General Biology

Ch 10 and 11: The Structure and Function of DNA and How Genes are controlled

“Translation and Mutation”

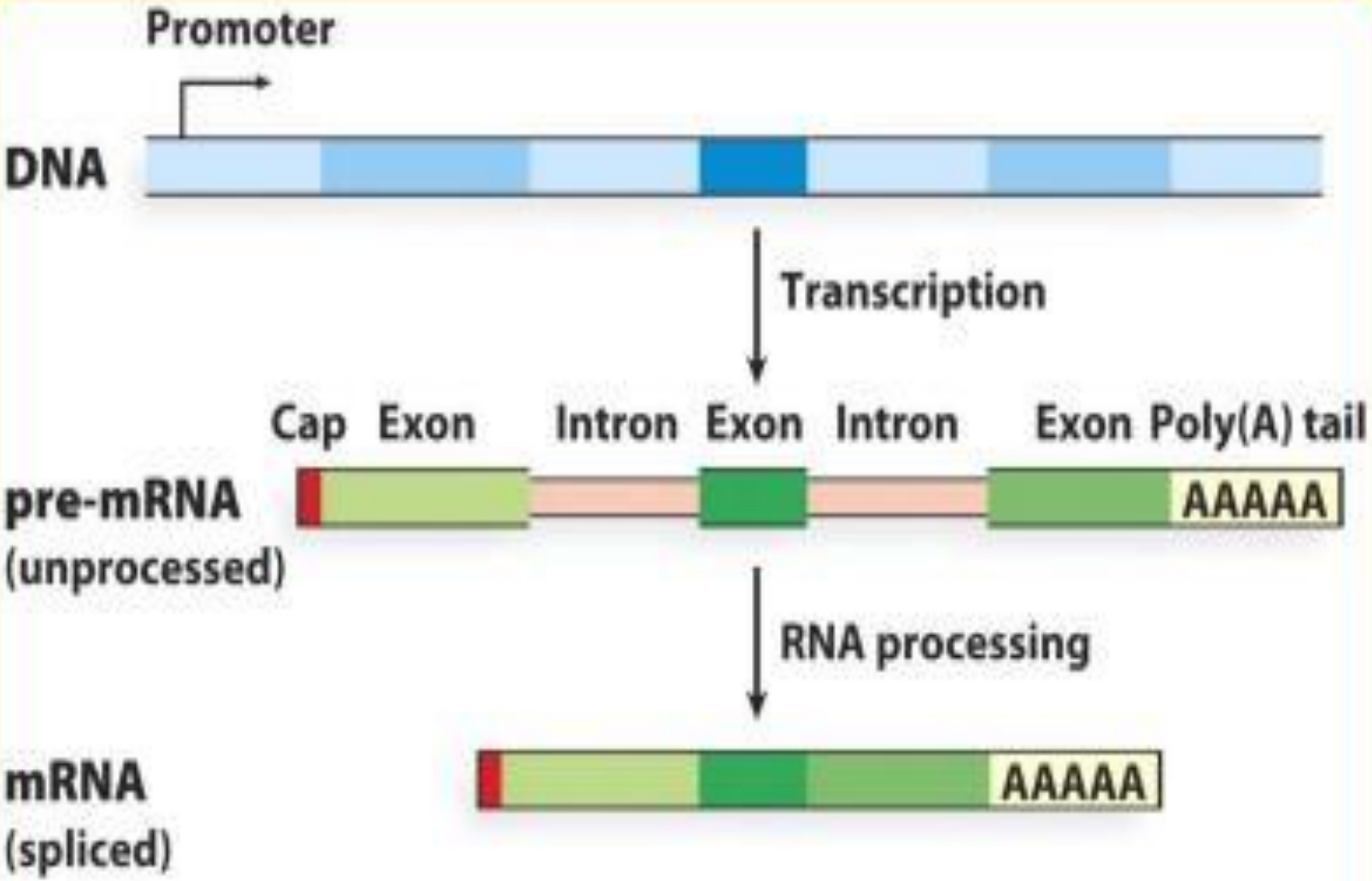
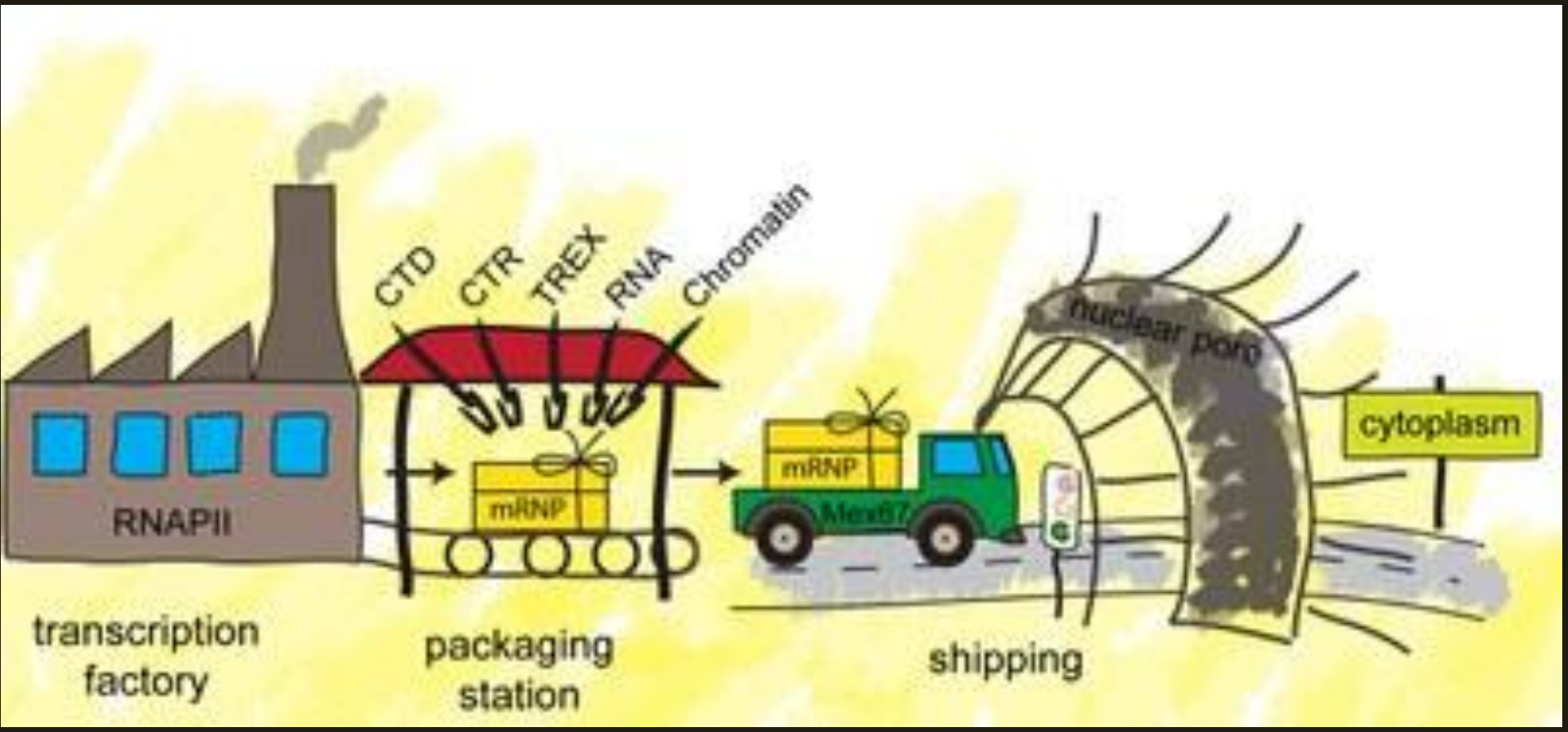


Figure 16-7
Molecular Biology: Principles and Practice

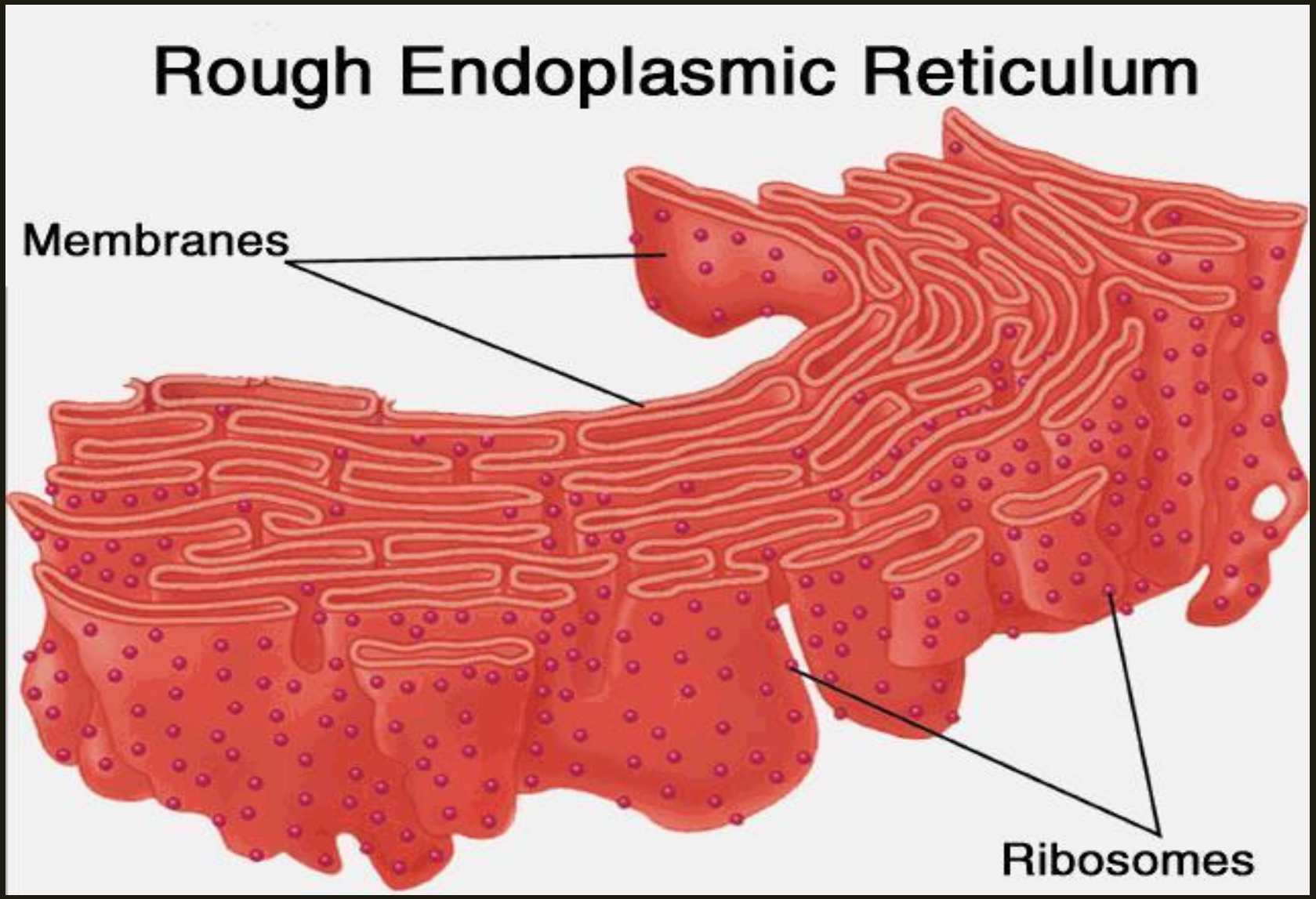
Food for thought!!!!

- What is the advantage of having introns?
- What happens to the introns after they are spliced off?
- Why do cells contain nucleases that chop off nucleotides from 5' or 3' end?
- Why do you think prokaryotic RNAs don't have a cap or tail?
- What are the so called 'junk' sequences in DNA?
- How can you regulate transcription?

