Tishk International University
Faculty of Nursing

GENETICS
Nursing Department

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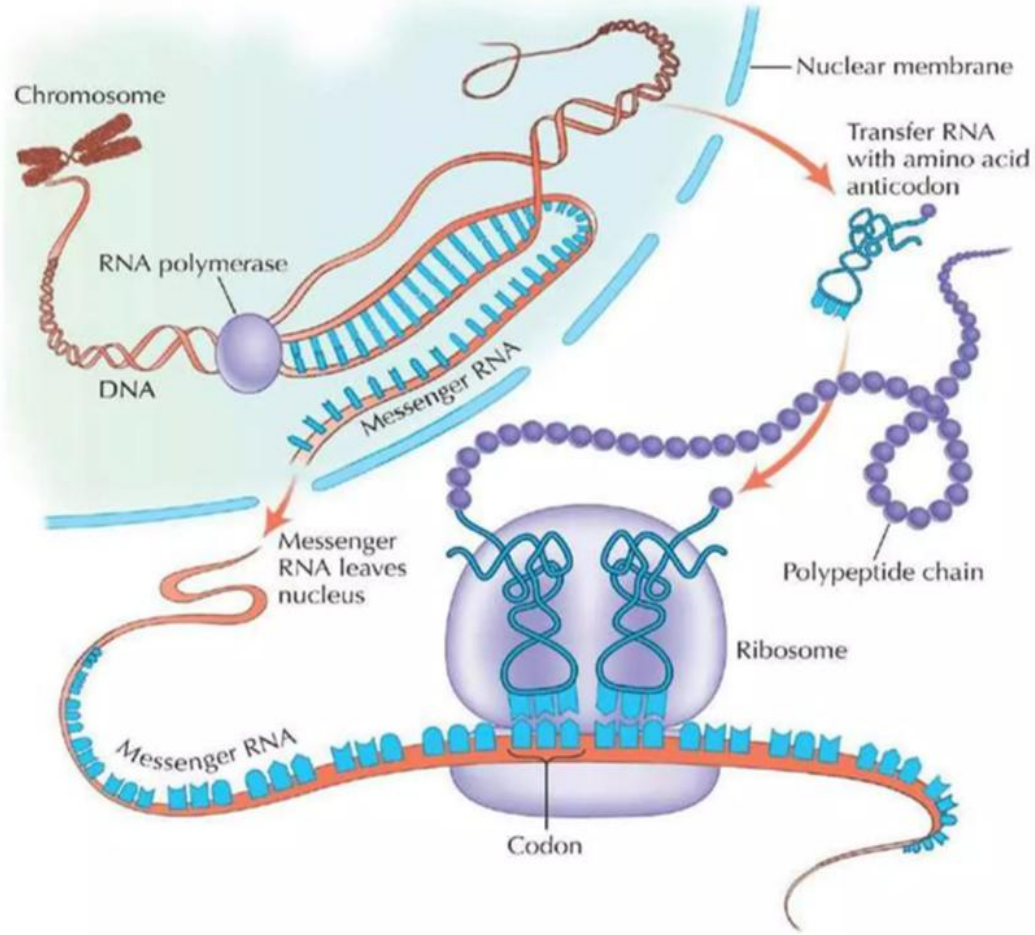
PhD in molecular Biology

