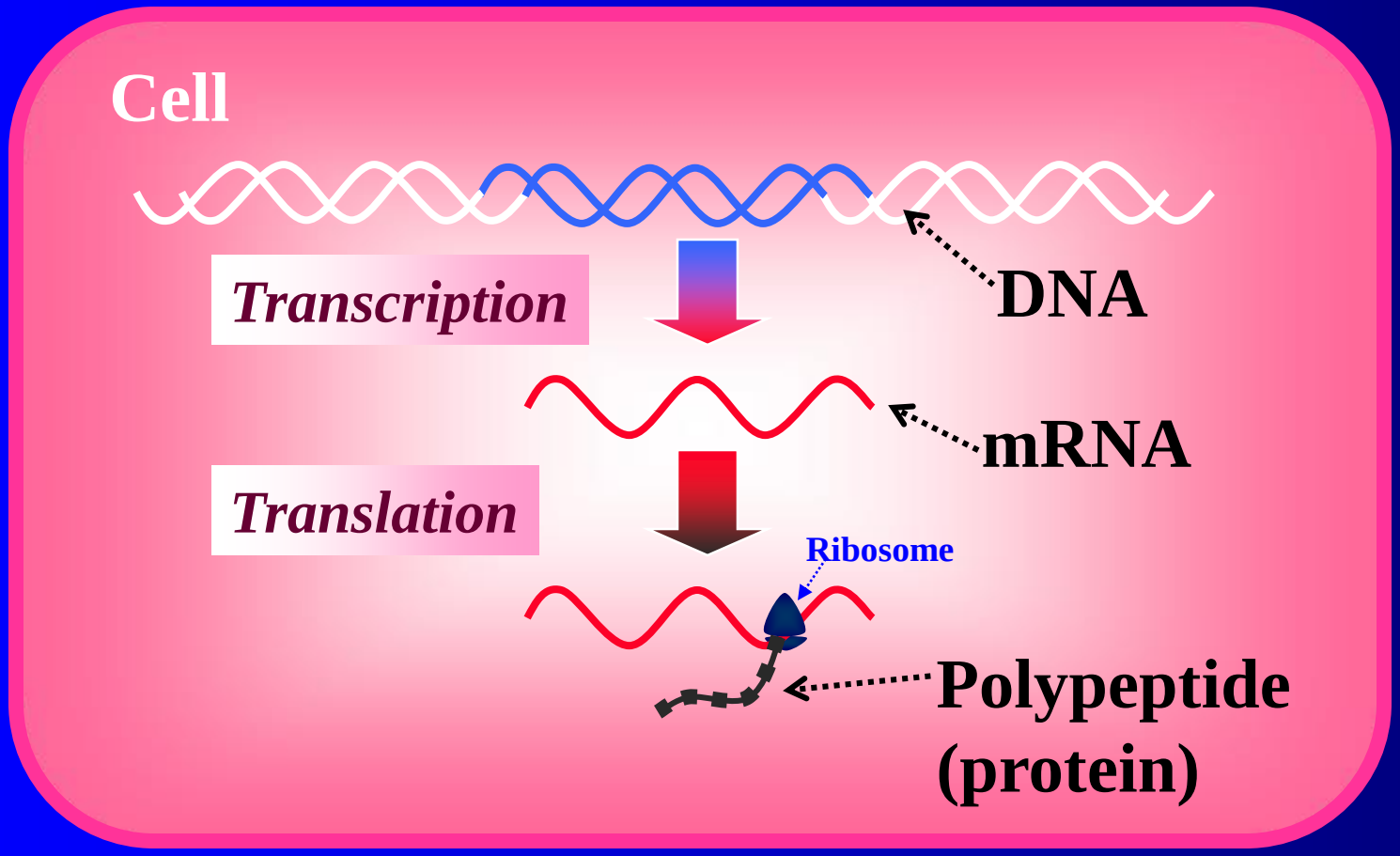
Introduction

The Central Dogma

of Molecular Biology



Protein Synthesis

Flow of Information:

DNA → RNA → Proteins

Transcription Translation

Transcription is the process by which a molecule of DNA is copied into a **complementary strand of RNA**.

This is called **messenger RNA (mRNA)** because it acts as a messenger between DNA and the ribosomes where **protein synthesis is carried out.**

Protein Synthesis Transcription

Transcription process

- **RNA polymerase** (an enzyme) attaches to DNA at a special sequence that **serves as a "start signal".**
- The DNA strands are separated and **one strand serves as a template**.
- The **RNA bases** attach to the complementary DNA template, thus **synthesizing mRNA**.