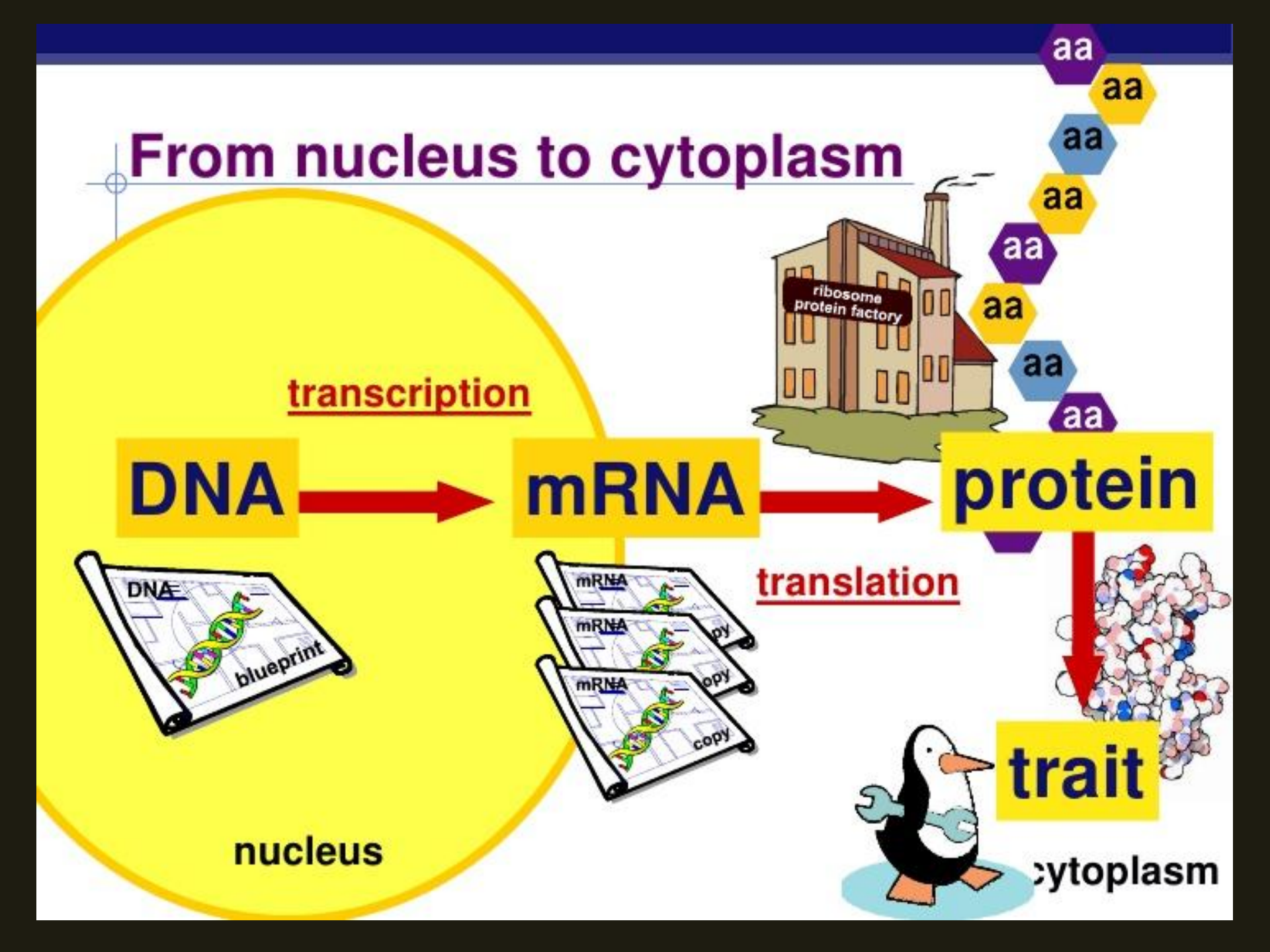
Eukaryotic or Prokaryotic cell?



The Destination

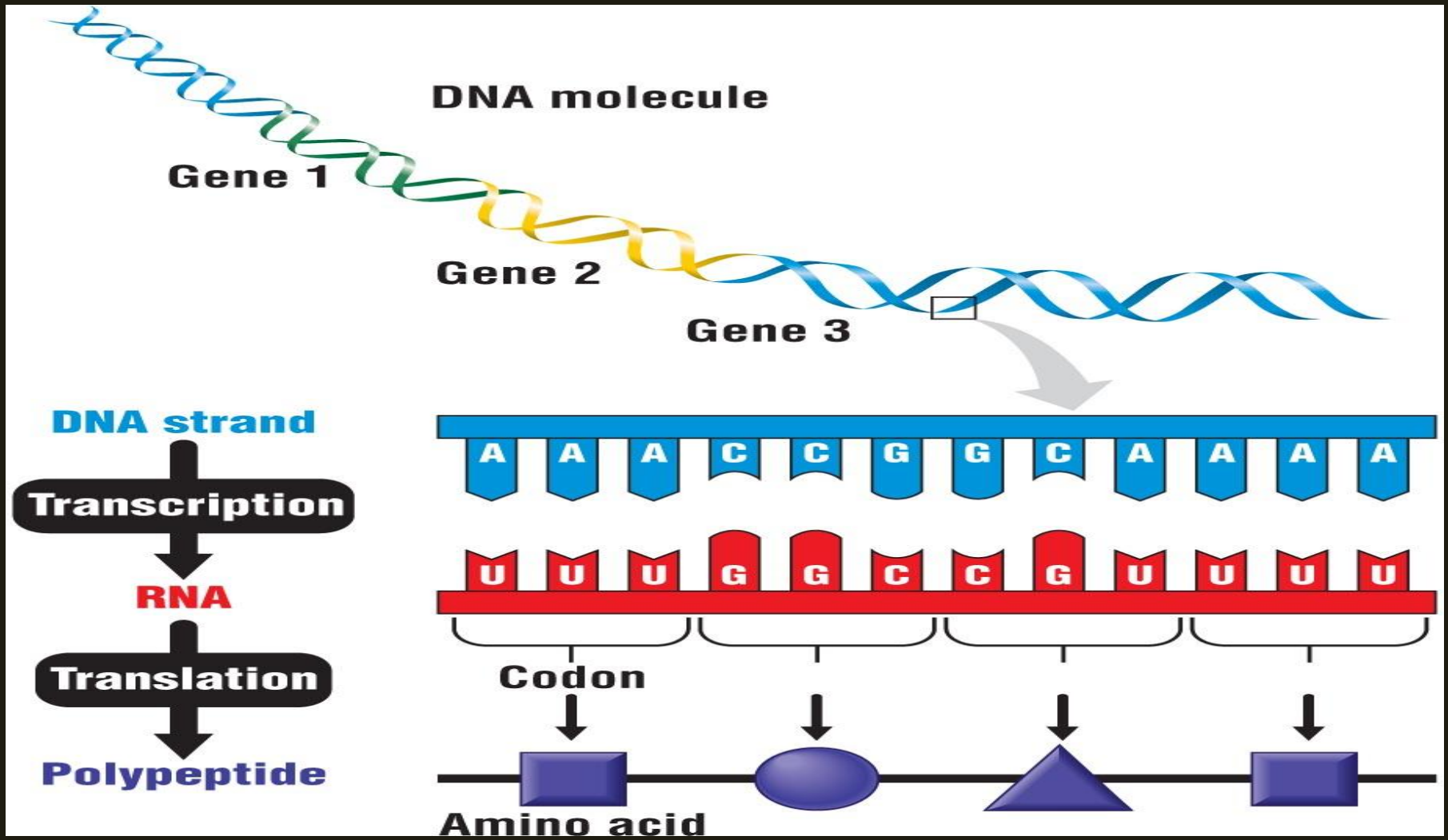


From nucleus to cytoplasm

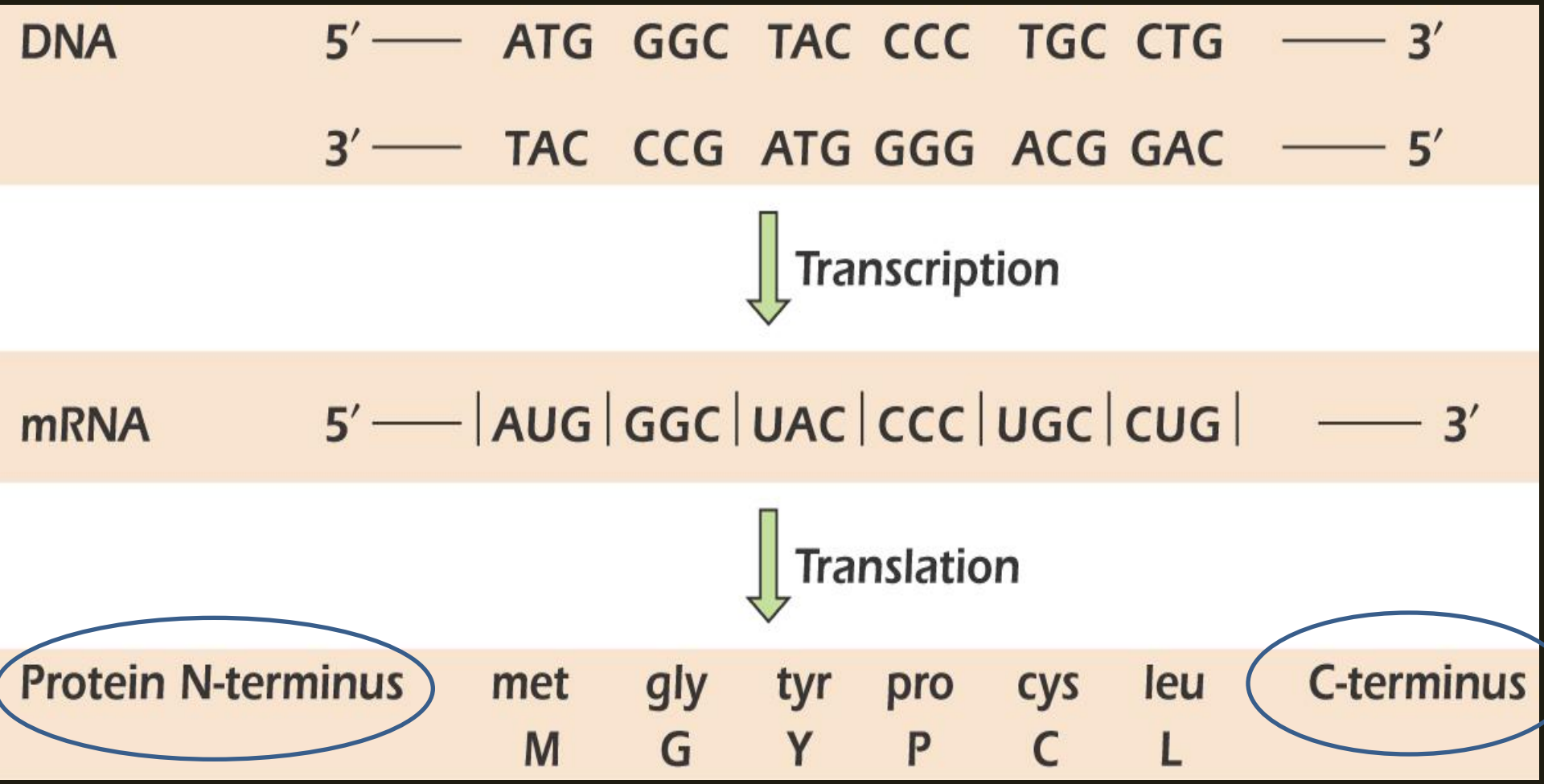



point of view.
Translation
another language;
language foreign to
written communica

