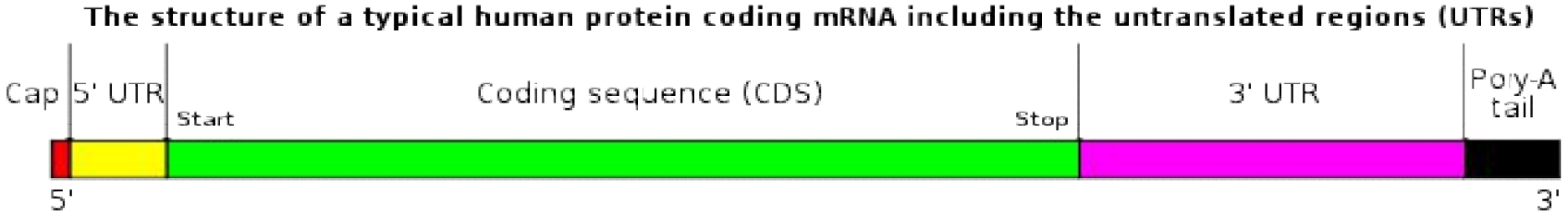
Types of RNA

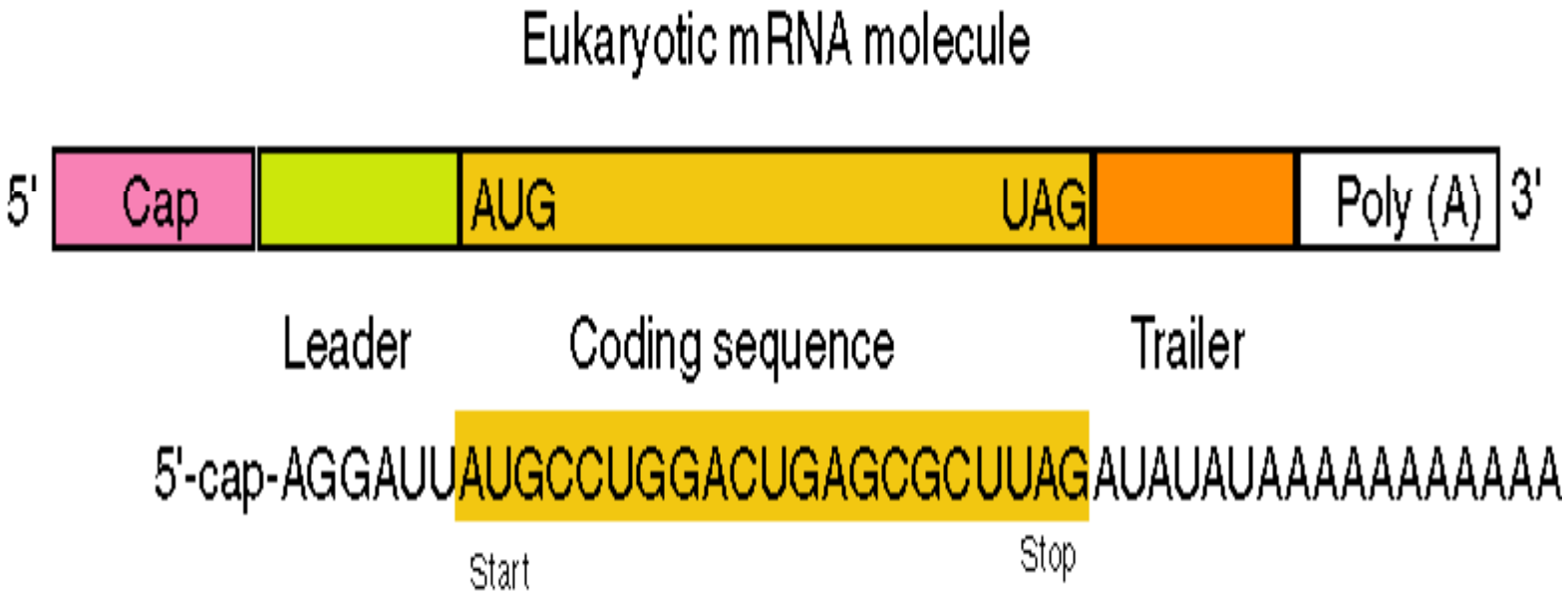
- In all prokaryotic and eukaryotic organisms, three main classes of RNA molecules exist-
  1) Messenger RNA (mRNA)
  2) Transfer RNA (tRNA)
  3) Ribosomal RNA (rRNA)
- The other are
  - ✓ small nuclear RNA (SnRNA),
  - ✓ micro RNA (miRNA)
  - ✓ small interfering RNA(SiRNA)
  - ✓ heterogeneous nuclear RNA (hnRNA).