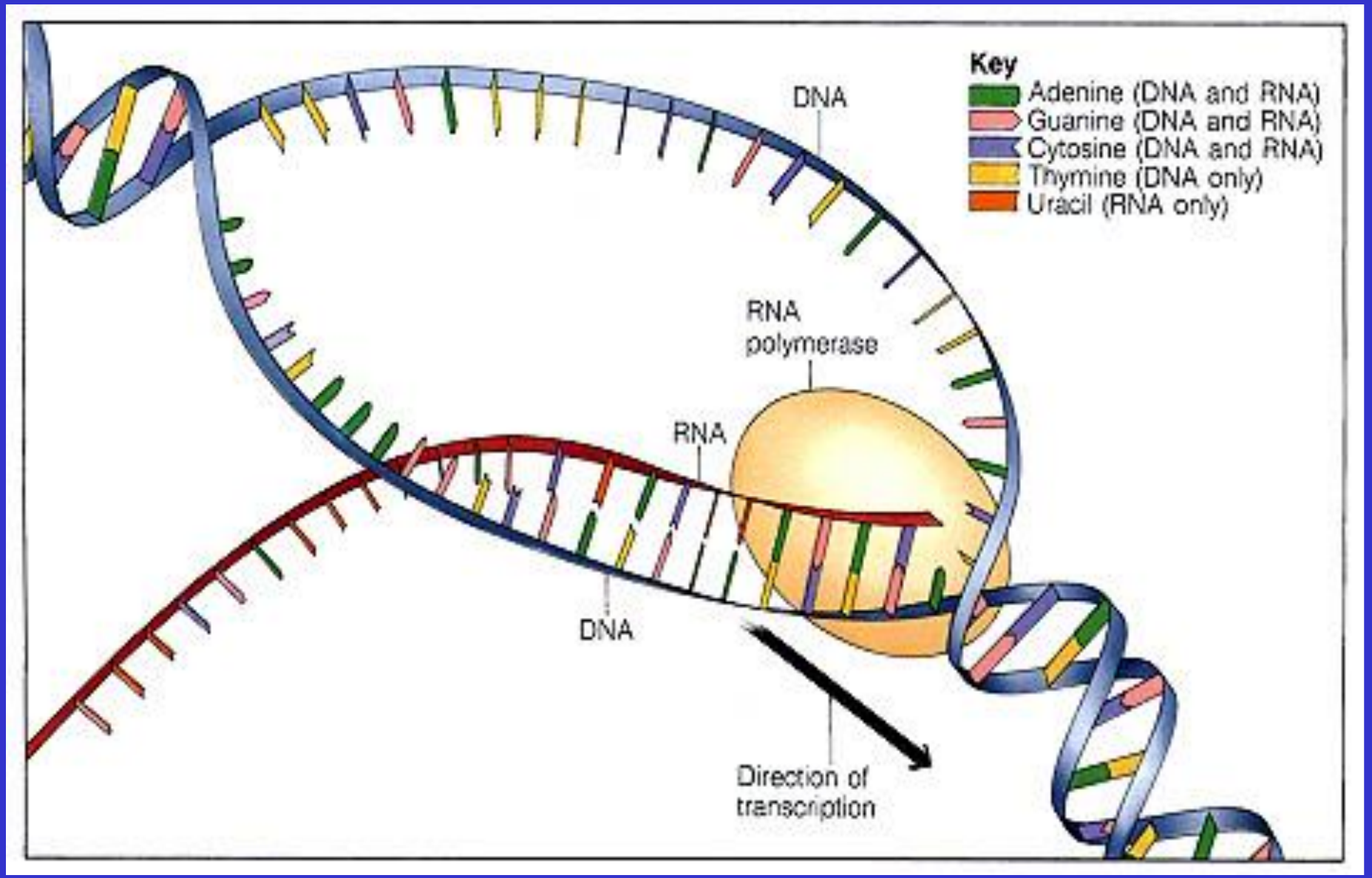
Protein Synthesis: Transcription

Transcription process continued

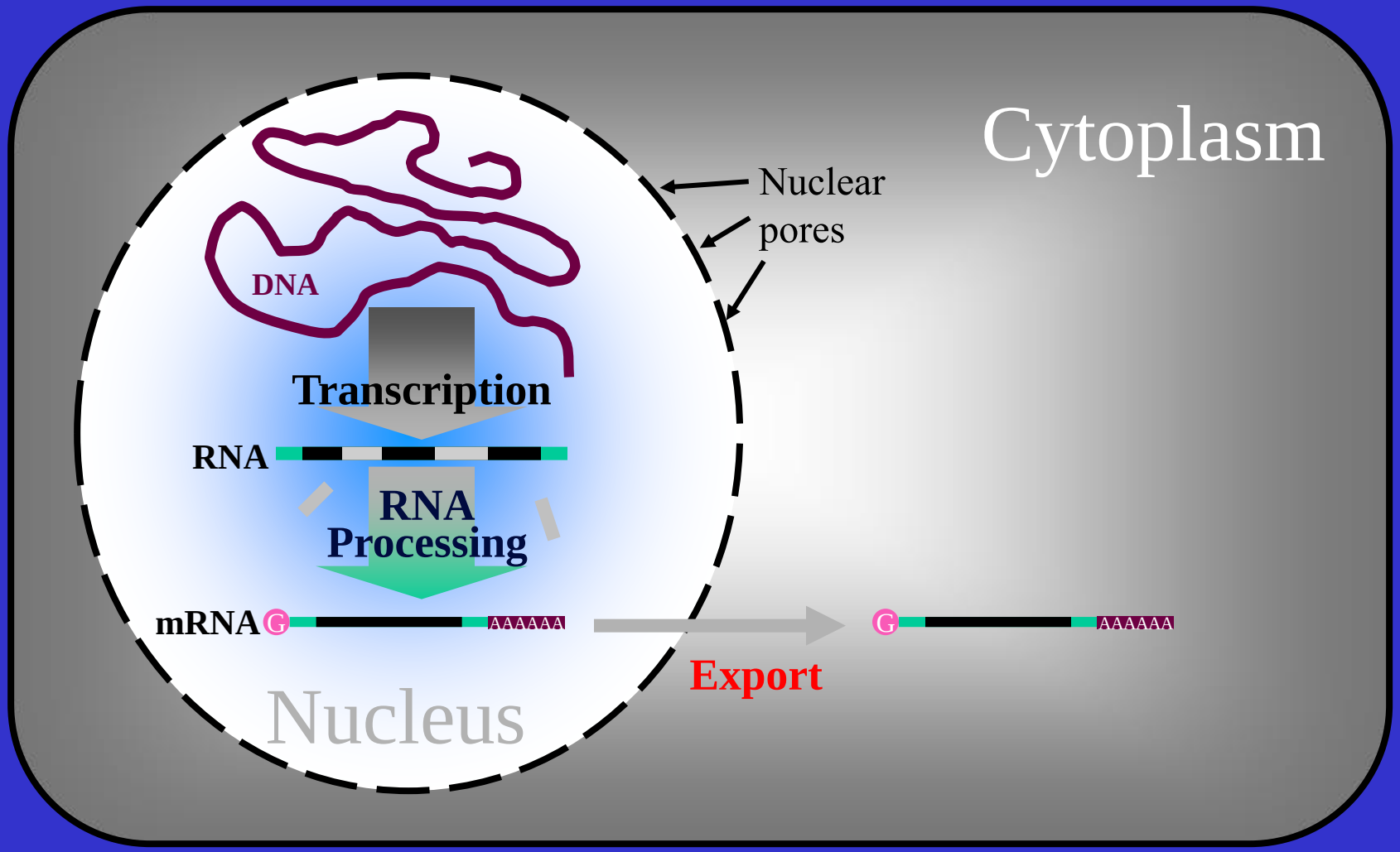
- The RNA polymerase recognizes a termination site on the DNA molecule and **releases the new mRNA molecule**.

(mRNA leaves the nucleus and travels to the **ribosome in the cytoplasm**.)

Protein Synthesis: Transcription



Eukaryotic Transcription



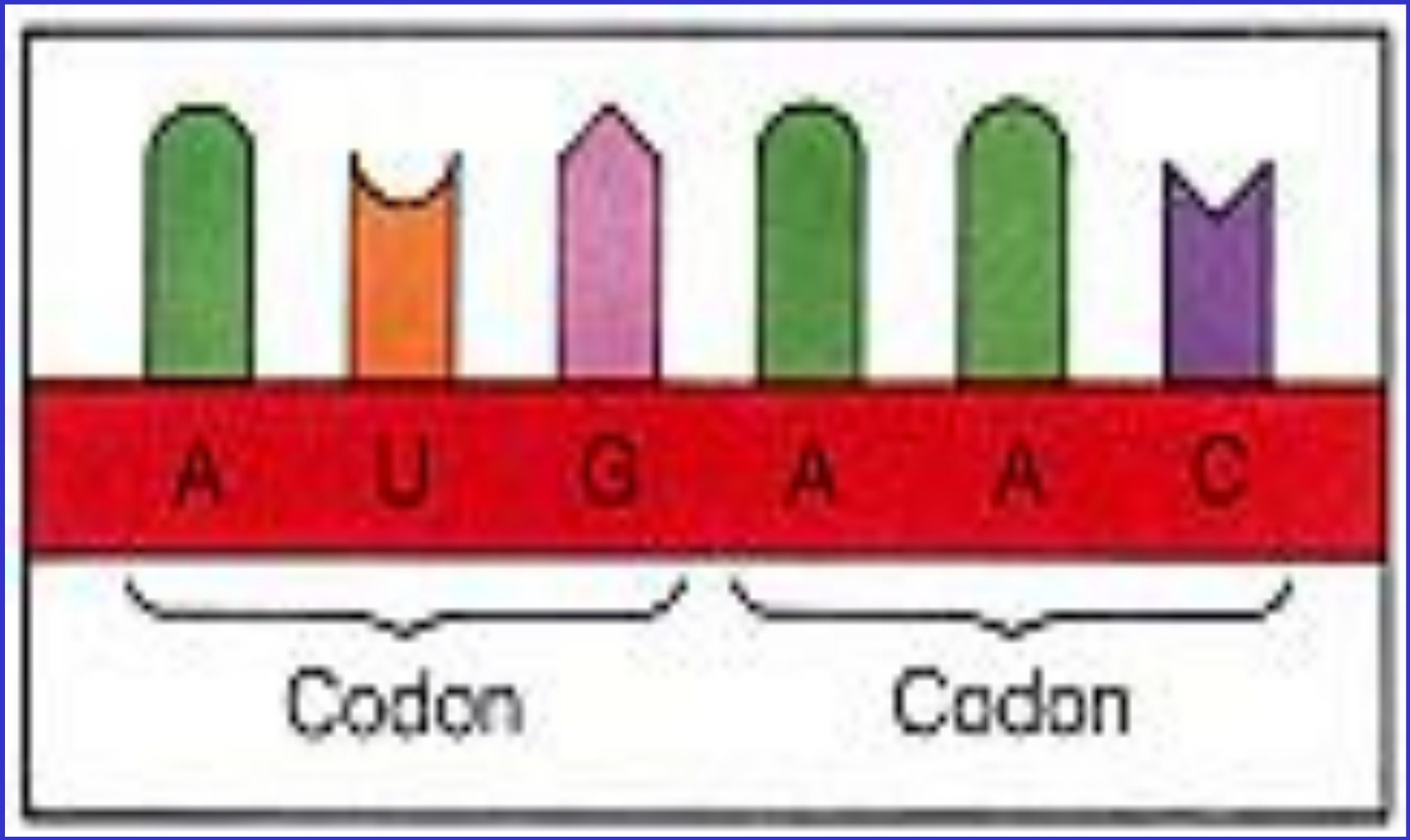
Protein Synthesis: Translation

Translation is the process of decoding a mRNA molecule into a **polypeptide chain or protein.**

