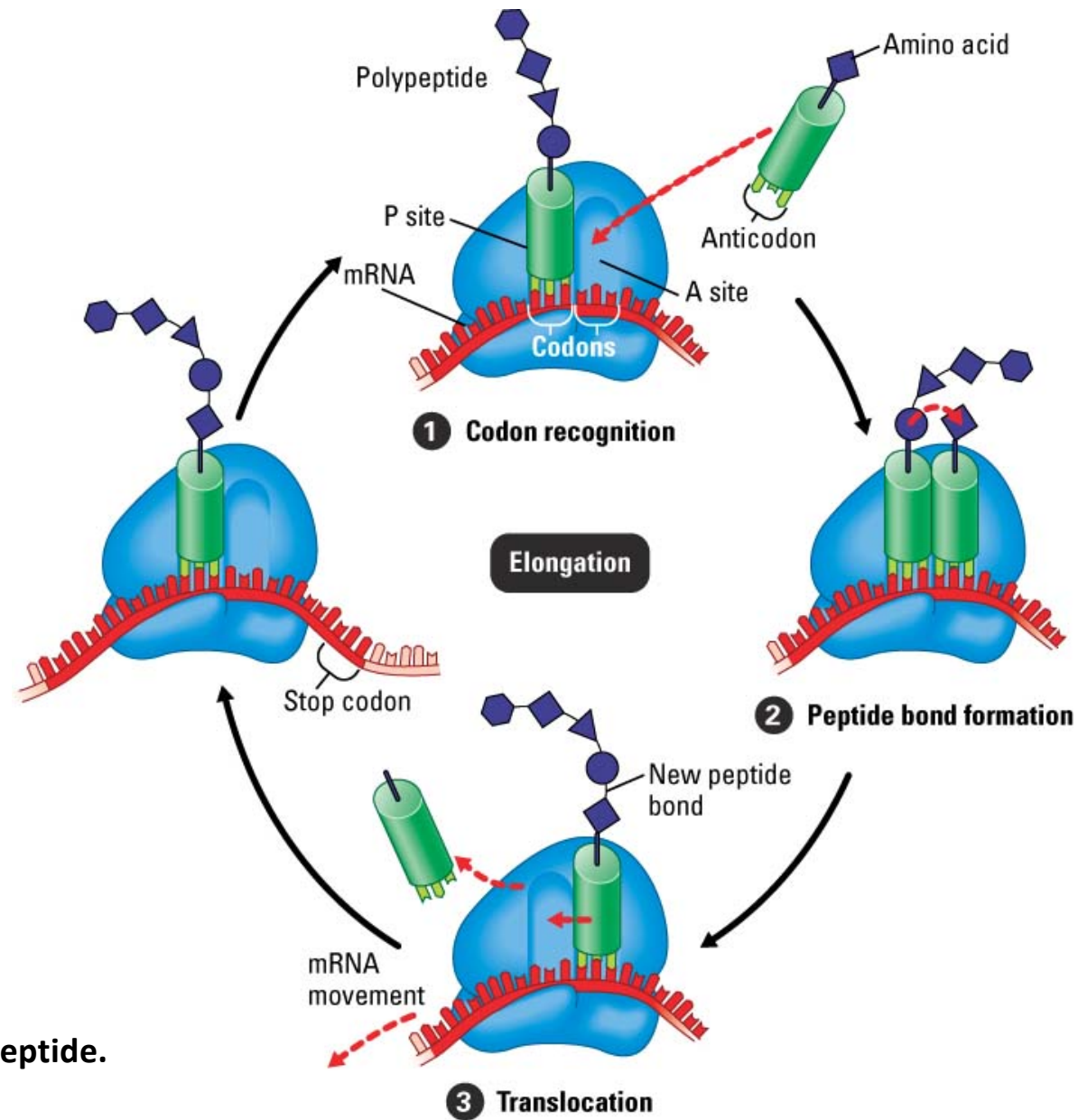
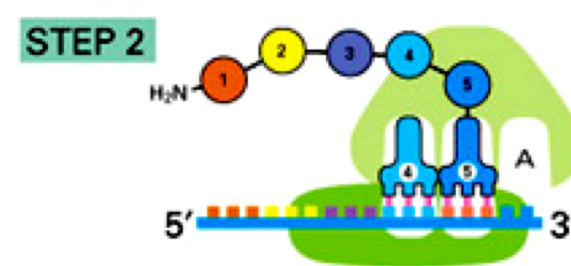
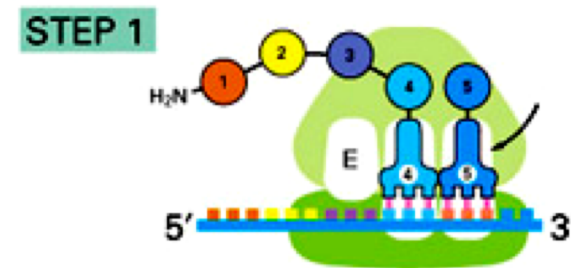
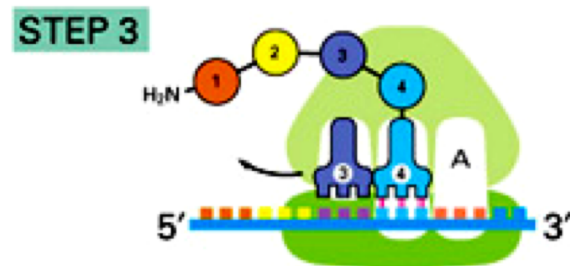
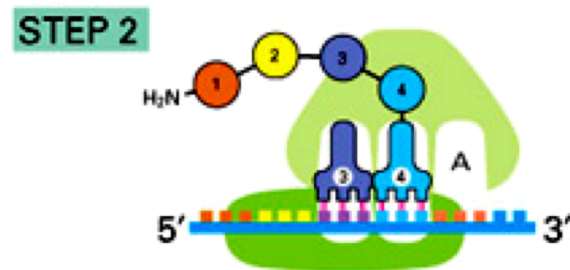
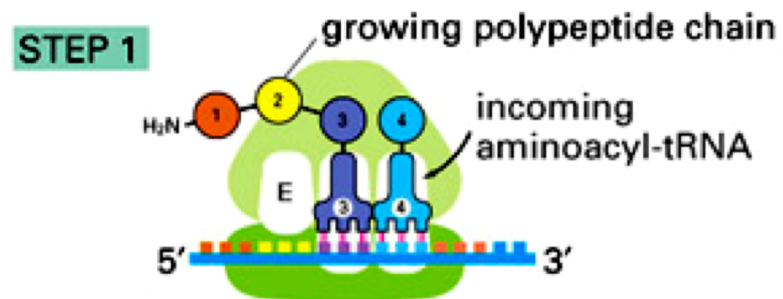


