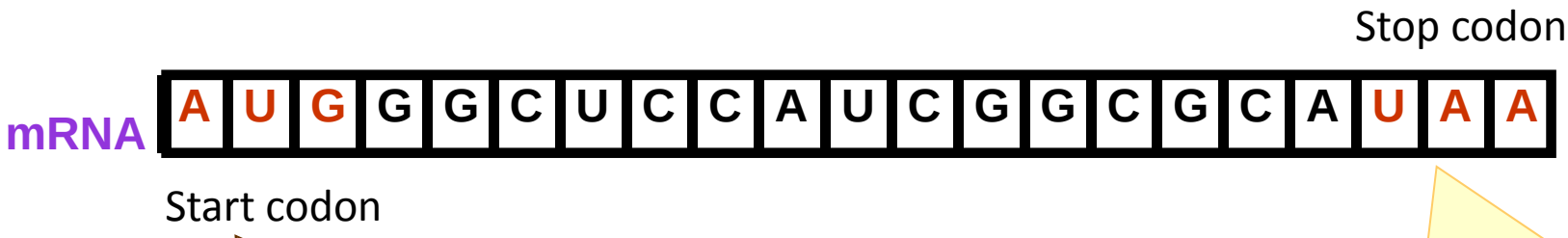
Start and Stop codons



AUG : signals the beginning of polypeptide chains in both prokaryotes & eukaryotes

UAA, UGA, UAG:
do not code for any known aa: signal the end of polypeptide chain synthesis

Further properties of the Genetic Code

- Orderly Code
- Amino acids with similar properties have similar codons
- The genetic code is widespread but not universal

Exceptions:

Mammalian mitochondria

AUA, AUG - start codons

UGA - Trp (not stop codon)

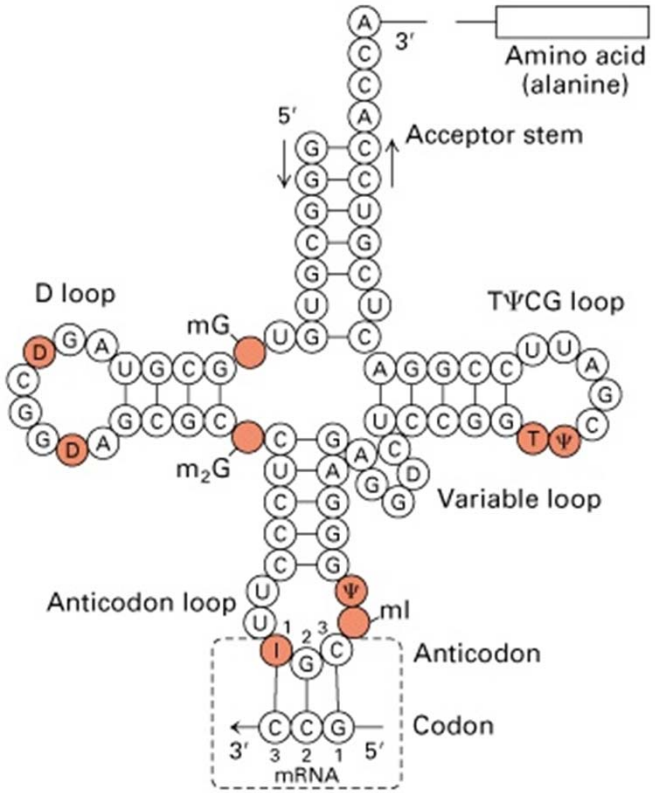
AGA, AGG - stop codons (not Arg)

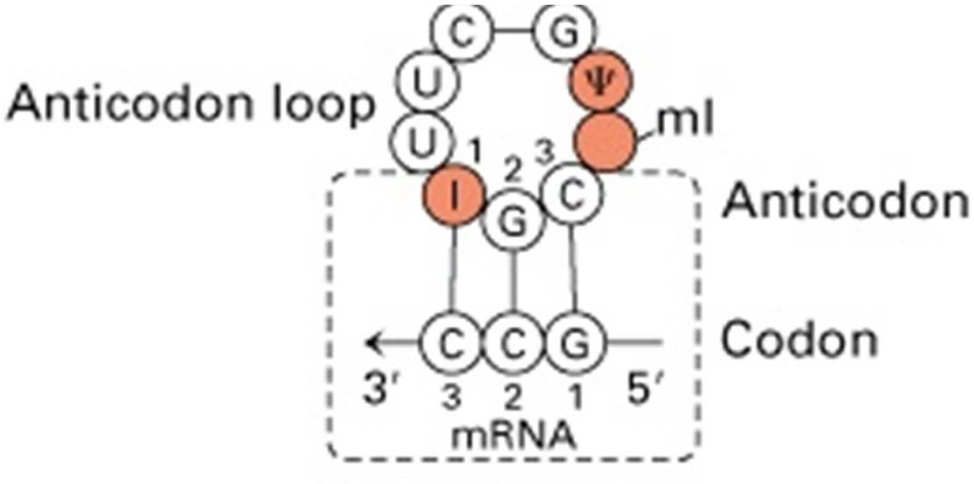
Some bacteria & ciliates
In ciliated protozoa - UAA, UAG - Glutamine (not stop codon)

Codon - Anticodon Interaction

- Transfer RNA (tRNA) : adaptor between the nucleic acid triplet code (codon) and the amino acid

- Anticodon on the tRNA base pairs with the mRNA codon





Wobble Hypothesis

- The first two nucleotides of a codon pair like DNA.
- Third base of most codons pairs rather loosely with the corresponding base of its anticodons.
- Crick called the third bases of such codons as “wobble”.
- Base pairing possibilities at the third position:

Anticodon	Codon base
U	A, G
C	G
A	U
G	U,C
I	U, C, A

Why Wobble?

- First two bases of a codon impart high specificity and tight binding
- The wobble or third base of the codon pairs only loosely with its corresponding base in the anticodon
- This permits rapid dissociation of the tRNA from its codon during protein synthesis
- Permits faster mRNA translation i.e. protein synthesis.

Summary

- The unit of genetic information is the codon
- There are 64 possible codons since there are 4 bases
- Each codon is specific to one amino acid or a start or stop signal
- The genetic code predicts the amino acid sequence of a protein from the DNA base sequence via the RNA intermediate.