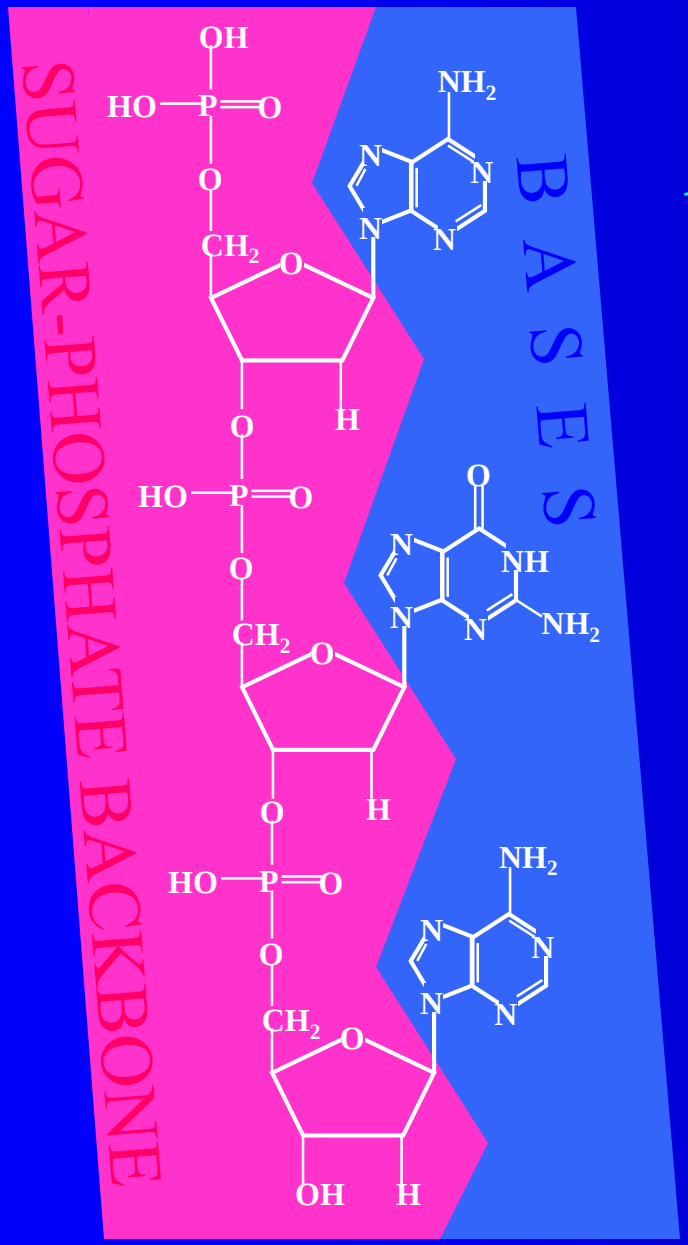
Each combination of 3 nucleotides on mRNA is called a **codon or three-letter code word.**

Each codon specifies a **particular amino acid** that is to be placed in the polypeptide chain (protein).

Protein Synthesis: Translation



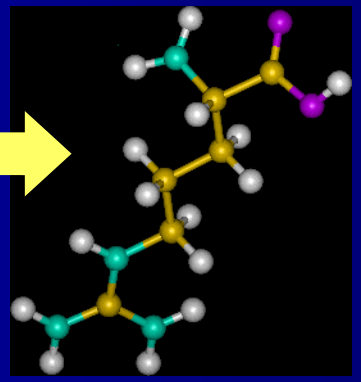
A Codon



Adenine

Guanine

Adenine

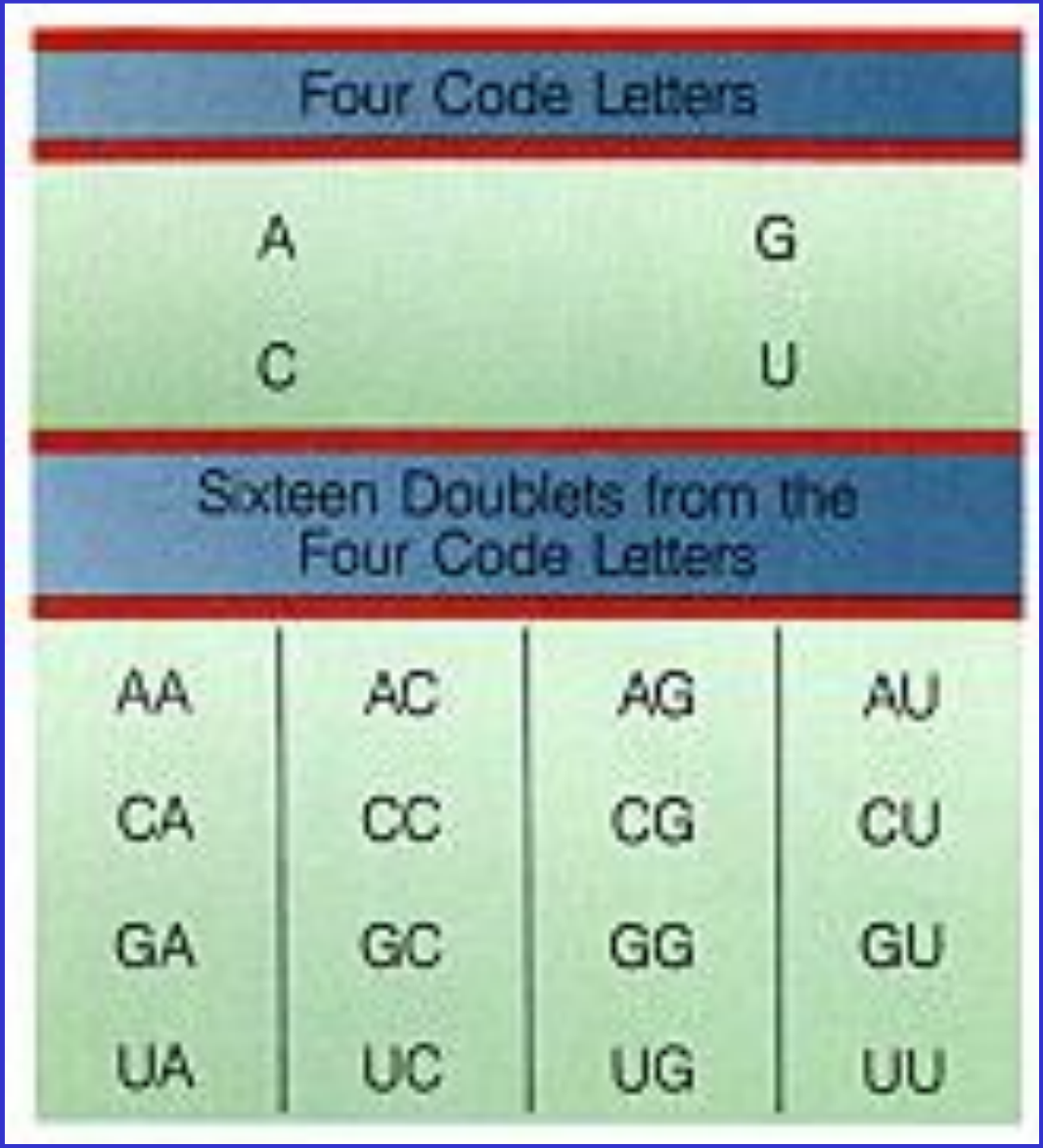


Arginine

Protein Synthesis: Translation

- A three-letter code is used because there are **20 different amino acids** that are used to make proteins.
- If a **two-letter code** were used there would not be enough codons to select all 20 amino acids.
- That is, there are 4 bases in RNA, so 4^2 (4x 4)=16; **where as 4^3 (4x4x4)=64**.