Figure 10.19
The elongation of a polypeptide.

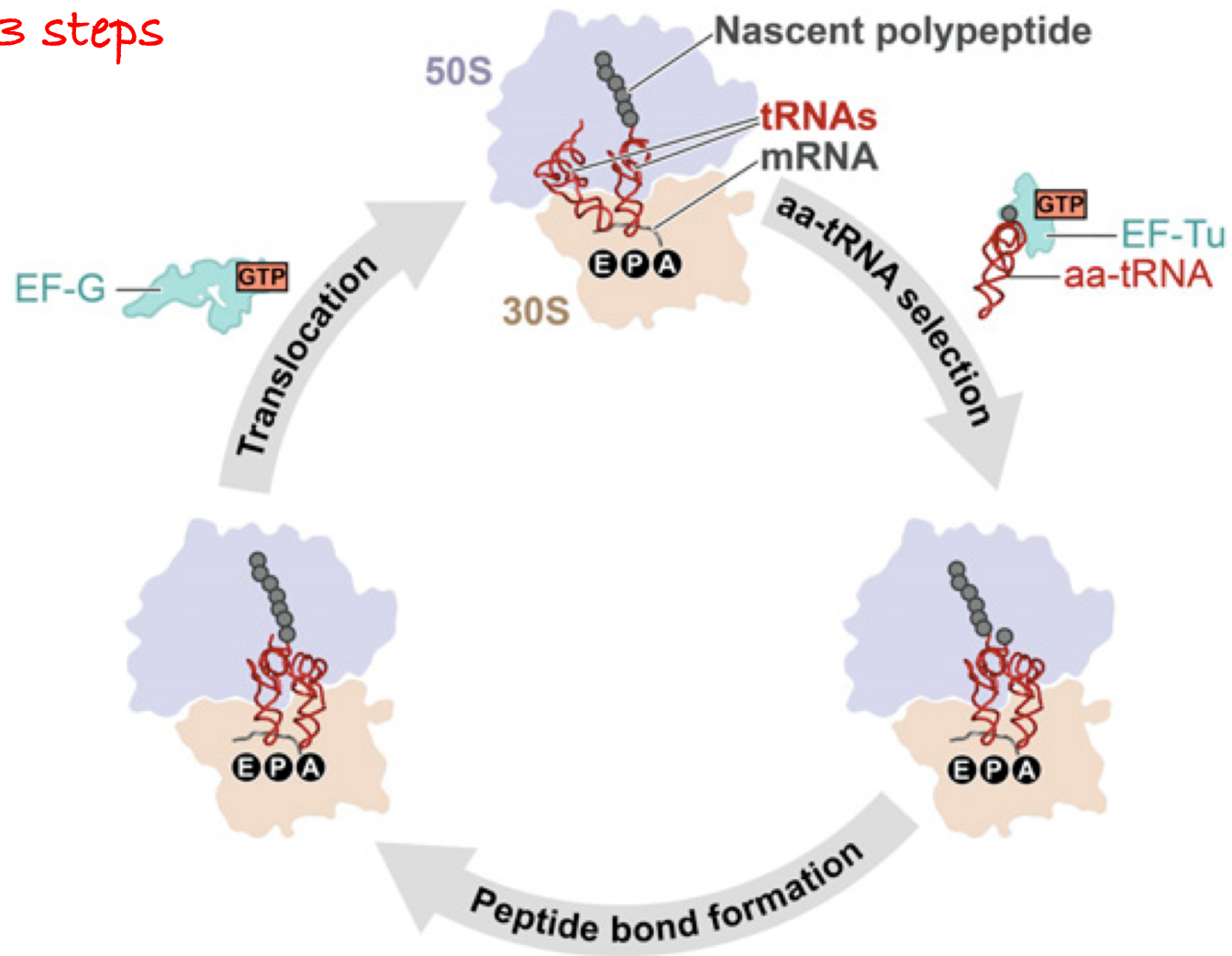
How do ribosomes and tRNA add amino acids during translation?