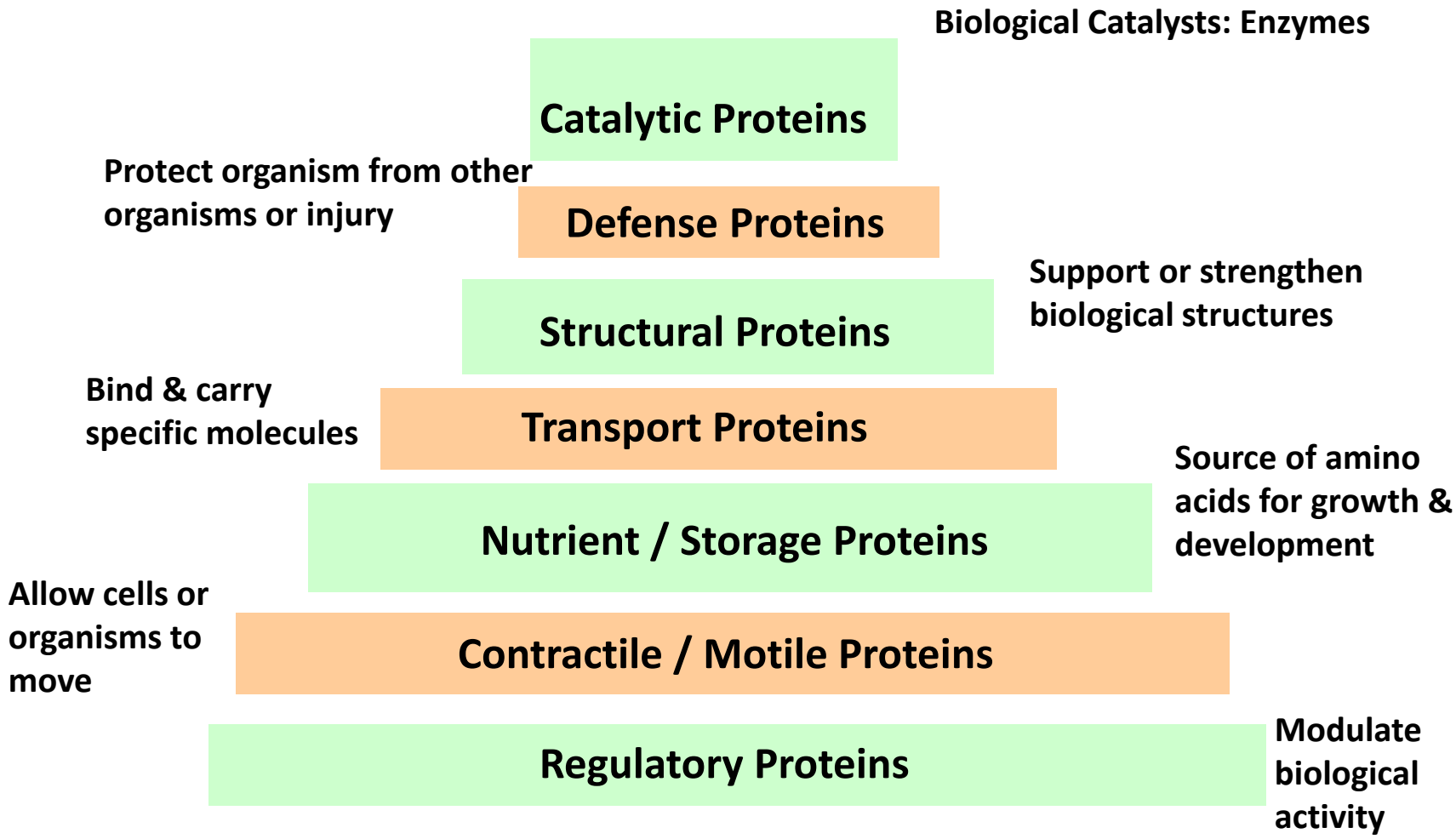
Translation

Objectives

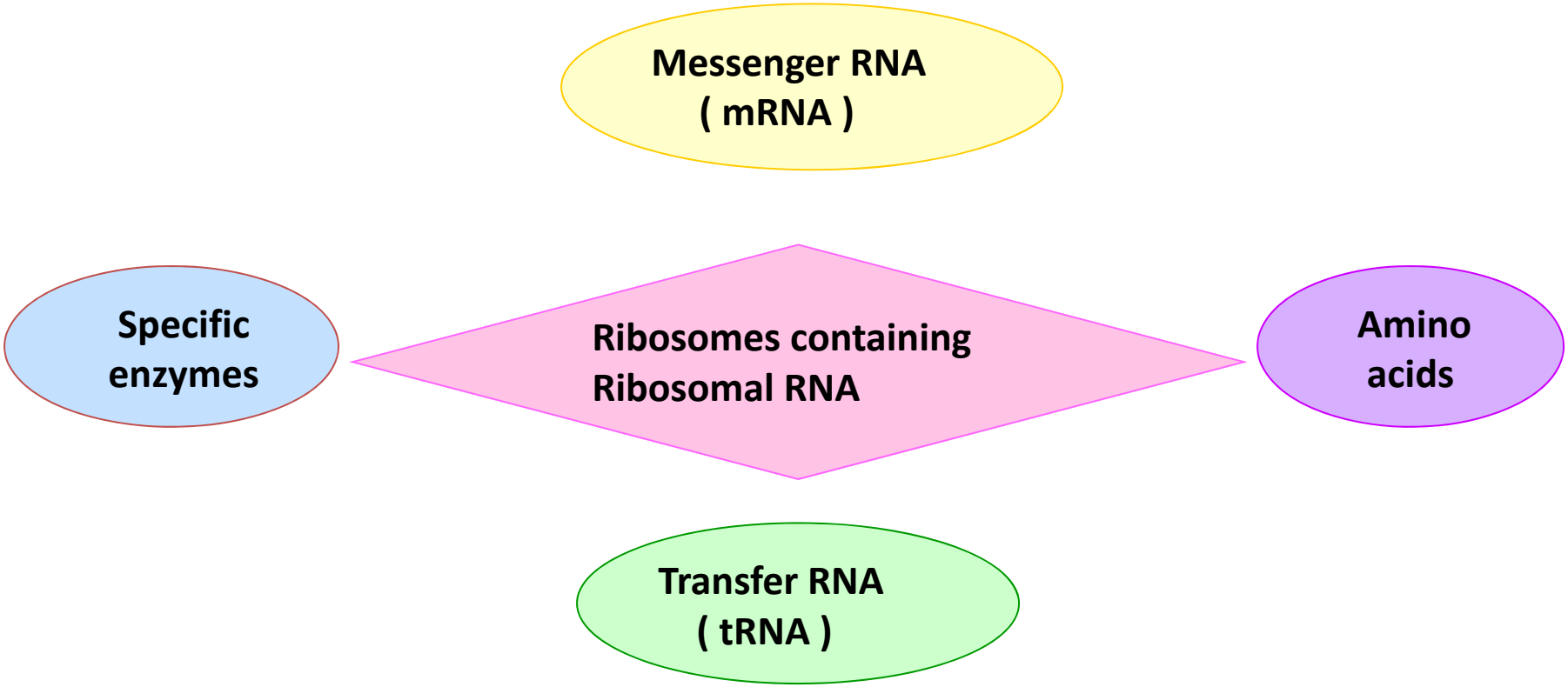
- Introduction to Translation
- Role of Translation
- Components of Translation
- The different stages involved in the process

Why are Proteins important?

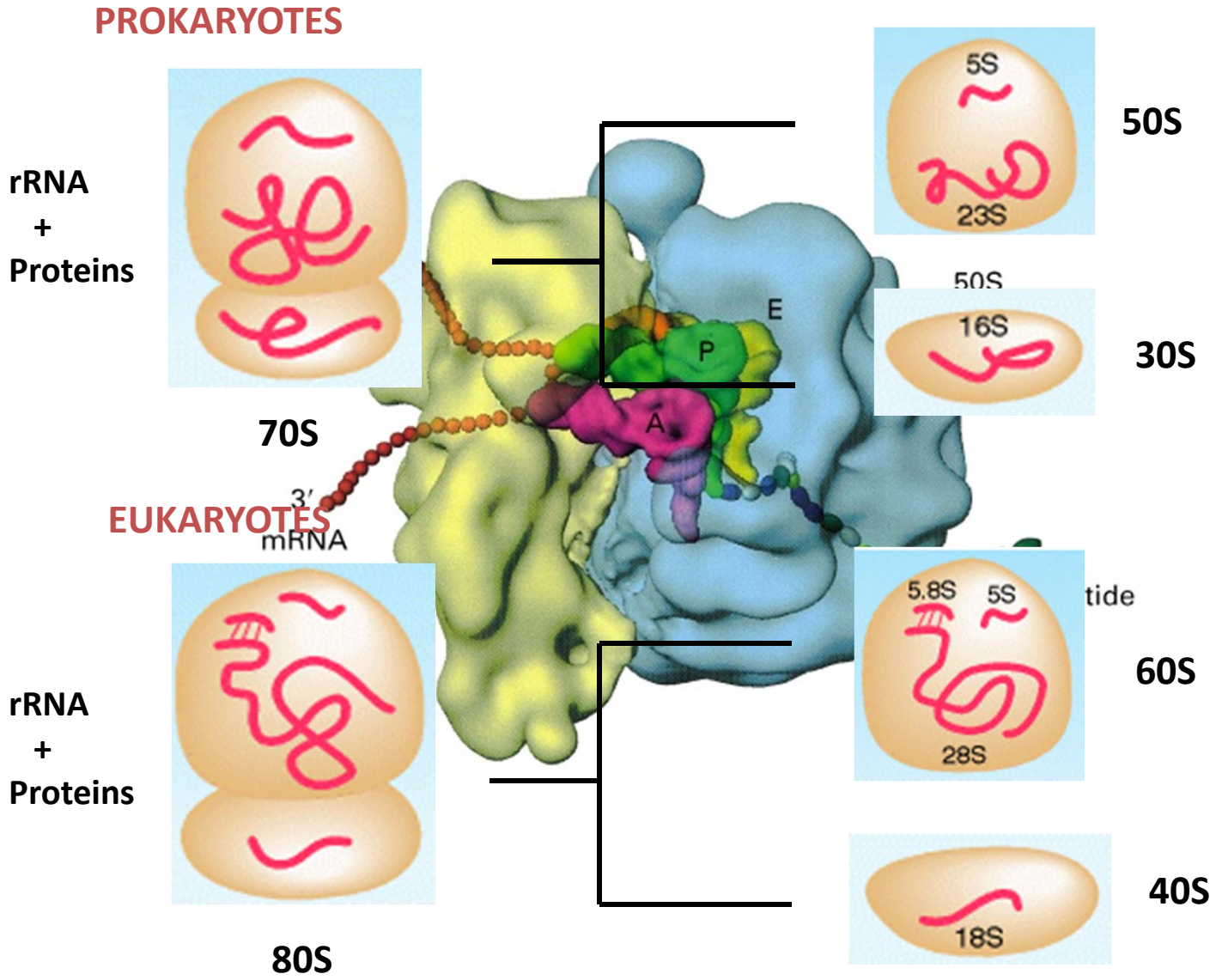
Most biological activities are carried out by proteins



Participating species in Protein Synthesis



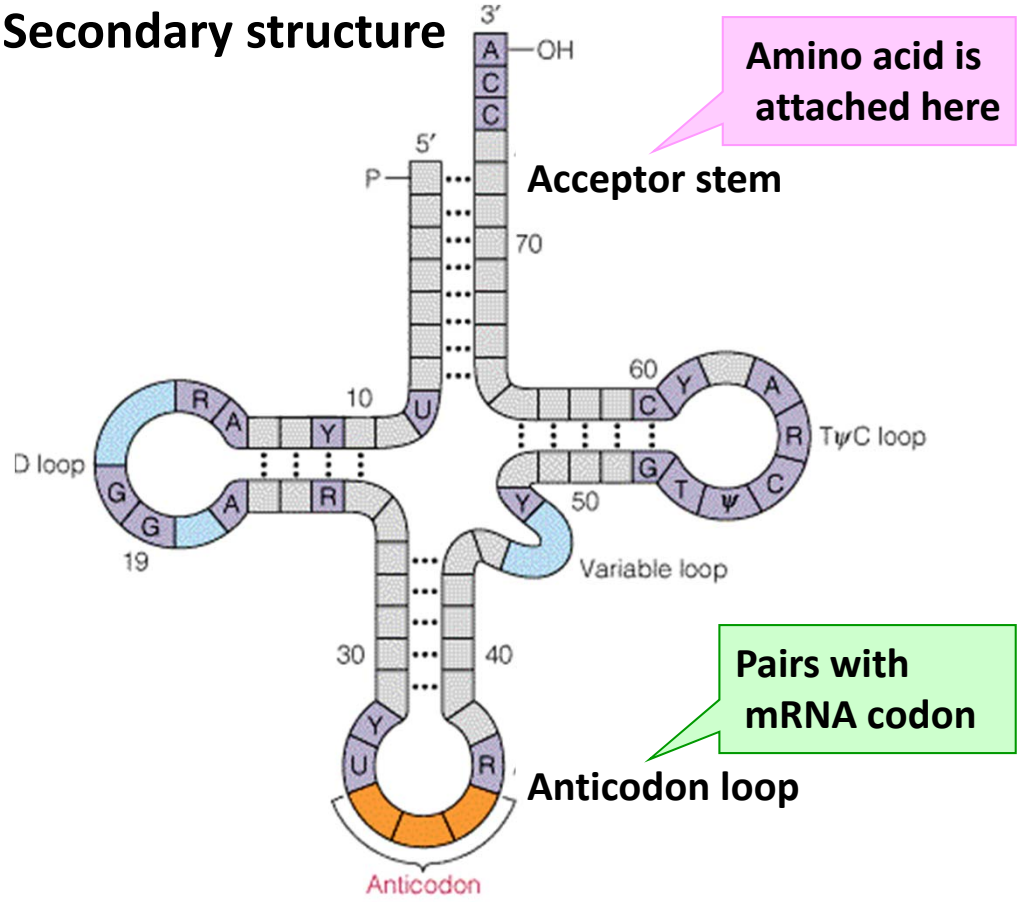
Ribosome : Protein manufacturing machinery



Transfer RNA (tRNA)

The key or adapter in traslating the **language of nucleic acids** into the **language of proteins**

