
NUCLEIC ACIDS

- **Nucleic acids store and transmit hereditary information.**
- **There are two types of nucleic acids:**

  1)- ribonucleic acid (RNA);

  2)- deoxyribonucleic acid (DNA).

The distribution of nucleic acids in the eukaryotic cell

- DNA is found in the nucleus

with small amounts in mitochondria and chloroplasts

- RNA is found throughout the cell

NUCLEIC ACID STRUCTURE

- Nucleic acids are **polynucleotides**
- Their building blocks are **nucleotides**
- **Nucleotide consist of phosphate group ,pentose suger ,and nitrogen base**

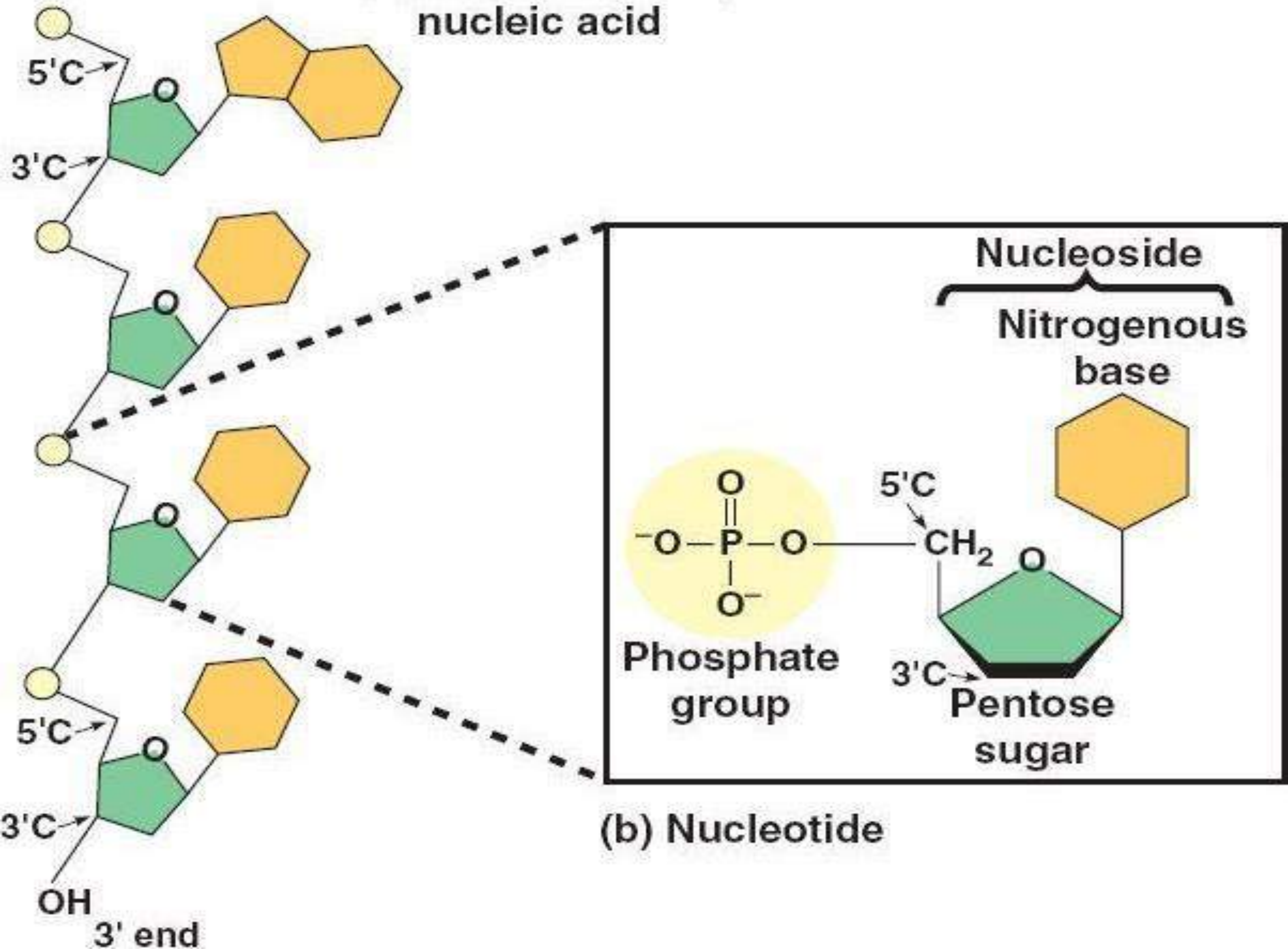
PHOSPHATE

Pentose SUGAR

Ribose or
Deoxyribose

Nitrogen BASE	
PURINES	**PYRIMIDINES**
Adenine (A) **Guanine(G)**	**Cytocine (C)** **Thymine (T)** **Uracil (U)**