Translation : elongation



One elongation cycle :

3 steps



Elongation : tRNAs arrive bound to EF-Tu

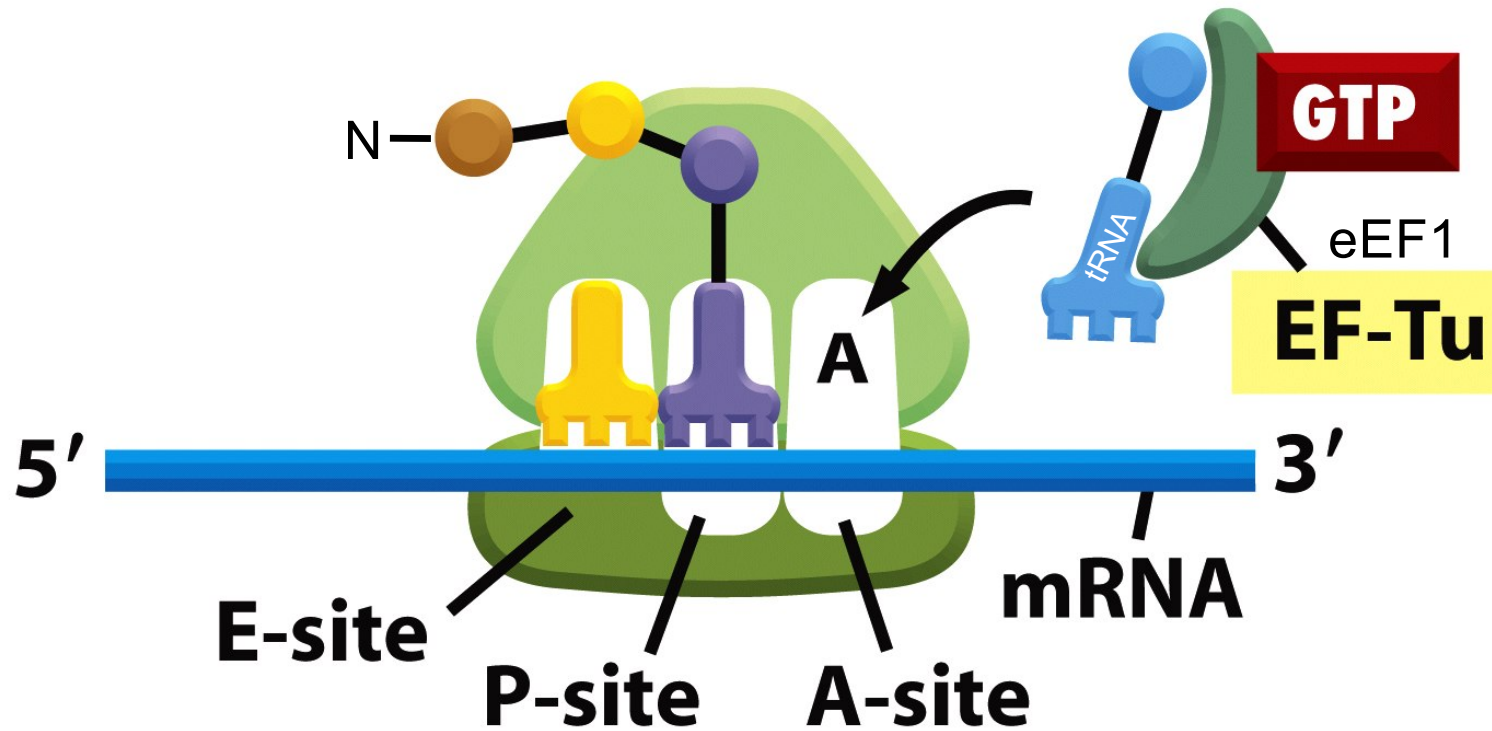


Figure 6-67 (part 1 of 7) *Molecular Biology of the Cell* (© Garland Science 2008)

