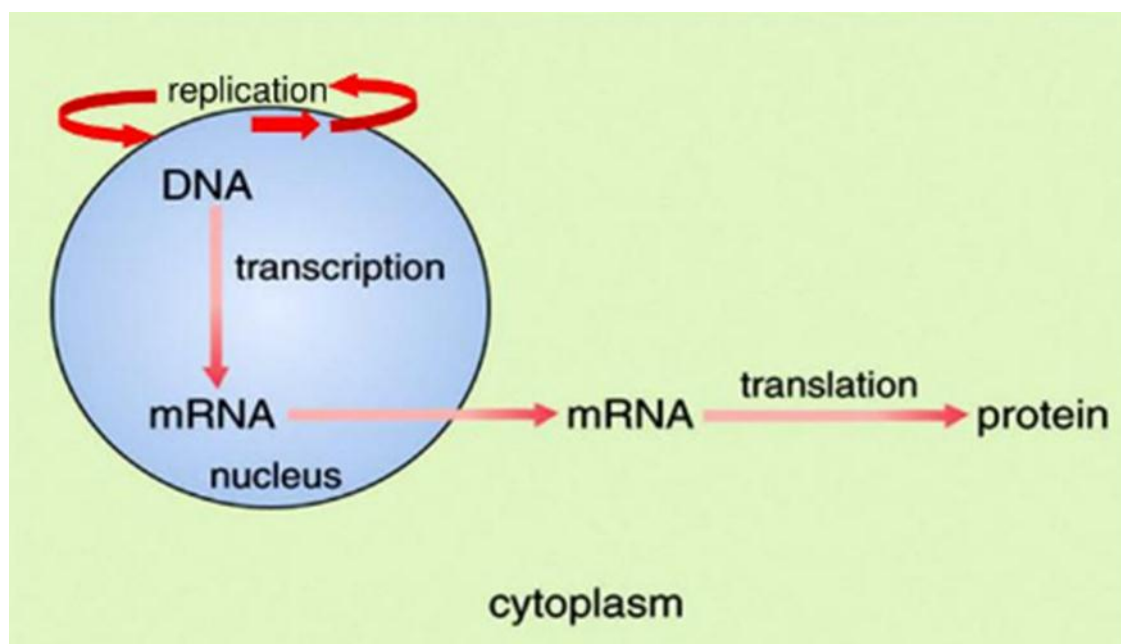


Lecture 1

1.1. Molecular biology

Molecular biology is the science that deals with living matters at the level of the molecules, in which control and buildup of the living organism. While traditional Biology science concentrated on the studying whole living organisms and how they interact within populations (a “top to down” approach) as biology science concentrates on cellular structures (like organelles), molecular pathways within cells and cell life cycles. Molecular biology strives to understand the living matters by examining the components that make them up (a “bottom to up” approach).

Molecular biology is focus on the nucleic acids (**DNA** and **RNA**) and the (**Proteins**). Biomolecules such as **carbohydrates** and **lipids** may also be studied in molecular biology for their interactions with nucleic acids and proteins.



Generally Molecular biology deals with following aspects:

- 1- Structure of DNA & RNA
- 2- DNA replication
- 3- DNA transcript into RNA (Transcription)
- 4- RNA translate into Protein (Translation)
- 5- Regulation of gene expression

1.2. Nucleic acid

Nucleic acid is a small biomolecules, essential unit of all known forms of life. It is the most important of all biomolecules, as they are found in abundance in all living matters. The main function of nucleic acid is **create** and **encode** and then **store** the information in the nucleus of every living cell of every life-form organism on Earth. Nucleic acids compose of two importance form are:

- DNA (Deoxyribose sugar Nucleic Acid).
- RNA (Ribose sugar Nucleic Acid).