Messenger RNA (mRNA)

- All members of the class function as messengers carrying the information in a gene to the protein synthesizing machinery
- ➢ The 5’ terminal end is capped by 7- methyl guanosine triphosphate cap.
- ➢ The cap is involved in the recognition of mRNA by the translating machinery.
- ➢ It stabilizes mRNA by protecting it from 5’ exonuclease.

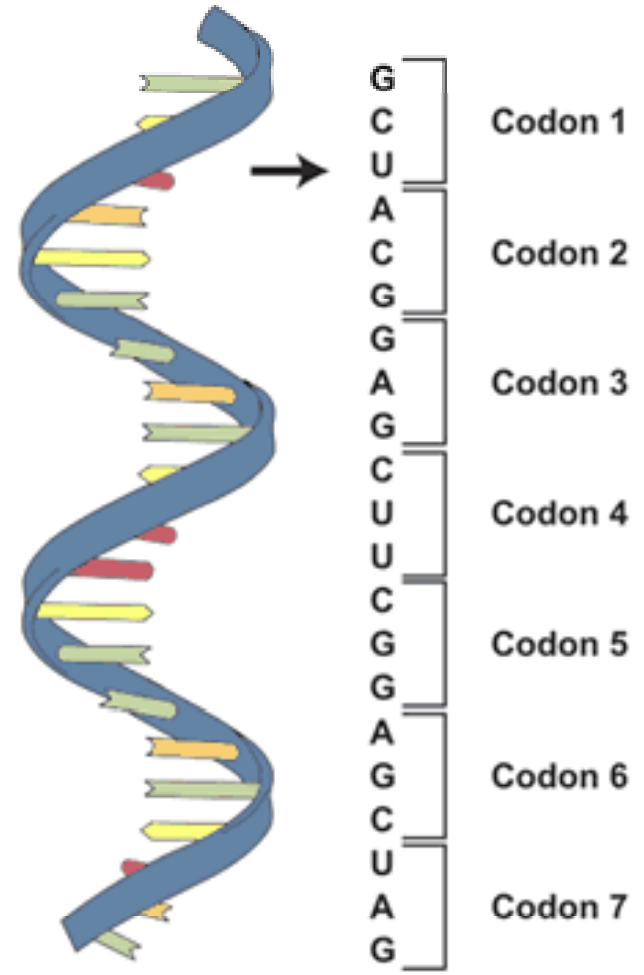
- The 3'end of most m-RNAs have a polymer of Adenylate residues (20-250).
- The tail prevents the attack by 3' exonucleases.
- On both 5' and 3' end there are non coding sequences which are not translated (NCS)
- The intervening region between non coding sequences present between 5' and 3' end is called coding region. This region encodes for the synthesis of a protein.


The structure of a typical human protein coding mRNA including the untranslated regions (UTRs)
Cap
5' UTR
Start
Coding sequence (CDS)
Stop
3' UTR
Poly-A tail
5'
3'


Eukaryotic mRNA molecule
5'
Cap
AUG
UAG
Poly (A)
3'
Leader
Coding sequence
Trailer
5'-cap-AGGAUUAUGCCUGGACUGAGCGCUUAGAUAUAUAAAAAAAAAAA
Start
Stop

- **Messenger RNA (mRNA)** is synthesized from a gene segment of DNA which ultimately contains the information on the primary sequence of amino acids in a protein to be synthesized.
- The genetic code as translated is for m-RNA not DNA.
- The **messenger RNA carries the code** into the cytoplasm where protein synthesis occurs.

