1.3 RNA STRUCTURE AND TYPES

RNA (ribonucleic acid) is a vital biomolecule present in all living cells, playing crucial roles in various biological processes. Its significance lies in its diverse functions: RNA acts as a messenger RNA (mRNA) during transcription, transferring the genetic information encoded in DNA to the ribosomes for protein synthesis. Additionally, RNA serves as ribosomal RNA (rRNA), forming an essential component of ribosomes, the cellular machinery responsible for translating mRNA into proteins. Transfer RNA (tRNA) facilitates protein synthesis by carrying specific amino acids to the ribosome based on the mRNA code. Besides its involvement in protein synthesis, RNA also plays regulatory roles as microRNAs (miRNAs) and other non-coding RNAs, affecting gene expression, cellular development, and responses to environmental stimuli. RNA's dynamic nature, diverse functions, and involvement in gene expression and regulation make it a fundamental molecule in life processes, contributing significantly to the complexities of cellular and organismal biology. RNA is different from DNA in some aspects and may have different functions, some of which have been enumerated in table below.

TABLE 1.3 *Key differences between RNA and DNA.*

	DNA (Deoxyribonucleic Acid)	***RNA (Ribonucleic Acid)***
Sugar	Deoxyribose	Ribose
Bases	Adenine (A), Thymine (T), Cytosine (C), Guanine (G)	Adenine (A), Uracil (U), Cytosine (C), Guanine (G)
Strands	Double-stranded helix	Mostly single-stranded
Helix Structure	Right-handed	Right-handed or left-handed (Z-DNA)
Stability	More stable	Less stable
Function	Genetic information storage	Protein synthesis (mRNA, tRNA, rRNA)

Location in Cells	Found in nucleus (eukaryotes), mitochondria, and chloroplasts	Found in the nucleus (pre-mRNA) and cytoplasm (mRNA, tRNA, rRNA)
Base Pairing	A-T (adenine-thymine) and C-G (cytosine-guanine)	A-U (adenine-uracil) and C-G (cytosine-guanine)
Functions as Enzyme	No enzymatic activity	Some RNA molecules can act as enzymes (ribozymes)
Modifications	Methylation occurs on cytosine residues (epigenetic regulation)	RNA molecules can undergo various modifications, like splicing and editing
Types and Functions	One type (genomic DNA) and responsible for inheritance and gene expression	Multiple types (mRNA, tRNA, rRNA, miRNA, etc.) with diverse roles in gene regulation and protein synthesis

These different types of RNA demonstrate the complexity and diversity of RNA's roles in cells, ranging from protein synthesis to gene regulation and other essential cellular functions. Each type of RNA contributes to the precise regulation and coordination of cellular processes necessary for the proper functioning of living organisms.

Messenger RNA (mRNA): mRNA is a single-stranded RNA molecule that carries the genetic information from the DNA in the nucleus to the ribosomes in the cytoplasm. It serves as a template for protein synthesis during translation, where the sequence of nucleotides in mRNA is translated into a specific sequence of amino acids to form a protein.

Ribosomal RNA (rRNA): rRNA is a major component of ribosomes, which are the cellular structures responsible for protein synthesis. Ribosomes consist of a large and small subunit, both of which contain rRNA molecules along with proteins. rRNA catalyzes the formation of peptide bonds between amino acids during translation.

Transfer RNA (tRNA): tRNA is a small RNA molecule that plays a critical role in protein synthesis. It carries specific amino acids to the ribosome, where they are incorporated into the growing polypeptide chain based on the codons in the mRNA. tRNA has an anticodon region that binds to the complementary codon on mRNA, ensuring the correct amino acid is added to the growing protein chain.

Small Nuclear RNA (snRNA): snRNA is involved in RNA splicing, a process that removes non-coding introns and joins together exons in pre-mRNA to produce mature mRNA. snRNA forms complexes with proteins known as small nuclear ribonucleoproteins (snRNPs) that catalyze the splicing reactions.

Small Nucleolar RNA (snoRNA): snoRNA is primarily found in the nucleolus, a subnuclear compartment, and is involved in the chemical modification and processing of rRNA. snoRNA guides enzymes to specific sites on rRNA where modifications, such as methylation and pseudouridylation, occur.

MicroRNA (miRNA): miRNA is a small RNA molecule that plays a crucial role in post-transcriptional gene regulation. It binds to complementary sequences in mRNA molecules, leading to the degradation of the target mRNA or inhibition of translation, thereby regulating gene expression.

Long Non-coding RNA (lncRNA): lncRNA is a diverse class of RNA molecules that do not code for proteins. They play various roles in gene regulation, chromatin remodeling, and other cellular processes.