Lecture title: Ribonucleic acids (RNAs)

Lecturer Affiliation: University of Mosul / College of Veterinary Medicine / Department of Physiology, Biochemistry and Pharmacolog

Ribonucleic acids (RNAs)

- Ribonucleic acids are present in nucleus and cytoplasm of eukaryotic cells.
- They are also present in prokaryotes.
- They are involved in the transfer and expression of genetic information.
- They act as primers for DNA formation.
- Some RNA act as enzymes and coenzymes.
- RNA also functions as genetic material for viruses.

Types of RNA:

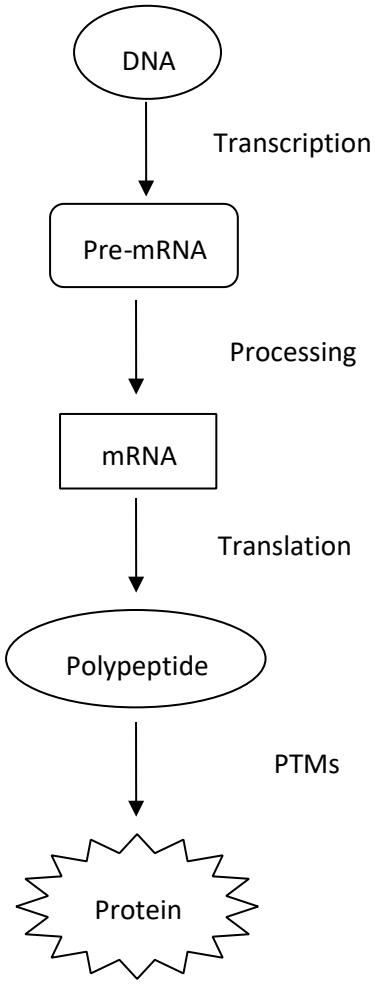
Messenger RNA

It accounts for 1-5% of cellular RNA.

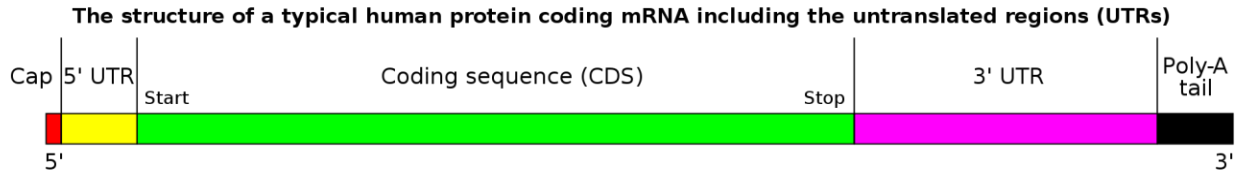
Structure

1. Majority of mRNA has primary structure. They are single-stranded linear molecules. They consist of 1000-10,000 nucleotides.
2. mRNA molecule have free or phosphorylated 3’ end and 5’ end.
3. mRNA molecule have different life spans. Their life span ranges from few minutes to days.
4. Eukaryotic mRNAs are more stable than prokaryotic mRNA. **Functions**
    1. mRNA is direct carrier of genetic information from the nucleus to the cytoplasm. (Central dogma (figure)).

2. Usually a molecule of mRNA contains information required for the formation of one protein molecule.
3. Genetic information is present in mRNA in the form of ***genetic code***.
4. Sometimes single mRNA may contain information for the formation of more than one protein.