DNA (Deoxyribose sugar Nucleic Acid)

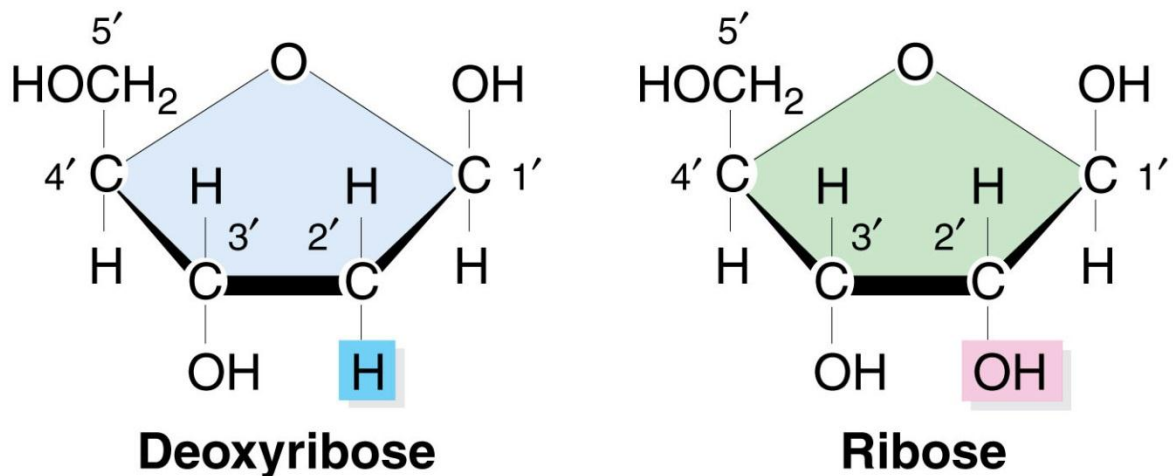
DNA is molecule of heredity, its function as the gene. DNA is present in all cells, DNA is present in the chromosome of nucleus, Mitochondria and Plastids. In eukaryotic cell DNA exist in double helix form, meanwhile in bacteria and mitochondria DNA showed circular form and in viruses are coiled form.

Structurally DNA consists of main three components are:

- 1- Sugar
- 2- phosphoric acid
- 3- Nitrogenous bases

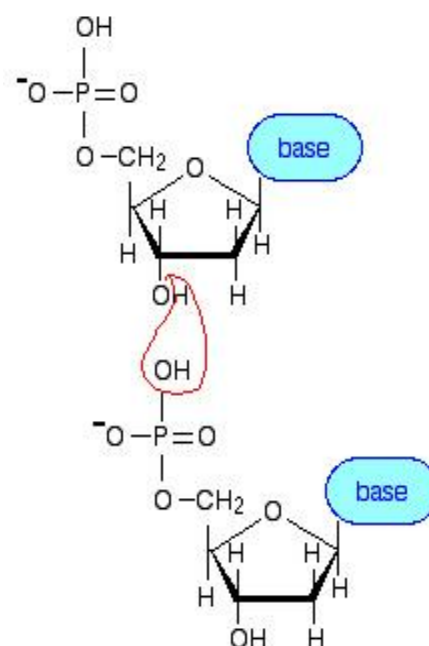
1- Sugar

The sugar present in DNA molecule is called Deoxyribose. It is pentose sugar which contains five carbon atoms ($C_5H_{10}O_4$) and has (H) group at carbon 2' position. Meanwhile the sugar in RNA molecule is Ribose and has (OH) group at carbon 2' position.



2- Phosphoric acid (H_3PO_4)

Phosphoric acid links consecutive nucleotides by joining their pentose sugar with a **phosphate diester bond**, this bond links carbon 5' in one nucleotide with carbon 3' in the next nucleotide.