Secondary structure



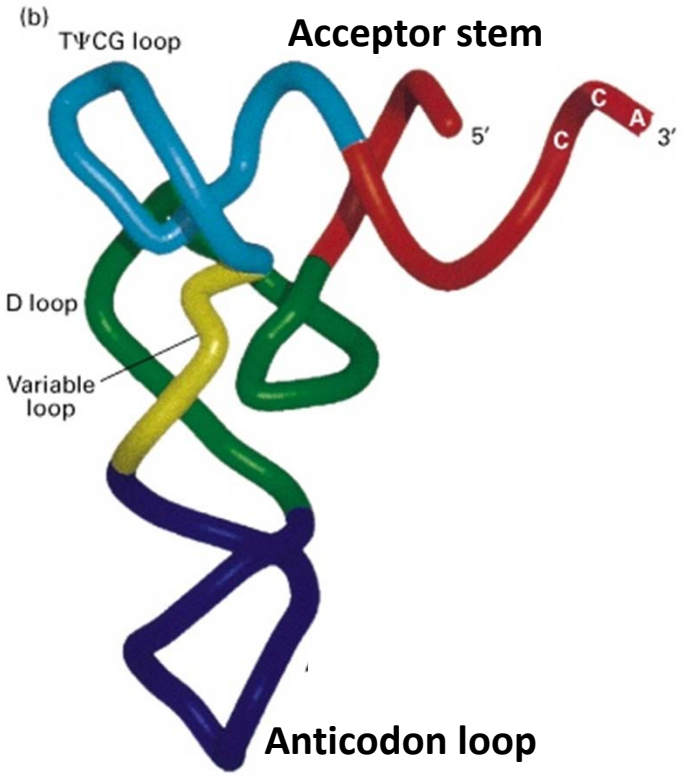
Amino acid is attached here

Acceptor stem

Pairs with mRNA codon

Anticodon loop

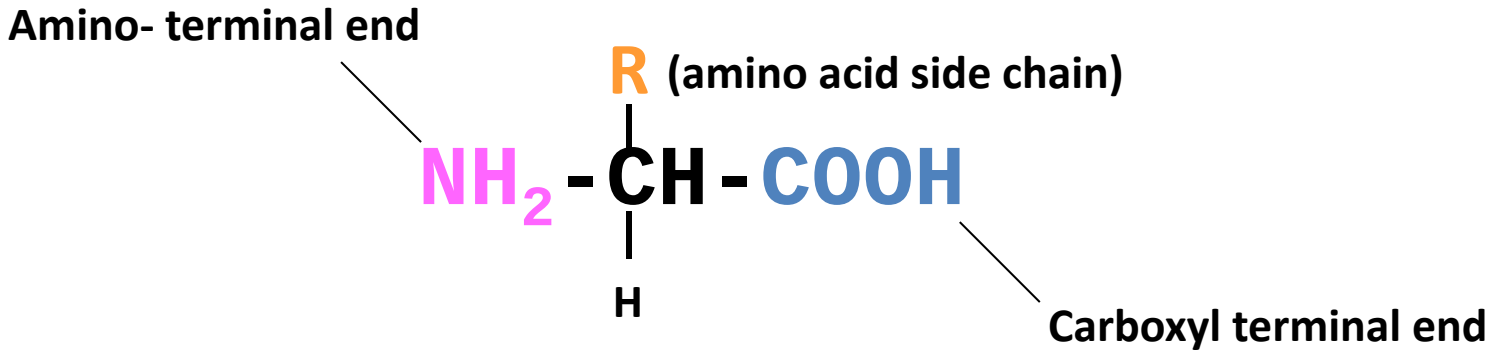
Tertiary Structure



Anticodon loop

Amino Acids

Amino acids are the building blocks of proteins



Polypeptide synthesis begins at the amino terminal end

Making of a Protein

Activation of amino acids

↓

Initiation

↓

Elongation

↓

Termination & release

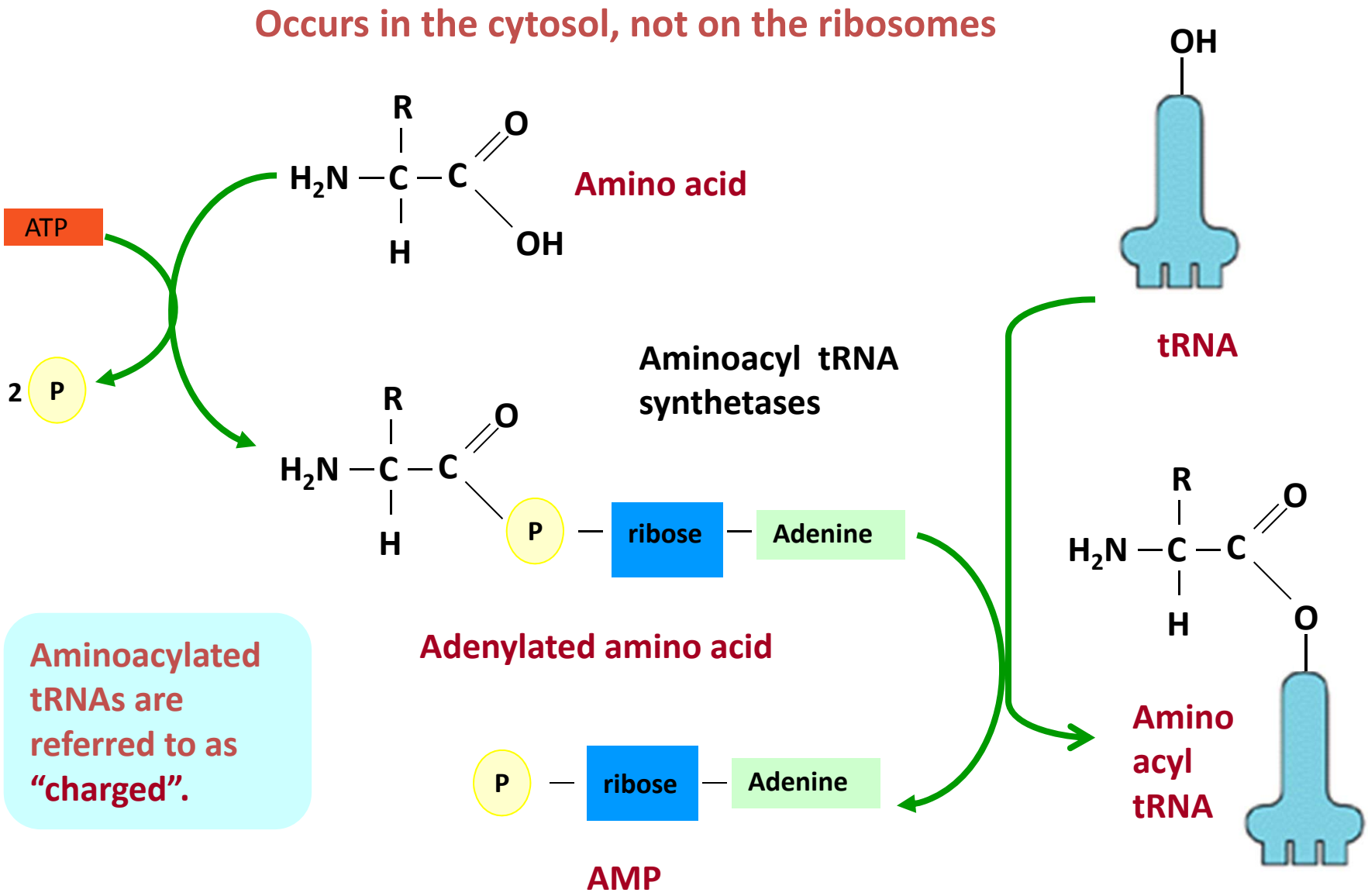
↓

Folding & processing

↓

 Biologically acvtive form

Activation of amino acids

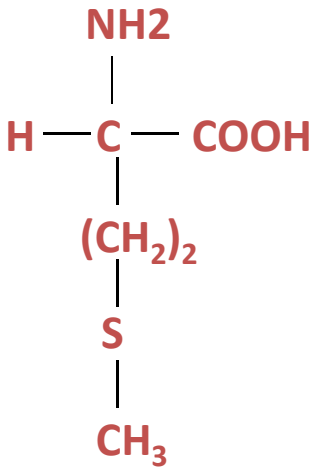


Initiation

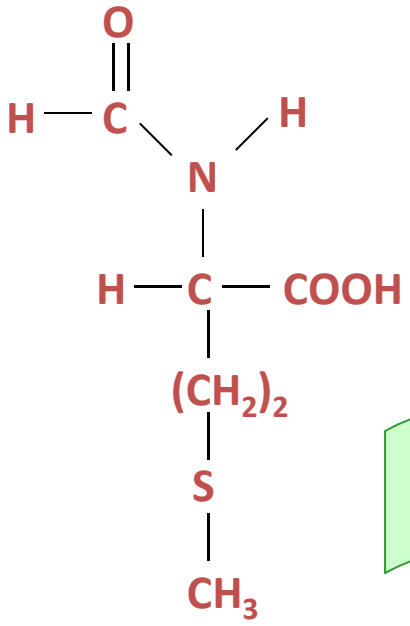
Specific amino acid initiates protein synthesis

The first amino acid incorporated is Methionine.