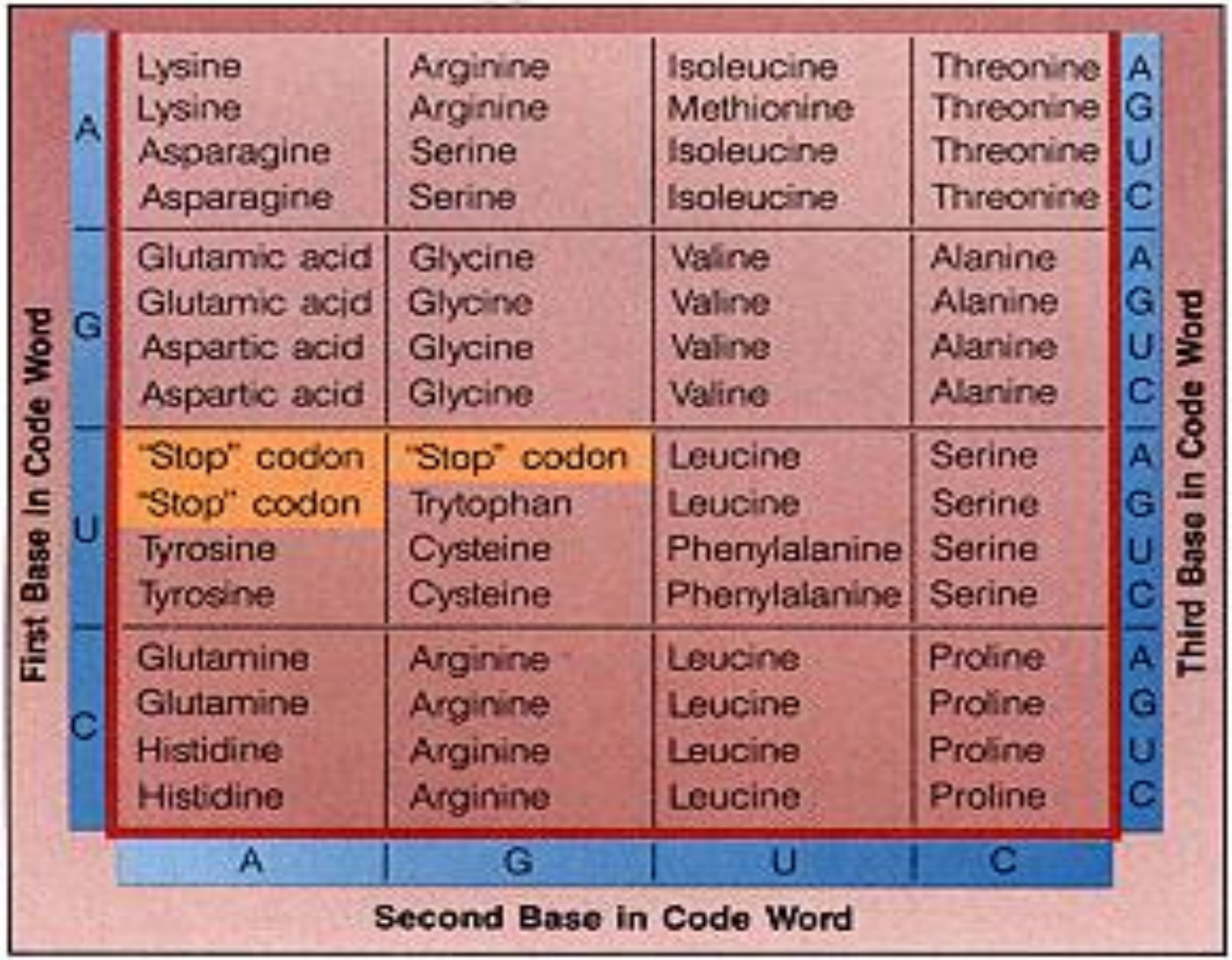
Protein Synthesis: Translation



Protein Synthesis: Translation

- Therefore, there is a total of 64 codons with mRNA, **61specify a particular amino acid**.
- This means there are **more than one codon** for each of the 20 amino acids.
- The remaining three codons (UAA, UAG, & UGA) are **stop codons**, which signify the end of a polypeptide chain (protein).
- Besides selecting the amino acid methionine, the codon **AUG** also serves as the "**initiator codon**, which starts the synthesis of a protein