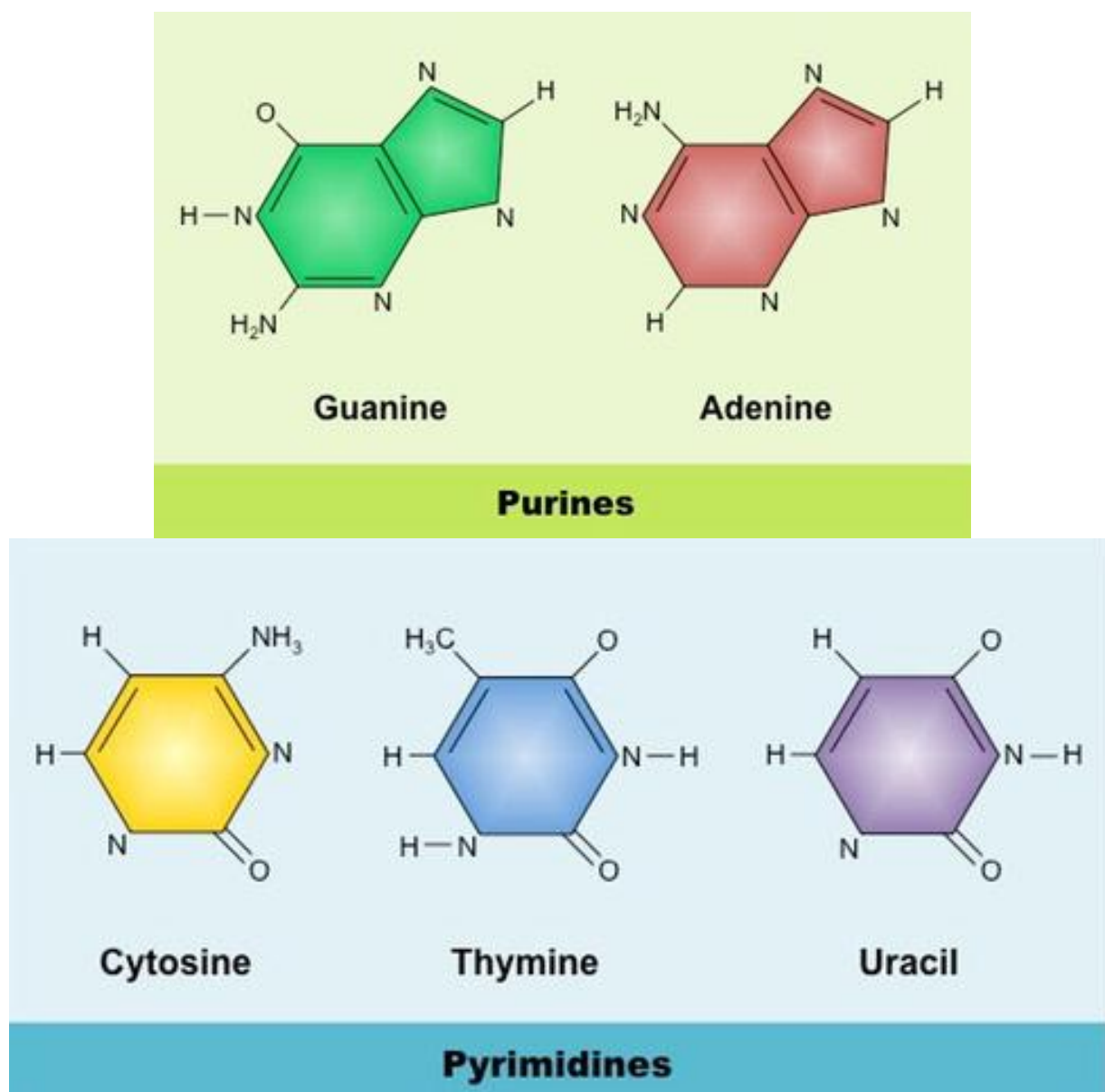


3- Nitrogenous bases

The nitrogenous bases are organic compounds; they are two main types, namely

- Purine: are two-ringed nitrogenous compounds. (**Adenine** (A) and **Guanine** (G)).
- Pyrimidine: are single-ringed nitrogenous compounds. (Thymine (T) and **Cytosine** (C)).