Methionine of an initiator tRNA is formylated (in prokaryotes), called $tRNA^{fMet}$



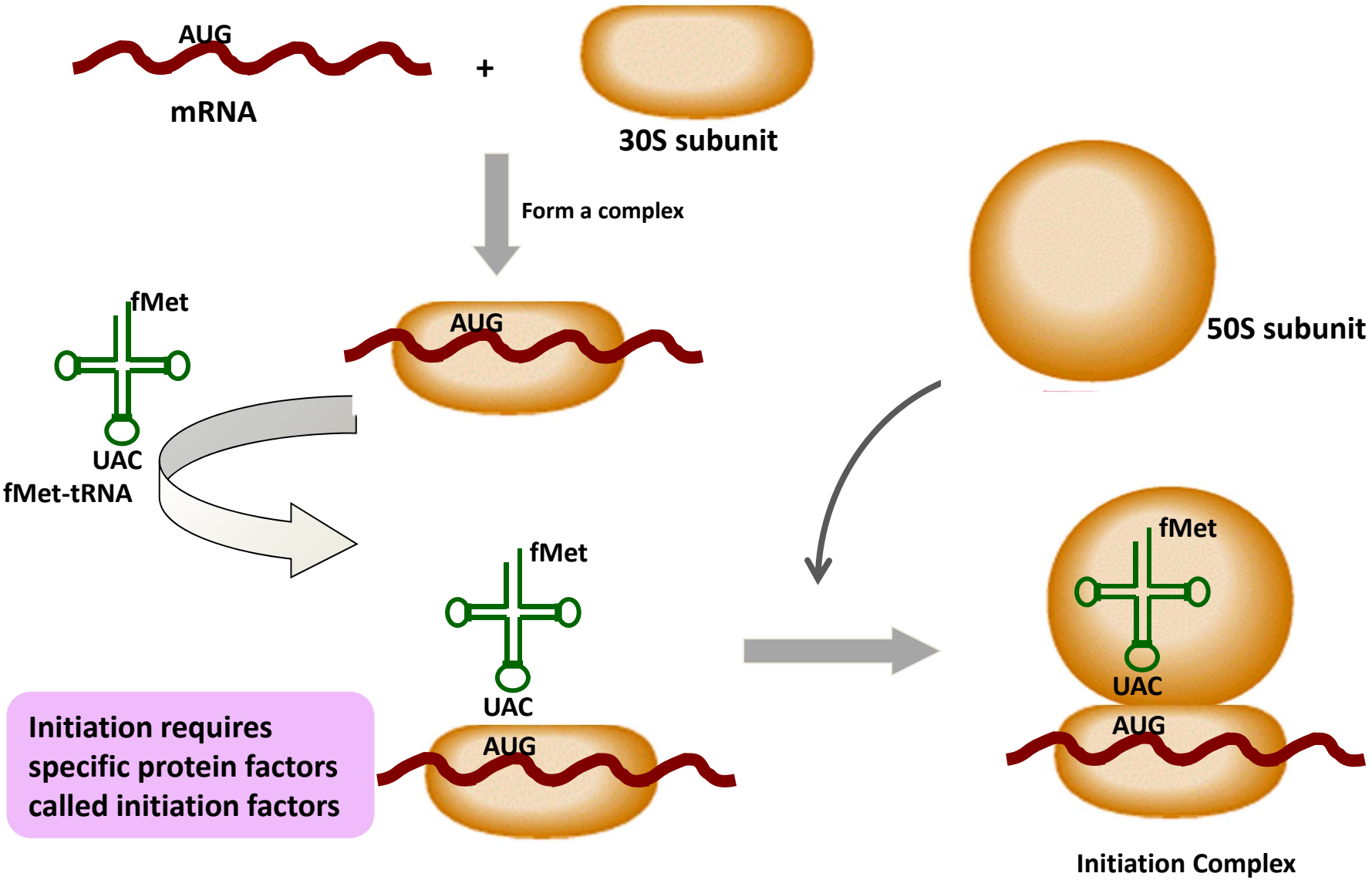
Methionine



N-Formylmethionine

Only used at initiation

Formation of Initiation Complex



Initiation requires specific protein factors called initiation factors

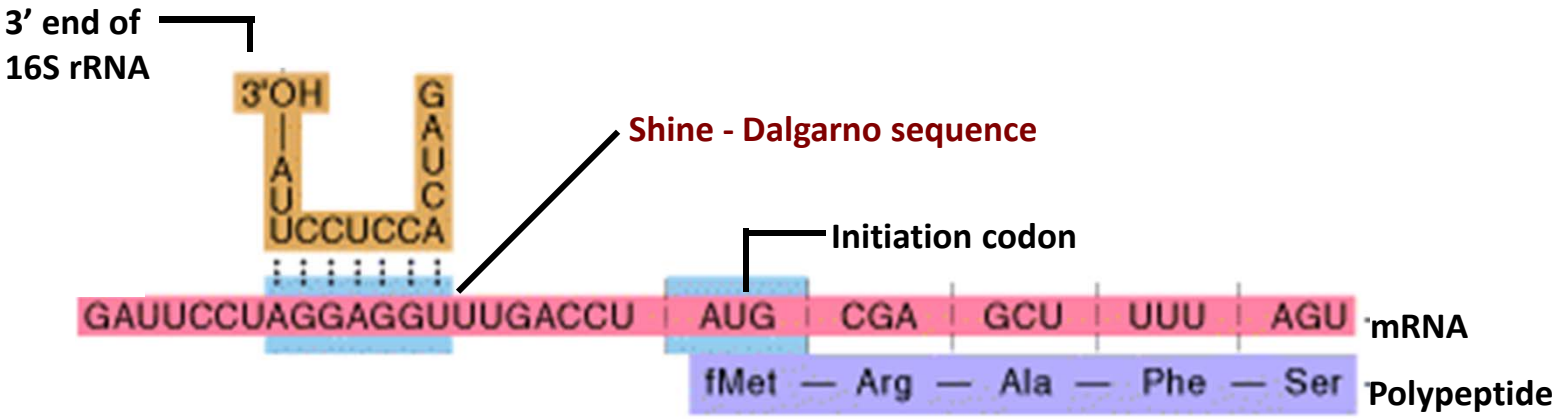
How are the correct initiation codons selected from the many AUG & GUG codons in an mRNA??

BACTERIA

In bacteria, true initiation codons preceded by sequences called Shine - Dalgarno sequences

Pairs well with 3’ end of 16S rRNA in the ribosome

Initiating signal - positions the ribosome properly next to the initiation codon



How are the correct initiation codons selected from the many AUG & GUG codons in an mRNA??