Protein Synthesis: Translation

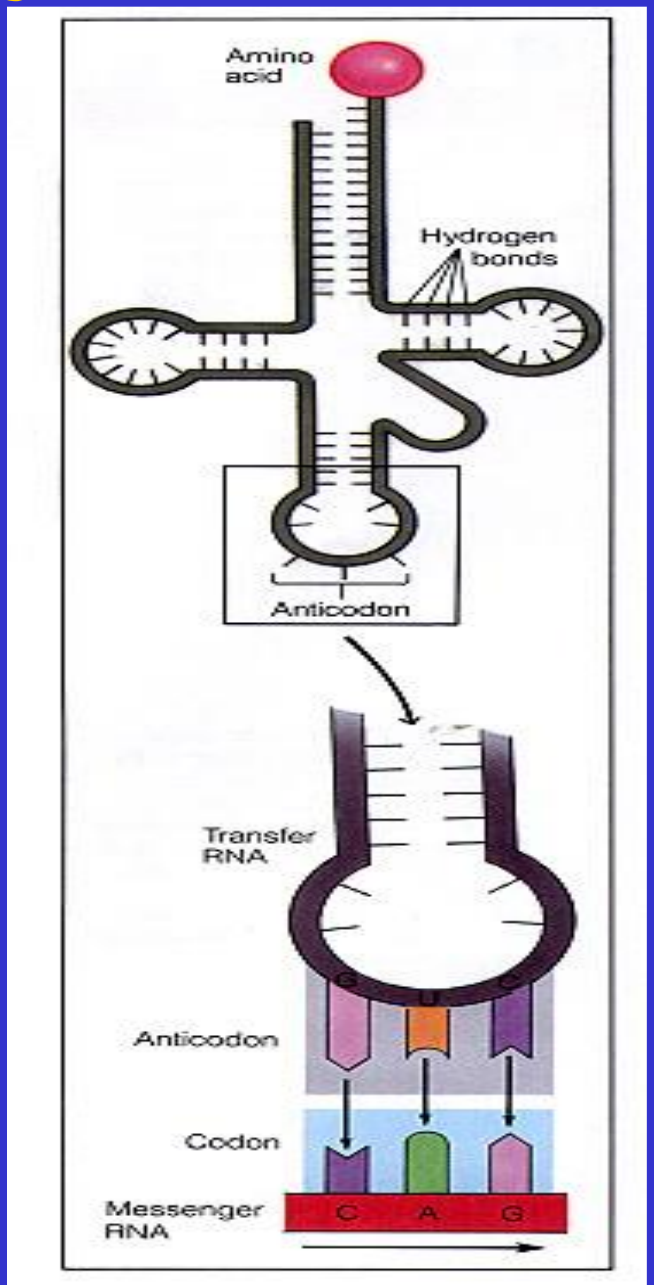


Protein Synthesis: Translation

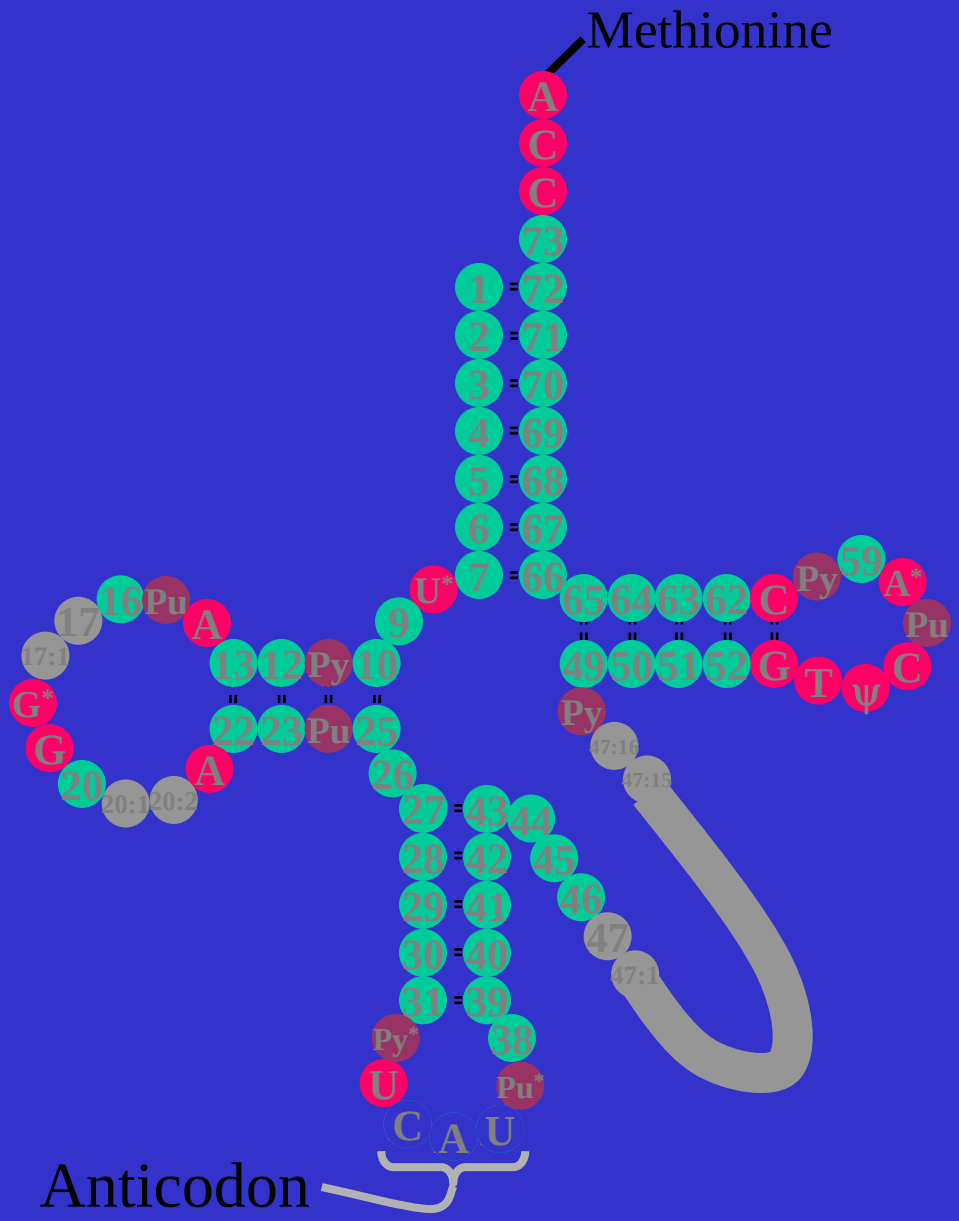
Transfer RNA (tRNA)

- Each tRNA molecule has **2 important sites of attachment**.
- One site, called the **anticodon**, binds to the codon on the mRNA molecule.
- The other site attaches to a **particular amino acid**.
- During protein synthesis, the anticodon of a tRNA molecule **base pairs** with the appropriate mRNA codon.

Protein Synthesis: Translation



Met-tRNA


Methionine
A
C
C
73
1
72
2
71
3
70
4
69
5
68
6
67
7
66
U*
9
16
Pu
17
17:1
A
13
12
Py
10
G*
G
22
23
Pu
25
20
20:1
20:2
A
26
27
43
44
28
42
45
29
41
46
30
40
47
31
39
47:1
38
Py*
U
Pu*
C
A
U
Anticodon
65
64
63
62
C
Py
59
A*
Pu
49
50
51
52
G
T
ψ
C
Py
47:16
47:15

Protein Synthesis: Translation

Ribosome:

- Are made up of 2 subunits, a large one and a smaller one, each subunit contains **ribosomal RNA (rRNA) & proteins**.
- Protein synthesis starts when the **two subunits bind to mRNA**.
- The initiator codon AUG binds to the first anticodon of tRNA, **signaling the start of a protein.**

Protein Synthesis: Translation

Ribosome:

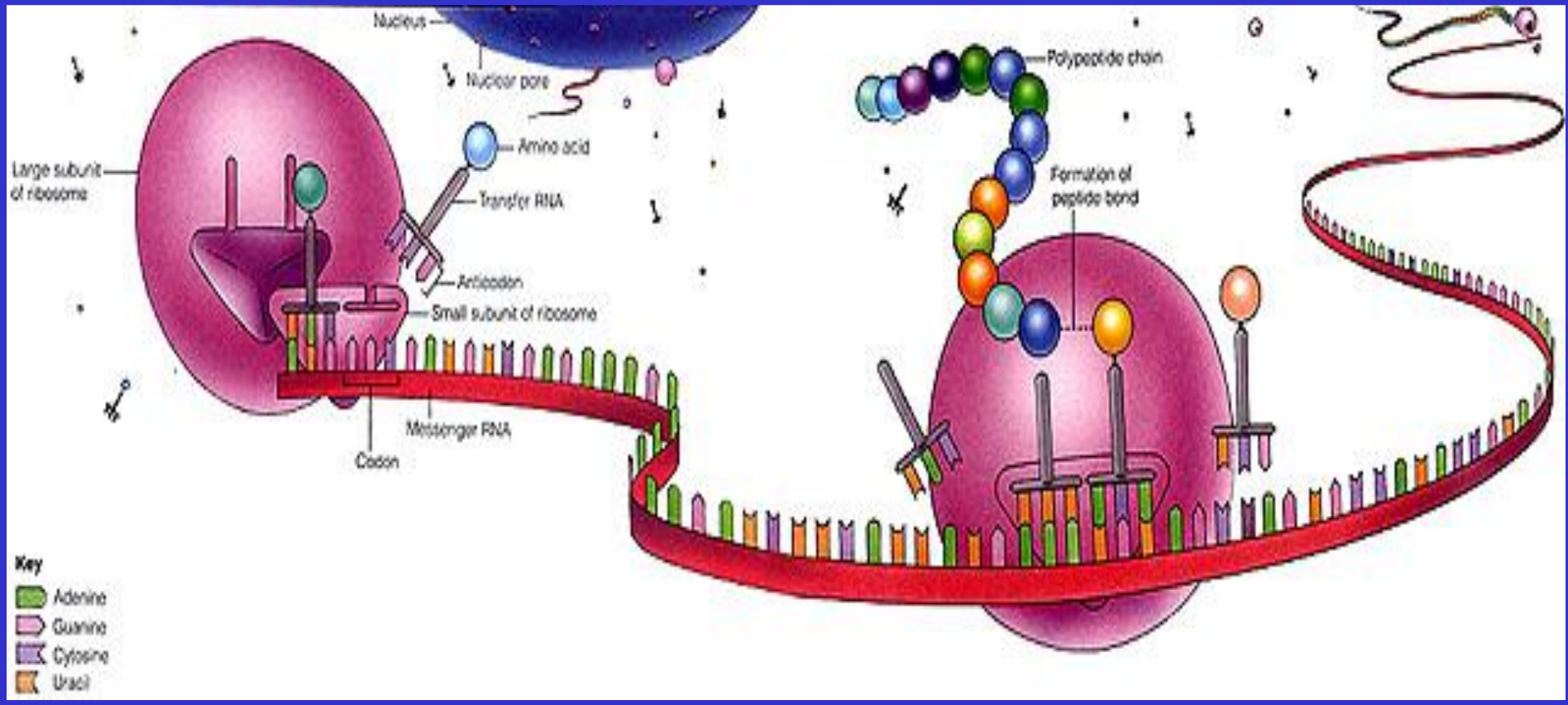
- The anticodon of another tRNA binds to the next mRNA codon, bringing the **2nd amino acid** to be placed in the protein.
- As each anticodon & codon bind together a **peptide bond forms between the two amino acids.**

Protein Synthesis: Translation

Ribosome:

