## L.7 The structure and functions of RNAs:

Is a single stranded molecule, closely similar to a molecule of DNA, but differs from DNA in that it is single-stranded rather than double stranded and contain ribose instead of deoxyribose and contain Uracil (U) instead of Thymine (T). RNA is a single stranded polynucleotide molecule. Functionally, DNA stores genetic information, whereas RNA controls how that information is used.

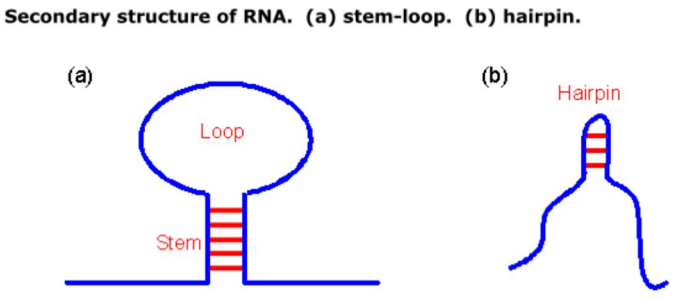
## RNA can take 3 levels of structure:

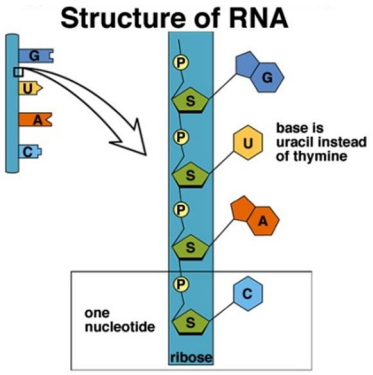
**Primary:** consists of a linear sequence of nucleotides that are linked together by phosphodiester bonds .

**Secondary:** The secondary structure of RNA consists of a single polynucleotide. Base pairing in RNA occurs when RNA folds between complementarity regions. Both single- and double-stranded regions are often found in RNA molecules. Stem- loop or hairpin loop is the most common element of RNA secondary structure.

**Tertiary**: It is a higher order than the secondary structure, in which large-scale folding in a linear polymer occurs and the entire chain is folded into a specific 3-dimensional shape.

**Quaternary**: The quaternary structure of nucleic acids is similar to that of protein quaternary structure. . Although some of the concepts are not exactly the same, the quaternary structure refers to a higher-level of organization of nucleic acids.




## Types of RNA:

There are three types of RNA: mRNA (5%) ,tRNA (15%) and rRNA (80%)

**1-Messenger RNA (m RNA):**

Carries genetic information copied from DNA in the form of a series of 3-base code, each of which specifies a particular amino acid. It passes from the nucleus to the cytoplasm. Where it's found in association with ribosomes to serve as a template for the ordering of amino acids into polypeptides, so the information flow from DNA to mRNA to polypeptide (protein) .

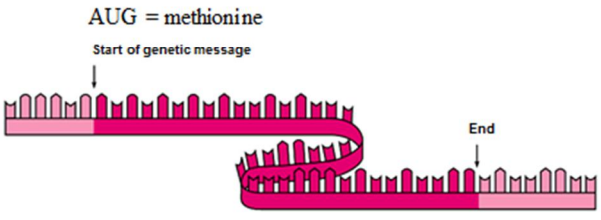
To use the information in an mRNA sequence a cell requires two other major classes of RNA : rRNA and tRNA.

**Transfer RNA**:

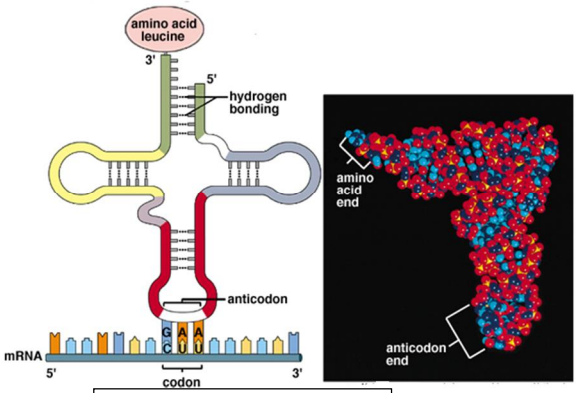
Also called adaptor RNA because is a much smaller molecule of RNA.A tRNA molecule is made of a single strand of RNA consisting of only about 75-80 nucleotides. By twisting and folding upon itself, tRNA form several double-stranded regions .A single-stranded loop at one end of the folded molecule contains a special triplet of bases called anticodon. The anticodon triplet is complementary to codon triplet on mRNA . Transfer RNA molecules have two distinct functions:

1- It is the key that read the code on the mRNA.

2- Picking up the appropriate amino acids, which have been activated by special enzymes.