week 9

Translation and Proteins



DNA

↓

RNA

↓

PROTEIN

- **Proteins are composed of one or more polypeptides.**
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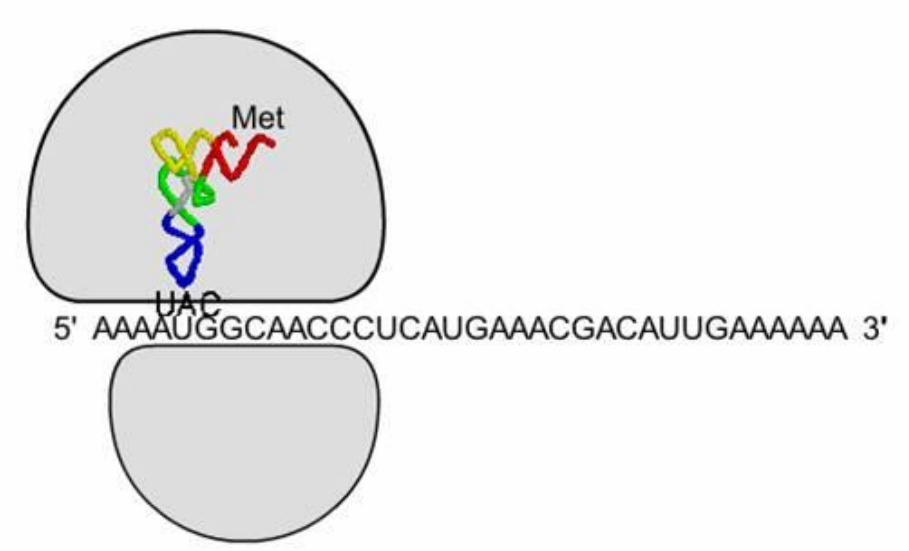
- Polypeptides are linear chains of amino acids. After synthesis, the new polypeptide folds spontaneously into its active configuration and combines with the other necessary subunits to form an active protein.

- Thus, all the information necessary to produce the protein is contained in the DNA base sequence that codes for the polypeptides.
- There are 20 different amino acids coded in DNA.

- Translation

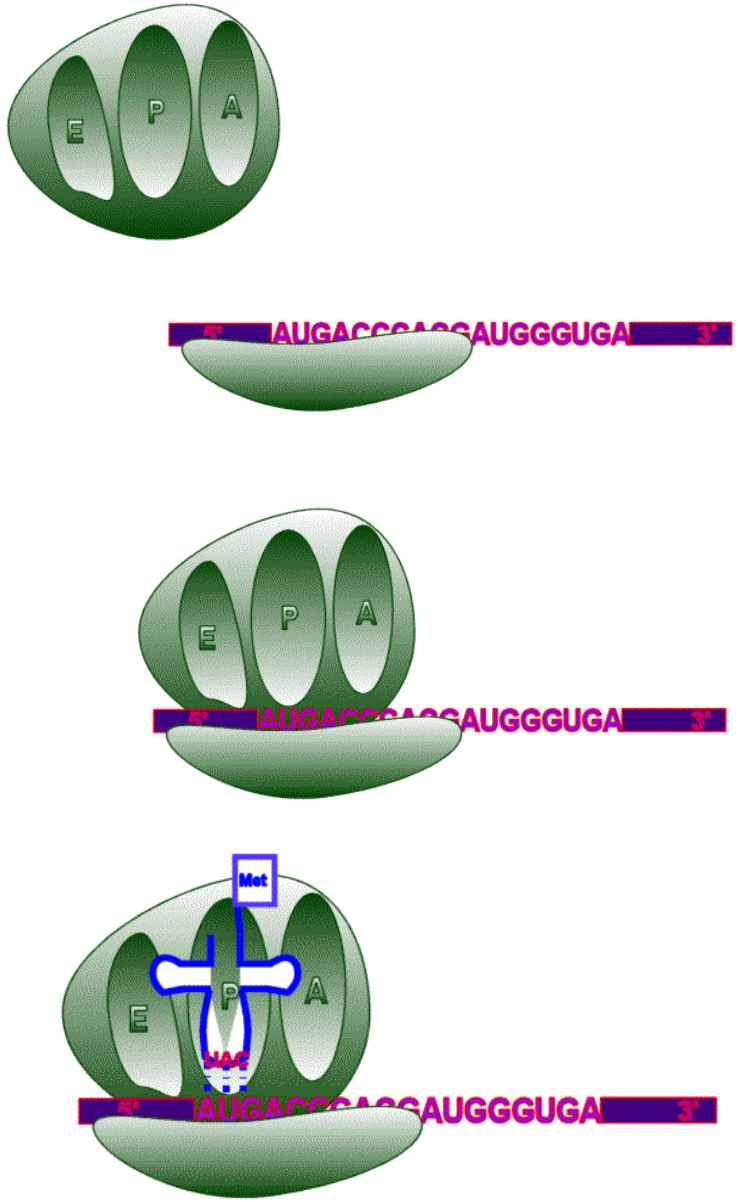
Translation of mRNA into protein is accomplished by the ribosome, an RNA/protein hybrid. Ribosomes are composed of 2 subunits, large and small.