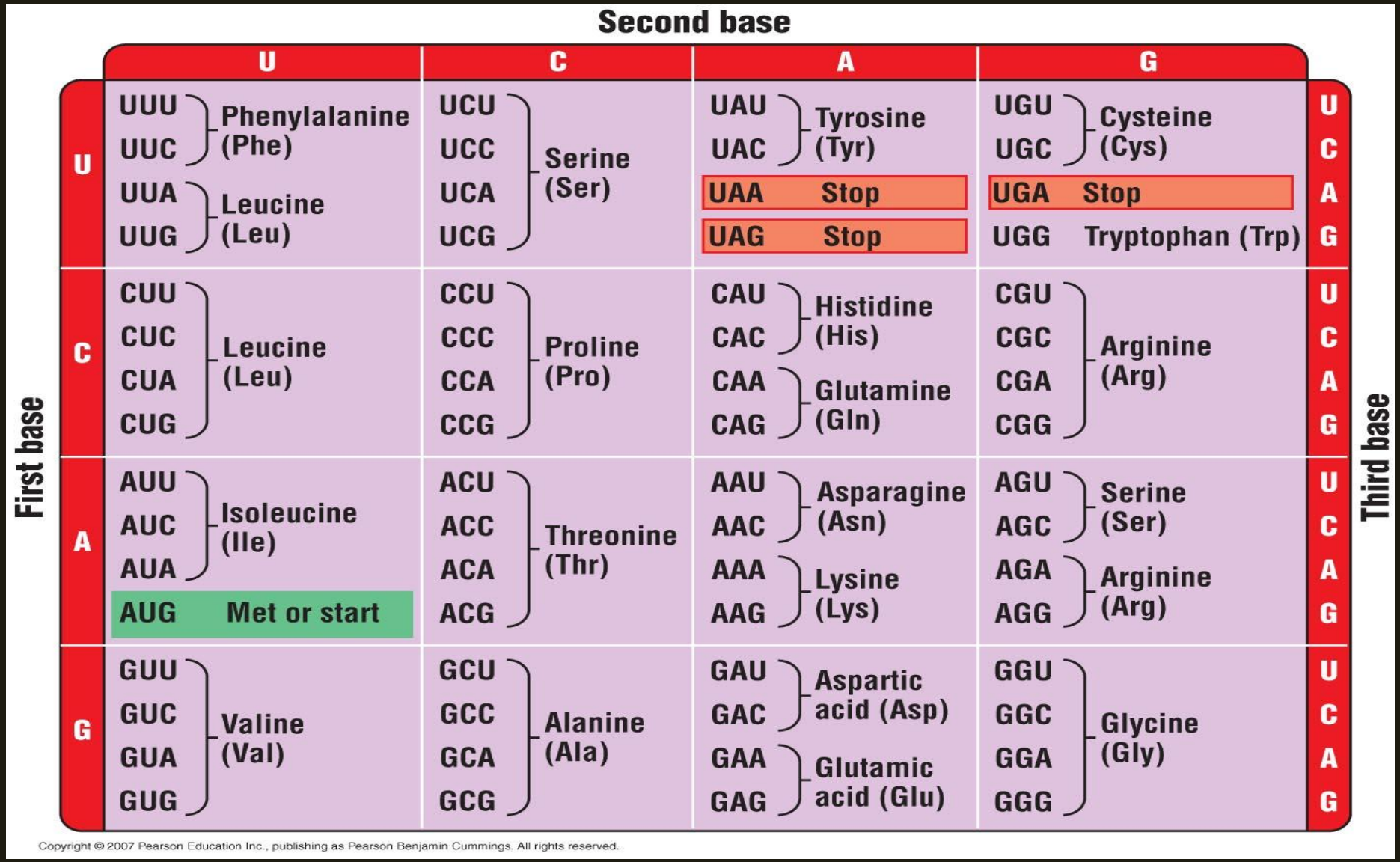
Protein Translation



Codons are triplets


DNA
5′ —— ATG GGC TAC CCC TGC CTG —— 3′
3′ —— TAC CCG ATG GGG ACG GAC —— 5′
Transcription
mRNA
5′ —— | AUG | GGC | UAC | CCC | UGC | CUG | —— 3′
Translation
Protein N-terminus
met gly tyr pro cys leu
M G Y P C L
C-terminus

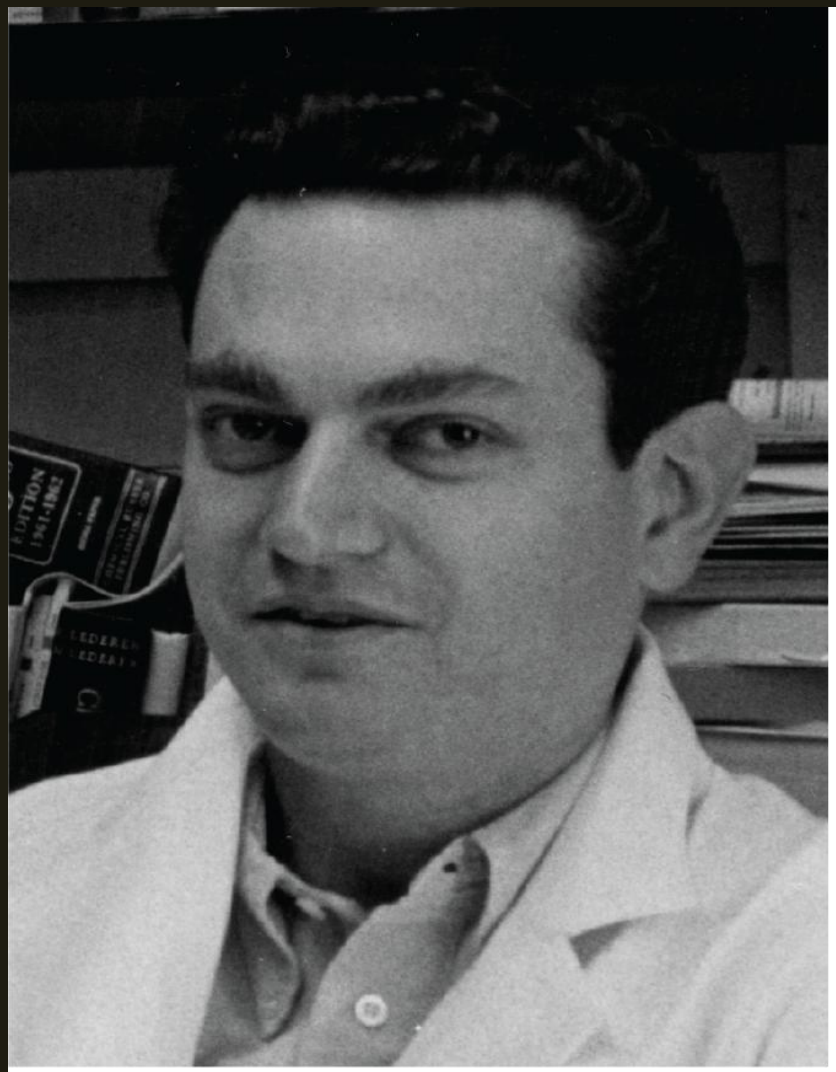
Deciphering the genetic code…



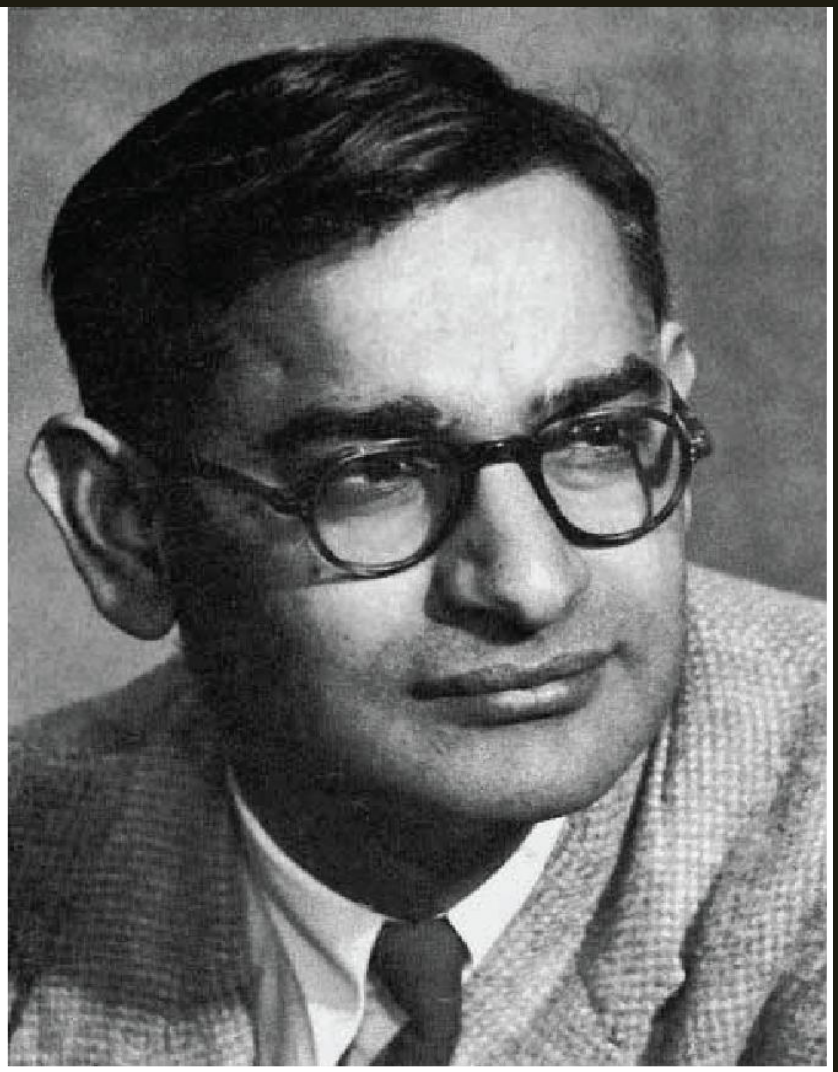
Note the start and stop codon (Nonsense codon)

Why codons constitute “3” nucleotides and not one or two?