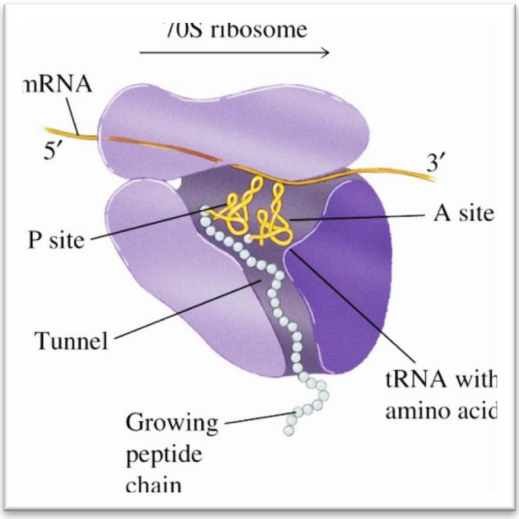

**Messenger RNA**




**Transfer RNA**

**Ribosomal RNA:**

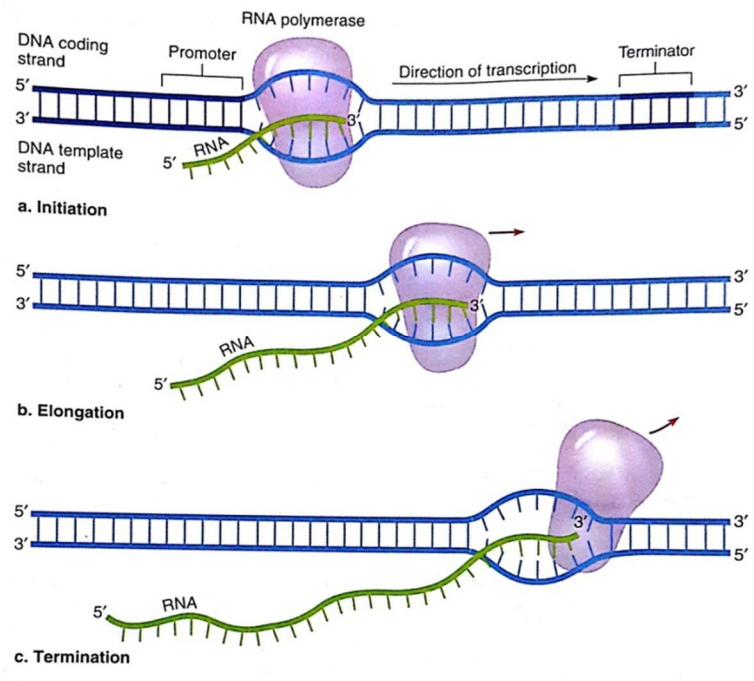
rRNA associated with a set of proteins to form the ribosomes. These complex structures move along the mRNA molecule. A ribosome consists of two subunits, each made up of protein and ribosomal RNA, The larger ribosomal subunit has three types of rRNA and the small subunit has one. Each ribosome has a binding site for m RNA on its small subunits. In addition, its large subunit has binding sites for tRNA. One of these, the (p) site, holds the tRNA carrying the growing polypeptide chain while another, the (A) site, holds a tRNA carrying the next amino acids to be added to the chain. Certain rRNAs catalyze the formation of the peptide bonds between amino acid such an RNA with enzymatic function is called ribozyme .Other rRNAs help to align the ribosome and mRNA.




## Transcription:

It’s the transfer of genetic information from DNA to RNA in the nucleus ,transcription begins when a section of a DNA double helix in chromosome unwinds ,and one strand (**Sense strand**) act as a template for the formation of an mRNA molecule its will be used to make protein . The process of transcription occurs in three stages: **Initiation, elongation and termination**. In the first step , an enzyme called **RNA polymerase and transcription factors (**regulate which genes are transcribed**)** bind to a specific nucleotides sequence in DNA, which marks the beginning of a gene. This sequence is called a **promoter region** .After the polymerase is bound, the

adjacent double stranded DNA unwinds, exposing the template strand. Nucleotides that will make up the mRNA molecule form H- bonds with the complementary nucleotides in the template DNA strand .In the **elongation stage ,** RNA polymerase joins the RNA nucleotides into a polynucleotide chain. The rules of base pairing in transcription are the same as in DNA replication, with one exception: an A on the DNA template specifies a U in the RNA transcript (there is no T in RNA ).In human,30-50 nucleotides per second are added to an mRNA molecule. When the RNA polymerase reaches to the end of the gene (terminator region),it detaches from the DNA template, the mRNA molecule is released ,the DNA strands reform a double helix, and transcription is terminated (in human most of transcripts are about 5000 nucleotides or may be reaches up to 200000 nucleotides).




## Messenger RNA is processed and spliced:

In humans many genes contain nucleotide sequences that are transcribed, but not translated. These non-coding sequences called **introns** can vary in number from zero to 75 or more. The other types of sequences in a gene that are transcribed and translated into polypeptides are called exons. The combination of exons and introns determines the length of a gene, and often the exons make up only a fraction of the

total length. Transcription produces large RNA precursor molecules known as pre-mRNAs .These precursors are processed and modified in the nucleus to produce mature mRNA molecules that are transported to the cytoplasm. Where they bind to the ribosomes for translation .Pre-mRNA molecules are processed by the addition of nucleotides to the 5'end called cap (aid in the binding of the mRNA to the ribosome during translation).the cap consists of a backwardly inserted quinine (G),Which attracts an enzyme that adds methyl group (CH3),to the G. This methylated cap is a recognition site for protein synthesis .At the 3' end a string of 30-100 (A) nucleotides ,called poly –A tail is add .The poly A tail is necessary for protein synthesis to begin, and may also stabilize the mRNA so that it stays intact. After transcription, the pre –mRNA molecules are spliced and shortened by the removal of all introns, and the exons are spliced together by enzymes to form the mature mRNA. After processing and splicing, the mRNA moves from the nucleus to the cytoplasm, where the encoded information is translated into protein .

Several human genetic disorders are the result of abnormal pre-mRNA splicing. In β –thalassemia one or more mutations at the border between introns and exons lowers the efficiency of splicing, and results in a deficiency in the amount of the gen product (beta globin) synthesized.