



Genetic code, tRNA & Ribosomes

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Genetic code

- “ The genetic code is the collection of bases sequences (codons) that corresponds to each amino acid.
- “ Since there are 20 amino acids that occur in proteins, there must be more than 20 codons to include signals for starting and stopping of polypeptide.
- “ It has been shown that the code is a triplet code, where three nucleotides encode one amino acid. And this agrees with the mathematical argument as being the minimum necessary.
 - A single base can not be a codon because there are 20 amino acids and only four bases
 - Pairs of bases also can not serve as codons because there are only 4^2 or sixteen possible pairs of the four bases
 - Triplet of bases are possible because there are 4^3 or 64 triplets. Which is more than adequate.
 - Hence many amino acids are specified by more than one triplet and genetic code is said to be degenerate or to have redundancy.

Features of Genetic code

- “ Most amino acids have more than one codon
 - Only Methionine and Tryptophan have a single codon
 - Multiple codons corresponding to a single amino acid usually differ only by the third base. For example, GGU, GGC, GGA, GGG all code for glycine. Thus the code is said to be redundant or degenerate

- “ One codon signals the initiation of polypeptide synthesis
The start codon-AUG-which codes for methionine.

- “ Three codons signal the termination of polypeptide synthesis
The stop codons: UAA, UAG, UGA

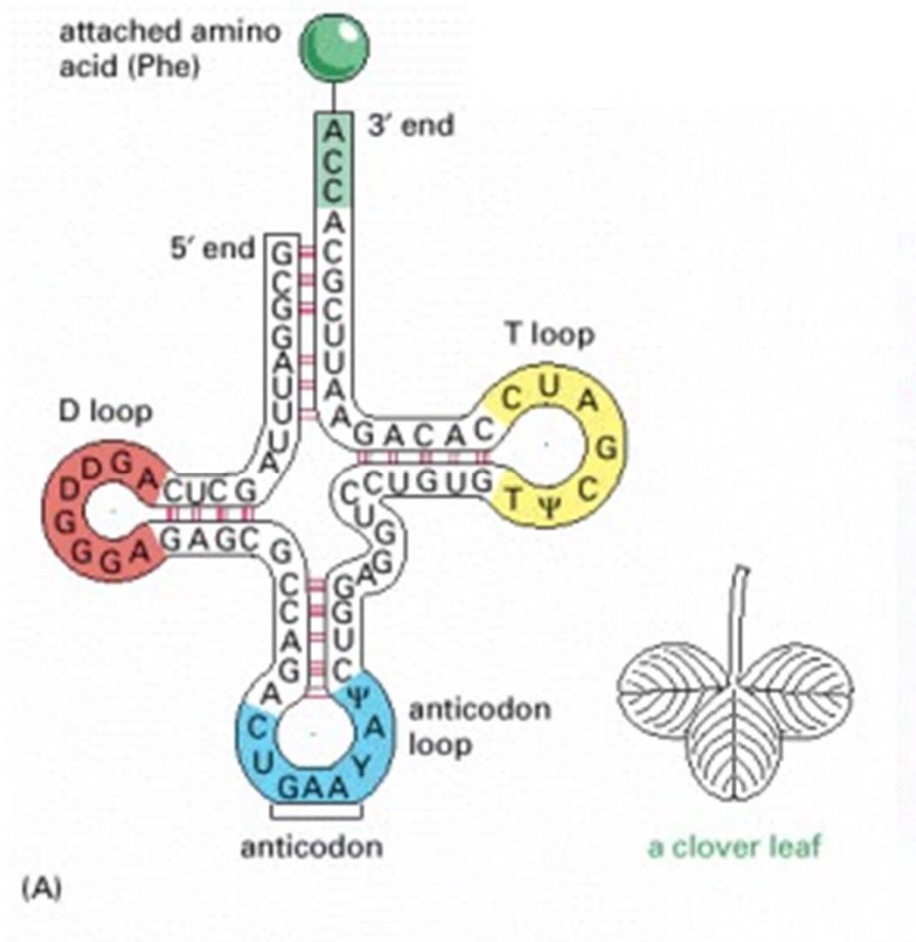
- “ And the code is generally said to be universal in all organisms but with few exceptions existing.

Transfer RNA and aminoacyl synthetases

- “ The operation by which the base sequence within an mRNA is translated into an amino acid sequence is accomplished by tRNA molecules and set of enzymes called aminoacyl-tRNA synthetases
- “ These aminoacyl-tRNA synthetases covalently attach the amino acid to the tRNA molecules.

