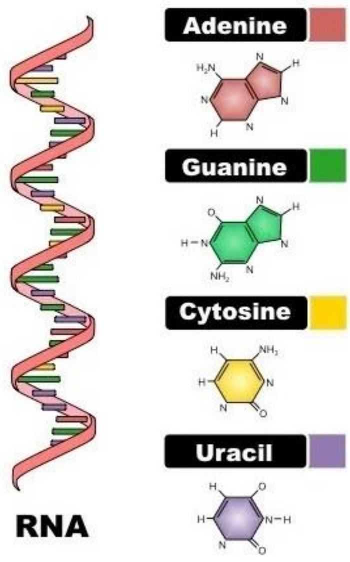
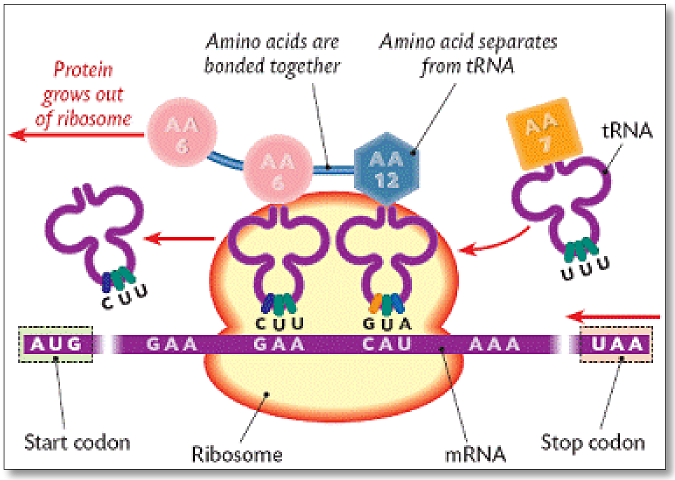
RNA (Ribonucleic Acid)

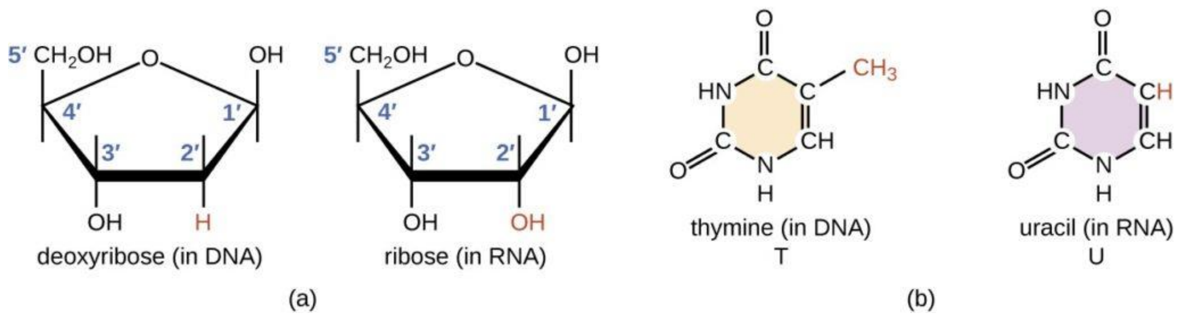
RNA is a single stranded polymer of ribonucleotides. It occurs in viruses, prokaryotic cells and Eukaryotic cells. It is largely found in cytoplasm. It forms the major constituent of ribosome.

- RNA forms in the nucleolus, and then moves to specialized regions of the cytoplasm depending on the type of RNA formed.
- RNA, containing a ribose sugar, is more reactive than DNA and is not stable in alkaline conditions. RNA's larger helical grooves mean it is more easily subject to attack by enzymes.
- RNA strands are continually made, broken down and reused, and more resistant to damage from UV light than DNA.
- RNA's mutation rate is relatively higher, Unusual bases may be present.
- The number of RNA may differ from cell to cell.
- Rate of renaturation after melting is quick.
- RNA is more versatile than DNA, capable of performing numerous, diverse tasks in an organism.
- It is a polymeric molecule essential in various biological roles in coding, decoding, regulation, and expression of genes

Chemical Composition: chemically RNA is made up of Ribose sugar, Phosphate and nitrogenous bases like Adenine, guanine, cytosine and Uracil. In RNA, thymine is absent.