The *Nobel* Prize in Physiology or Medicine 1968



Marshall Nirenberg



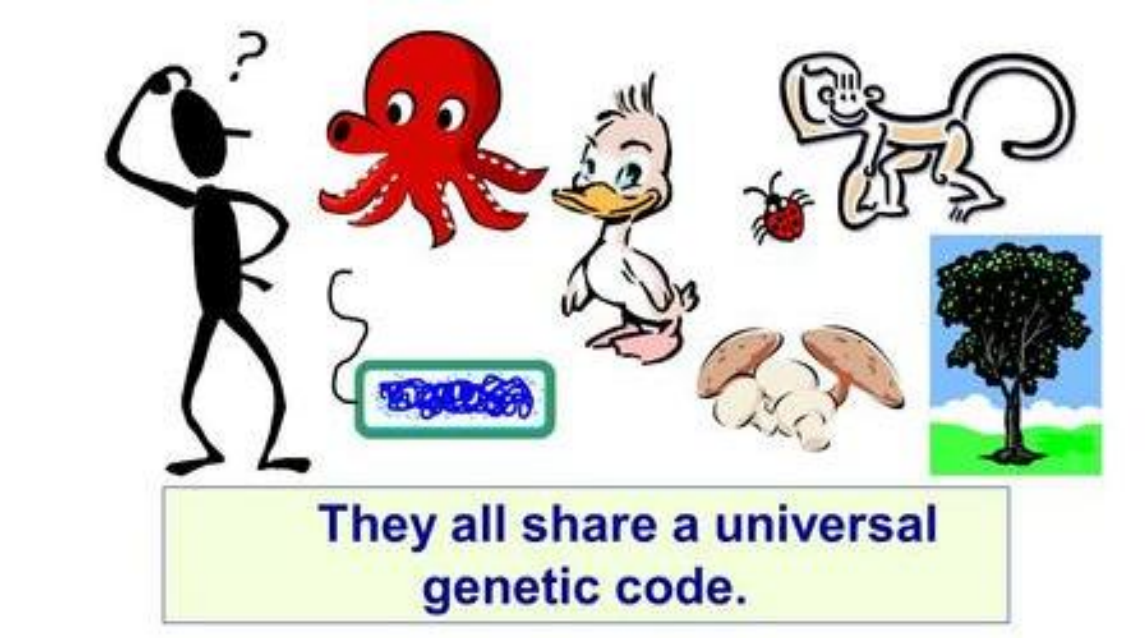
Har Gobind Khorana

Features of Genetic Code

The Genetic Code

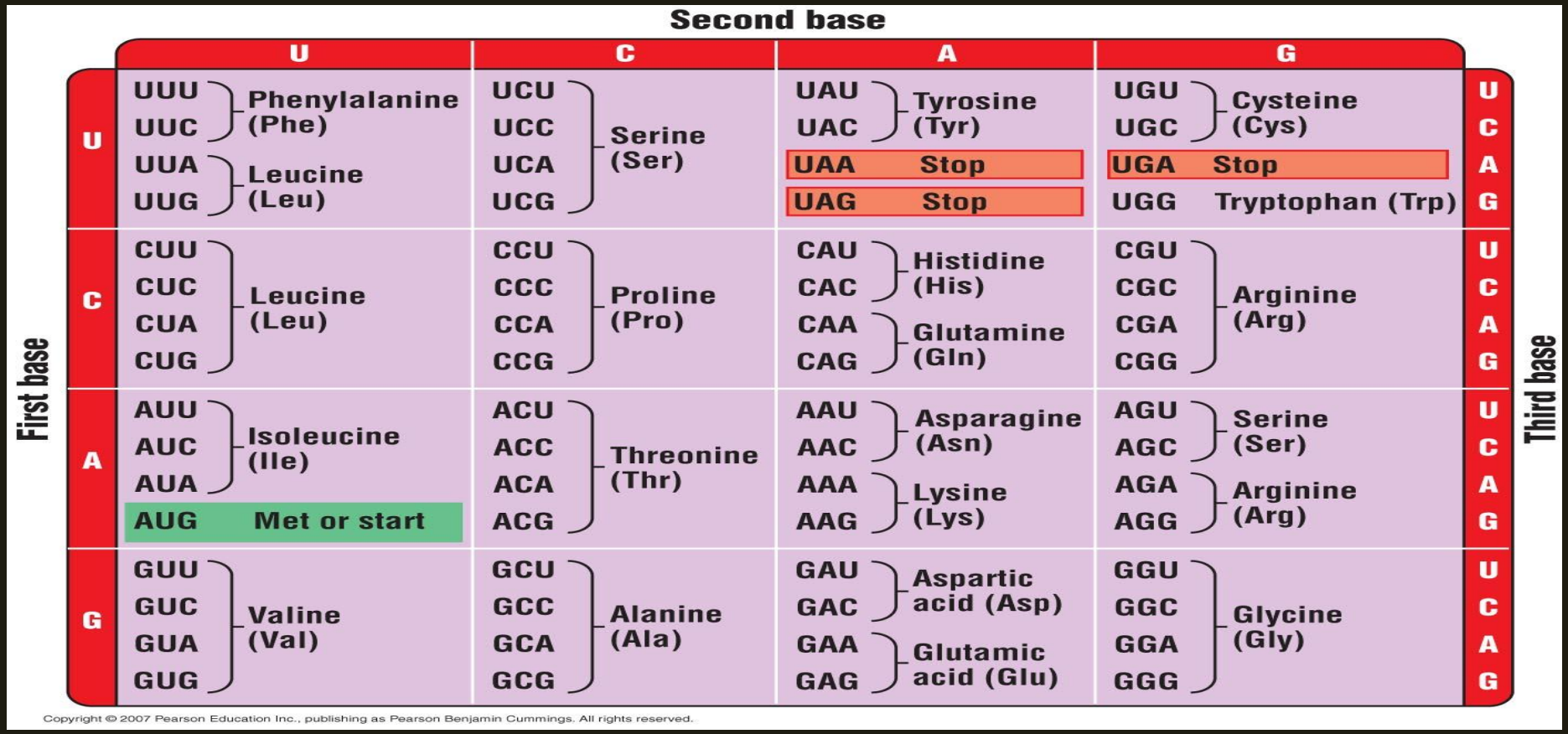
- How many codons combinations can you make from four bases?
- 64
- Of the 64 triplets,
  - 61 code for amino acids and
  - 3 are stop codons, instructing the ribosomes to end the polypeptide.
- A given RNA triplet always specifies a given amino acid.

The genetic code is universal, shared by organisms from the simplest bacteria to the most complex plants and animals!!!!



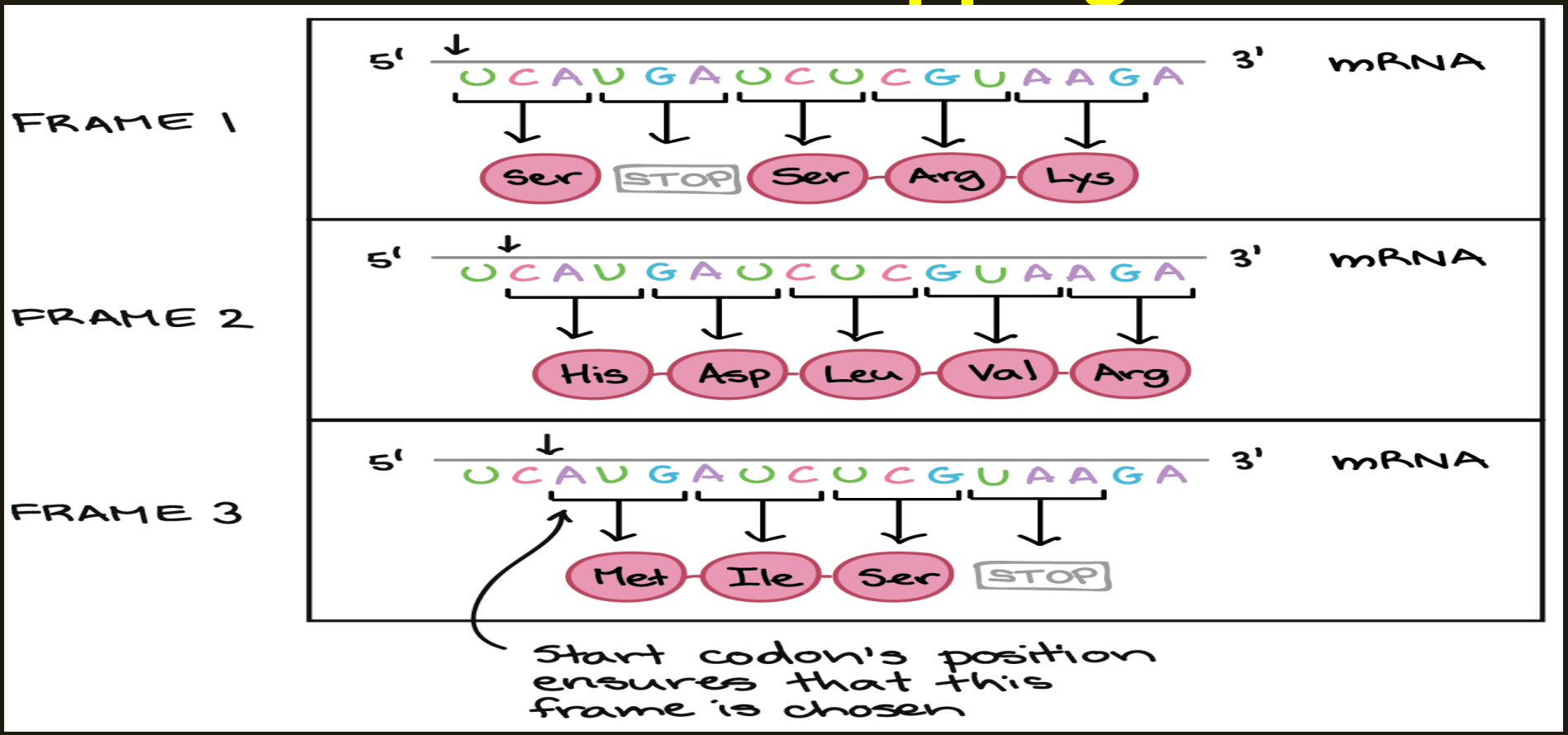
What can be its advantage to us?

Degeneracy of the Genetic Code



Although each codon is specific for only one amino acid (or one stop signal), the genetic code is described as degenerate, or redundant, because a single amino acid may be coded for by more than one codon.

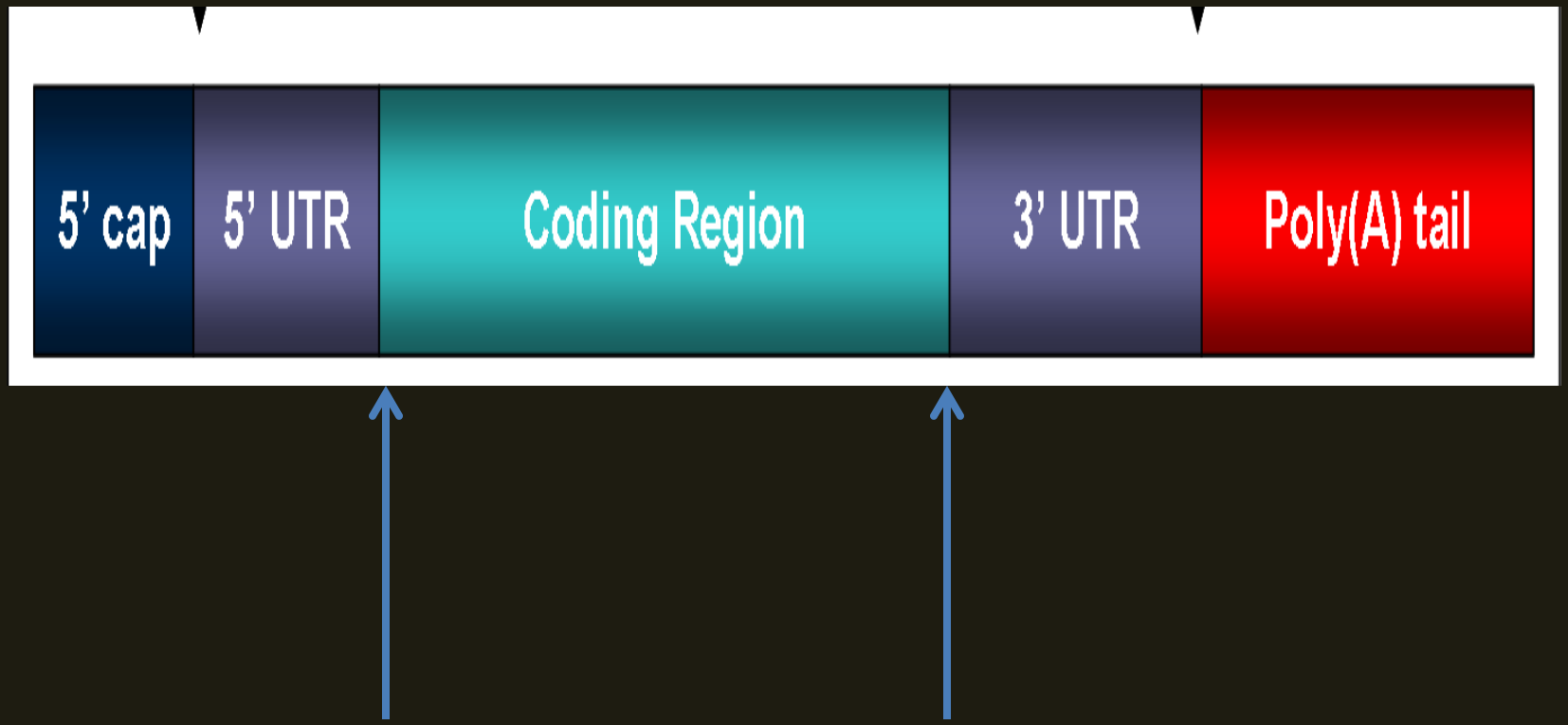
The Reading Frame: Genetic is non-overlapping



How does a cell know which of these protein to make?