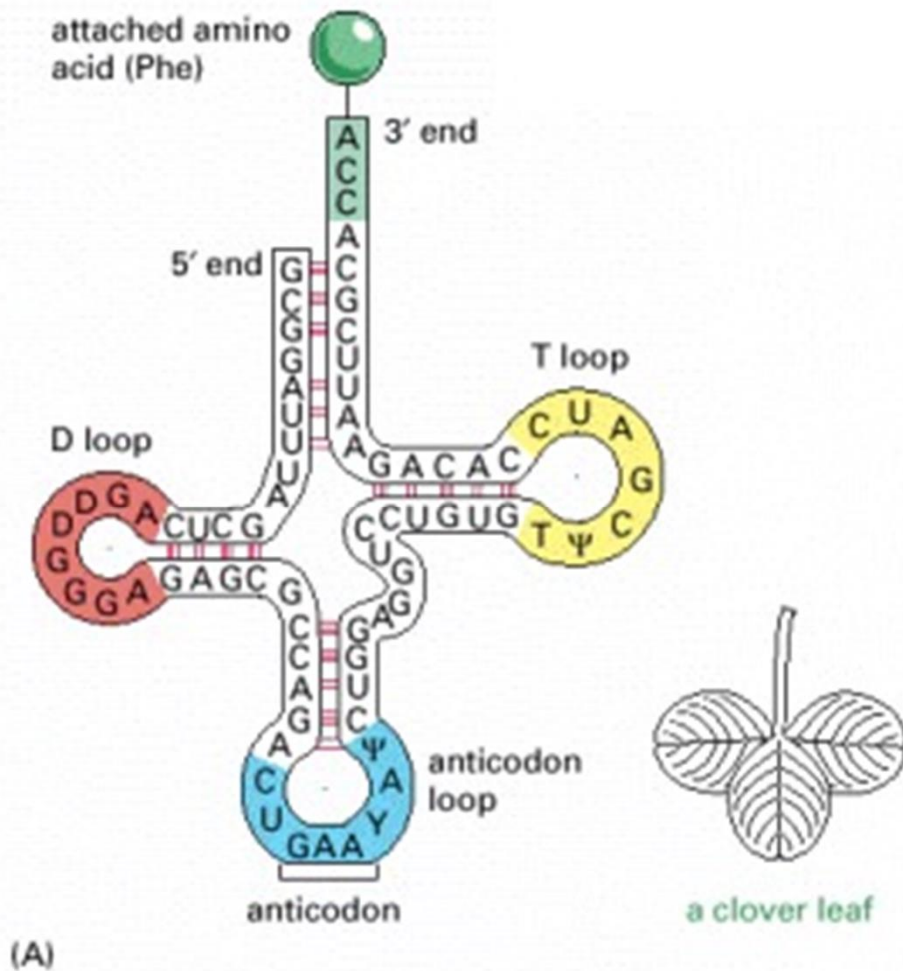
tRNA

The tRNA molecules are small single stranded nucleic acids ranging in size from 73-93 nucleotides.



“ Due to pairing of complementary regions (base sequences) short double stranded regions are formed, causing the molecule to form in to a structure in which open loops are connected by double stranded stems.

Clover leaf structure of tRNA.



Anticodon: a sequence of three bases that can form base pairs with a codon sequence in the mRNA

No tRNA molecule has complementary anticodon to any of the stop codons (UAG, UGA, UAA), hence they are called stop codons.

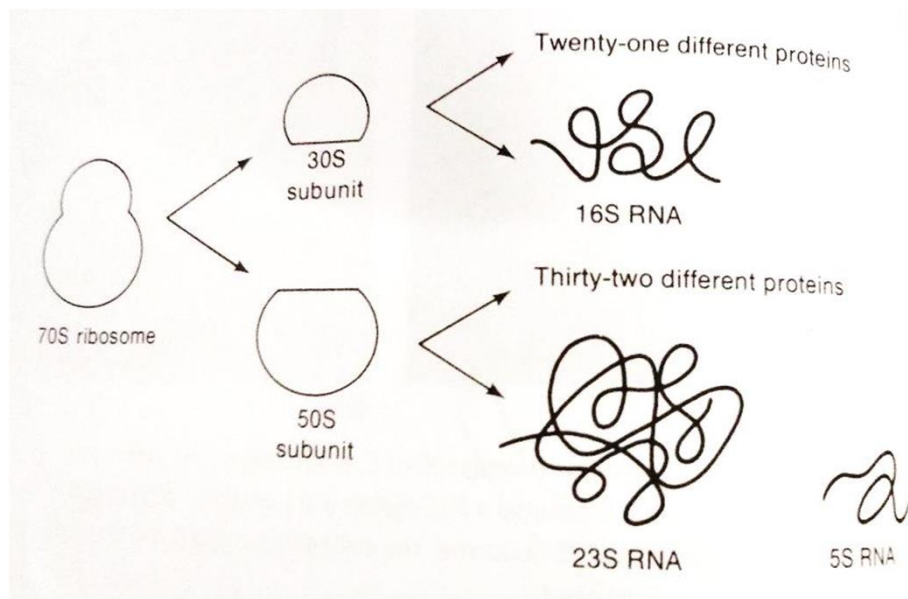
Amino acid attachment site: The amino acid corresponding to a particular mRNA codon that base pairs with the tRNA anticodon is covalently linked to this terminus.