(a) Ribonucleotides contain the pentose sugar ribose instead of the deoxyribose found in deoxyribonucleotides. (b) RNA contains the pyrimidine uracil in place of thymine found in DNA.

Nucleosides of RNA

RNA has 4 types of nucleosides, they are

(a) Ribose adenosine (b) Ribose guanosine (c) Ribose cytidine and d) Ribose Uridine.

Ribose sugar + Adenine =Riboseadenosine

Ribose sugar + Guanine =Riboseguanosine.

Ribose sugar + Cytogine = Riboge cytidine.

Ribose sugar + uracil = Ribose uridine.

Nucleotides of RNA –

Nucleotides of RNA are Called Ribonucleotides**.** RNA has four types of nucleotides, they are

(a) Ribose adenylic acid or Ribose adenosine monophosphate (Amp)

(b) Ribose guanylic acid or Ribose guanosine manophosphate (Gmp)

(e) Ribose cytidylic acid or Riboge cytidine monophosphate (cmp)

(e) Ribose uridylic acid or Ribose uridine monophosphate (ump)

i) Ribose Sugar + Adenine + phosphate = Ribose adenylic acid.

ii) Ribose Sugar + Guanine + phosphate = Ribose guanylic acid.

iii) Ribose Sugar + cytodine + phosphate = Ribosecytidylic acid.

iv) Ribose Sugar + Uracil + phosphate = RiboseUridylic acid.

- **Salient features of RNA .**

Genetic RNA and non-genetic RNA

Genetic RNA : The RNA that carry genetic or heredity character & from generation to generation is called genetic RNA. **Eg:** RNA in Tmv (Tobacco mosaic virus), HIV, Influenza virus, polio virus etc...

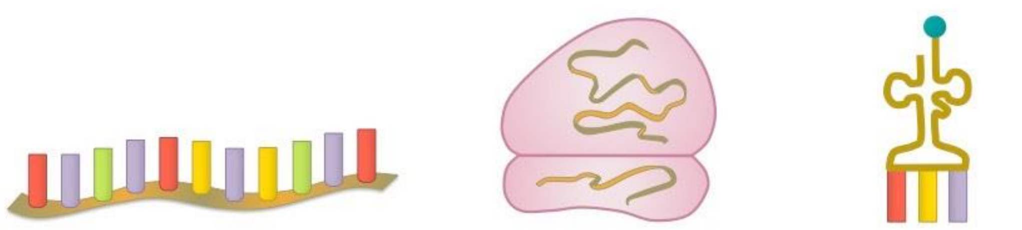
Non genetic RNA: It is RNA does not carry genetic character from generation to generation but helps in protein synthesis.

Based on the structure and function, Genetic RNAS are classified into 3 types. They are

(1) mRNA (messenger RNA)

(2) rRNA (ribosomal RNA)

(3) tRNA (transfer RNA).



Like DNA, RNA is a long polymer consisting of nucleotides.

- RNA is a single-stranded helix.
- The strand has a 5′end (with a phosphate group) and a 3′end (with a hydroxyl group).
- It is composed of ribonucleotides.
- The ribonucleotides are linked together by 3′ – 5′ phosphodiester bonds.
- The nitrogenous bases that compose the ribonucleotides include adenine, cytosine, uracil, and guanine.