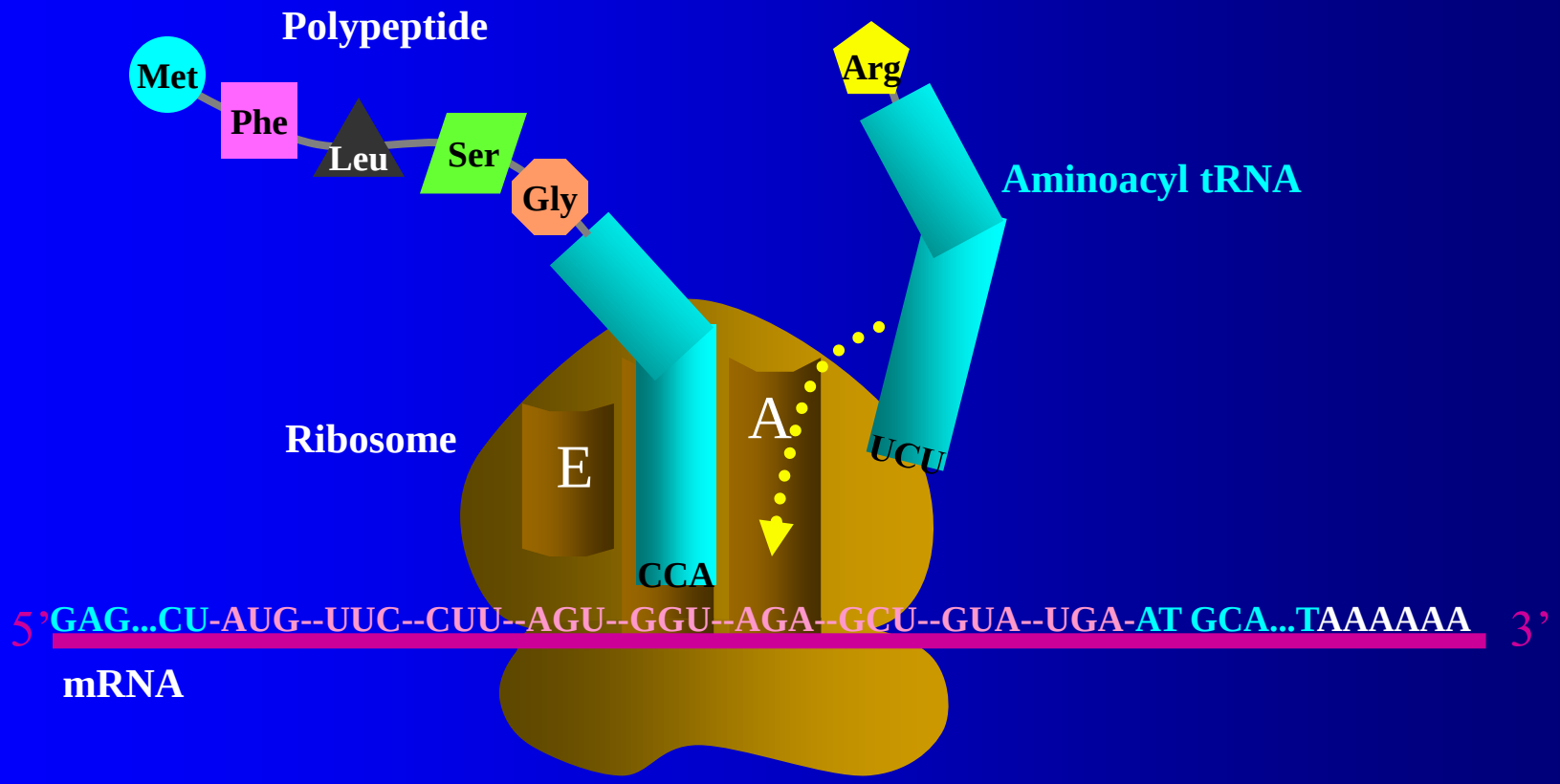
- The protein chain continues to grow until ribosome reaches the **stop codon**, which results in the release of the new protein and mRNA, **completing the process of translation**.