- The specific aminoacid has been determined by the genetic code based upon **triplets** of nucleotides which provide 64 different codes using the 4 nucleotides.
- **Each nucleotide triplet, called a codon**, can be "read" and translated into an amino acid to be incorporated into a protein being synthesized.
- All of the 64 codons or triplets have a known function, with 61 coding for amino acids and the other 3 serving as a stop or termination signal for protein synthesis.
- there are usually several codons for each amino acid. Only methionine and tryptophan have a single codon.



mRNA
Ribonucleic acid

Image adapted from: National Human Genome Research Institute. Talking Glossary of Genetic Terms. Available at: www.genome.gov/Pages/Hyperion/DIR//VIP/Glossary/Illustration/codon.shtml.

Transfer RNA (tRNA)

- Transfer RNA are the smallest of three major species of RNA molecules
- They have 74-95 nucleotide residues
- tRNA transfer the amino acids from cytoplasm to the protein synthesizing machinery.
- They are also called Adapter molecules, since they act as adapters for the translation of the sequence of nucleotides of the mRNA in to specific amino acids
- There are at least 20 species of tRNA one corresponding to each of the 20 amino acids required for protein synthesis.
- **tRNA** is the only RNA species that contains the **nucleoside thymidine.**

Structure

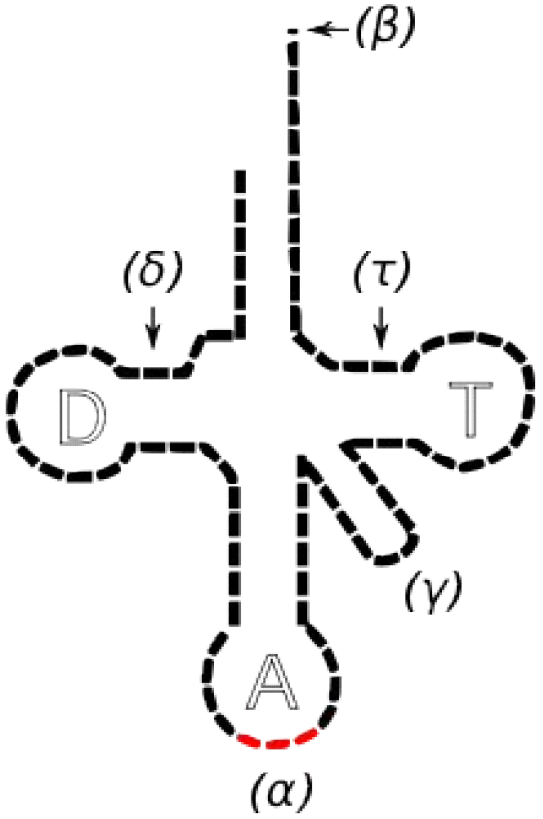
1) Primary structure: The nucleotide sequence of all the tRNA molecules allows extensive intrastand complementarity that generates a secondary structure.

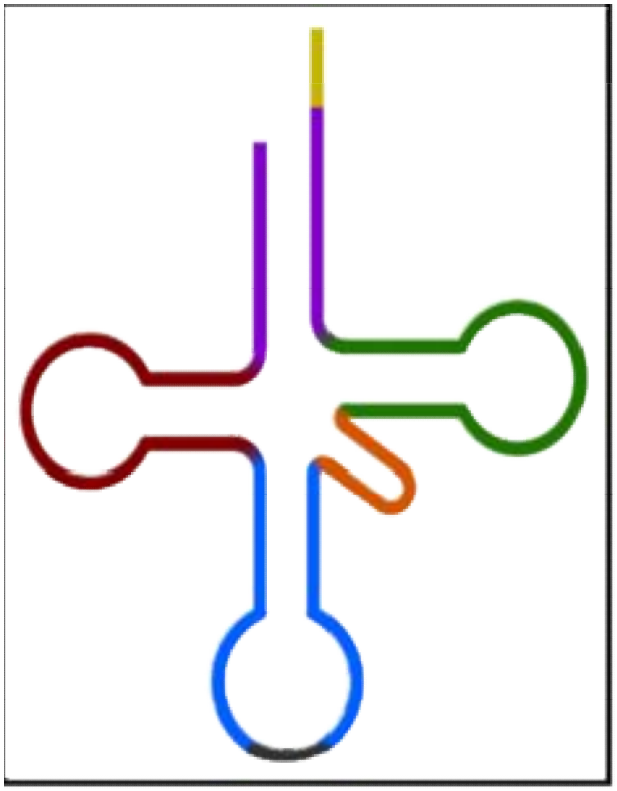
2) Secondary structure: Each single tRNA shows extensive internal base pairing and acquires a clover leaf like structure. The structure is stabilized by hydrogen bonding between the bases and is a consistent feature.