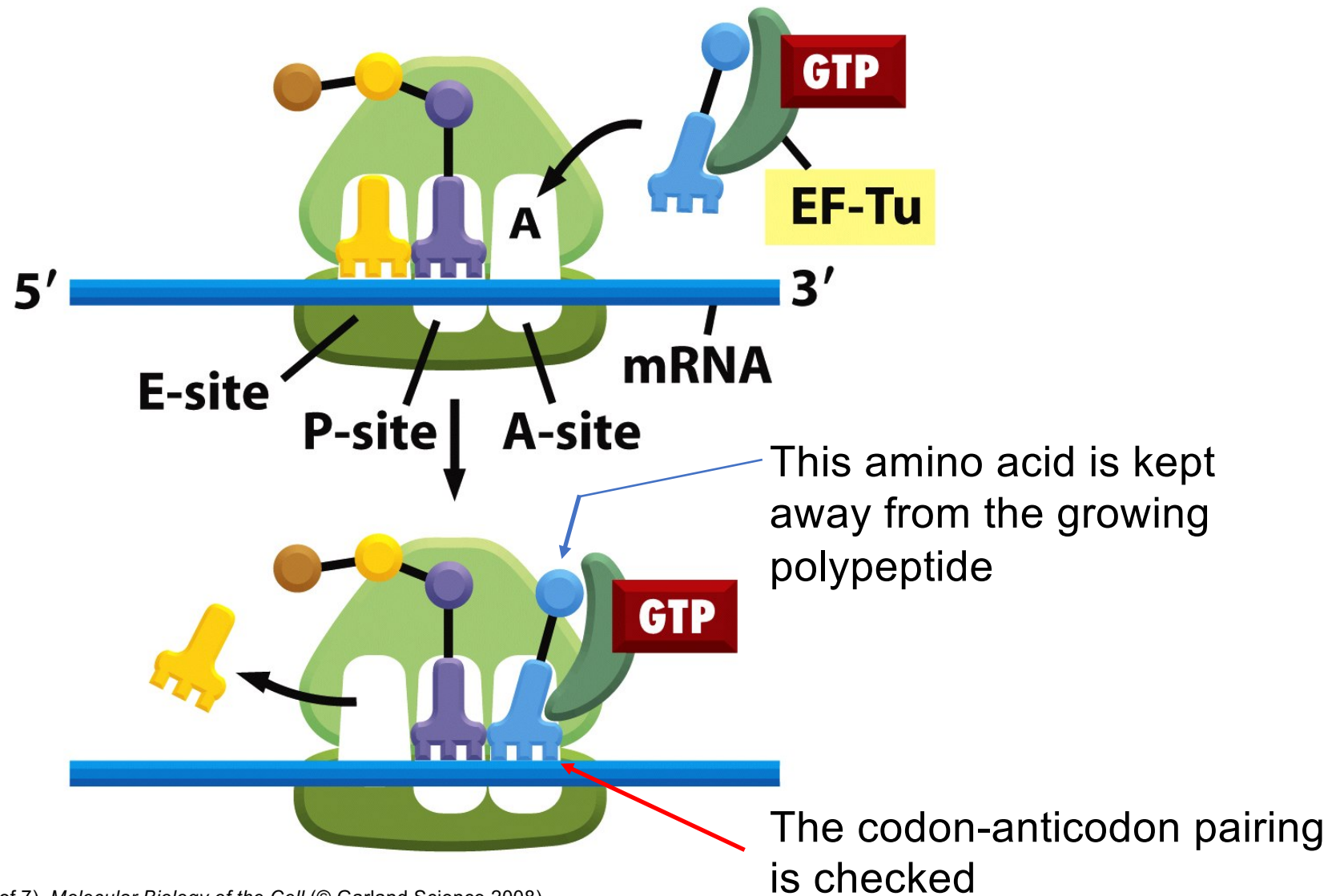
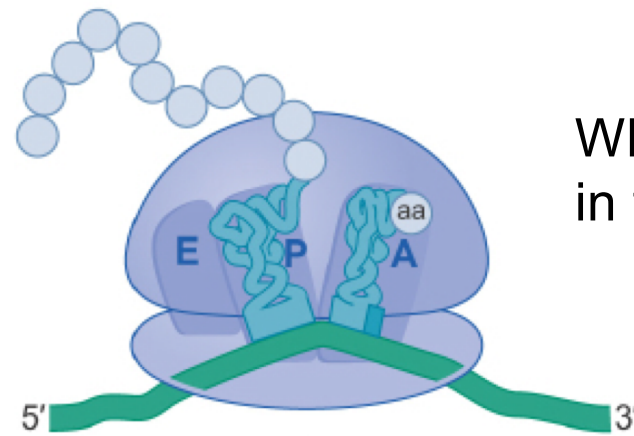
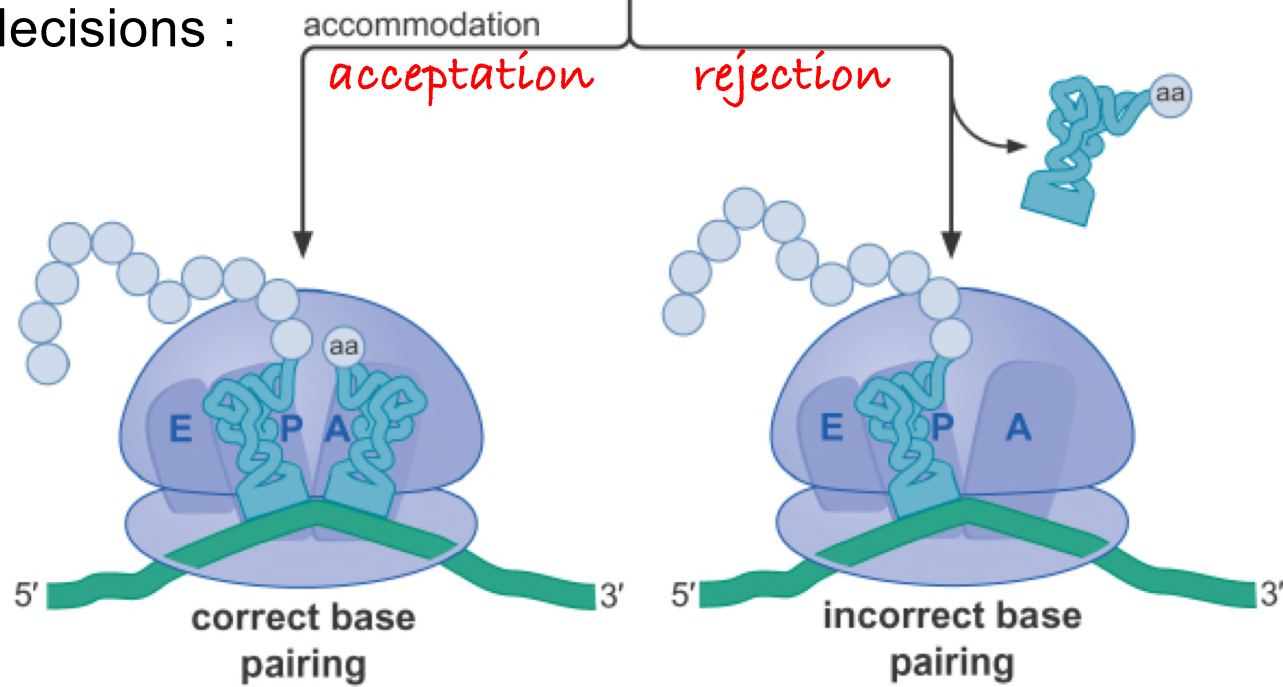