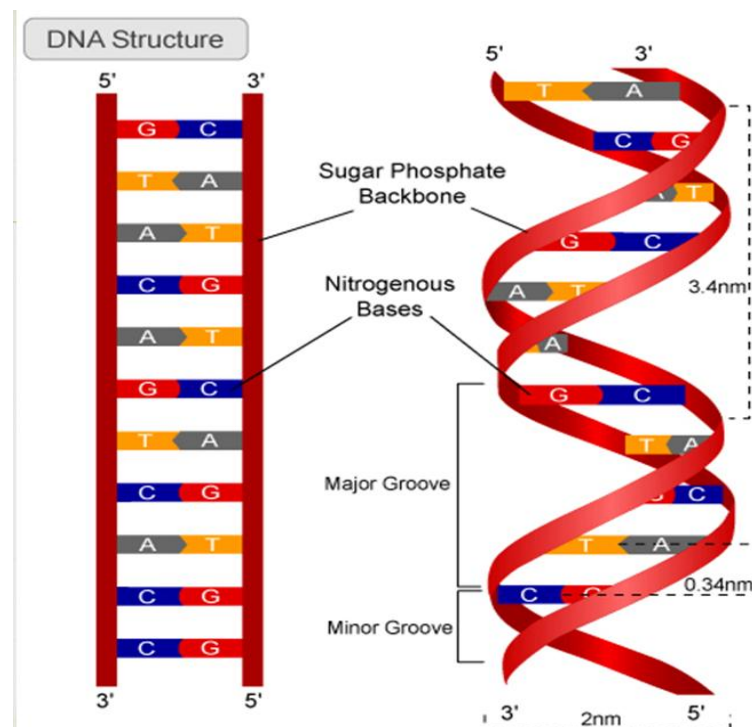
Note: RNA molecule has **Uracil** (U) instead **Thymine** (T) nitrogenous base.



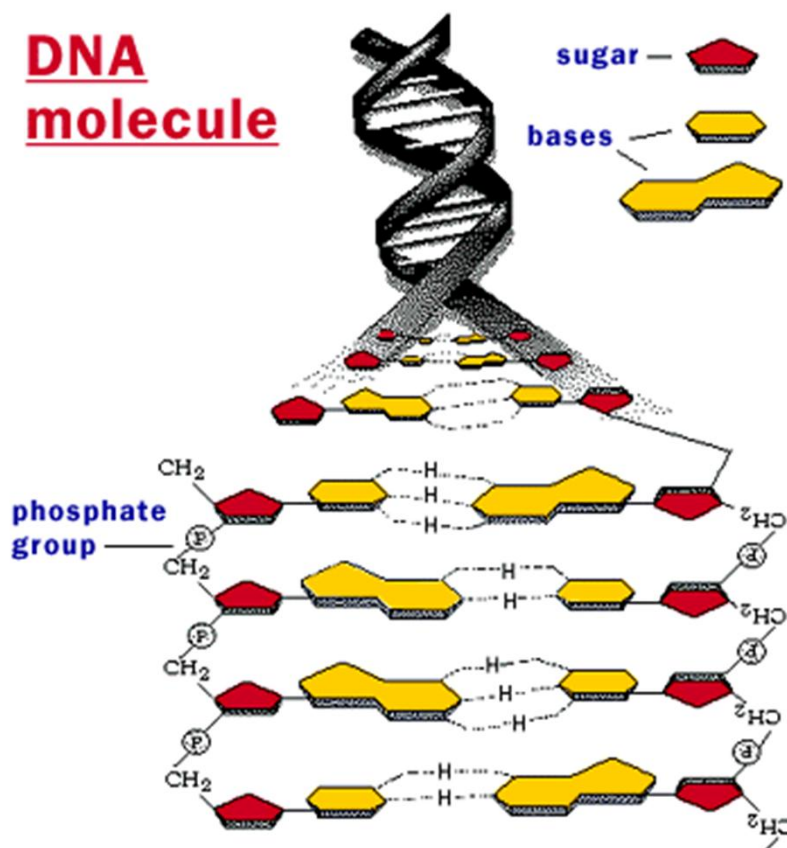
1.3. Structure of DNA (Crick and Watson model of DNA)

Crick and Watson in 1953 designed the structure of DNA, and they were awarded Nobel Prize in 1962 for this work. According to Watson and Crick DNA model is DNA has **double strands helix form**.