- Second stage of protein production
- mRNA is on a ribosome



More Initiation

- The initiation process involves first joining the mRNA, the initiator methionine-tRNA, and the small ribosomal subunit. Several “initiation factors”--additional proteins--are also involved. The large ribosomal subunit then joins the complex.

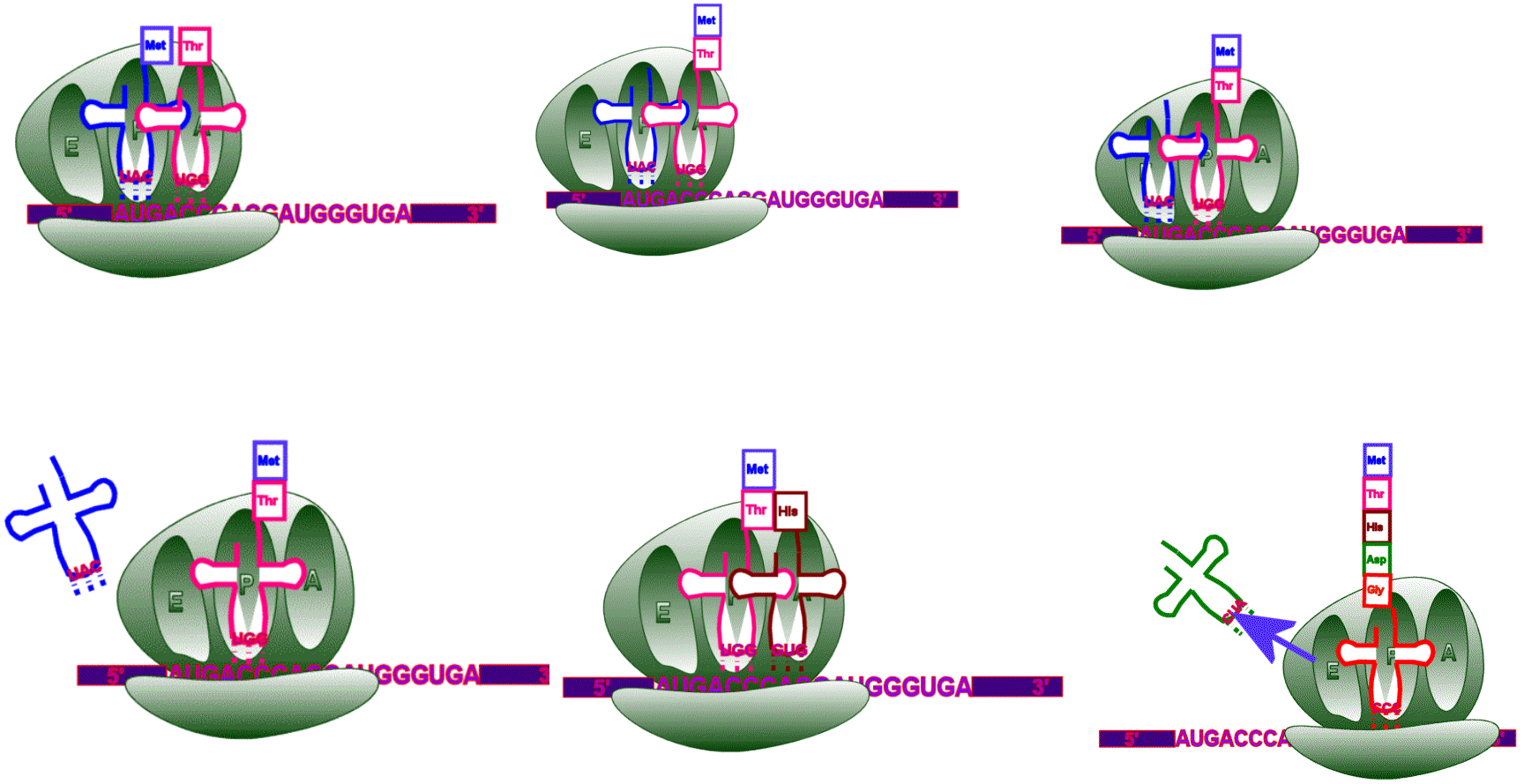


Elongation

- The ribosome has 2 sites for tRNAs, called P and A. The initial tRNA with attached amino acid is in the P site. A new tRNA, corresponding to the next codon on the mRNA, binds to the A site. The ribosome catalyzes a transfer of the amino acid from the P site onto the amino acid at the A site, forming a new peptide bond.
- The ribosome then moves down one codon. The now-empty tRNA at the P site is displaced off the ribosome, and the tRNA that has the growing peptide chain on it is moved from the A site to the P site.