How do you know where to start off……

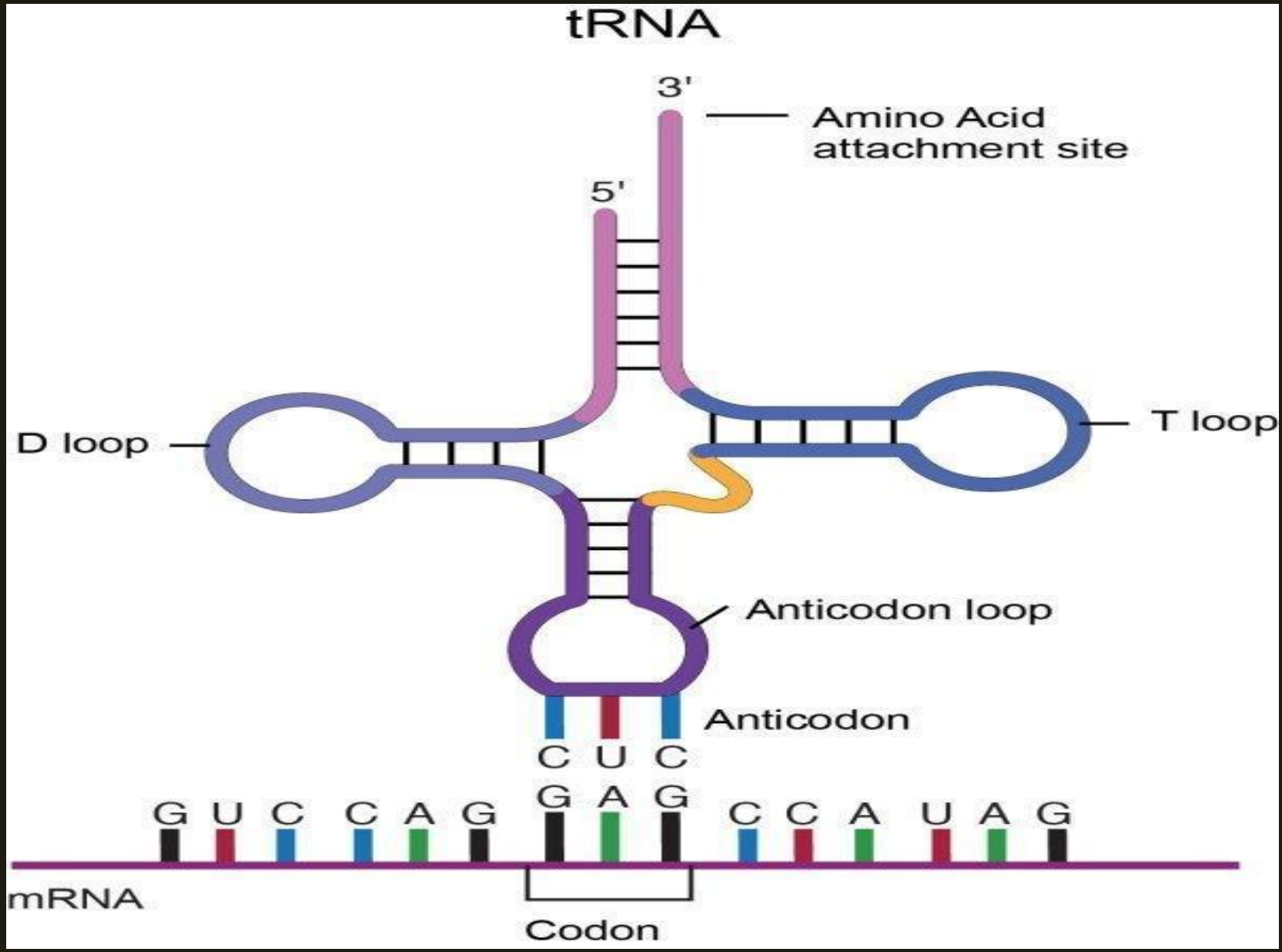
The Concept of UTR- Un-translated Region in mRNA



Translation: The Players

- Translation is a process of encoding protein from an mRNA.
- The ingredient required for translation
  - mRNA produced by transcription.
  - ribosomes and
  - transfer RNA
  - enzymes and
  - sources of chemical energy, such as ATP

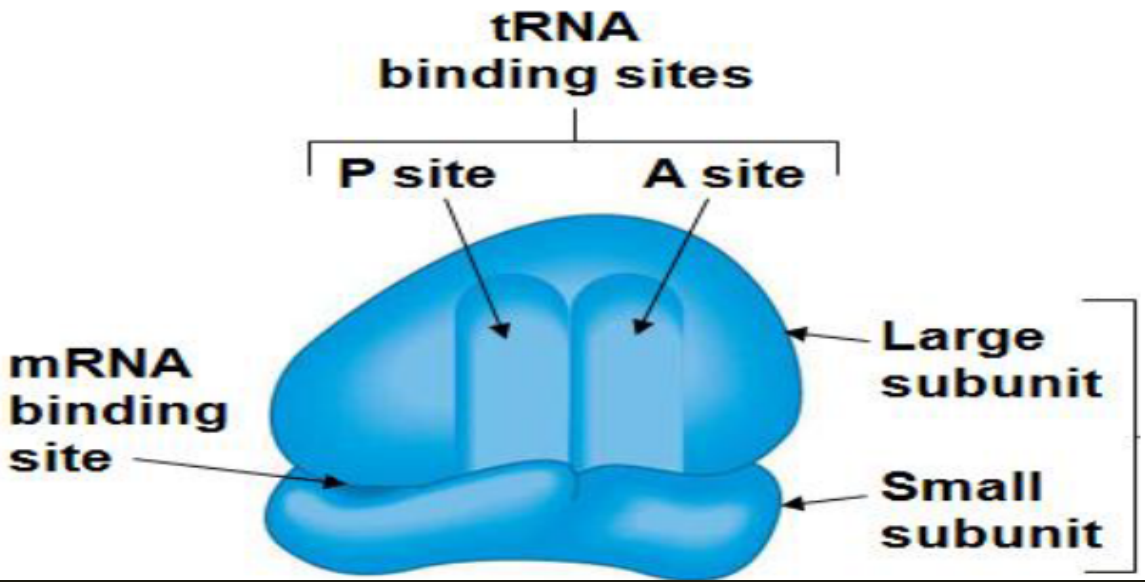
Player-1 (tRNA)

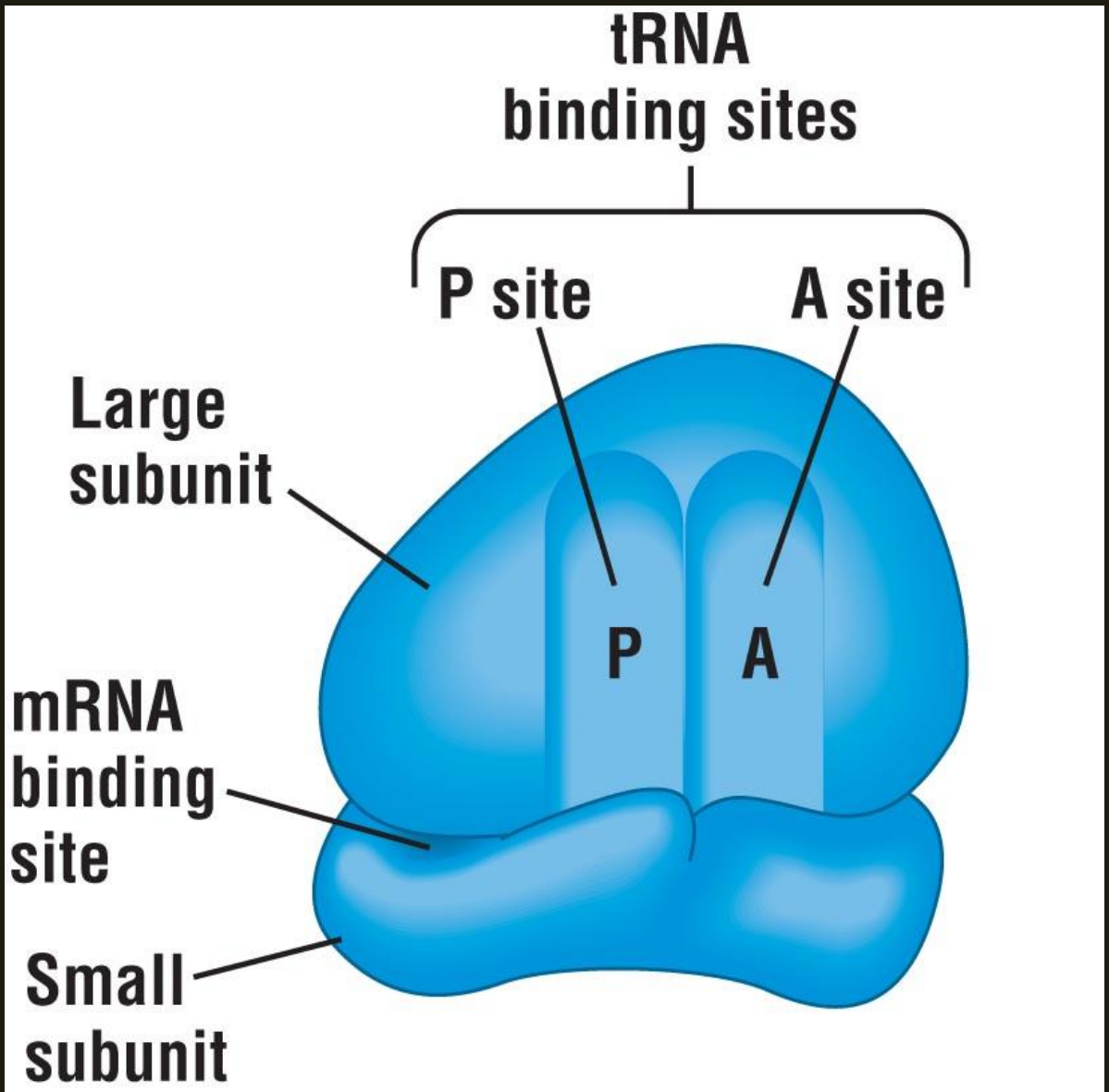


Player-2 (Ribosomes)

Ribosomes

- Ribosomes are the organelles in the cytoplasm that
  - coordinate the functioning of mRNA and tRNA and
  - actually make polypeptides.
- A ribosome consists of two subunits – large & small.
- Each subunit is made up of
  - proteins and
  - **ribosomal RNA (rRNA).**



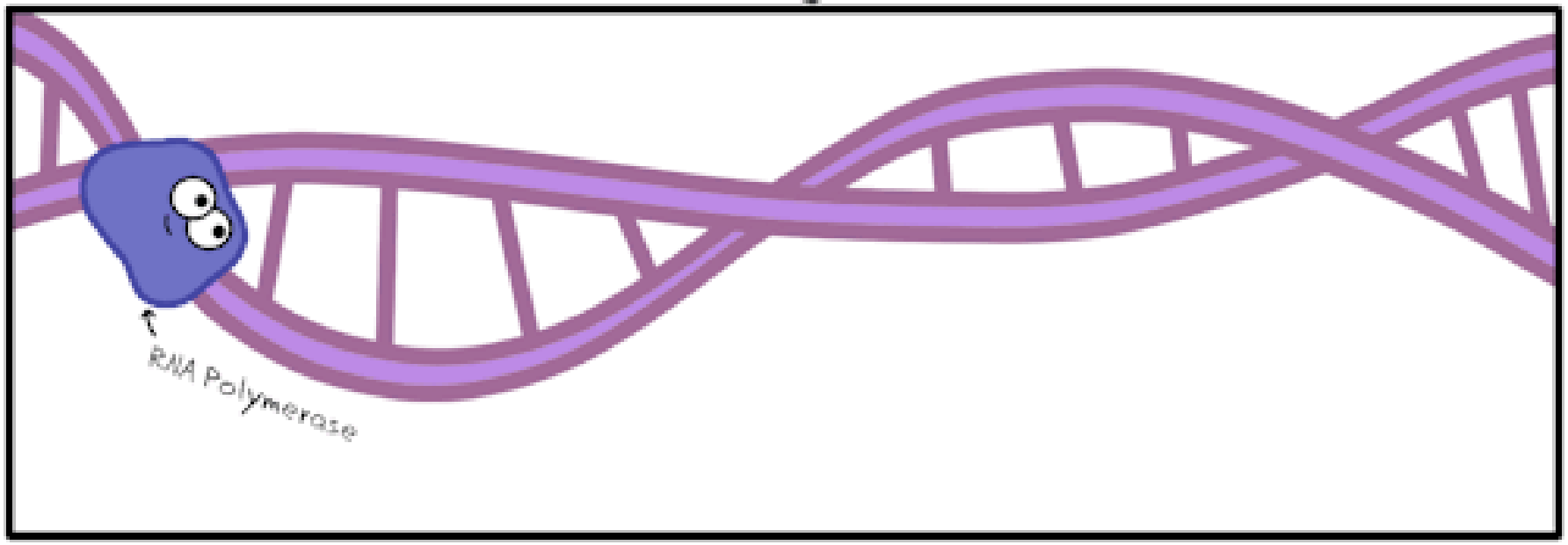


(a) A simplified diagram of a ribosome.