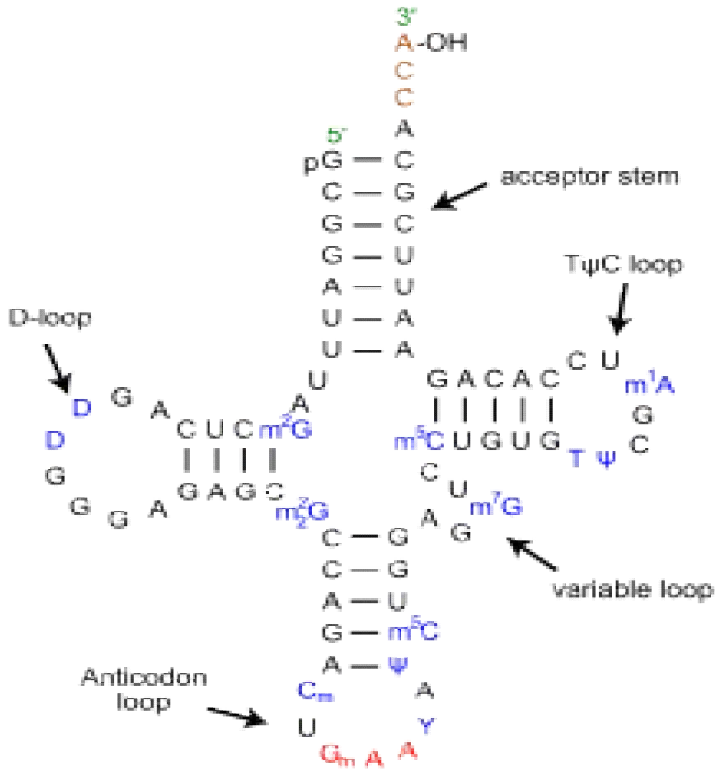
Secondary structure (Clover leaf structure)

All tRNA contain 5 main arms or loops

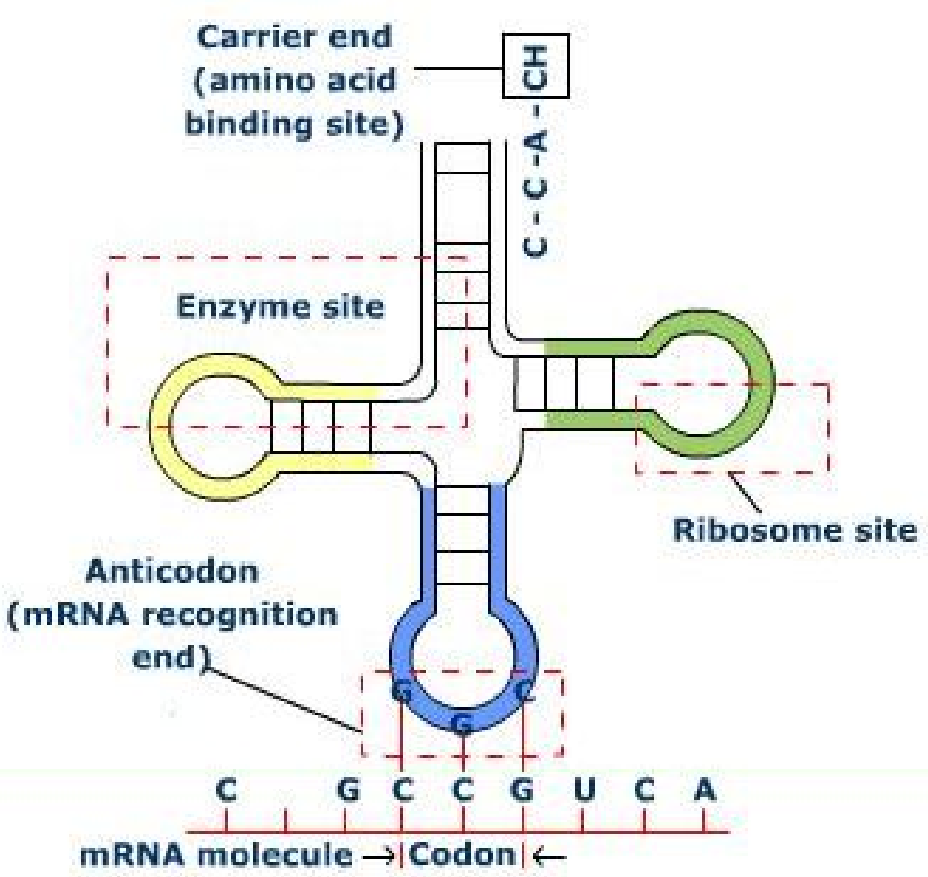
a) Acceptor arm
b) Anticodon arm
c) DHU arm **(DihydroUracil)**
d) TΨC arm (**Thymidine Pseudouridine Cytosine)**
e) Extra arm