Central dogma of Molecular Biology



Structure of mRNA in animals

Transfer RNA t-RNA accounts for 10-15% of

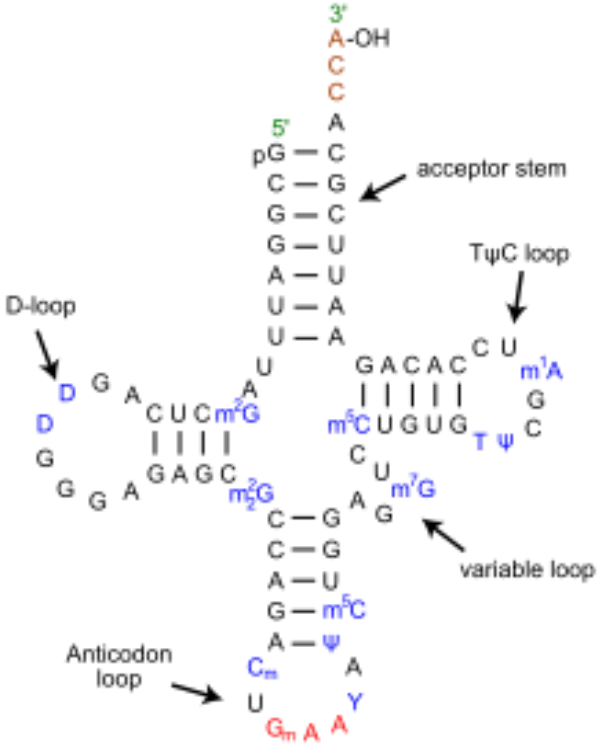
total cell RNA.

Structure

They are the smallest of all the RNAs. Usually they consist of 50-100 nucleotides.

They are single strand molecules. t-RNA molecules contain many unusual bases

715 per molecule.



Functions

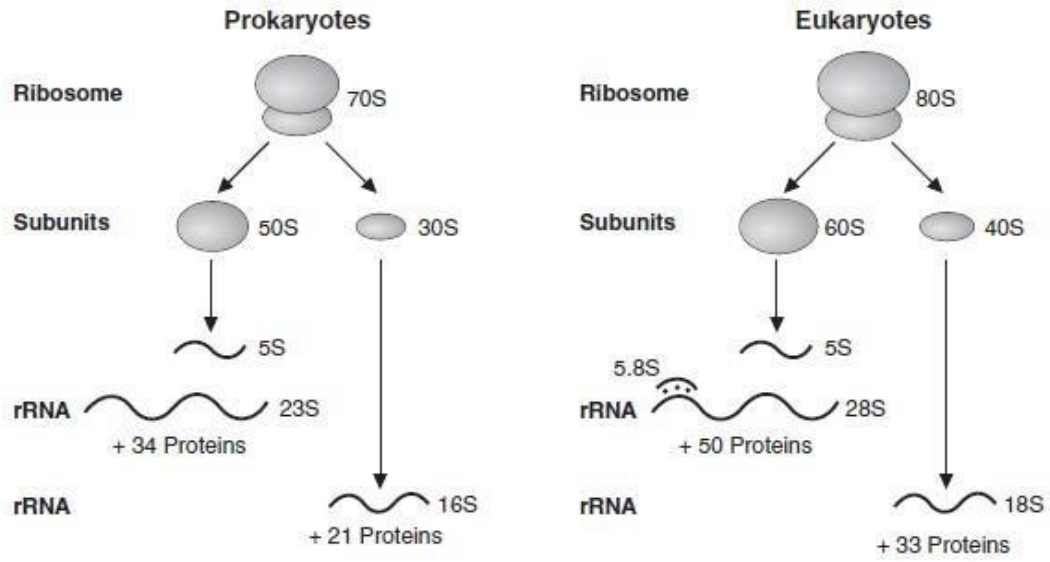
1. It is the ***carrier*** of amino acids to the site of protein synthesis.
2. There is at least one t-RNA molecule to each of 20 amino acids required for protein synthesis.
3. Eukaryotic t-RNAs are less stable whereas prokaryotic RNAs are more stable.

Ribosomal RNA

- Ribosomal RNA or r-RNA accounts for 80% of total cellular RNA. It is present in ribosomes.

- In ribosomes, r-RNA is found in combination with protein. It is known as ***ribonucleoprotein (RNP)***.

- The length of r-RNA ranges form 100-600 nucleotides. Both prokaryotic and eukaryotic ribosomes contain r-RNA molecules. r-RNAs differ in sedimentation coefficients (S).
- There are four types of r-RNAs in eukaryotes. They are 5, 5.8, 18 and 28S rRNA molecules. Prokaryotes have 3 types of r-RNA molecules. They are 5, 16 and 23S r-RNA molecules.



Functions

1. r-RNAs are required for the formation of ribosomes.
2. 16S RNA is involved in initiation of protein synthesis.