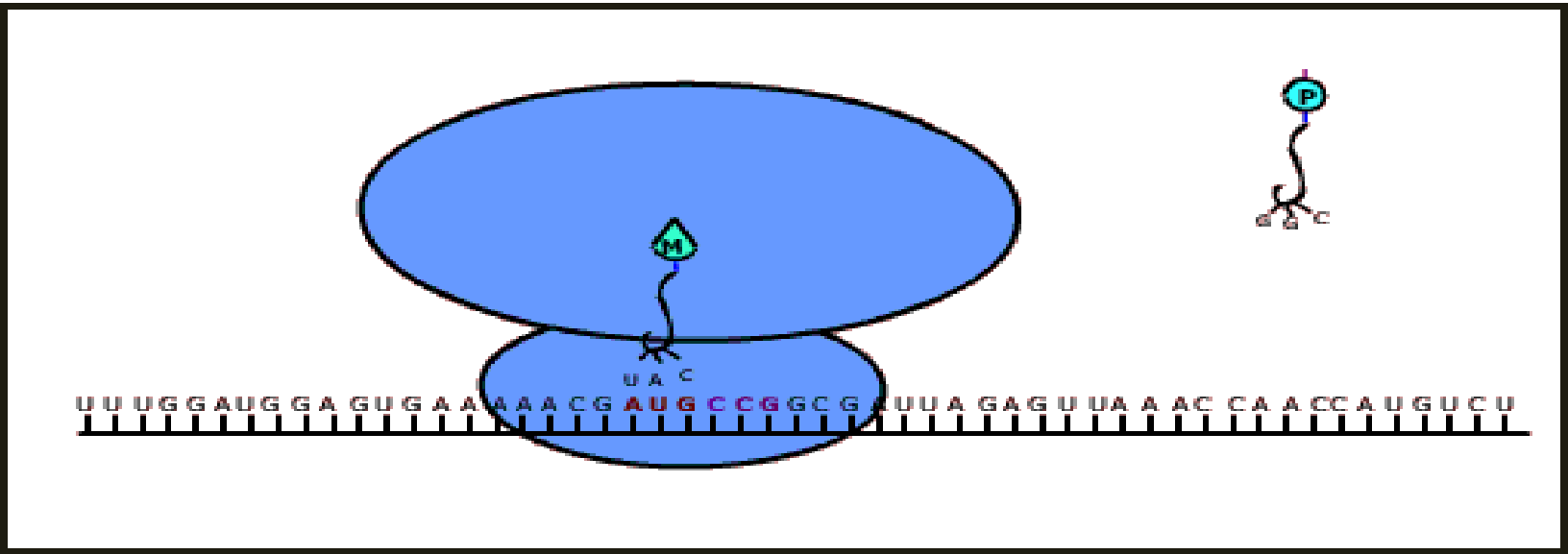
Protein Synthesis

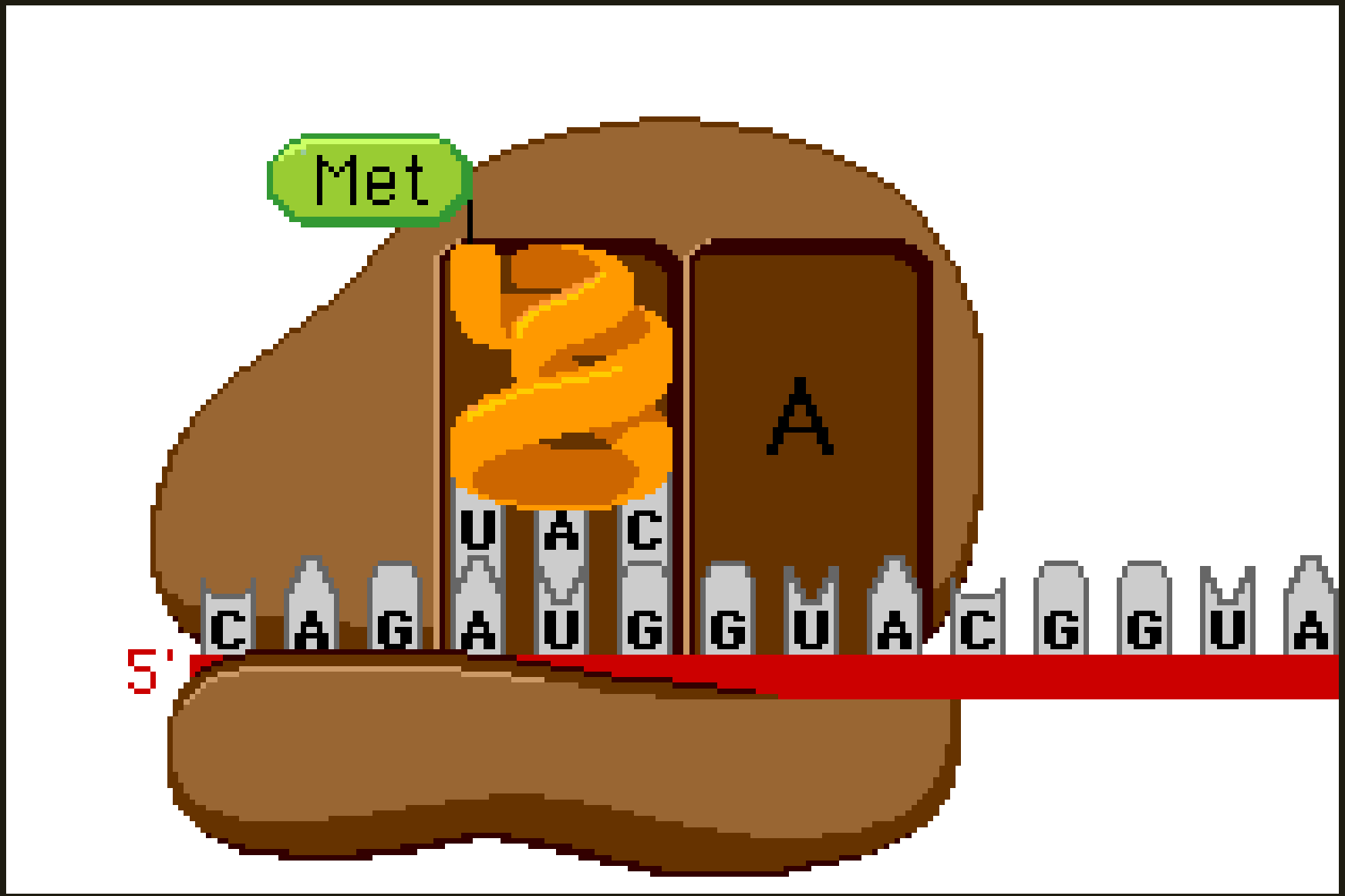
Amoeba Sisters

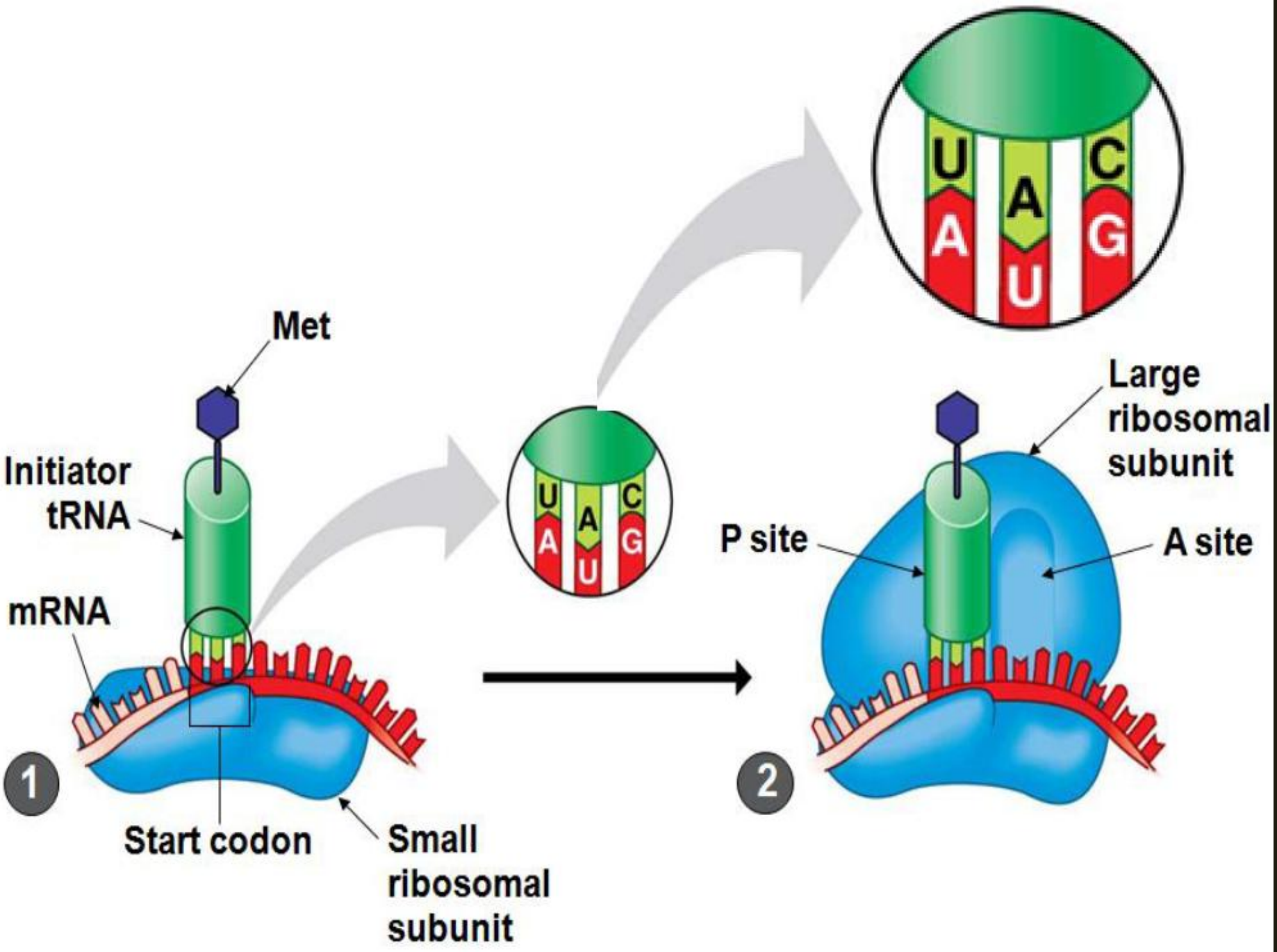
#AmoebaGIFs



Step 1: Transcription

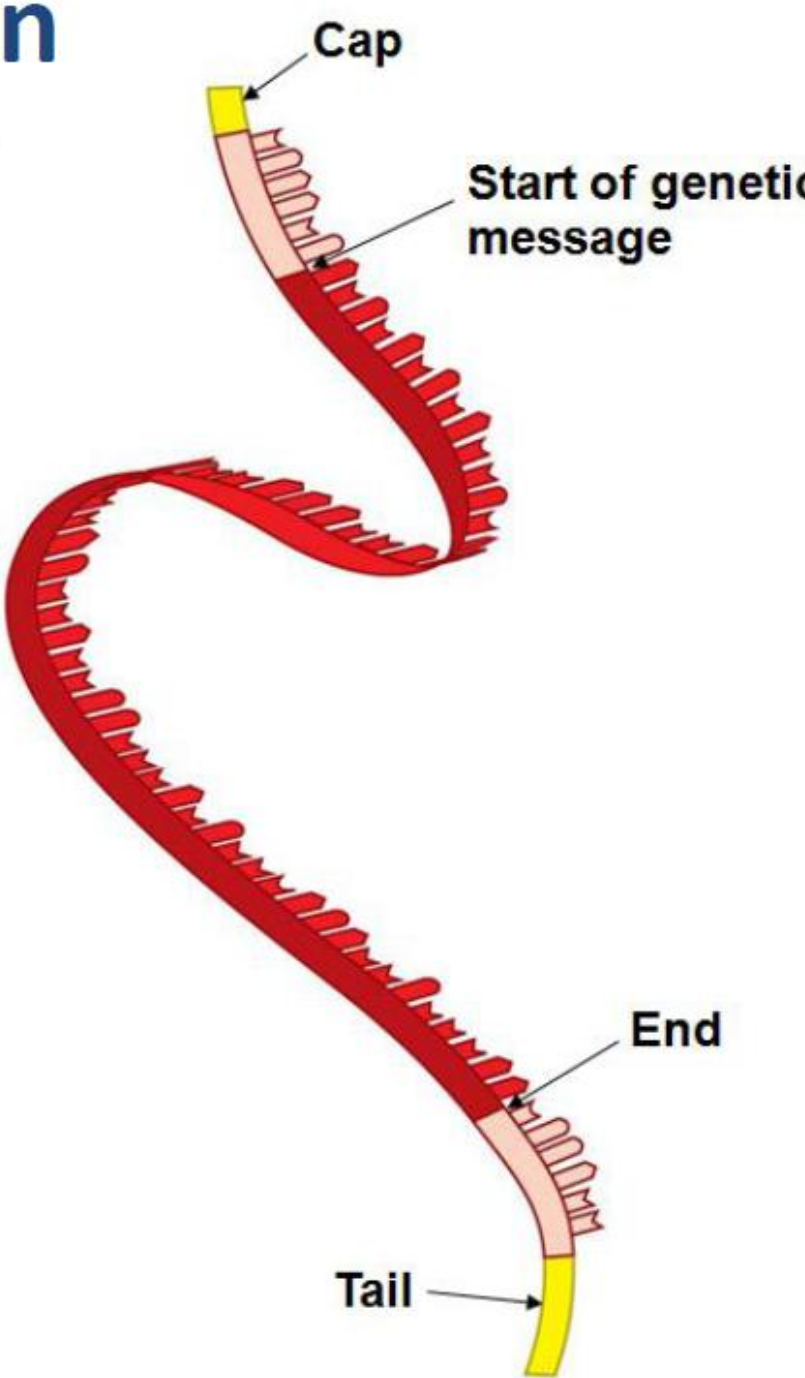



Met
A
U
A
C
C
A
G
A
U
G
G
U
A
C
G
G
U
A
5'


U
A
C
A
U
G
Met
Initiator
tRNA
mRNA
1
Start codon
Small
ribosomal
subunit
Large
ribosomal
subunit
P site
A site
2

Initiation

- Initiation brings together
  - mRNA - binds to a small ribosomal subunit,
  - the tRNA carrying first amino acid attaches to **start codon** and
  - large subunit of the ribosome.
- cap and tail help the mRNA bind to the ribosome.