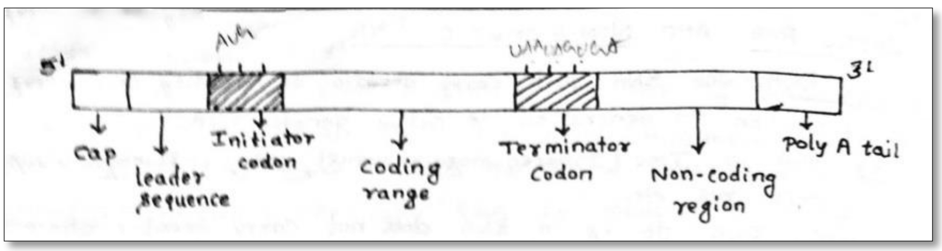
Thus, the difference in the structure of RNA from that of DNA include:

- The bases in RNA are adenine (A), guanine (G), uracil (U) and cytosine (C).

- Thus thymine in DNA is replaced by uracil in RNA, a different pyrimidine. However, like thymine, uracil can form base pairs with adenine.
- The sugar in RNA is ribose rather than deoxyribose as in DNA.
- The corresponding ribonucleosides are adenosine, guanosine, cytidine and uridine. The corresponding ribonucleotides are adenosine 5'-triphosphate (ATP), guanosine 5'-triphosphate (GTP), cytidine 5'-triphosphate (CTP) and uridine 5'-triphosphate (UTP).

Messenger RNA (mRNA)

mRNA (Messenger RNA) mRNA was discovered by VOLKIN in the term mRNA was Coined by Jacob and Monad.



Characters of mRNA

It is a linear single stranded polynucleotide chain. It forms about 3 to 5% of the total RNA content. It consists of about 900 to 1500 nucleotides. It has blue print or genetic message for protein synthesis. It has no base pairing.

Eukaryotic mRNA has a cap structure at s' end which is a 7 methyl Guanosine nucleotide. Cap is absent in prokaryotic RNA.

Structure

mRNA a linear molecule consists of about 900-1500 ribonucleotides. It has a cap structure at 5^1 end which is a 7' methyl guanosine nucleotide. The cap is followed by the non coding region called leader Sequence. The leader sequence is followed by Coding an initiator codon AUG. It is followed by the coding or sensible region. The triplet codons present in this region Code for aminoacids. The coding region followed by the terminator Codons UAA, UAG or UGA. The coding region followed by the non-coding region. It is followed by the poly A tail (polyadenylate tail) which forms 3' end of the of mRNA, Present in Eukaryotic mRNA but absent in prokaryotic mRNA

FUNCTION

mRNA Carry the genetic information from the DNA in the form codons to the cytoplasm to synthesis protein at the ribosome.

TRANSFER RNA (tRNA)

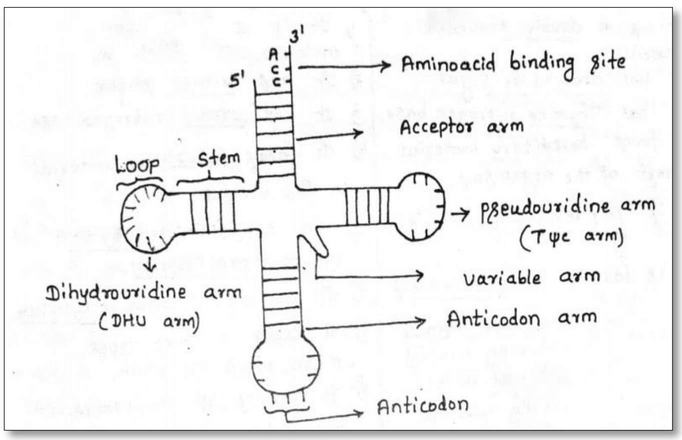
The RNA Carrying aminoacids to the ribosome for protein Synthesis is called tRNA.

Characters.