Differences between DNA and RNA

DNA	RNA

1. Sugar is deoxyribose	Sugar is ribose
2. Uracil, a pyrimidine base is usually absent	Thymine, a pyrimidine base is usually absent
3. Double-stranded molecules	Single stranded molecules
4. Sum of purine bases is equal to sum of pyrimidine bases (A + G = C + T)	Sum of purine bases is not equal to sum of pyrimidine bases (A + G ≠ C + T)
5. Bases are not modified	Bases are modified
6. They have no catalytic activity	Some RNA have catalytically active
7. Only one form or type	More than three types
8. Usually not subjected to degradation in cell	Degraded in the cell by nucleases
9. DNA is present in nucleus and mitochondria	RNA is present in nucleus and cytoplasm
10. Main function is to storage and transfers of genetic information	Main function is involved in protein synthesis and gene expression regulation

Reverse transcription

1. Synthesis of DNA from an RNA template is catalyzed by reverse transcriptase.
2. Retroviruses contain RNA as their genetic material.

a. The retroviral RNA serves as a template for synthesis of DNA by reverse transcriptase.

b. The DNA that is generated can be inserted into the genome (chromosomes) of the host cell and be expressed.

Genetic code:

1. The genetic code is the collection of codons that specify all the amino acids found in proteins.
2. A codon is a sequence of 3 bases (triplet) in messenger RNA (mRNA) that specifies a particular amino acid. During translation, the successive codons in an mRNA determine the sequence in which amino acids add to the growing polypeptide chain.
3. The genetic code is degenerate. Each of the 20 common amino acids has at least one codon; many amino acids have numerous codons.
4. The genetic code is non-overlapping (i.e., each nucleotide is used only once).

a. It begins with a start codon (AUG) near the 5' end of the mRNA.

b. It ends with a termination (stop) codon (UGA, UAG, or UAA) near the 3' end.

5. The code is continuous (i.e., there are no breaks or markers to distinguish one codon from the next).

6. The code is nearly universal. The same codon specifies the same amino acid in almost all species studied.

7. The start codon (AUG) determines the reading frame. Subsequent nucleotides are read in sets of three, sequentially following this codon.

8. It is triplet code. Each amino acid is coded by sequence of three nucleotides. It is known as *codon*. For example, UUU codes for phenylalanine, GGG codes for glycine and CCC codes for proline.

9. A given codon codes only one amino acid. But an amino acid is coded by more than one codon. Existence of more than one codon for an amino acid is known as abundance of genetic code. For example, arginine is coded by six codons.

10. For a given codon on mRNA, an anti-codon is present on tRNA. Codon and anti-codon always read from 5′ → 3′ direction. Further, codon and anticodons are anti-parallel and complementary in base composition. They interact with each other through base pairing.

7. Genetic code is commaless. Once reading of codons on mRNA begins it is continued until a termination codon is reached.

Table 18.1 Genetic code

		Second Nucleotide					
		G	**A**	**C**	**U**		
		GGG }	GAG } Glu	GCG }	GUG }	G	
		GGA } Gly	GAA }	GCA } Ala	GUA } Val	A	
F	**G**	GGC }	GAC } Asp	GCC }	GUC }	C	**T**
I		GGW }	GAU }	GCU }	GUU }	U	**H**
R							**I**
S		AAG } Arg	AAG } Lys	ACG }	AUG Met	G	**R**
T		AGA }	AAA }	ACA } Thr	AUA }	A	**D**
N	**A**	AGC } Ser	AAC } Asn	ACC }	AUC } Ileu	C	**N**
U		AGU }	AAU }	ACU }	AUU }	U	**U**
C							**C**
L		CGG }	CAG } Gln	CCG }	CUG }	G	**L**
E		CGA } Arg	CAA }	CCA } Pro	CUA } Leu	A	**E**
O	**C**	CGC }	CAC } His	CCC }	CUC }	C	**O**
T		CGU }	CAU }	CCU }	CUU }	U	**T**
I							**I**
D		UGG Try	UAG } Ter	UCG }	UUG } Leu	G	**D**
E		UGA Ter	UAA }	UCA } Ser	UUA }	A	**E**
	U	UGC } Cys	UAC } Tyr	UCC }	UUC } Phe	C	
		UUU }	UAU }	UCU }	UUU }	U	