Elongation

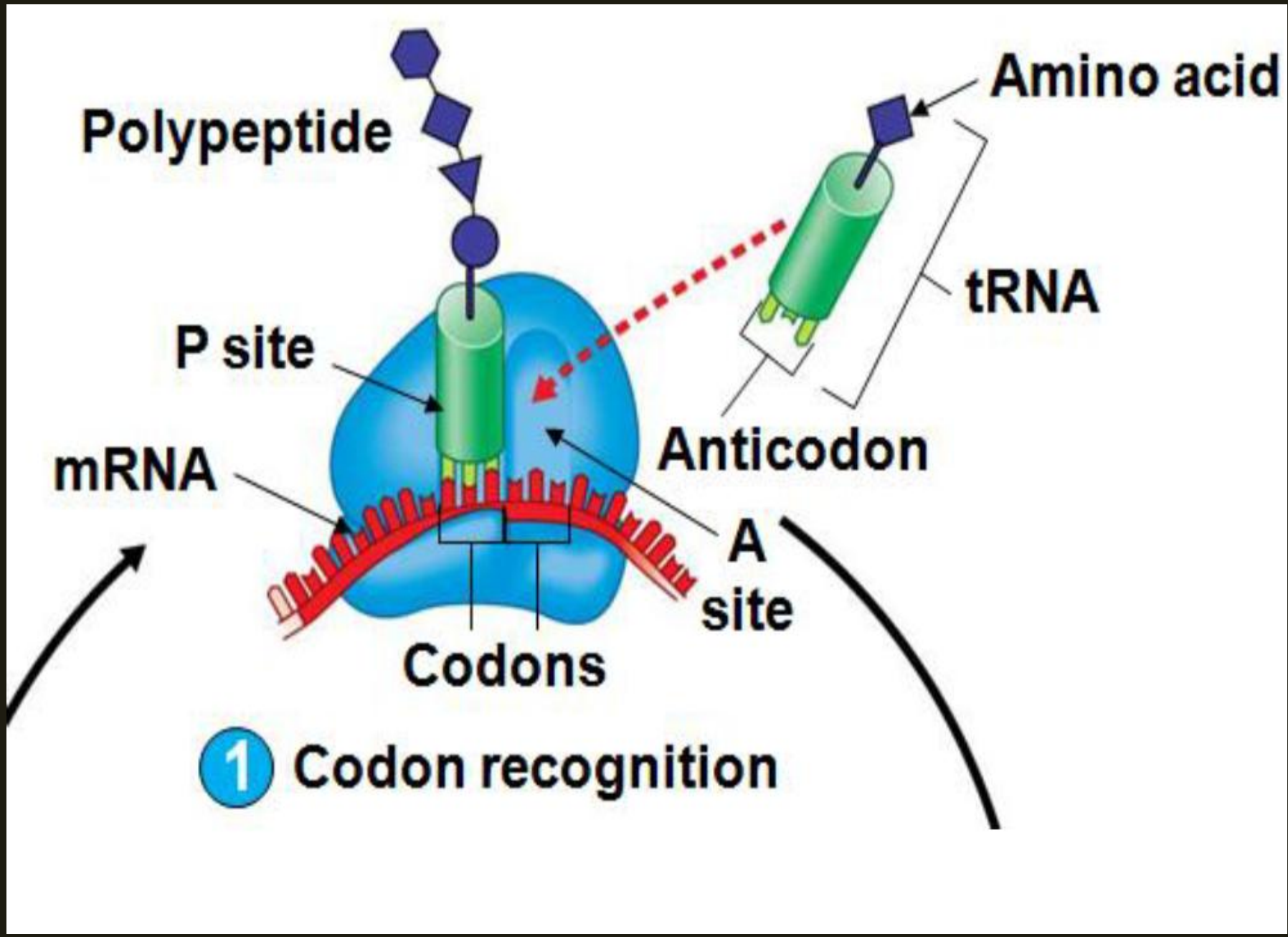
- After initiation, amino acids are added one by one to the first amino acid.
- Each addition occurs in the three-step elongation process.
  - **Step 1**: **Codon recognition**. The anticodon of an incoming tRNA molecule, carrying its amino acid, pairs with the mRNA codon in the A site of the ribosome.

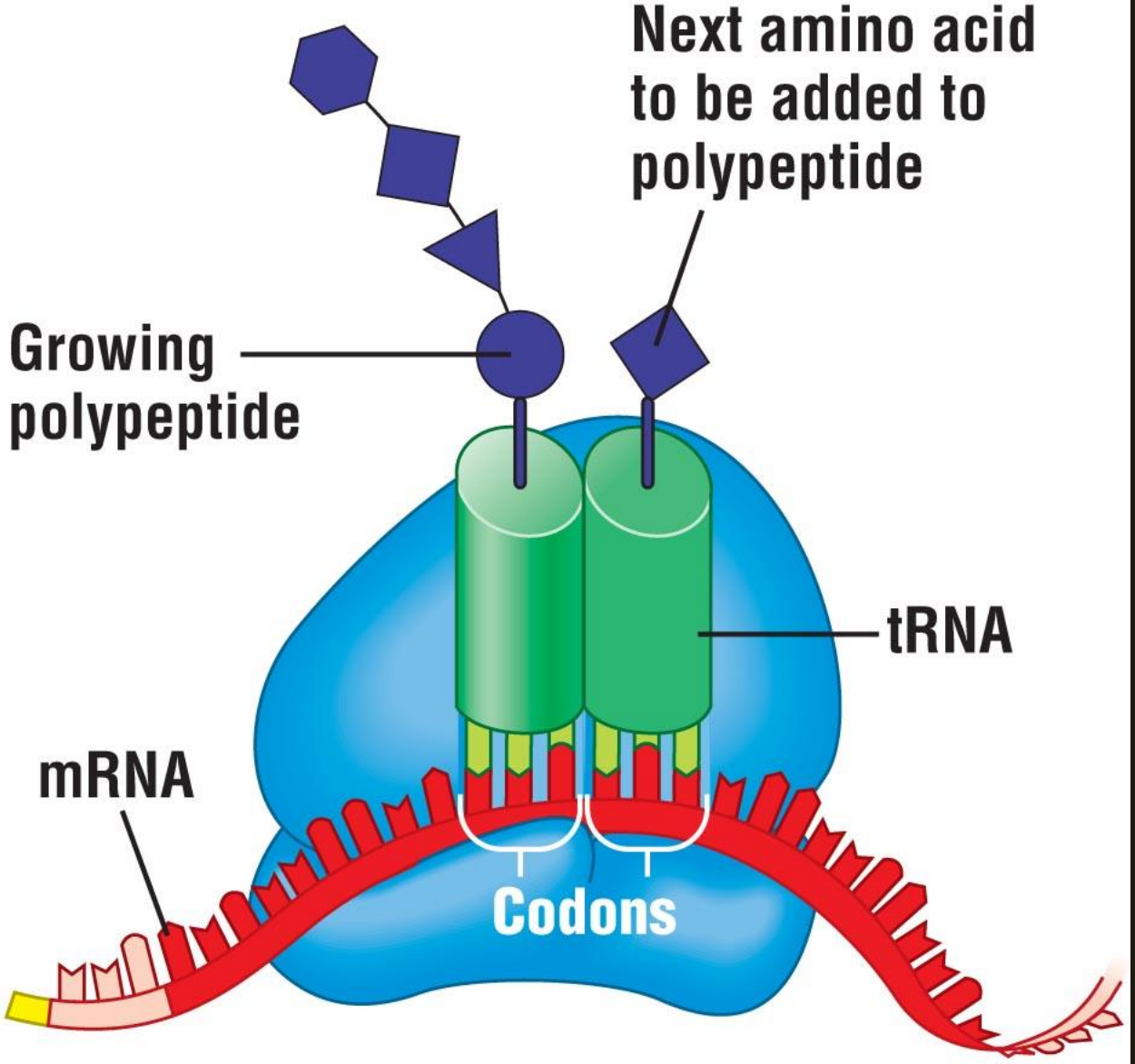
Elongation

- **Step 2**: **Peptide bond formation**.
  - The polypeptide leaves the tRNA in the P site and attaches to the amino acid on the tRNA in the A site.
  - The ribosome creates a new peptide bond.
  - Now the chain has one more amino acid.