Protein Synthesis: Translation

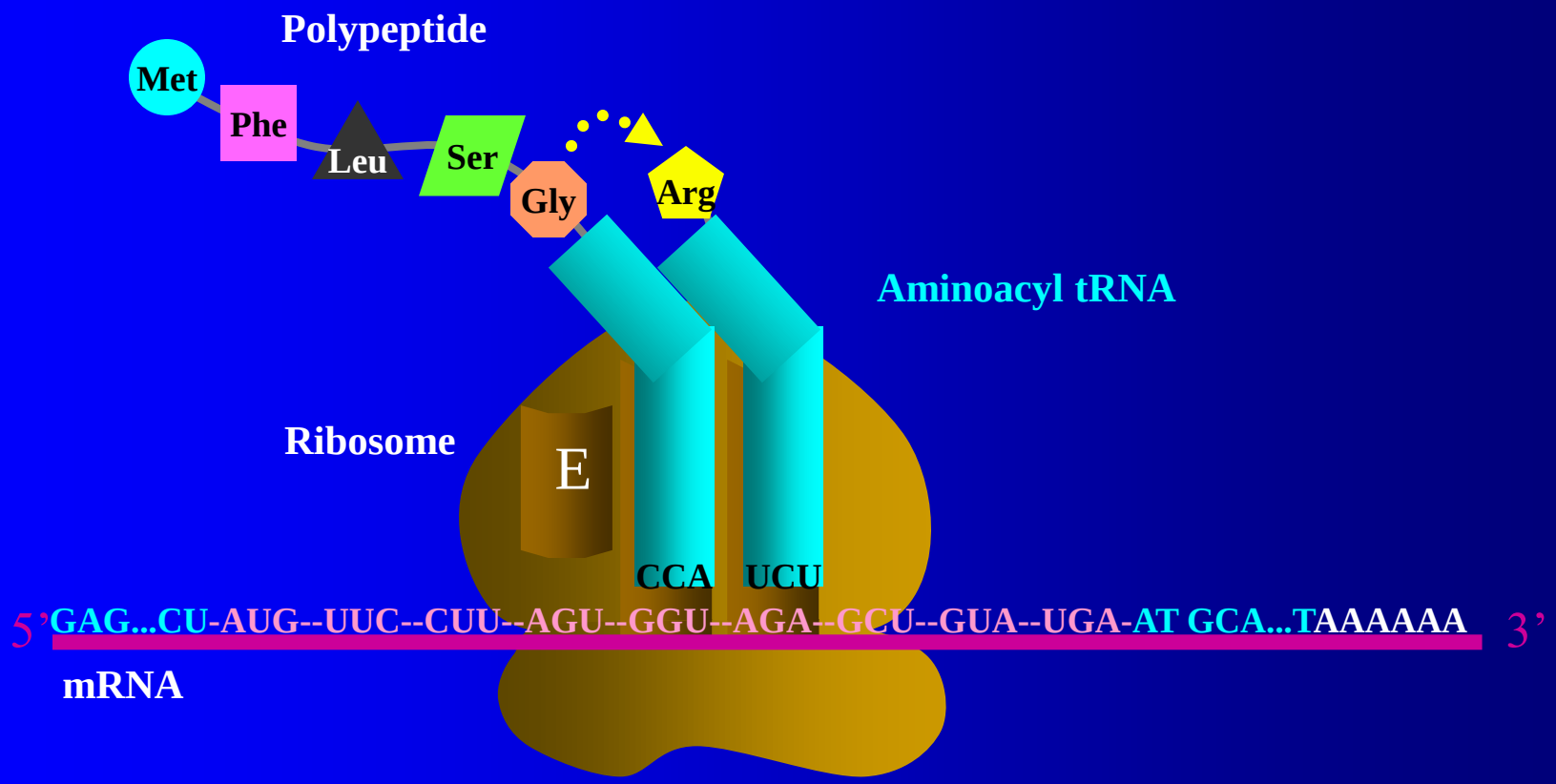


Translation - Initiation

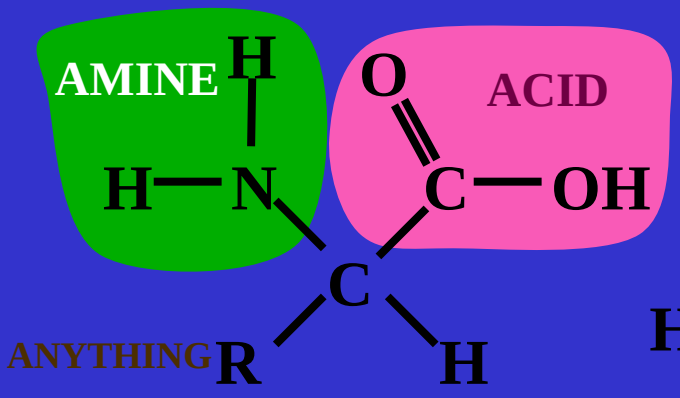
Translation - Elongation



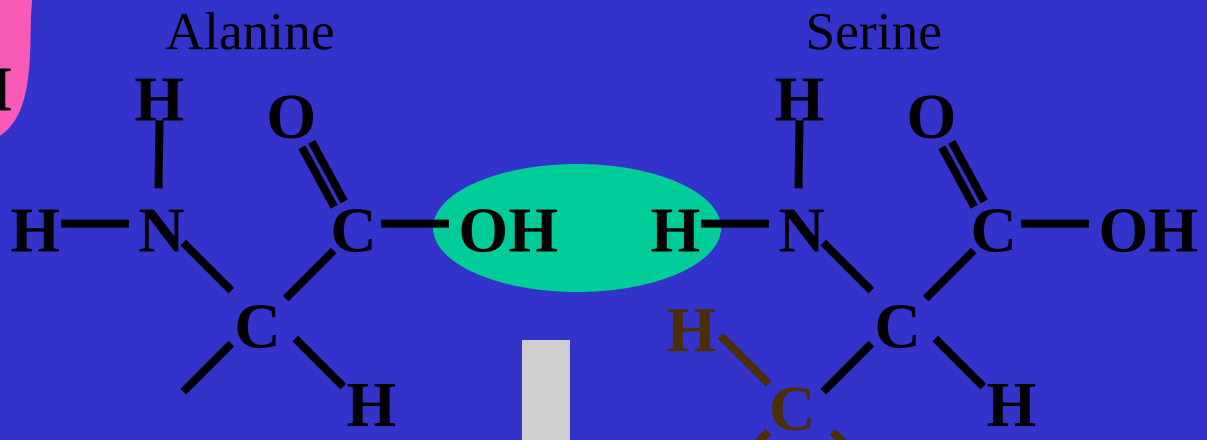
Translation - Elongation

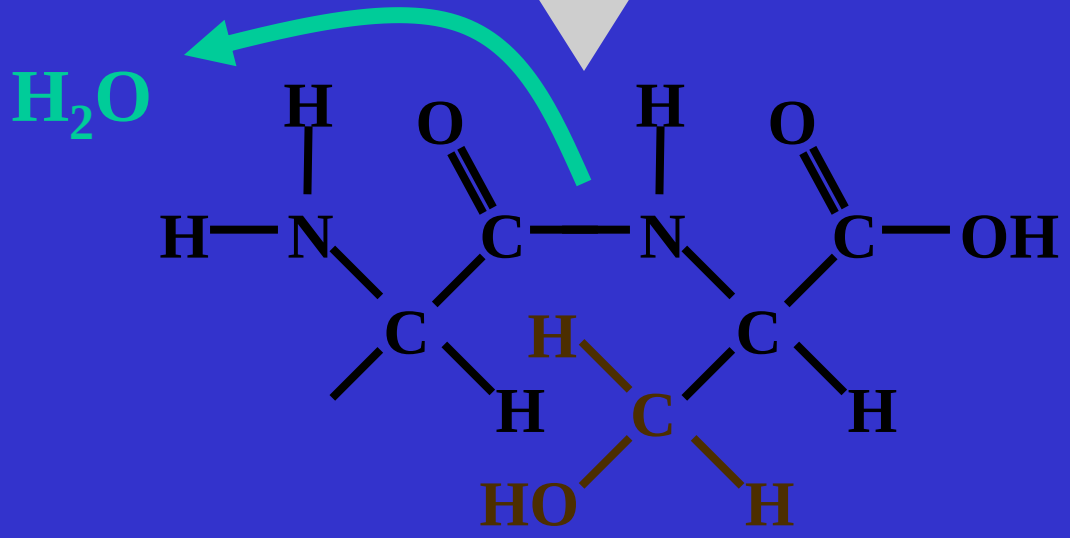