Figure 6-67 (part 2 of 7) *Molecular Biology of the Cell* (© Garland Science 2008)

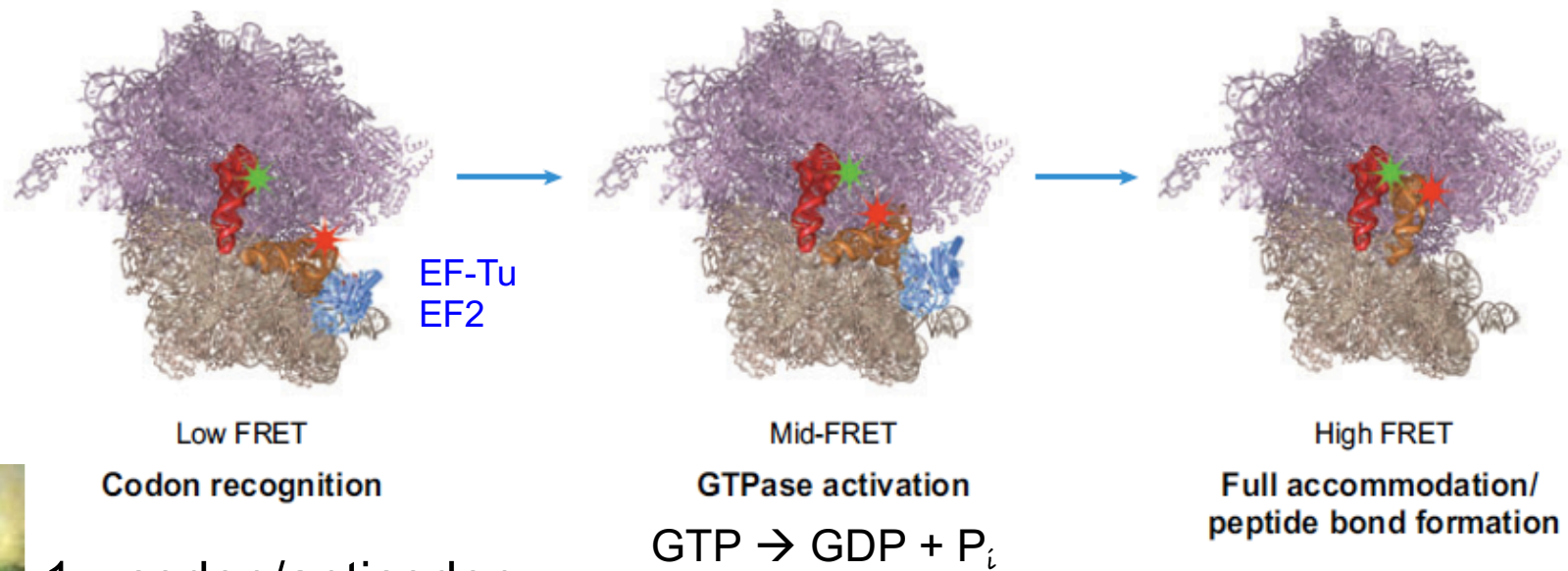


When a tRNA arrives
in the A site

Two possible decisions :



Note the position of the in-coming tRNA



1. codon/anticodon is checked



Marshall et al. Annu. Rev. Biochem. 2008.77:177-203.

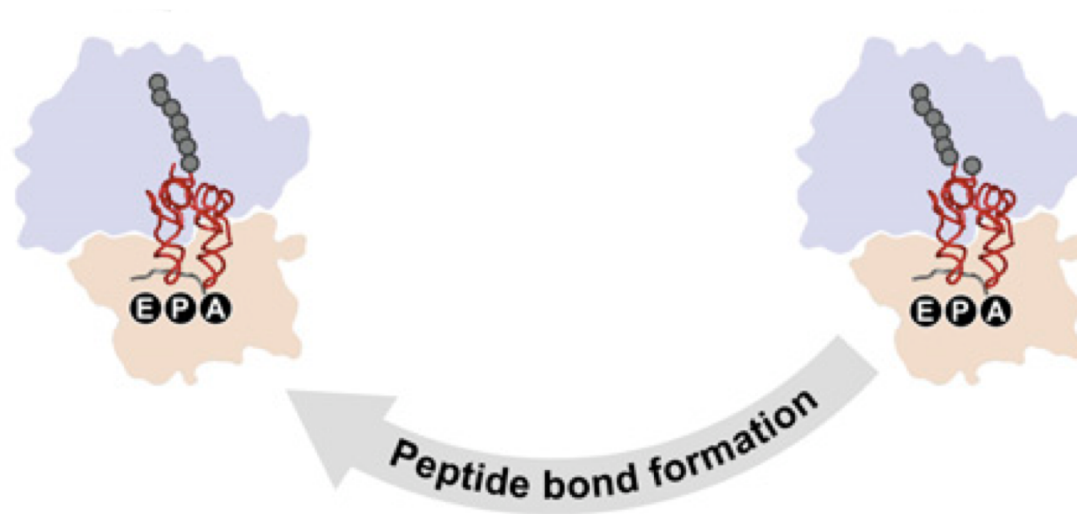
One elongation cycle :