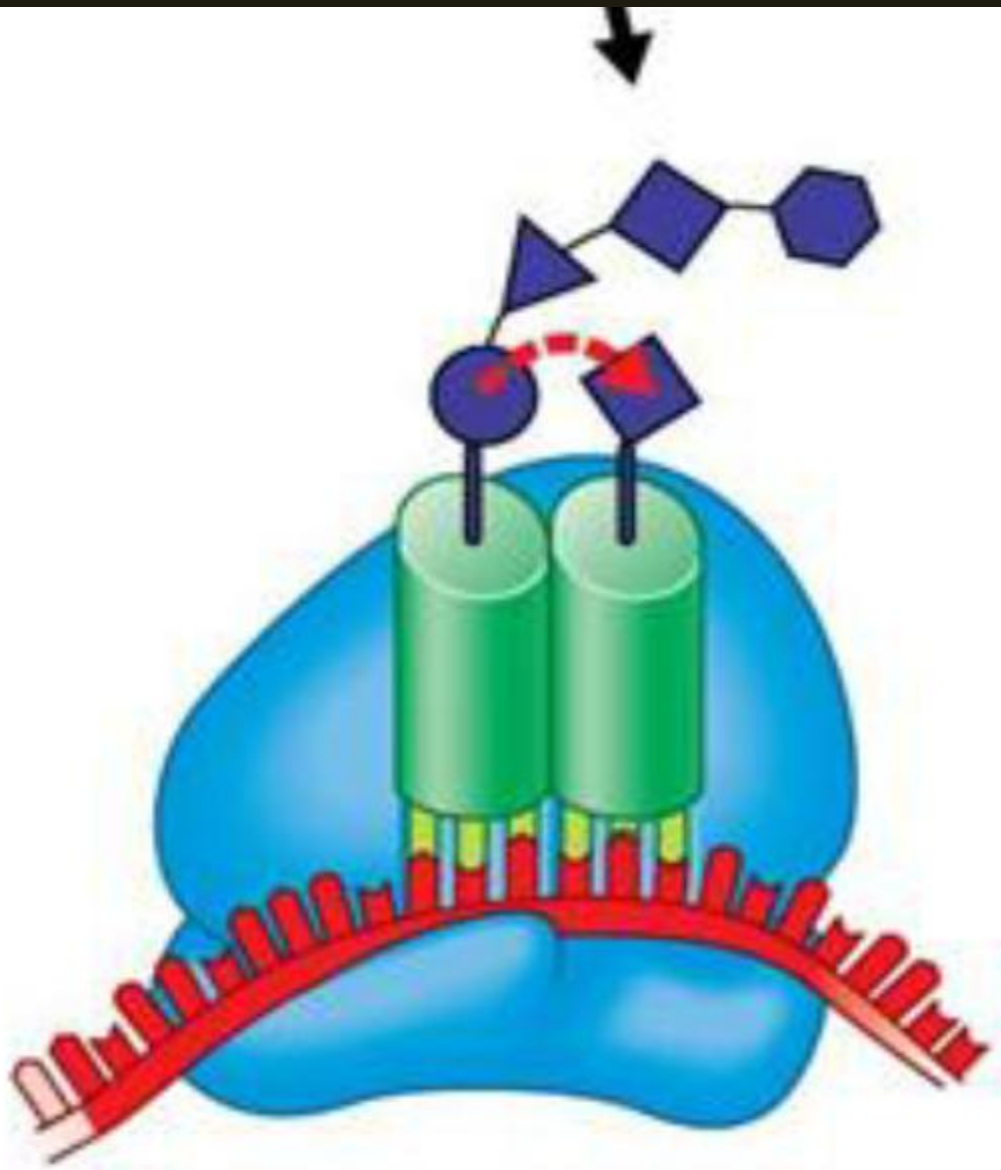
Elongation

- **Step 3**: **Translocation**.
  - The P site tRNA now leaves the ribosome, and the ribosome moves the remaining tRNA, carrying the growing polypeptide, to the P site.
  - The mRNA and tRNA move as a unit.
  - This movement brings into the A site the next mRNA codon to be translated, and the process can start again with step 1.

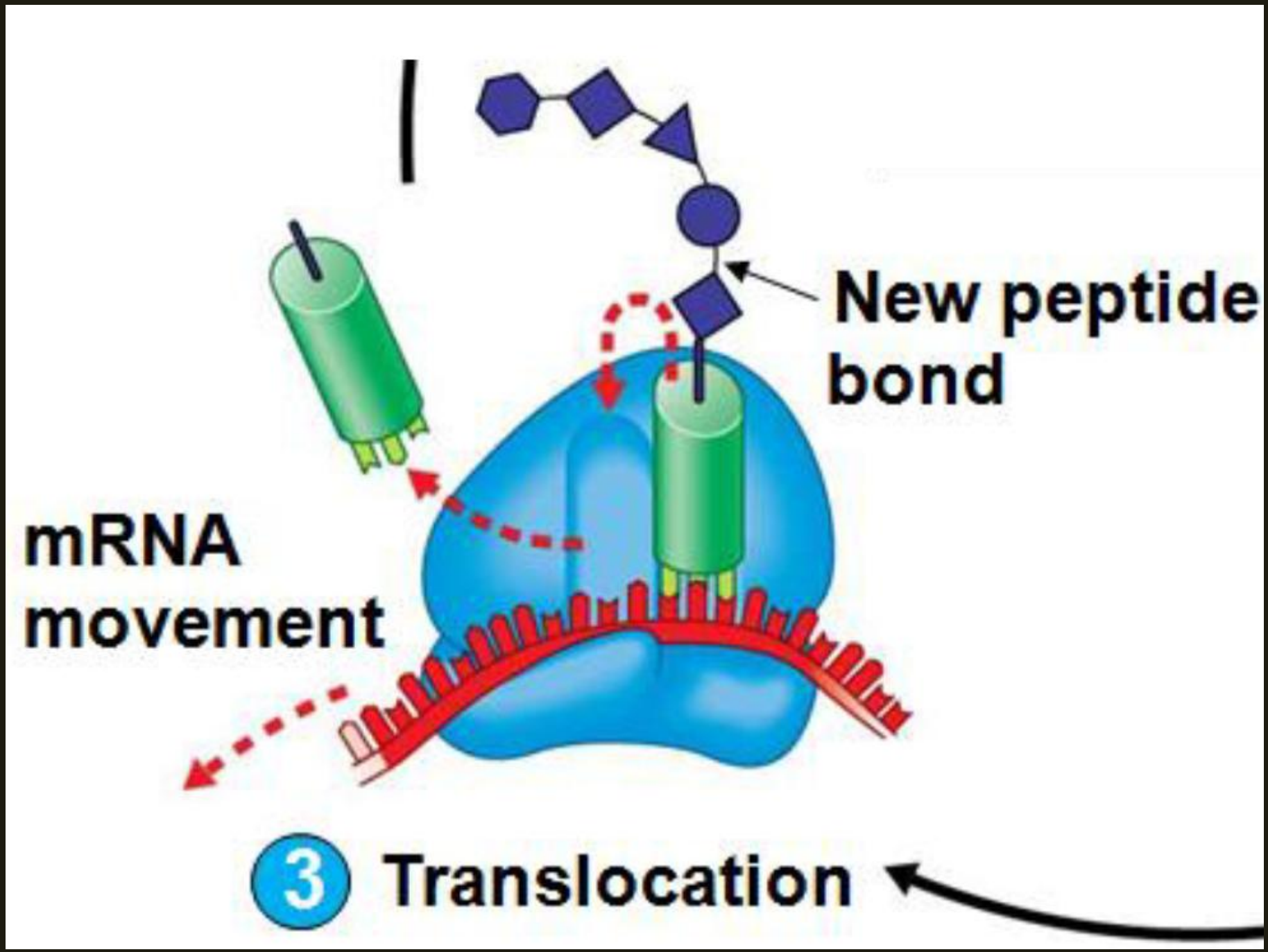

Amino acid
Polypeptide
tRNA
P site
Anticodon
mRNA
A
site
Codons
1 Codon recognition

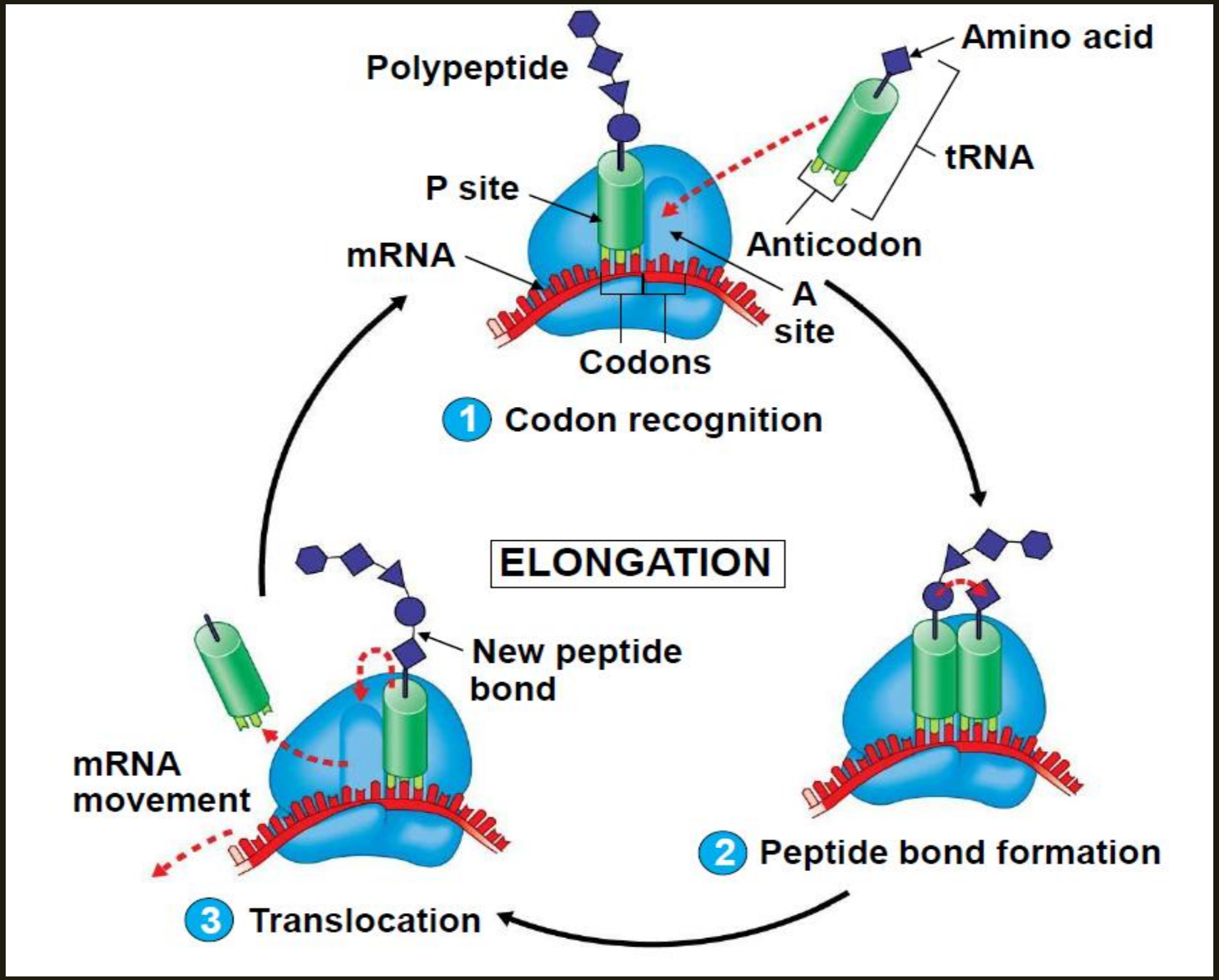


(b) The "players" of translation.



2 Peptide bond formation


New peptide bond
mRNA movement
3 Translocation


Polypeptide
Amino acid
tRNA
P site
mRNA
Anticodon
A site
Codons
1 Codon recognition
ELONGATION
New peptide bond
mRNA movement
2 Peptide bond formation
3 Translocation

Termination

- Elongation continues until
  - a **stop codon (UAA/UGA/UAG)** reaches the ribosome's A site,
  - the completed polypeptide is freed, and
  - the ribosome splits back into its subunits.