Protein Synthesis

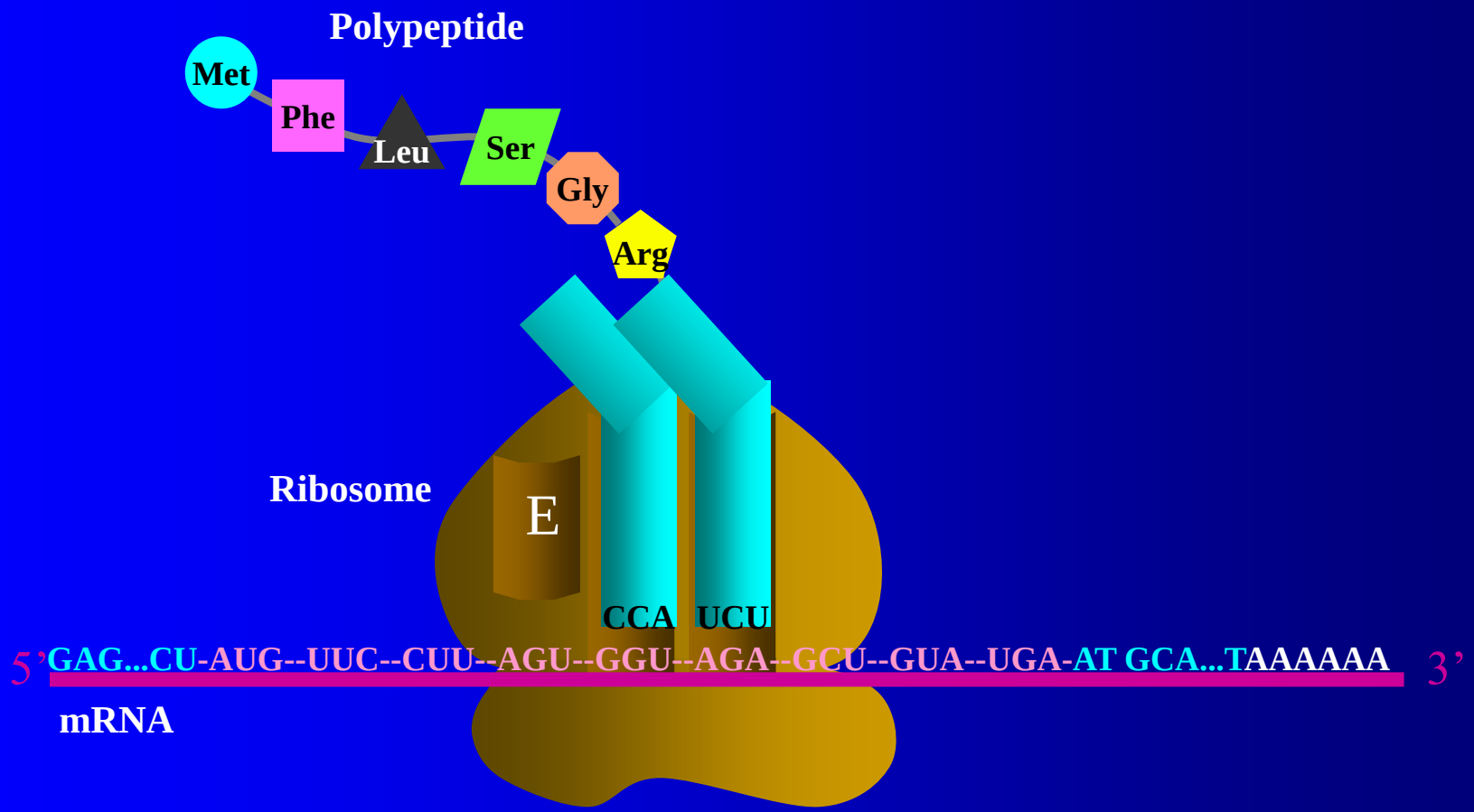


Amino Acid

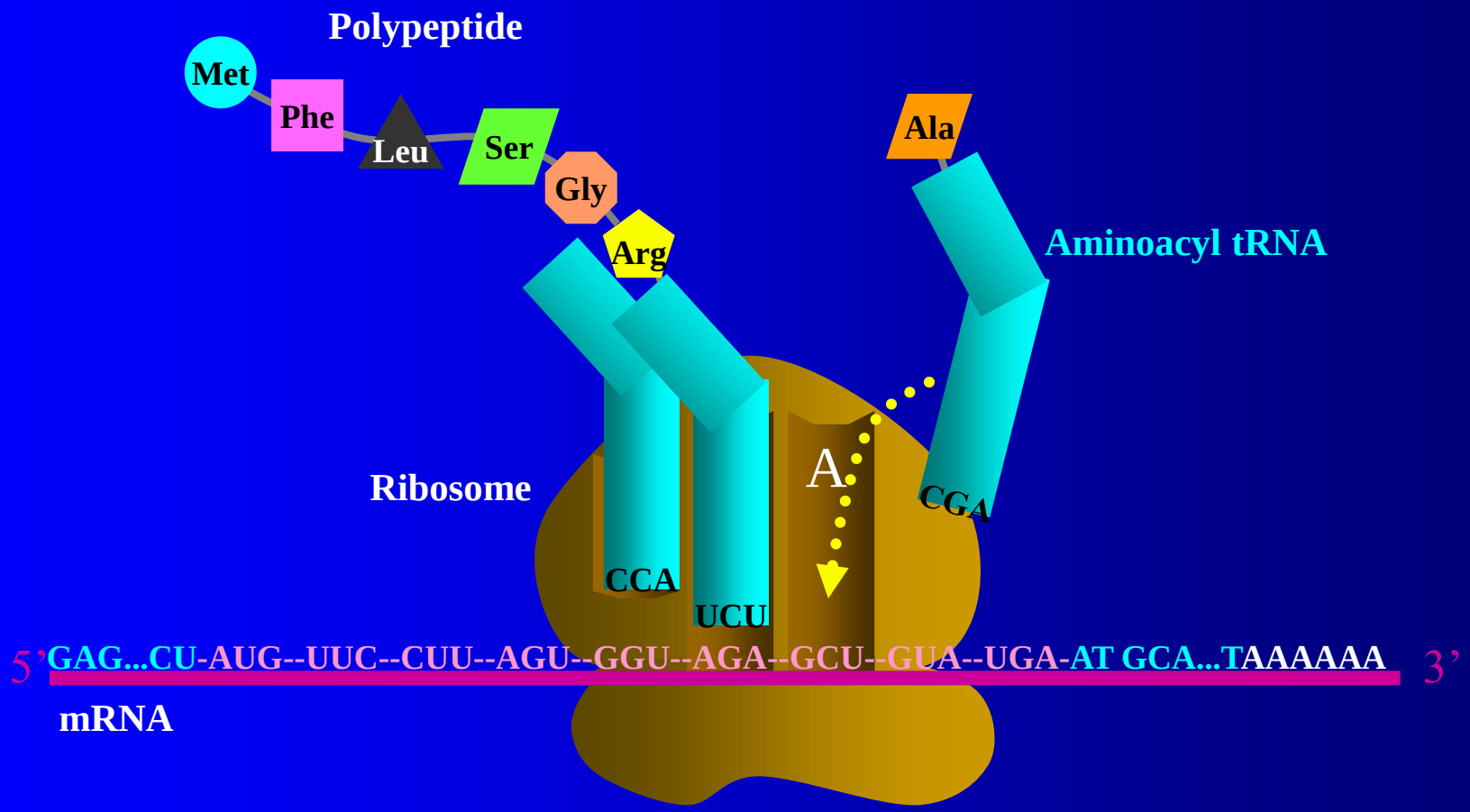




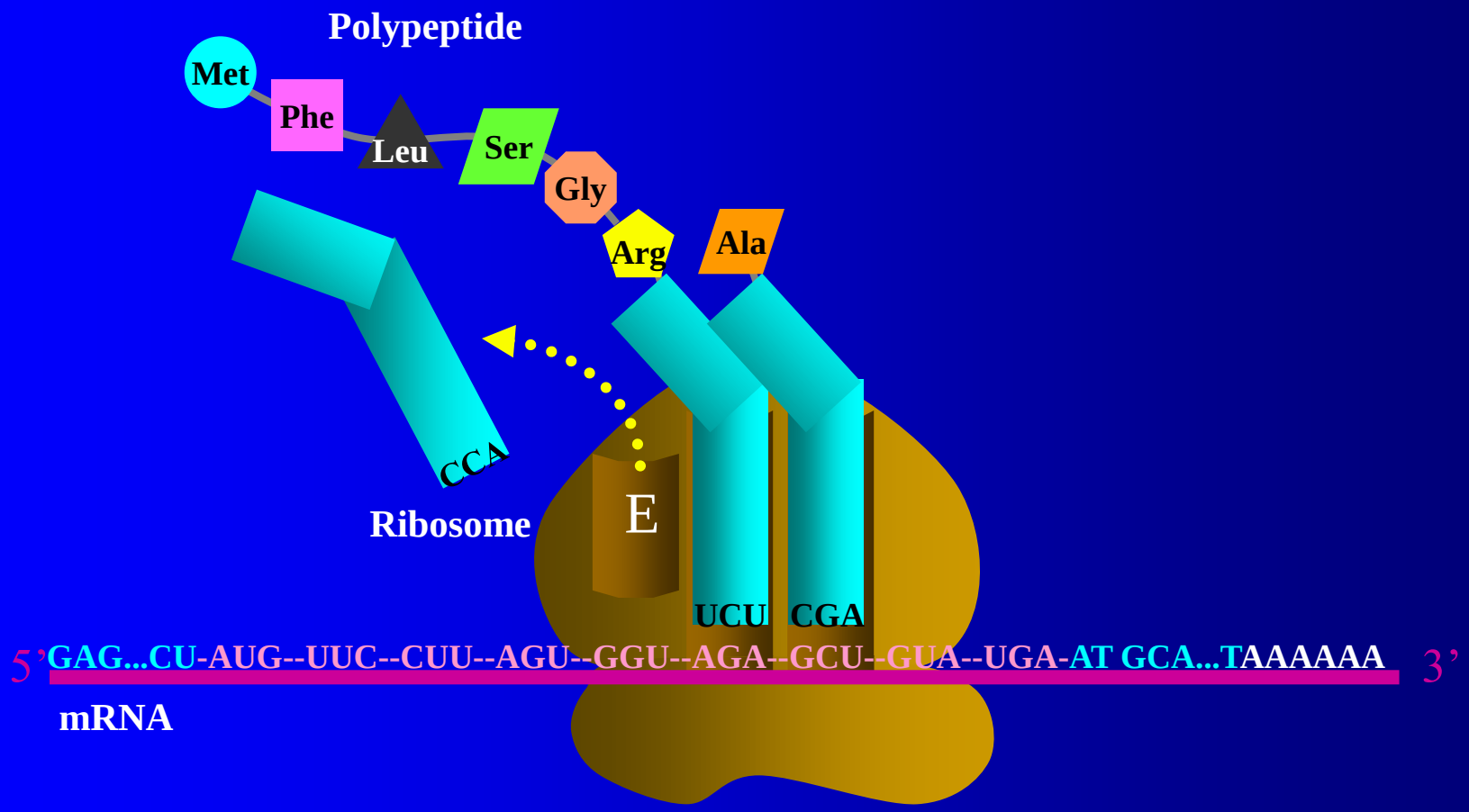
Translation - Elongation



Translation - Elongation



Translation - Elongation



Transcription And Translation In Prokaryotes