EUKARYOTES

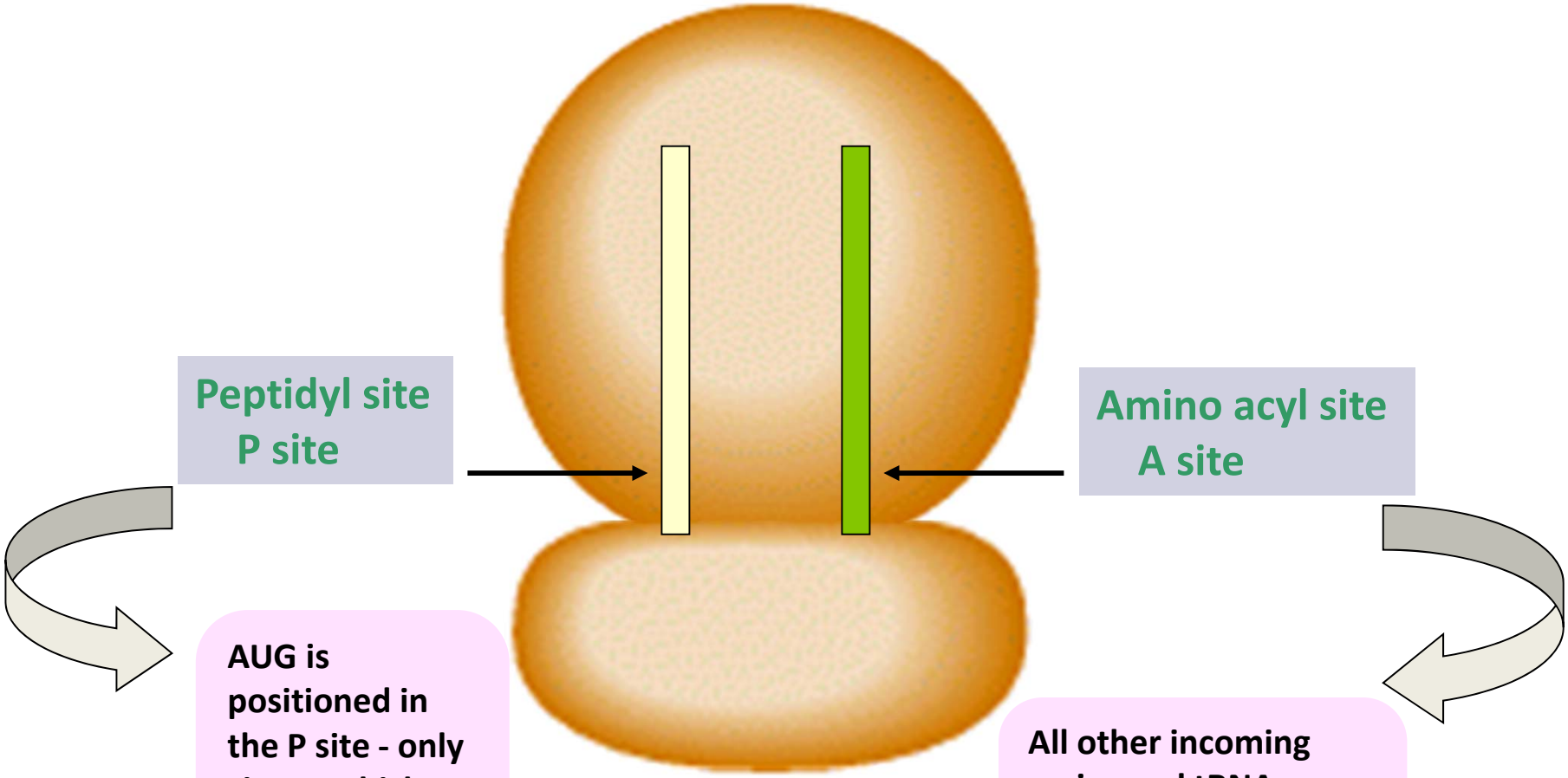
No eukaryotic Shine - Dalgarno sequence

Initiation occurs at the first start codon after 5'-cap

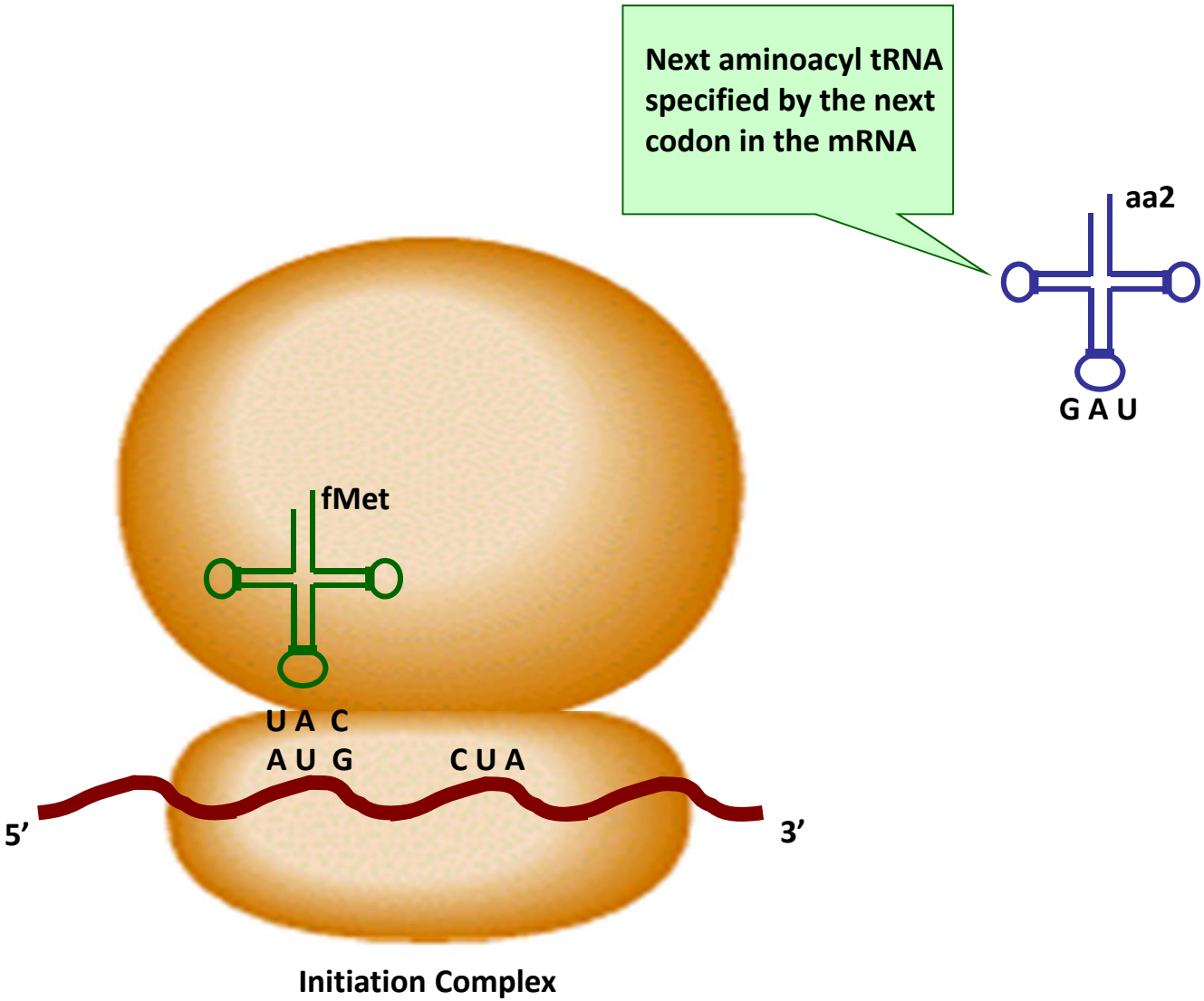
AUG is the first codon that corresponds to the first amino acid of the polypeptide

Methionine is inserted, not N-formyl methionine

Ribosomal tRNA binding sites



Elongation

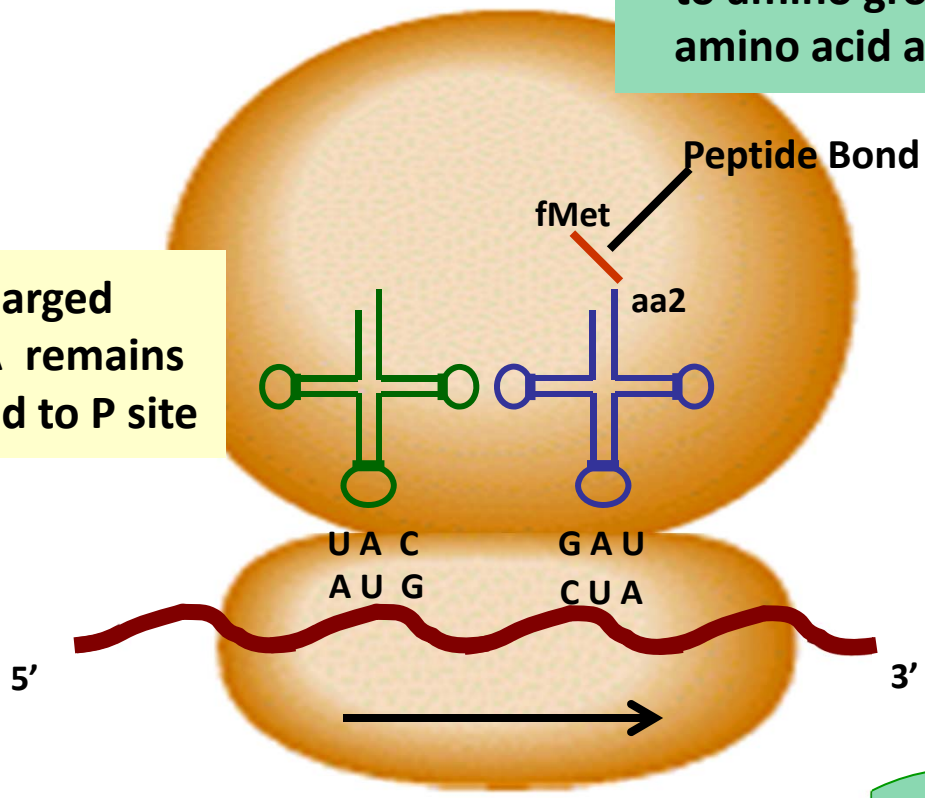


Initiation Complex

Elongation

N-formylmethionyl group transferred from its tRNA to amino group of 2nd amino acid at the A site

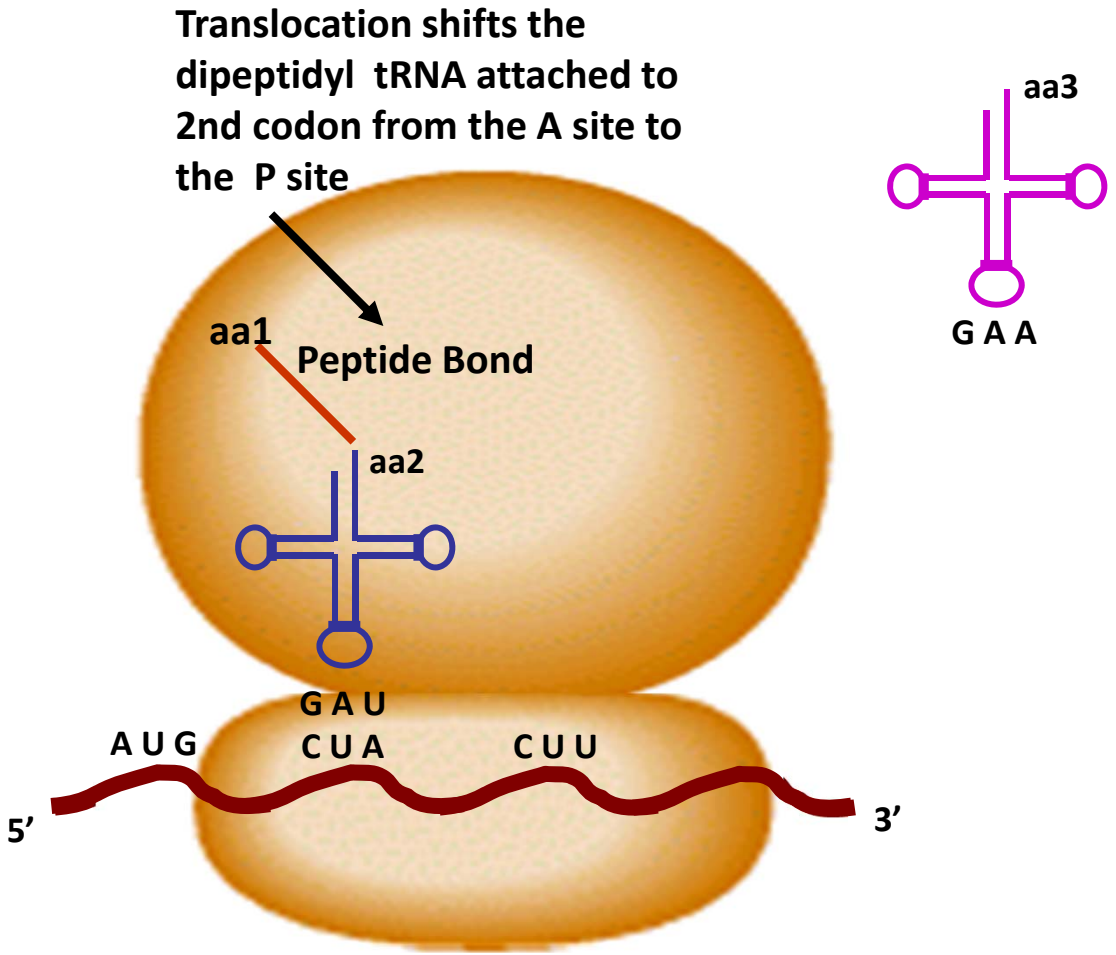
Peptidyl transferase activity



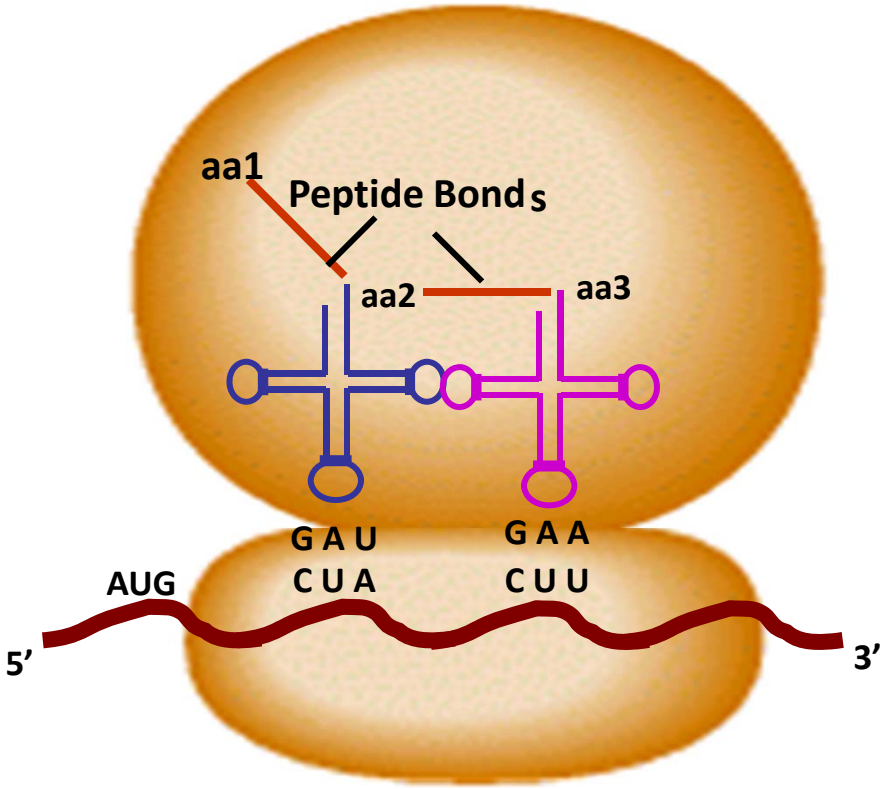
Ribosome moves over one codon towards the 3' end of the mRNA