- DNA is macromolecule made up of two chains, each chain is **polynucleotide chain**.
- Each polynucleotide is made up of many small units called **nucleotide**.
- Each nucleotide is made up of three chemical components, namely: a **phosphoric acid (H_3PO_4)**, a **deoxyribose sugar** and a **nitrogenous base**.
- The nitrogenous base is **adenine, guanine, thymine and cytosine**.
- The nucleotide of DNA is named according to the type of nitrogen base present. As there are four type of nitrogen base, DNA contains for type of nucleotides. Namely:
 - 1- AMP- Adenosine MonoPhosphate.
 - 2- GMP- Guanosine MonoPhosphate.
 - 3- TMP- Thymidine MonoPhosphate.
 - 4- CMP- Cytidine MonoPhosphate.



- In each nucleotide, sugar is attached to phosphoric acid at one side and nitrogen base at other side.
- Nitrogen base molecule is joined to the sugar by *glycoside bond*, and sugar is joined with phosphoric acid by *phosphodiester bond*.
- DNA has two polynucleotide chains; the nucleotides of adjacent chains are linked by *hydrogen bond*. Where nitrogen base (A) joined to (T) in adjacent chain by double hydrogen bond (A=T), meanwhile nitrogen base (G) joined to (C) in adjacent chain by triple hydrogen bond (G≡C).
- The amount of adenine (A) is equal to the amount of thymine (T) and the amount of guanine (G) is equal to the amount of cytosine (C).



- At one end of the polynucleotide chain, the 3' carbon of the sugar is free and it is not linked to any nucleotide so it's called **prime (3') end**. At the other end, the 5' carbon of sugar is free and it's called **prime (5') end**.

- The 3' end of one chain lies close to the 5' end of the other chain, hence the two stands of DNA called **antiparallel**.
- The width (diameter) of DNA helix is 20\AA . The distance between two nucleotide is 3.4\AA .
- DNA helix has two external grooves, namely **Major groove** and **Minor groove**. The major groove is wide and deep and the minor groove is narrow.

1.4. RNA (Ribose sugar Nucleic Acid)

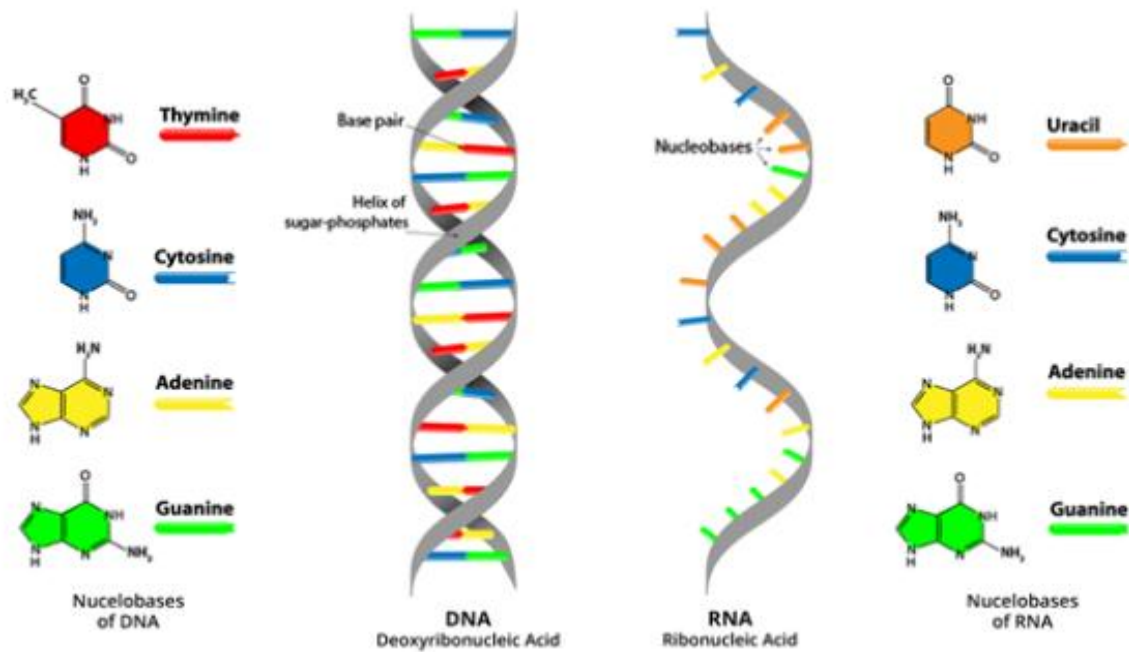
Also called non-genetic material. RNA is found in cytoplasm in large mounts and lesser mount in nucleus, in cytoplasm RNA found in ribosomes (protein synthesis).