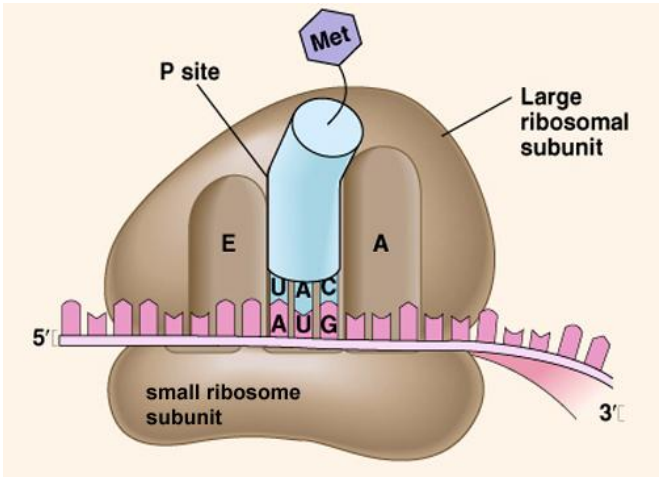
- The process is then repeated:
  - the tRNA at the P site holds the peptide chain, and a new tRNA binds to the A site.
  - the peptide chain is transferred onto the amino acid attached to the A site tRNA.
  - the ribosome moves down one codon, displacing the empty P site tRNA and moving the tRNA with the peptide chain from the A site to the P site.

Elongation

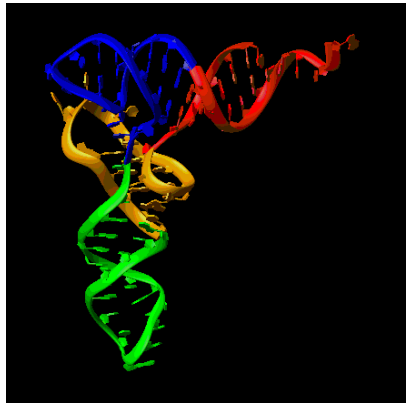


Ribosomes

- 2 subunits, separate in cytoplasm until they join to begin translation
  - Large
  - Small
- Contain 3 binding sites
  - E
  - P
  - A



tRNA



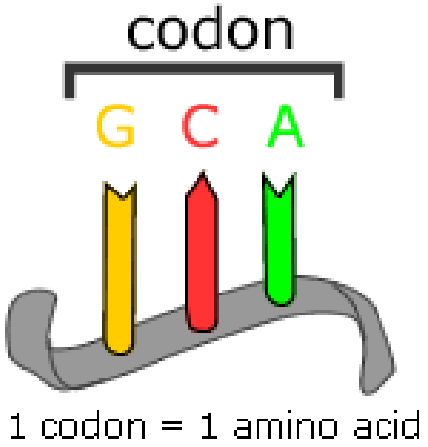
- Transfer RNA
- Bound to one amino acid on one end
- Anticodon on the other end complements mRNA codon

tRNA Function

- Amino acids must be in the correct order for the protein to function correctly
- tRNA lines up amino acids using mRNA code