It forms about 3 to 15% of the total RNA content. It is shortest RNA consists of about 80 ribonucleotides. tRNA folded itself to produce double stranded regions. The folded regions have base pairing i.e., A=U and C= G. It is also known as Soluble RNA (S RNA) or Adaptor RNA

STRUCTURE

Robert Holley was proposed Clover leaf model to explain the structure of tRNA. (The folded tRNA appear like clover leaf (Trifolium).



The tRNA shows the following structure.

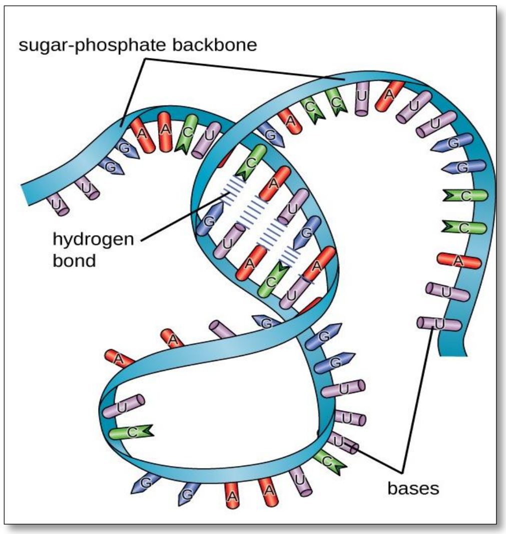
- The t RNA has two ends, 3'end and 5'end. The 3'end has the base Sequence 'CCA' and 5'end has GUA nucleotide.
- It has four arms. They named as Acceptor arm, Pseudouridine arm (Tψc arm) DHU arm (Dihydrouxidine arm) and Anticodon arm.

- Each arm has two parts namely stem and loop, but acceptor arm hat only stem. Acceptor arm has amino acid binding site 1.e., CCA to which amino acid is attached. It consists of 3 unpaired and 7 paired nitrogenous bases.
- DHU arm 4 paired and 10 unpaired nitrogenous bases. It is meant for attachment tRNA synthetase during protein Synthesis.
- TψC arm has 5 paired and 4 unpaired nitrogenous bases. It is meant for attachment to a ribosome during protein Synthesis.
- Anti codon arm have 5 paired and 7 unpaired nitrogenous bases of these three unpaired nitrogenous bases forms anticodon or NODOC. It is Complementary to codon on mRNA.

Function

tRNA transfer amino acid to ribosome (site of protein synthesis) during protein synthesis. Transfer RNA brings or transfers amino acids to the ribosome that corresponds to each three-nucleotide codon of rRNA. The amino acids then can be joined together and processed to make polypeptides and proteins.

rRNA (Ribosomal RNA)



- It is most abundantly (largely) occurring RNA in the cell. it forms about 80% of the total RNA content. It forms major component of ribosome. it has many folded regions, folded regions have base pairing i e, A=U & C≡ G. It consists of 120 to 4500 ribonucleotides. It is also known as Structural RNA.

- It is a RNA forms the structural Component of the ribosome. Ribosomes consist of two major components: the small ribosomal subunits, which read the RNA, and the large subunits, which join amino acids to form a polypeptide chain.
  Each subunit comprises one or more ribosomal RNA (rRNA) molecules and a variety of ribosomal proteins (r-protein or rProtein).
- Different rRNAs present in the ribosomes include small rRNAs and large rRNAs, which denote their presence in the small and large subunits of the ribosome.
- rRNAs combine with proteins in the cytoplasm to form ribosomes, which act as the site of protein synthesis and has the enzymes needed for the process.
- These complex structures travel along the mRNA molecule during translation and facilitate the assembly of amino acids to form a polypeptide chain. They bind to tRNAs and other molecules that are crucial for protein synthesis.

Functions: It helps to form the structure of ribosome and helps to bind the mRNA and tRNA to ribosome and rRNA directs the translation of mRNA into proteins.