- “ A specific aminoacyl tRNA synthetase matches the amino acid with anticodon.
- “ To do so, the enzyme must be able to distinguish one tRNA molecule from another.
- “ When an amino acid has become attached to a tRNA molecule. The tRNA is said to be **acylated or charged**
Ex: Gly-tRNA (Glycine attached to corresponding tRNA)
- “ tRNA molecules lacking an amino acid is called **uncharged tRNA**
- “ tRNA acylated with incorrect amino acid is called **mischarged tRNA**.
- “ At least one aminoacyl synthetase exists for each amino acid
- “ For accurate protein synthesis : Attachment of correct amino acid to a tRNA molecule by the synthetase & accuracy in codon:anti-codon binding is necessary.

Ribosomes

- “ A ribosome is a multi component particle containing several enzymes needed for protein synthesis.
- “ It also brings together a single mRNA molecule and charged tRNA molecules into proper position and orientation so that mRNA gets translated into amino acid sequence.

- ” All ribosomes contain two subunits
- ” Prokaryotes have 70S ribosome
 - ” S is a measure of sedimentation rate
 - ” A 70S ribosome consists of one 30S subunit and one 50S subunit

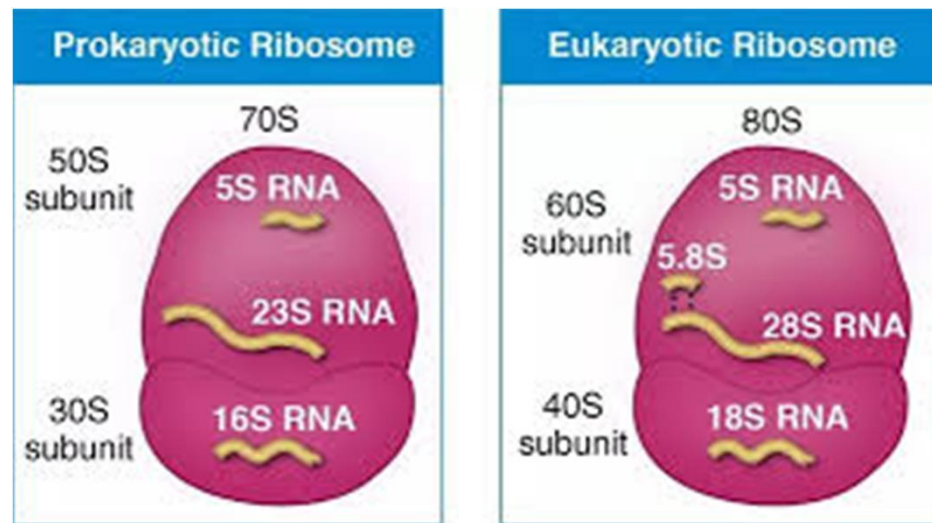


- ” Both the 30S and 50S particles can be dissociated into RNA (rRNA) and protein molecules under appropriate conditions.
- ” Each 30S subunit contains one 16S rRNA and 21 different proteins and 50S contains one 5S rRN, one 23S rRNA molecule and 32 different proteins.

Ribosomes in Eukaryotes

In Eukaryotes a typical ribosome is an 80S Ribosome consists of two subunits: 40S and 60S.

- “ A 40S subunit consisting of one 18S rRNA and about 30 proteins
- “ A 60S subunit consisting of one 5S , one 5.8S, and one 28S rRNA molecule and about 50 proteins.



References:

1. Essentials of Molecular biology By Freifelder/Malacinski
2. An introduction to Genetic analysis by Griffiths
3. The Cell by Cooper GM
4. Molecular biology of the Cell by Bruce Alberts

Online resource for further reading:

Genetic code, tRNA and Ribosomes

<https://www.ncbi.nlm.nih.gov/books/NBK26829/>

For any other topics of interest in the subject Molecular biology can be found at the following UGC MOOCS portal.

http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/75

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