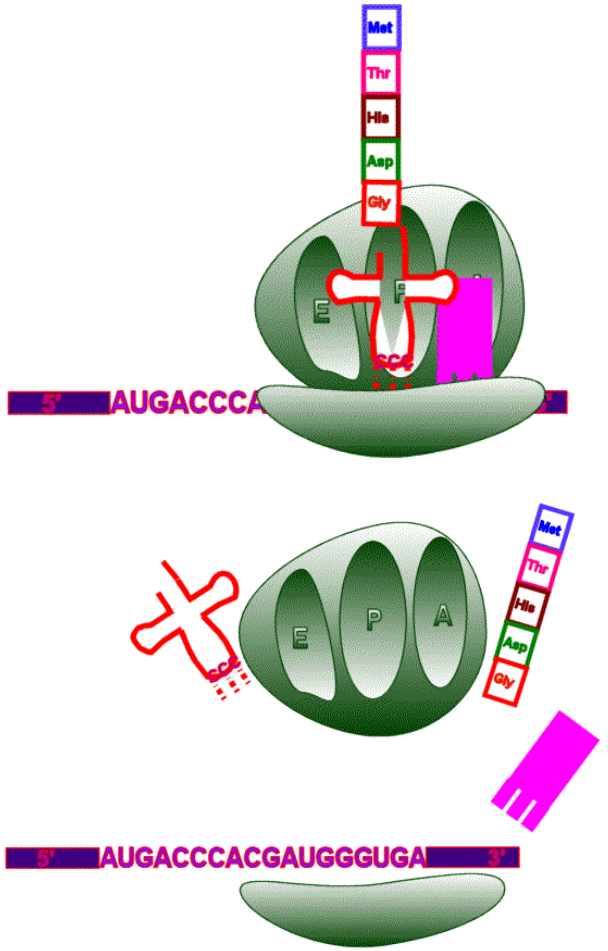
Reading the DNA code

- Every 3 DNA bases pairs with 3 mRNA bases
- Every group of 3 mRNA bases encodes a single amino acid
- Codon- coding triplet of mRNA bases



Termination

- Three codons are called “stop codons”. They code for no amino acid, and all protein-coding regions end in a stop codon.
- When the ribosome reaches a stop codon, there is no tRNA that binds to it. Instead, proteins called “release factors” bind, and cause the ribosome, the mRNA, and the new polypeptide to separate. The new polypeptide is completed.
- Note that the mRNA continues on past the stop codon. The remaining portion is not translated: it is the 3’ untranslated region (3’ UTR).



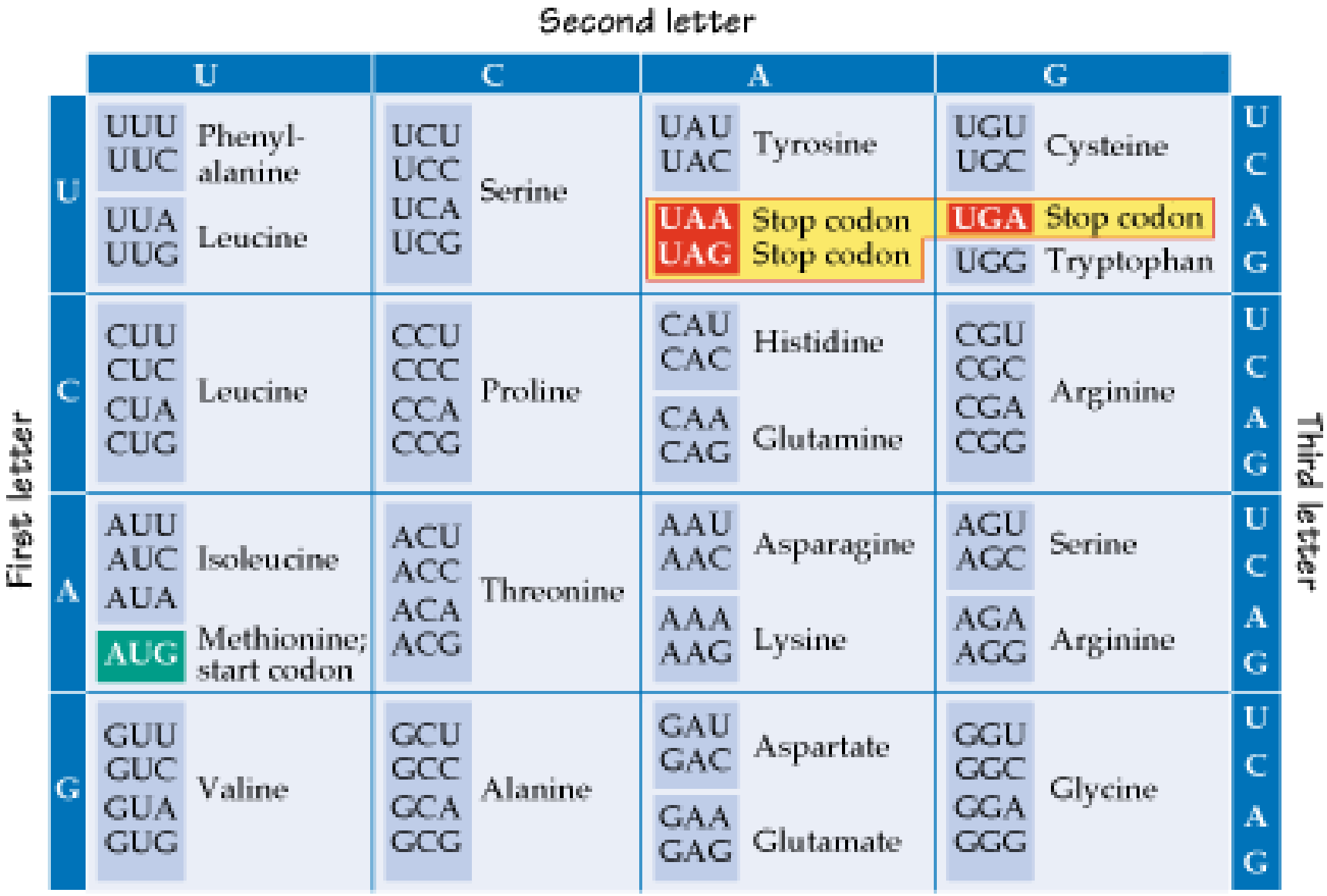
Protein Synthesis: Differences Between Prokaryotes and Eukaryotes	
Prokaryotic protein synthesis	Eukaryotic protein synthesis
Translation occurs even before the transcription of mRNA ends	Transcription occurs followed by translation
Except in archaebacterial, bacterial mRNA formation does not include the addition of a *cap* and a *poly A tail*	mRNA formation includes the addition of 5' cap and a poly A tail at the 3' end of mRNA transcript
Translation begins at AUG codon	Translation begins via the 5' cap, binding the mRNA to the ribosomal unit at the first AUG codon
Initiating factors: PIF-1, PIF-2, PIF-3	Initiating factors: eIF1-6, eIF4B, eIF4C, eIF4D, eIF4F