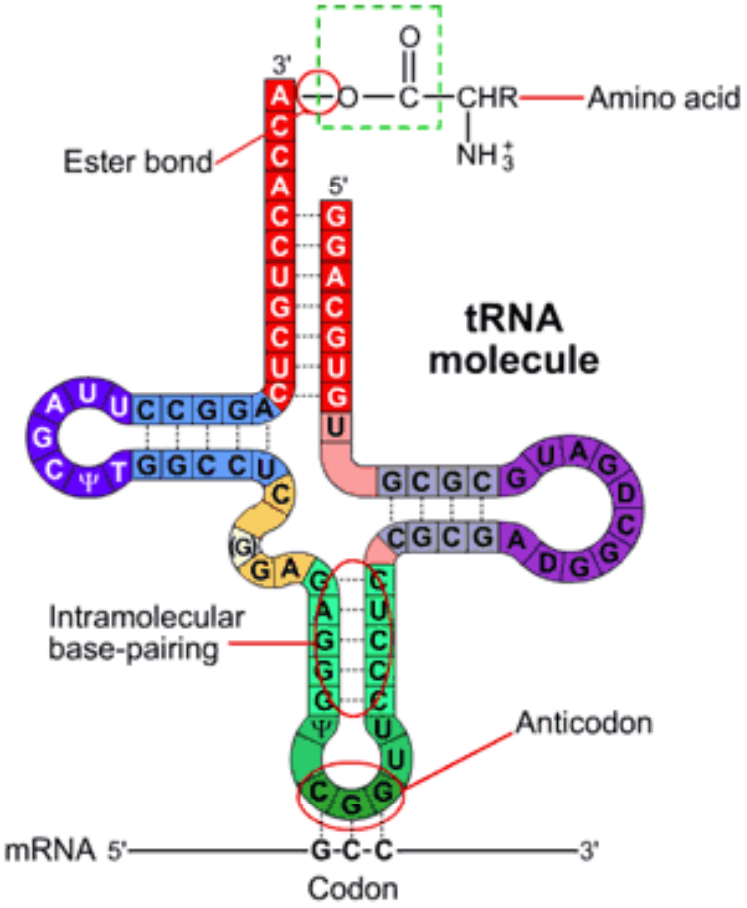






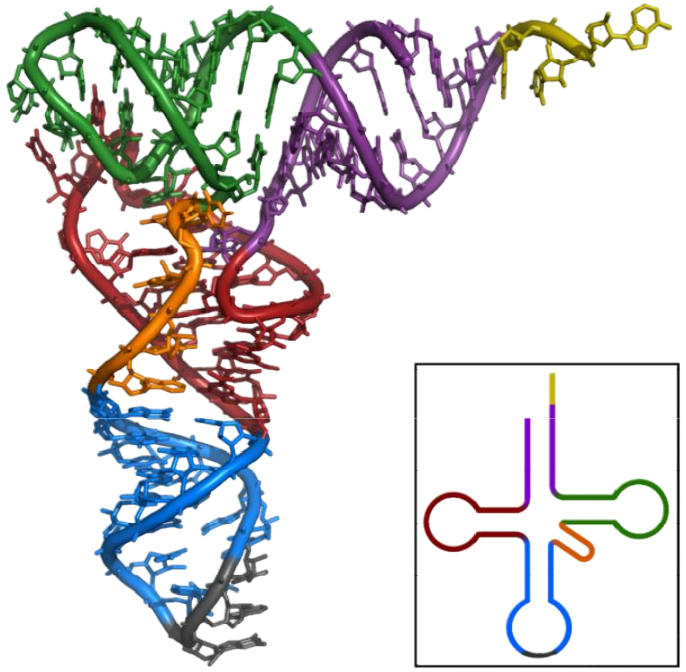
Secondary structure of tRNA. ***CCA tail*** in **yellow**, ***Acceptor stem*** in purple, ***Variable loop*** in **orange**, ***D arm*** in **red**, ***Anticodon arm*** in **blue** with ***Anticodon*** in **black**, ***T arm*** in **green**.