Structure of RNA

- RNA is formed of a **single strand**.
- RNA consist of several units called **ribo-nucleotide**, hence each RNA molecule is formed of several nucleotide.
- Each nucleotide is made up of three components are: **phosphate, ribose sugar and nitrogen bases**.
- Nitrogen bases are **purine** (adenine (A) and guanine (G)), and **pyrimidine** (uracil (U) and cytosine (C)).
- In RNA molecule the mount of purine and pyrimidine are **not present in equal**.

There are three major type of RNA:

- 1- Messenger RNA(mRNA).
- 2- Transfer RNA (tRNA).
- 3- Ribosomal RNA (rRNA).



Difference between DNA and RNA are:

DNA	RNA
It is double stranded nucleic acid.	It is single stranded nucleic acid.
It contains deoxyribise sugar.	It contains ribose sugar.
It contains Thymine (T) as a nitrogenous base.	It contains Uracil (U) instead of Thymine.
It is the genetic and hereditary material of the cells.	It is involved in synthesis of proteins.
It is present in the nucleus of the cells.	It is present in both nucleus and cytoplasm.

1.5. Type of RNA molecule:

1- Messenger RNA

- mRNA is ribonucleic acid which is responsible to carries the genetic information from DNA in nucleus to cytoplasm for protein synthesis, mRNA forms about 3-5% of total cellular RNA.
- mRNA is synthesized as complementary strand to chromosomal DNA, the genetic information from DNA is transcribed (copy) to newly synthesized mRNA, and mRNA molecule carries this genetic information in form of **triple code** called (**codon**).

- Newly mRNA molecule travel through nucleus membrane to cytoplasm where ribosomes to translate the genetic information (genetic code) into protein.

There are two type of mRNA:

- a- Monocistronic mRNA: this molecule contains the codon of single cistron (functional gene) and its code for a single poly peptide chain (e.g. eukaryotic mRNA).
- b- Polycistronic mRNA: this molecule contains many cistron (functional gene) and code for several different poly peptide chains (e.g. prokaryotic mRNA).

2- Ribosomal RNA (rRNA):

The rRNA constitutes about 80% of total cellular RNA. Its occurs in ribosomes (protein synthesis house). In prokaryote, ribosome called (**70s**) according to their sedimentation rate. Each ribosome is composed of two units are: **30s** rRNA and **50s** rRNA. Meanwhile in eukaryote, the ribosome called (**80s**) which are composed of two subunits is: **40s** rRNA and **60s** rRNA.

The function of rRNA is not known, but recent research and evidence suggest that one of the subunit of rRNA helps to release mRNA from DNA. Aslo rRNA acts as **ribozyme** that catalyze the synthesis of peptide bond between amino acids.

3- Transfer RNA (tRNA) or soluble RNA:

- tRNA plays important role in protein synthesis by transfer the activated amino acid in cytoplasm to ribosome where protein synthesized, and then transmits amino acid to the poly peptide chain.

- In 1965 R.W. Holly proposed a model of tRNA and called a **clover leaf** model, according to this model tRNA has the following:

- Amino acid arm
- D-loop
- T-loop
- Anticodon-loop

There is at least (40-60) type of tRNA molecules; each molecule has a different anticodon-loop for different 20 amino acid.

