

**Course- B.Sc. (Botany Honours), Part -3**

**Paper-VI (Group-B), Molecular Biology**

**Topic- Structure and Function of RNA.**

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# Structure and Function of RNA

- RNA or ribonucleic acid is a polymer of nucleotides which is made up of a ribose sugar, a phosphate, and bases such as adenine, guanine, cytosine, and uracil.
- It is a polymeric molecule essential in various biological roles in coding, decoding, regulation, and expression of genes.

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 (abbreviated 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).
- Most RNA molecules are single-stranded but an RNA molecule may contain regions which can form complementary base pairing where the RNA strand loops back on itself.
- If so, the RNA will have some double-stranded regions.
- Ribosomal RNAs (rRNAs) and transfer RNAs (tRNAs) exhibit substantial secondary structure, as do some messenger RNAs (mRNAs).

## Type of RNA

In both prokaryotes and eukaryotes, there are three main types of RNA –

- **rRNA (ribosomal)**
- **tRNA (transfer)**
- **mRNA (messenger)**

### mRNA (messenger)

- Accounts for about 5% of the total RNA in the cell.
- Most heterogeneous of the 3 types of RNA in terms of both base sequence and size.
- It carries the genetic code copied from the DNA during transcription in the form of triplets of nucleotides called codons.
- As part of post-transcriptional processing in eukaryotes, the 5' end of mRNA is capped with a guanosine triphosphate nucleotide, which helps in mRNA recognition during translation or protein synthesis.

- Similarly, the 3' end of an mRNA has a poly A tail or multiple adenylate residues added to it, which prevent enzymatic degradation of mRNA. Both 5' and 3' end of an mRNA imparts stability to the mRNA.

### **Function**

mRNA transcribes the genetic code from DNA into a form that can be read and used to make proteins. mRNA carries genetic information from the nucleus to the cytoplasm of a cell.

### **rRNA (ribosomal)**

- Found in the ribosomes and account for 80% of the total RNA present in the cell.
- 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.

### **Function**

rRNA directs the translation of mRNA into proteins.

### **tRNA (transfer)**

- tRNA is the smallest of the 3 types of RNA having about 75-95 nucleotides.
- tRNAs are an essential component of translation, where their main function is the transfer of amino acids during protein synthesis. Therefore they are called transfer RNAs.
- Each of the 20 amino acids has a specific tRNA that binds with it and transfers it to the growing polypeptide chain. tRNAs also act as adapters in the translation of the genetic sequence of mRNA into proteins. Therefore they are also called adapter molecules.

### **Structure of tRNA**

tRNAs have a clover leaf structure which is stabilized by strong hydrogen bonds between the nucleotides. Apart from the usual 4 bases, they normally contain some unusual bases mostly formed by methylation of the usual bases, for example, methyl guanine and methylcytosine.

- Three structural loops are formed via hydrogen bonding.
- The 3' end serves as the amino acid attachment site.
- The center loop encompasses the anticodon.
- The anticodon is a three-base nucleotide sequence that binds to the mRNA codon.
- This interaction between codon and anticodon specifies the next amino acid to be added during protein synthesis.

### **Function**

Transfer RNA brings or transfers amino acids to the ribosome that correspond to each three-nucleotide codon of rRNA. The amino acids then can be joined together and processed to make polypeptides and proteins.

### **Other Properties of RNA**

- 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.
- RNA is 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.

### **Function 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 ribozymes.

### **REFERENCES**

1. David Hames and Nigel Hooper (2005). Biochemistry. Third ed. Taylor & Francis Group: New York.
2. Bailey, W. R., Scott, E. G., Finegold, S. M., & Baron, E. J. (1986). Bailey and Scott's Diagnostic microbiology. St. Louis: Mosby.
3. <https://www.news-medical.net/life-sciences/-Types-of-RNA-mRNA-rRNA-and-tRNA.aspx>
4. <https://www.thoughtco.com/types-of-rna-and-their-functions-606386>