3 steps

2. Formation of a peptide bound

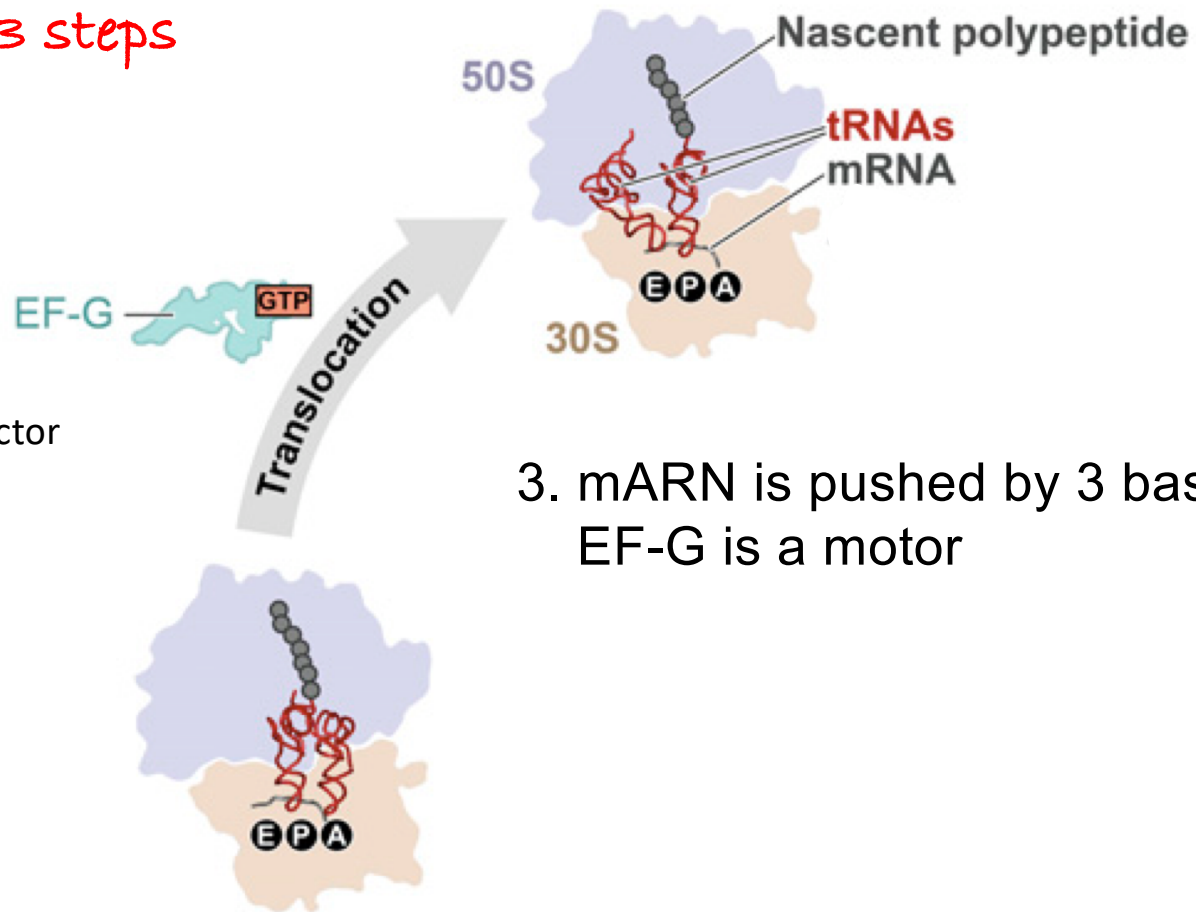
What about the energy ?

Is the reaction
exergonic
or
endergonic ?



One elongation cycle :