TRANSLOCATION

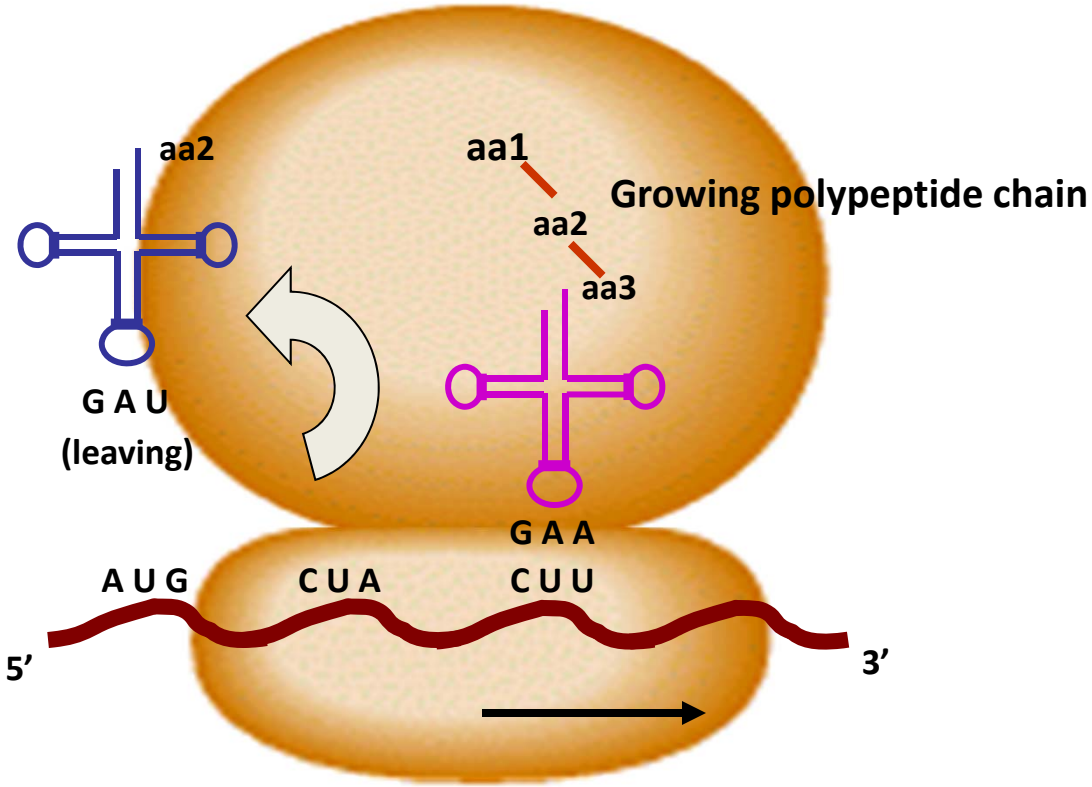
Elongation


Translocation shifts the dipeptidyl tRNA attached to 2nd codon from the A site to the P site
aa3
G A A
aa1
Peptide Bond
aa2
G A U
C U A
A U G
C U U
5’
3’

