TRANSFER RNA (t-RNA)

- Transfer RNA or Soluble RNA is the smallest form of RNA.
- Transfer RNA consists of single strand of RNA folded to form a three dimensional Structure.
- The function of transfer RNA is that it transfers a specific active amino acid to a growing polypeptide chain at the ribosomal site of protein synthesis.
- The tRNA consists of 73- 95 nucleotide residues and its molecular weight is between 24,000- 31000.
- The tRNA present in cytosol of cell. Mitochondria and chloroplasts contain smaller tRNAs.
- tRNA is a single stranded molecule. It has a 3' terminal site for amino acid attachment and a 5' end. The covalent linkage between amino acid at the 3' end of the tRNA is catalyzed by an aminoacyl tRNA synthetase.
- Cells have at least one kind of tRNA for each amino acid; at least 32 tRNAs are required to recognize all the amino acid codons (some recognize more than one codon), but some cells use more than 32.
- There are several tRNA specific for same amino acids. These tRNAs are called isoacceptor tRNAs. These different types of tRNA capable of recognizing and binding same amino acids during the synthesis of proteins.
- The tRNAs are specific for aminoacids. I.e., it can bind with only that particular amino acids. So $tRNA^{Ala}$ denotes the tRNA specific for alanine.
- Prokaryotic tRNAs are More stable than eukaryotic tRNAs.

Structure of Transfer RNA

- tRNA has primary structure, secondary structure (usually visualized as the cloverleaf structure), and tertiary structure.

Primary Structure of tRNA

- It is just the base sequence of tRNA with 3’ aminoterminal arm and 5’ end with minimum number of intramolecular hydrogen bond and lack of folds.

Secondary structure of tRNA

- This is the most common structure of tRNA discovered by Robert Holley in 1965. This tRNA was specific for alanine in Yeast.
- This structure consists of the 3 Folds and it is referred to as Clover leaf structure.
- The secondary structure of tRNA consists of the following structural parts
  1. 3’Aminoacid Acceptor arm
  2. Tψ C arm
  3. DHU arm (D loop)
  4. Variable or Extra arm
  5. Anticodon arm

3’Aminoacid Acceptor arm

- The amino acid arm can carry a specific amino acid to the 2’- or 3’-hydroxyl group of the A residue at the 3’ end of the tRNA.

- The acceptor stem is a 7-base pair (bp) stem made by the base pairing of the 5'-terminal nucleotide with the 3'-terminal nucleotide (which contains the CCA 3'-terminal group used to attach the amino acid). The acceptor stem may contain non-Watson-Crick base pairs.
- The 3' end carries specific residue- CCA.
- The CCA tail is a cytosine-cytosine-adenine sequence at the 3' end of the tRNA molecule. This sequence is important for the recognition of tRNA by enzymes critical in translation

Anticodon arm

- The anticodon region of a transfer RNA is a sequence of three bases that are complementary to a codon in the messenger RNA.
- During translation, the bases of the anticodon form complementary base pairs with the bases of the codon by forming the appropriate hydrogen bonds.
- The overall distance from CCA at one end to the anticodon at the other end is constant.
- The orders of the nucleotide sequence in the anticodon arm are -Pyrimidine- Pyrimidine - X-Y-Z- Modified purine-Variable base-.

DHU arm (D loop)

- The D arm contains 2 or 3 D residue (Dihydrouracil) depending on the tRNA.
- This Dihydrouracil is an analogue of Uracil but it is an unusual base (minor nitrogenous base).

Variable region (Extra arm)

- It is located between the anticodon loop and Tψ C arm which is variable in size and it is not present all tRNAs.
- It is otherwise called extra arm or little loop which contains a variable number of residues.

Tψ C arm

- The Tψ C arm contains ribothymidine (T), not usually present in RNAs, and pseudouridine (ψ), which has an unusual carbon–carbon bond between the base and ribose
- The D and Tψ C arms contribute important interactions for the overall folding of tRNA molecules, and the Tψ C arm interacts with the large-subunit rRNA.