Carrier end
(amino acid
binding site)
C - C - A - CH
Enzyme site
Ribosome site
Anticodon
(mRNA recognition
end)
C G C C G U C A
mRNA molecule
Codon


3'
5'
Ester bond
Amino acid
tRNA
molecule
Intramolecular
base-pairing
Anticodon
mRNA 5'
G-C-C
3'
Codon

Tertiary structure of tRNA

- The L shaped tertiary structure is formed by further folding of the clover leaf due to hydrogen bonds between T and D arms.
- The base paired double helical stems get arranged in to two double helical columns, continuous and perpendicular to one another.



❖ Ribosomal RNA (rRNA)

- **Ribosomal ribonucleic acid (rRNA)** is the ***RNA*** component of the ***ribosome***, and is essential for ***protein synthesis*** in all living organisms.
- The functions of the ribosomal RNA molecules are necessary for ribosomal assembly and seem to play key roles in the binding of mRNA to ribosomes and its translation
- Recent studies suggest that an rRNA component performs the peptidyl transferase activity and thus is an enzyme (a ribozyme).
- It constitutes the predominant material within the ribosome, which is approximately 60% rRNA and 40% protein by weight.
- Ribosomes contain two major rRNAs and 50 or more proteins.
- The ribosomal RNAs form two subunits, the large subunit (LSU) and small subunit (SSU). The LSU rRNA acts as a ***ribozyme***, catalysing ***peptide bond formation***.

❖ Differences between RNA and DNA

S.No.	RNA	DNA
1)	Single stranded mainly except when self complementary sequences are there it forms a double stranded structure (Hair pin structure)	Double stranded (Except for certain viral DNA s which are single stranded)
2)	Ribose is the main sugar	The sugar mainly is deoxy ribose
3)	Pyrimidine components differ. Thymine is never found	Thymine is always there but uracil is never found
4)	Being single stranded structure. It does not follow Chargaff's rule	It does follow Chargaff's rule. The total purine content in a double stranded DNA is always equal to pyrimidine content.

S.No	RNA	DNA
5)	RNA can be easily destroyed by alkalies to cyclic diesters of mono nucleotides.	DNA resists alkali action due to the absence of OH group at 2' position
6)	RNA is a relatively a unstable molecule, undergoes easy and spontaneous degradation	DNA is a stable molecule. The spontaneous degradation is very too slow. The genetic information can be stored for years together without any change.
7)	Mainly cytoplasmic, but also present in nucleus (primary transcript and small nuclear RNA)	Mainly found in nucleus, extra nuclear DNA is found in mitochondria, plasmids etc
8)	The base content varies from 100- 5000. The size is variable.	Millions of base pairs are there depending upon the organism

S.No	RNA	DNA
9)	There are various types of RNA – mRNA, rRNA, tRNA, SnRNA, SiRNA, miRNA and hnRNA. These RNAs perform different and specific functions.	DNA is always of one type and performs the function of storage and transfer of genetic information.
10)	No variable physiological forms of RNA are found. The different types of RNA do not change their forms	There are variable forms of DNA (A, B and Z)
11)	RNA is synthesized from DNA, it can not form DNA(except by the action of reverse transcriptase). It can not duplicate (except in certain viruses where it is a genomic material)	DNA can form DNA by replication, it can also form RNA by transcription.
12)	Many copies of RNA are present per cell	Single copy of DNA is present per cell.