Elongation

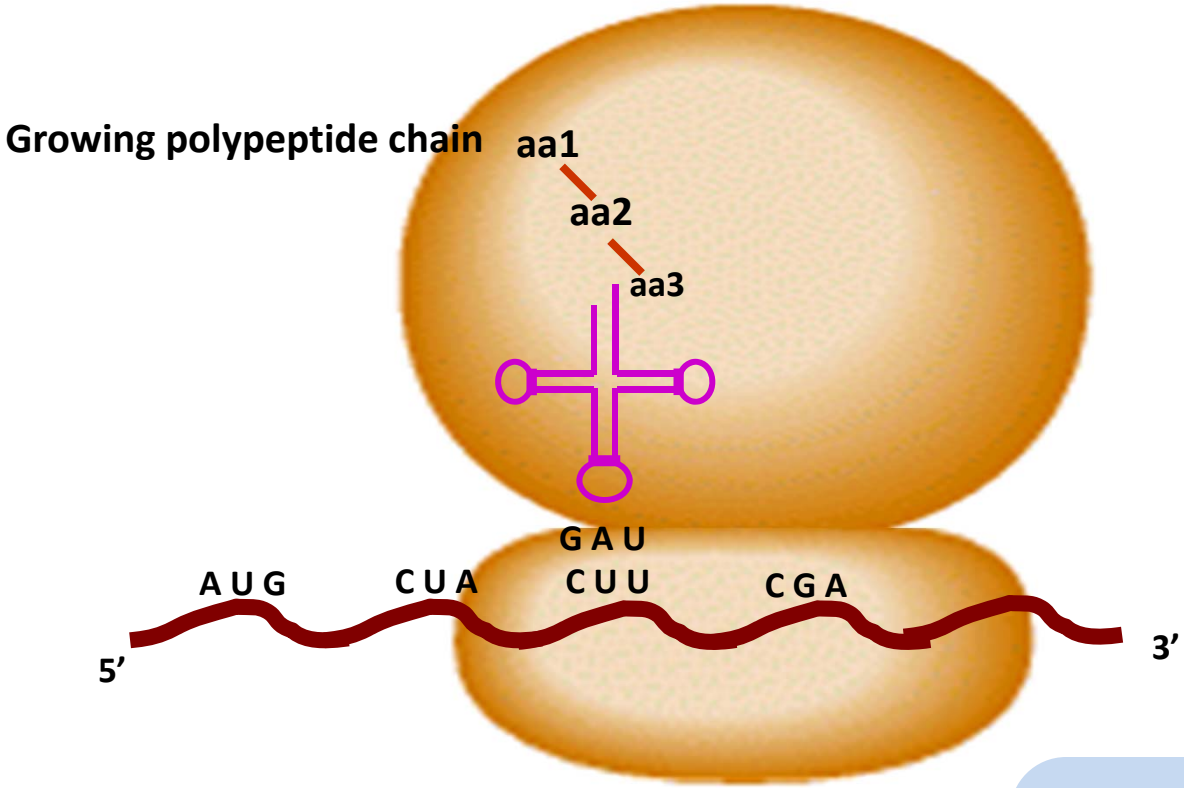


Elongation



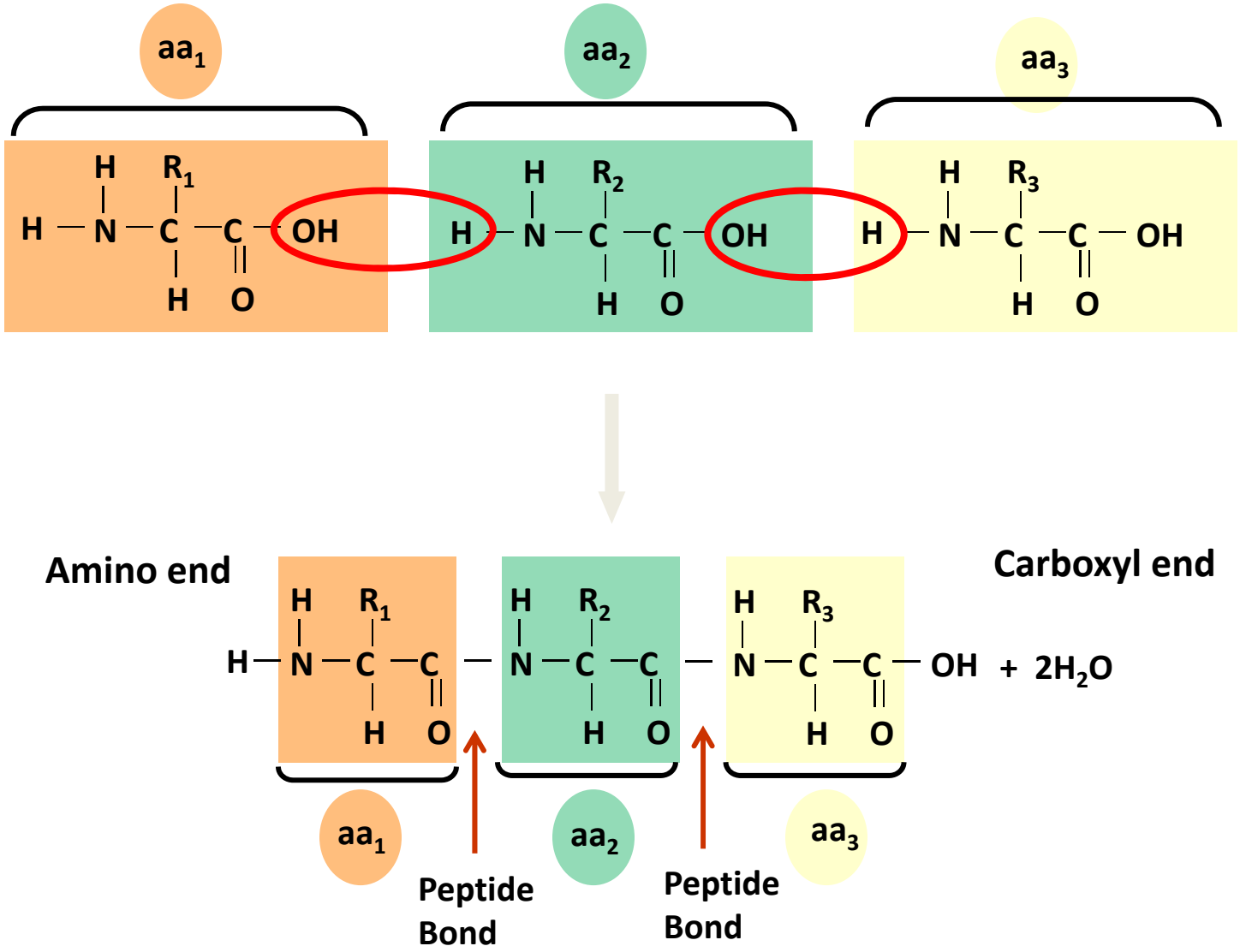
Ribosome moves over one codon

Elongation

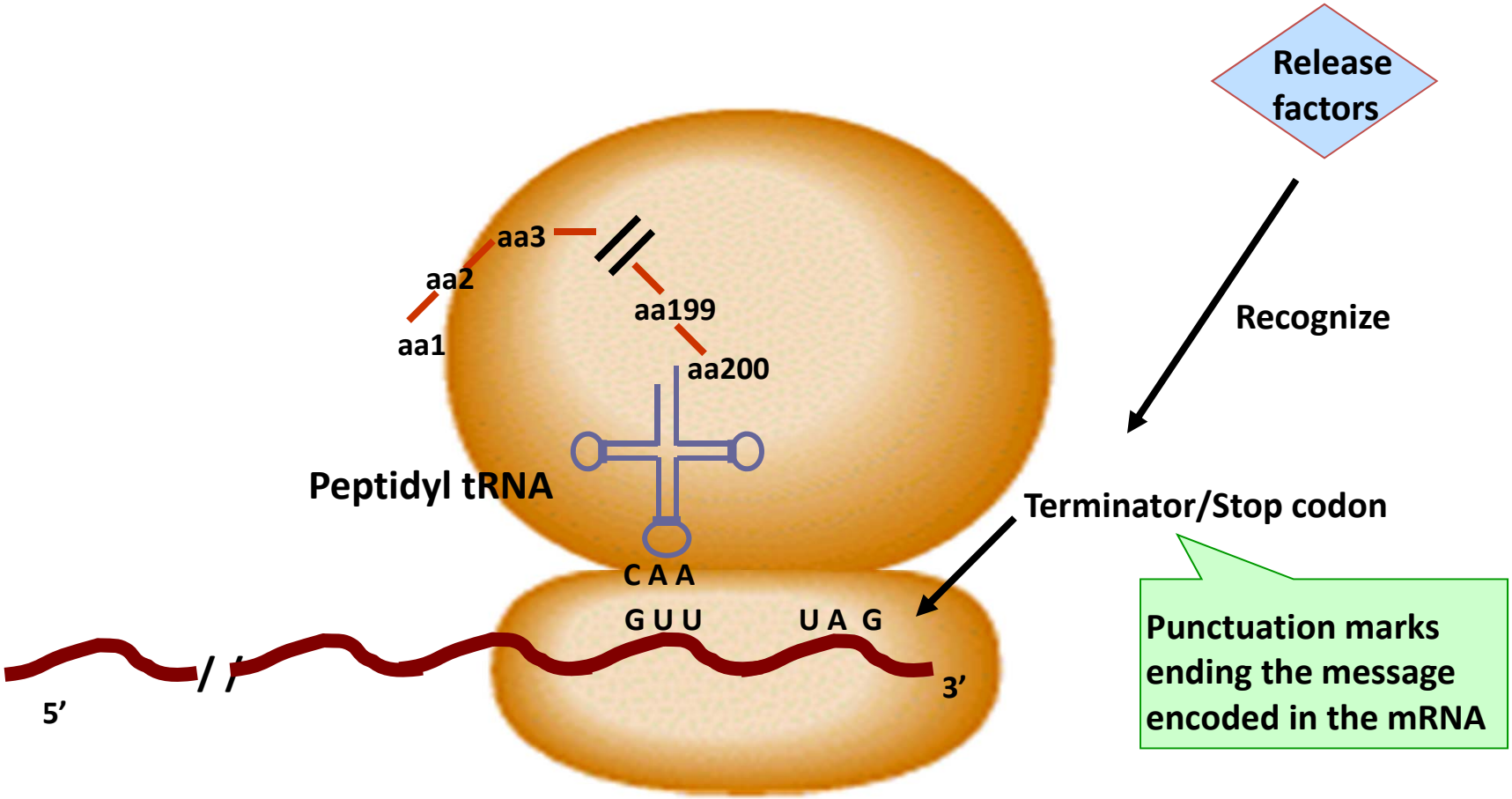


The various steps in elongation are facilitated by protein factors known as elongation factors