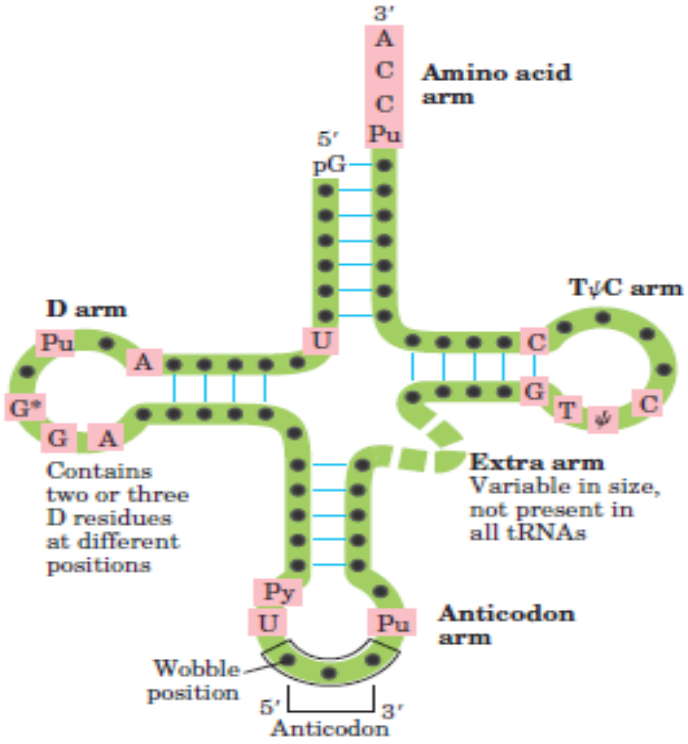

Figure: Cloverleaf Secondary structure of transfer RNA.

Tertiary Structure of tRNA

- This structure is called three dimensional structure of tRNA which is elucidated by Alexander Rich and Aron Klung based on the X-ray Crystallographic studies.
- The first tRNA tertiary structure elucidated was phenyl alanine tRNA from Yeast.
- This is exactly similar to the secondary structure and the features are given below.

1. The molecule is L-shaped.
2. There are two segment of the double helix. Each of these helices contains about 10 base pairs which correspond to one turn of the helix. These helical segments are perpendicular to each other and forming an L shaped structure.
3. The CCA terminus containing the attachment site for the amino acid is at one end of the L. The other end of the L is occupied by the anticodon loop. The DHU and Tψ C loop present in the corner of the L shaped structure
4. The CCA terminus and adjacent helical region do not strongly interact with the rest of the molecule. This part of the molecule may change conformation during amino acid activation and also during protein synthesis on the ribosome.

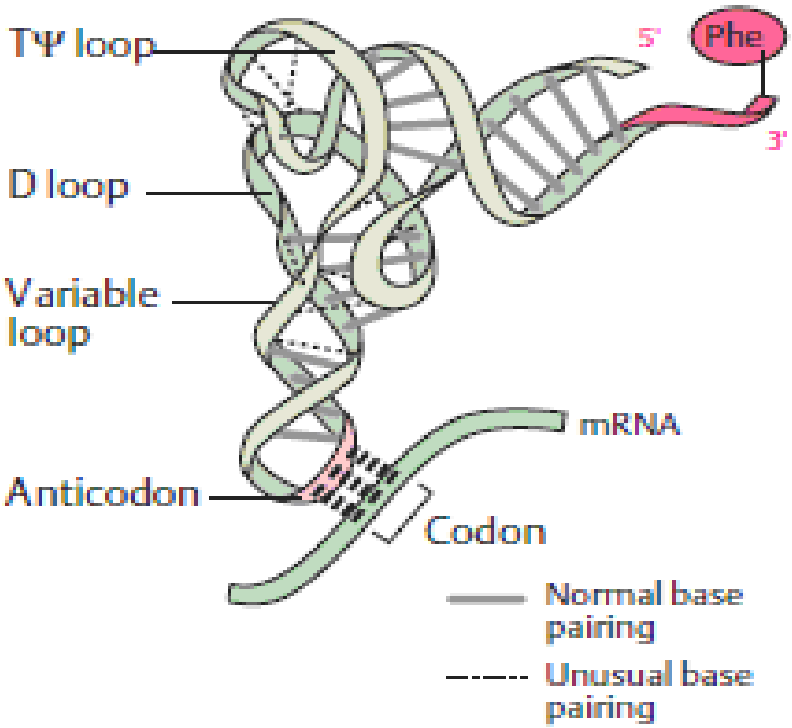

Figure: Tertiary structure of tRNA