3 steps

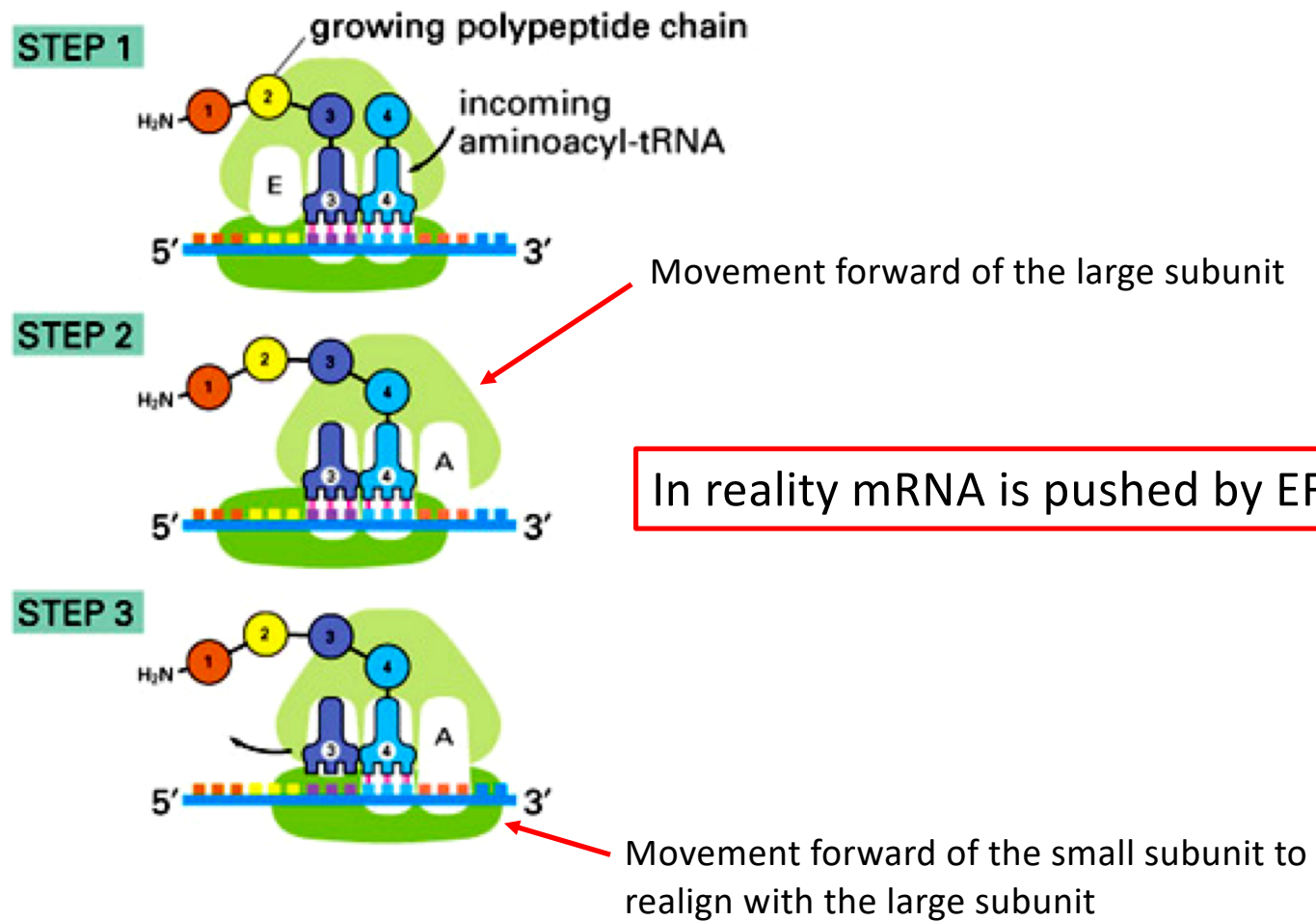


EF = Elongation Factor

3. mRNA is pushed by 3 bases
EF-G is a motor

Translocation :

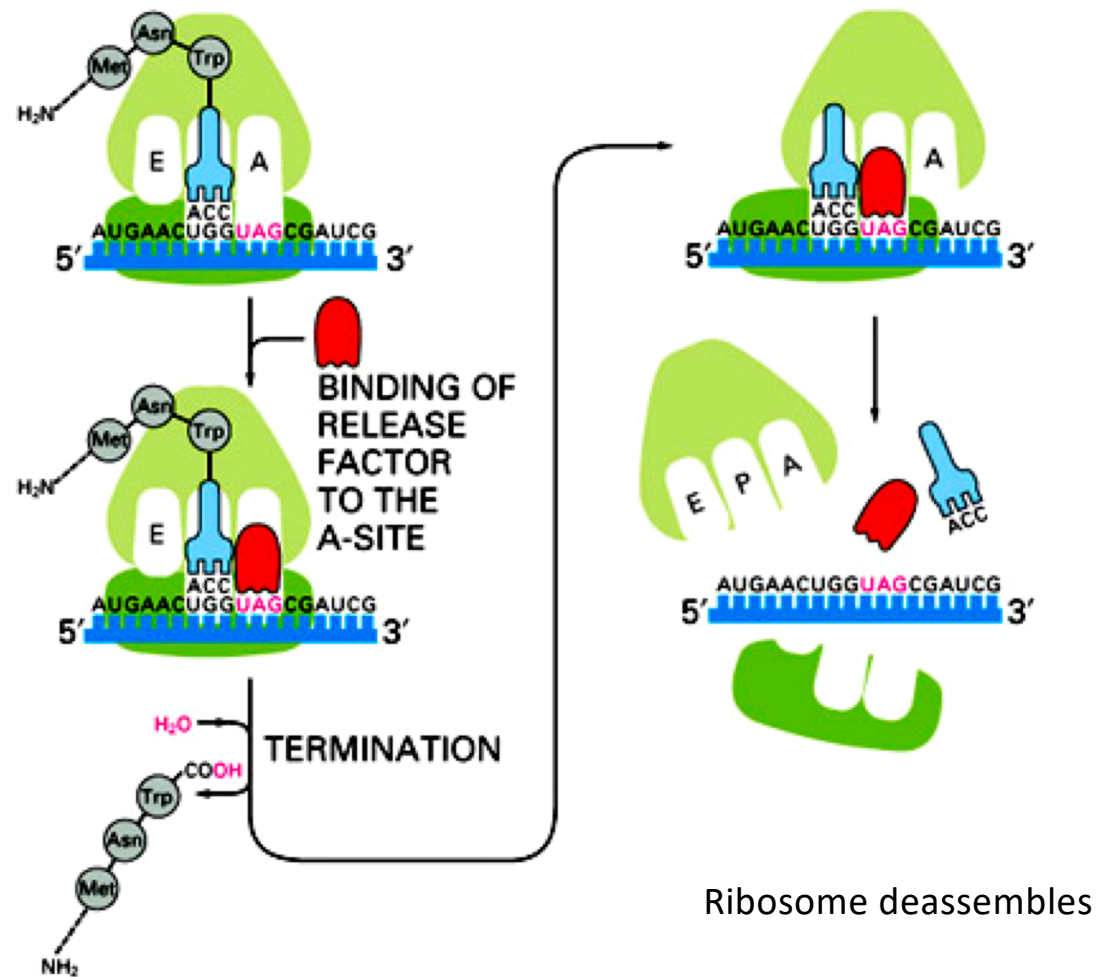
the model where the large subunit moves forward followed by movement of the small subunit is outdated.