Post-Translational Modification

- New polypeptides usually fold themselves spontaneously into their active conformation. However, some proteins are helped and guided in the folding process by chaperone proteins
- Many proteins have sugars, phosphate groups, fatty acids, and other molecules covalently attached to certain amino acids. Most of this is done in the endoplasmic reticulum.
- Many proteins are targeted to specific organelles within the cell. Targeting is accomplished through “signal sequences” on the polypeptide. In the case of proteins that go into the endoplasmic reticulum, the signal seqeunce is a group of amino acids at the N terminal of the polypeptide, which are removed from the final protein after translation.

The Genetic Code

- Each group of 3 nucleotides on the mRNA is a codon. Since there are 4 bases, there are $4^3 = 64$ possible codons, which must code for 20 different amino acids.
- More than one codon is used for most amino acids: the genetic code is “degenerate”. This means that it is not possible to take a protein sequence and deduce exactly the base sequence of the gene it came from.
- In most cases, the third base of the codon (the wobble base) can be altered without changing the amino acid.
- AUG is used as the start codon. All proteins are initially translated with methionine in the first position, although it is often removed after translation. There are also internal methionines in most proteins, coded by the same AUG codon.
- There are 3 stop codons, also called “nonsense” codons. Proteins end in a stop codon, which codes for no amino acid.


Second letter
First letter
Third letter
U
C
A
G
UUU UUC Phenyl-alanine
UUA UUG Leucine
UCU UCC UCA UCG Serine
UAU UAC Tyrosine
UAA Stop codon
UAG Stop codon
UGU UGC Cysteine
UGA Stop codon
UGG Tryptophan
CUU CUC CUA CUG Leucine
CCU CCC CCA CCG Proline
CAU CAC Histidine
CAA CAG Glutamine
CGU CGC CGA CGG Arginine
AUU AUC AUA Isoleucine
AUG Methionine; start codon
ACU ACC ACA ACG Threonine
AAU AAC Asparagine
AAA AAG Lysine
AGU AGC Serine
AGA AGG Arginine
GUU GUC GUA GUG Valine
GCU GCC GCA GCG Alanine
GAU GAC Aspartate
GAA GAG Glutamate
GGU GGC GGA GGG Glycine

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