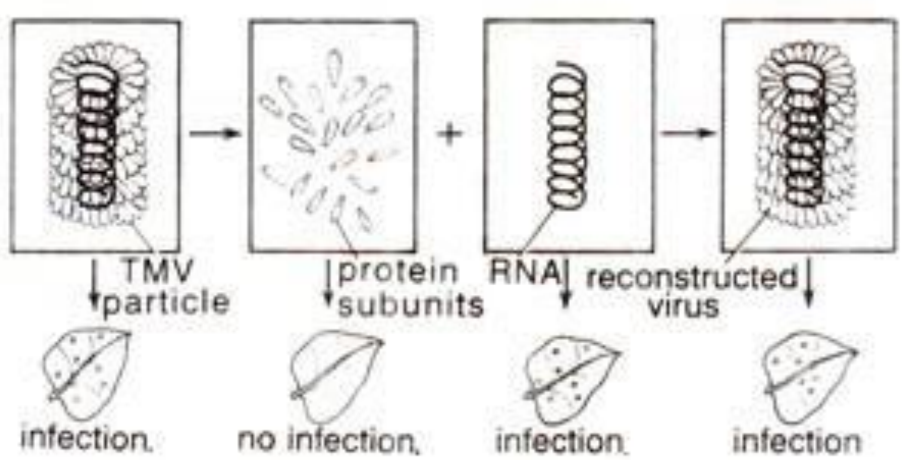
General functions of RNA

- RNA is a nucleic acid messenger between DNA and ribosomes.
- It serves as the genetic material in some organisms (viruses).
- Some RNA molecules play an active role within cells by catalyzing biological reactions, controlling gene expression, or sensing and communicating responses to cellular signals.
- Messenger RNA (mRNA) copies DNA in the nucleus and carries the info to the ribosomes (in cytoplasm).
- Ribosomal RNA (rRNA) makes up a large part of the ribosome; reads and decodes mRNA.
- Transfer RNA (tRNA) carries amino acids to the ribosome where they are joined to form proteins.
- Certain RNAs are able to catalyse chemical reactions such as cutting and ligating other RNA molecules, and the catalysis of peptide bond formation in the ribosome; these are known as ribosomes.

RNA as the Genetic Material (Fraenkel-Conrat experiment)

The genome of viruses may be DNA or RNA. Most of the plant viruses have RNA as their hereditary material. Fraenkel-Conrat (1957) conducted experiments on tobacco mosaic virus (TMV) to demonstrate that in some viruses RNA acts as genetic material.

- TMV is a small virus composed of a single molecule of spring-like RNA encapsulated in a cylindrical protein coat. Different strains of TMV can be identified on the basis of differences in the chemical composition of their protein coats and difference in symptoms on the tobacco leaves. By using the appropriate chemical treatments, proteins and RNA of TMV can be separated.
- Fraenkel-Conrat experimentally proved that in the absence of DNA, RNA acts as the genetic material. In one experiment protein and RNA components of the TMV were separated and both were used to infect the tobacco leaf separately.
- It was observed that in case of protein subunits, there was no symptoms on the leaf and no progeny viruses were obtained.
- RNA part caused the infection and symptoms appeared on the tobacco leaf. Fresh progeny of TMV was also obtained.



In the other experiment, two strains of TMV (type A and type B) showing different symptoms (one causing spots in random pattern and the other in a definite ring form) were taken. There Protein and RNA parts were separated and chimera (hybrid) viruses were synthesized using RNA of type A and protein of type B and vice-versa.

These chimera/hybrid viruses were used to infect the tobacco leaves. It was observed that symptoms on the leaf always belonged to the virus strain from which RNA was taken.

Fresh progeny also belonged to the same strain. (When the hybrid or reconstituted viruses were rubbed into live tobacco leaves, the progeny viruses produced were always found to be phenotypically and genotypically identical to the parental type from where the RNA had been isolated.)

These experiments proved that the genetic information of TMV is stored in the RNA and not in the protein.