Termination of translation

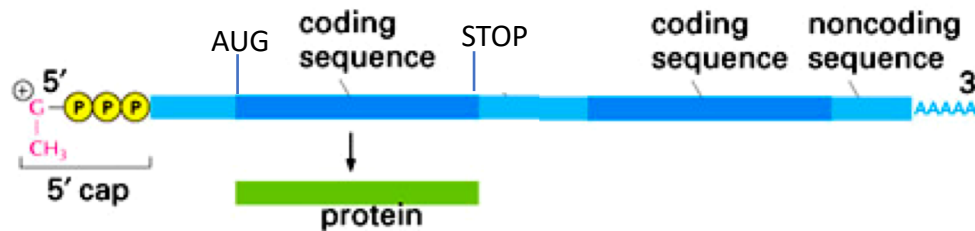
when ribosome reaches a stop-codon:

1. no complementary tRNA
2. release factors bind at A-site
3. detach and release polypeptide



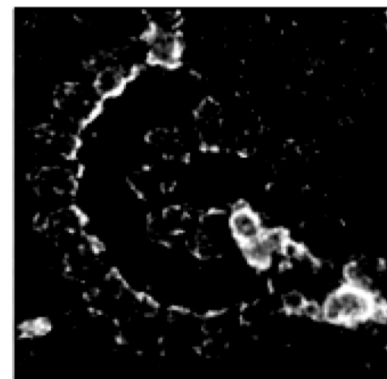
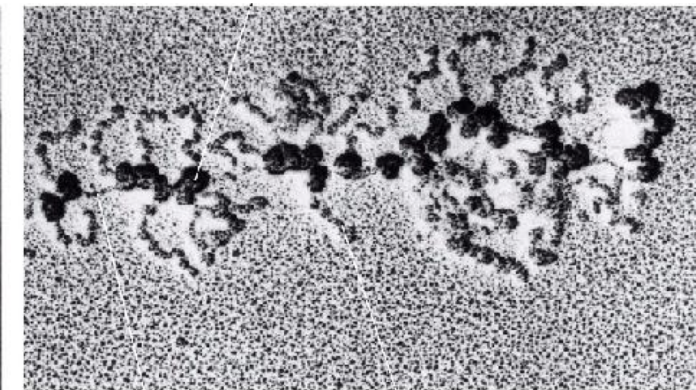
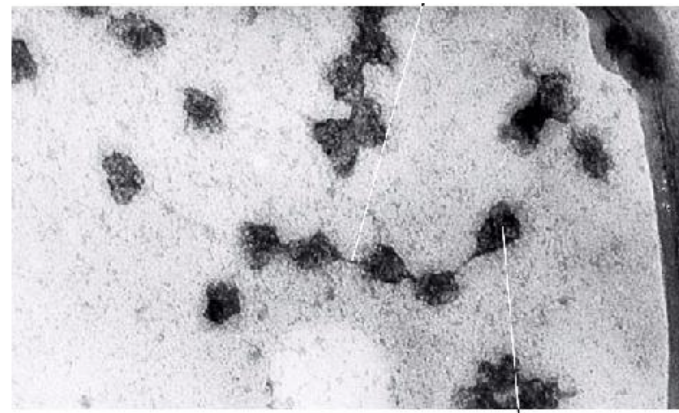
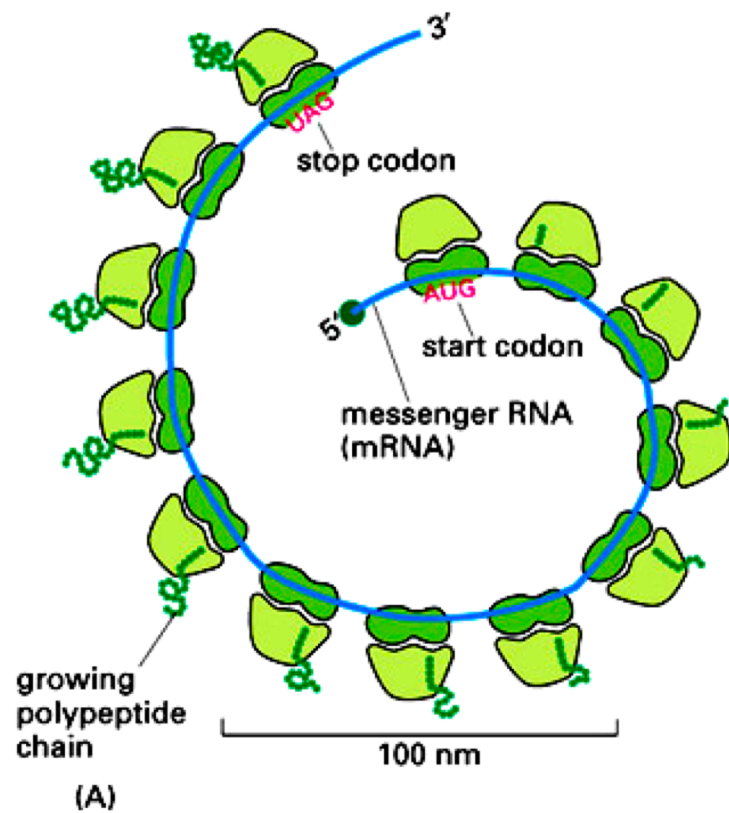
Eukaryotic messengers are monocistronic.

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



Now you should understand why only the first cistron is translated

Many ribosomes on a single mRNA



(B)

Ribosome

mRNA

Polypeptide chain