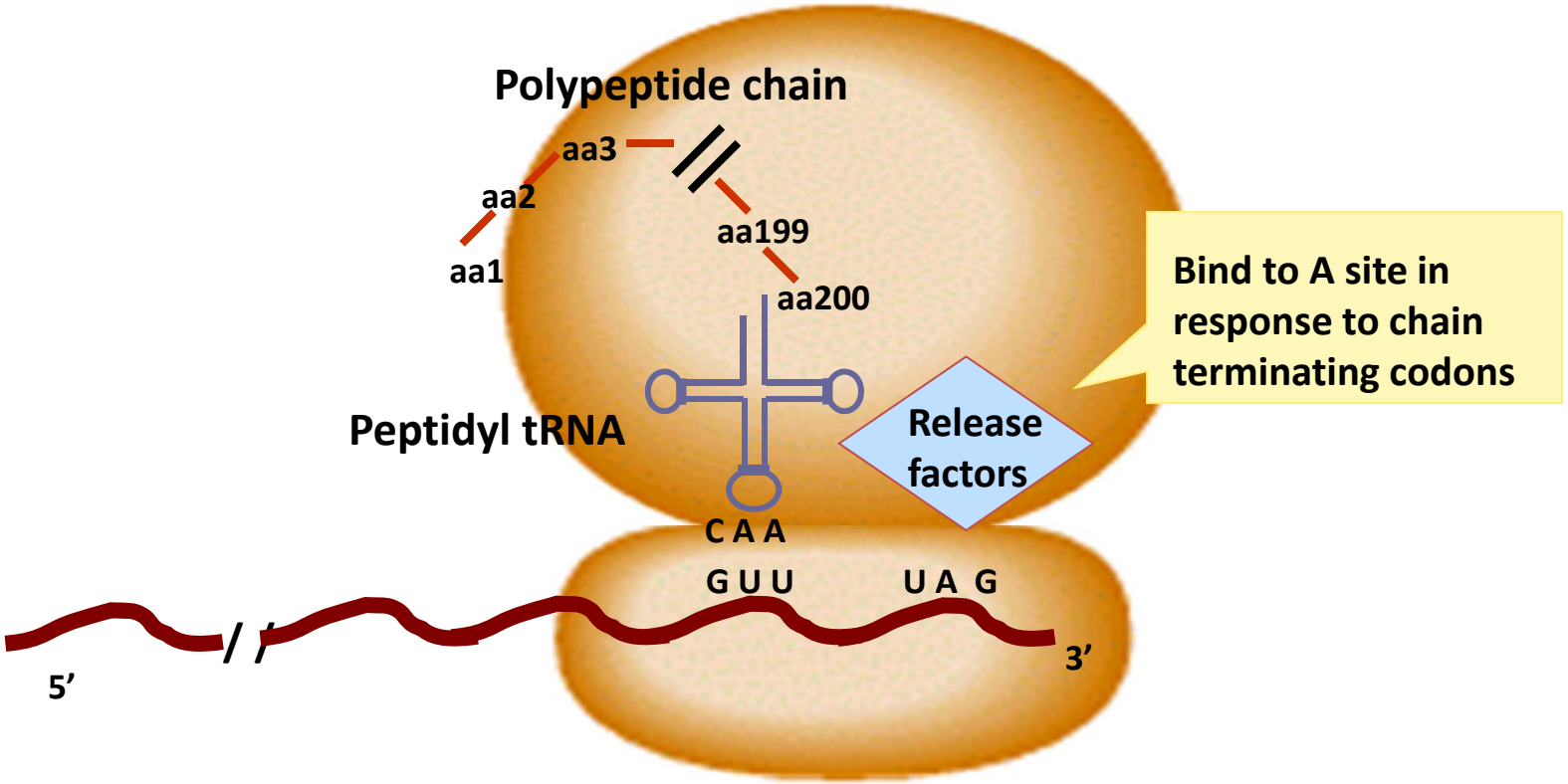
Peptide Bond Formation



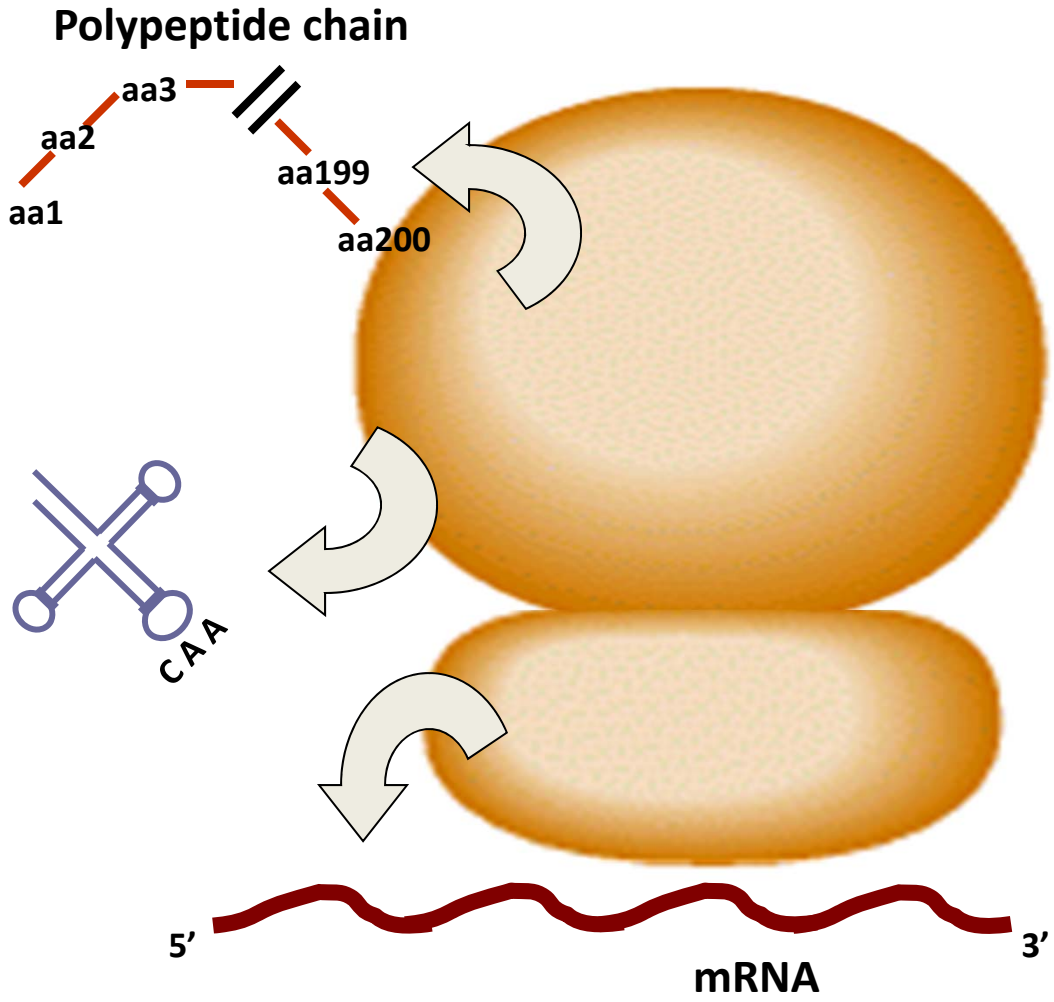
Termination



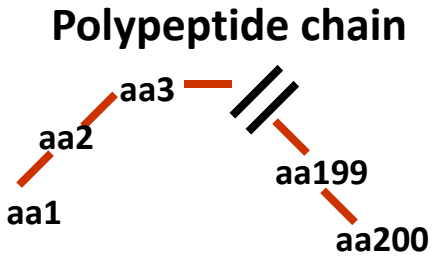
Termination

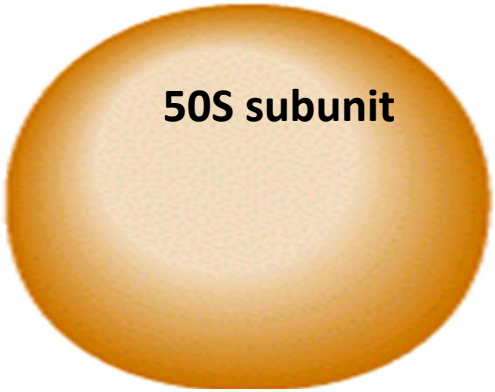


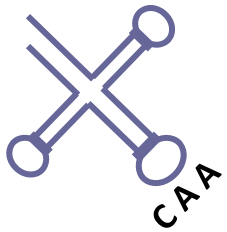
Release of the polypeptide chain



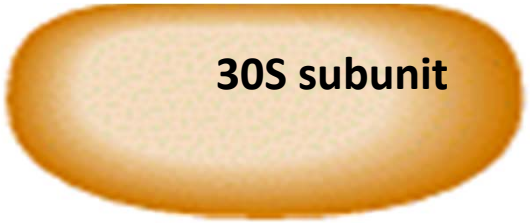
Release of the polypeptide chain



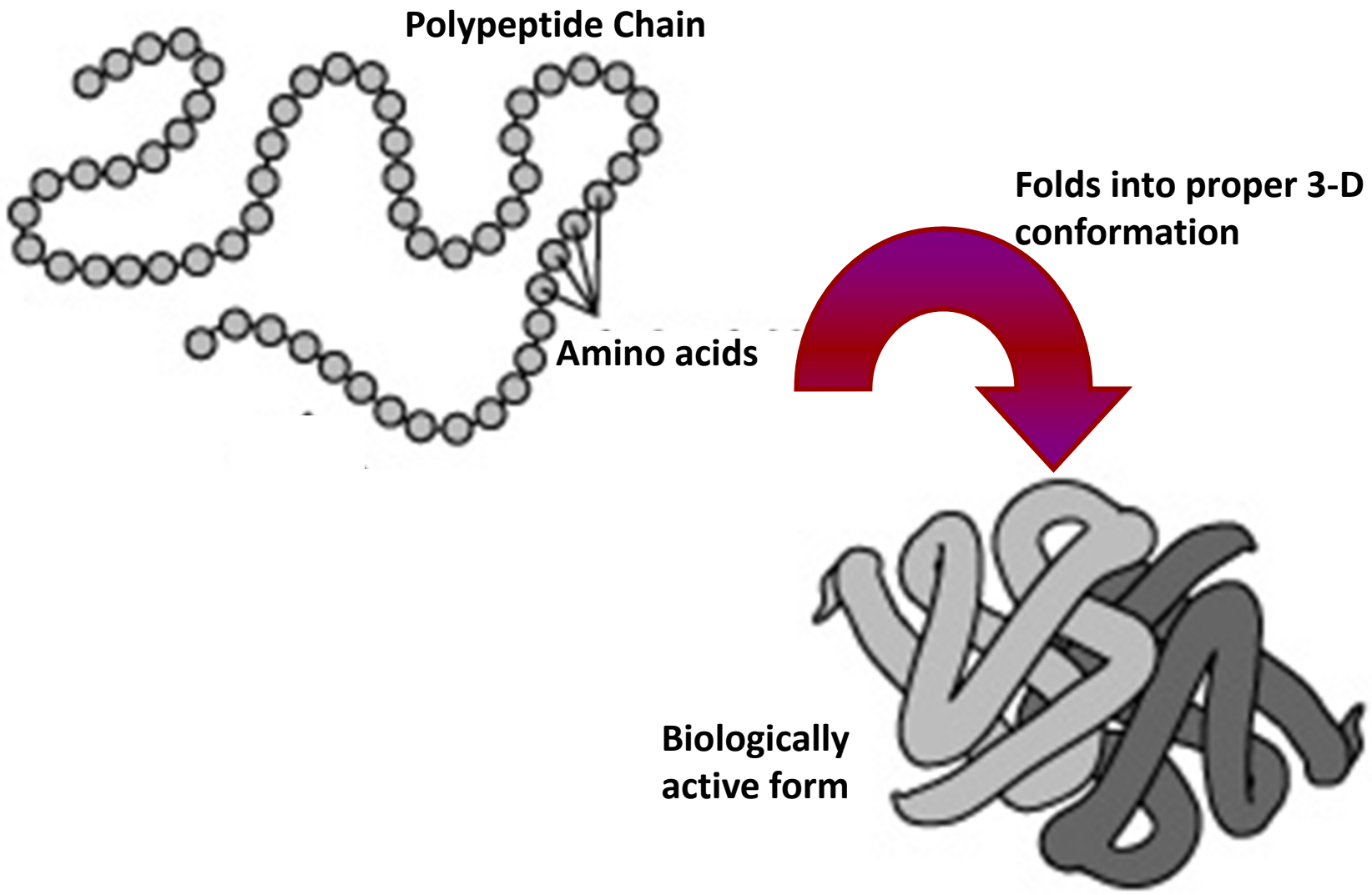




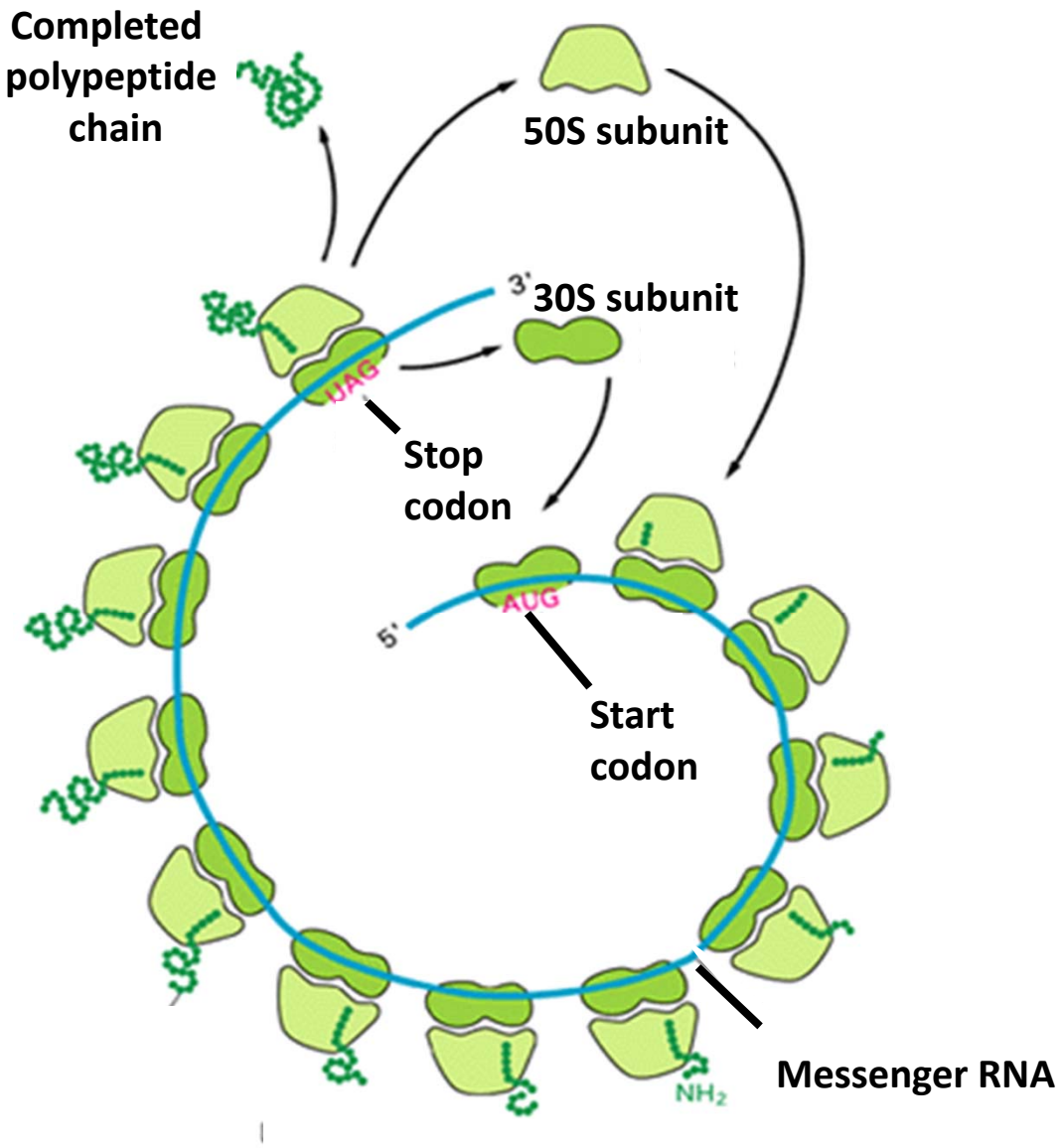
The ribosome dissociates into 2 subunits ending translation



Folding & Processing



Summary


Completed polypeptide chain
50S subunit
3'
30S subunit
UAG
Stop codon
5'
AUG
Start codon
NH2
Messenger RNA