NUCLEOTIDE

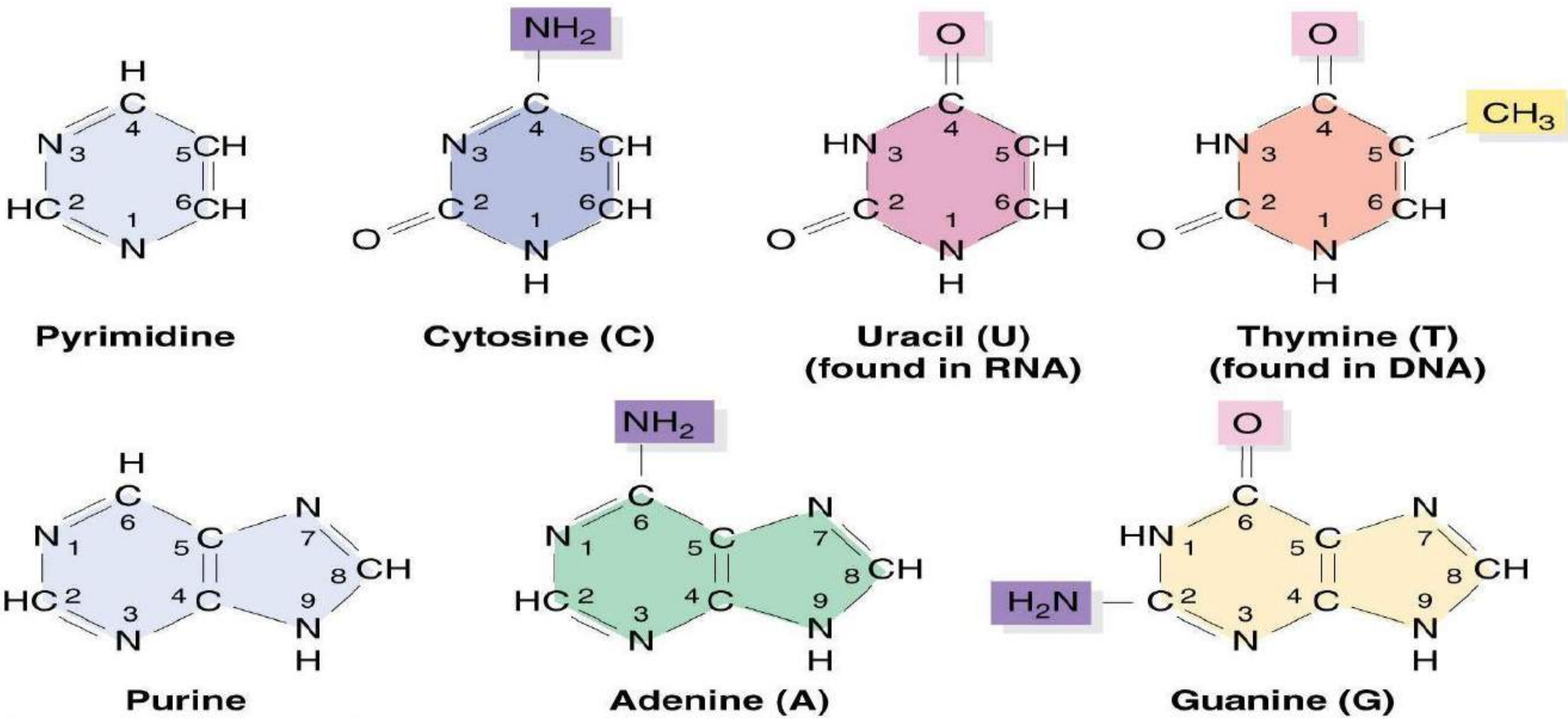


nucleic acid

(b) Nucleotide

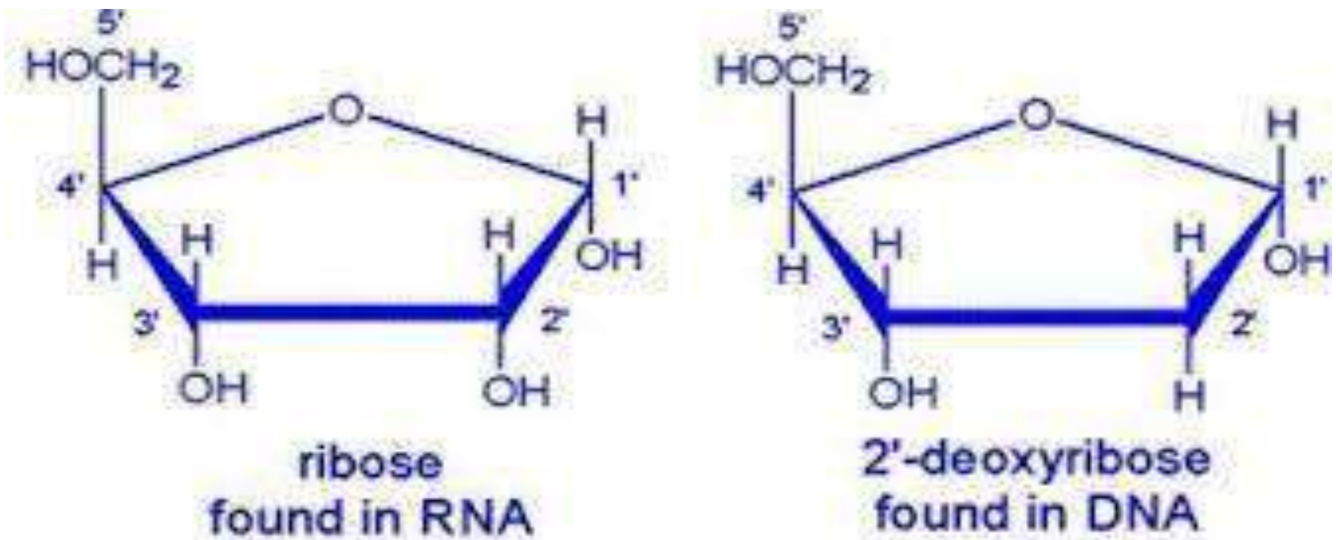
Nitrogen base

The nitrogen bases (rings of carbon and nitrogen**) come in two types: Purines and Pyrimidines.**



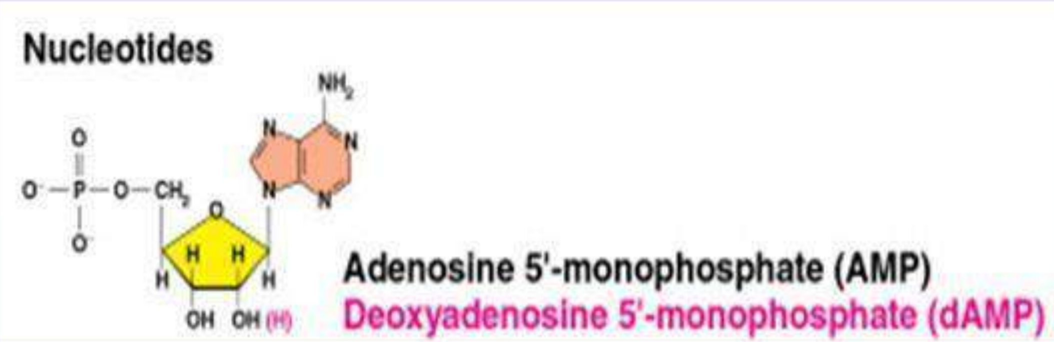
Pentose Sugar

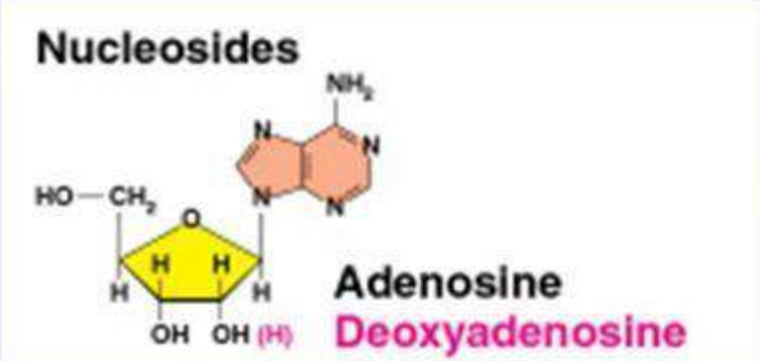
- The pentose sugar joined to the nitrogen base is ribose in nucleotides of RNA and deoxyribose in DNA. The only difference between the sugars is the lack of an oxygen atom on carbon 2 in deoxyribose. To differentiate the atoms of the pentose suger from the nitrogen base, the position number of the carbohydrate is followed by a ´ (prime).



Nucleosides and Nucleotides

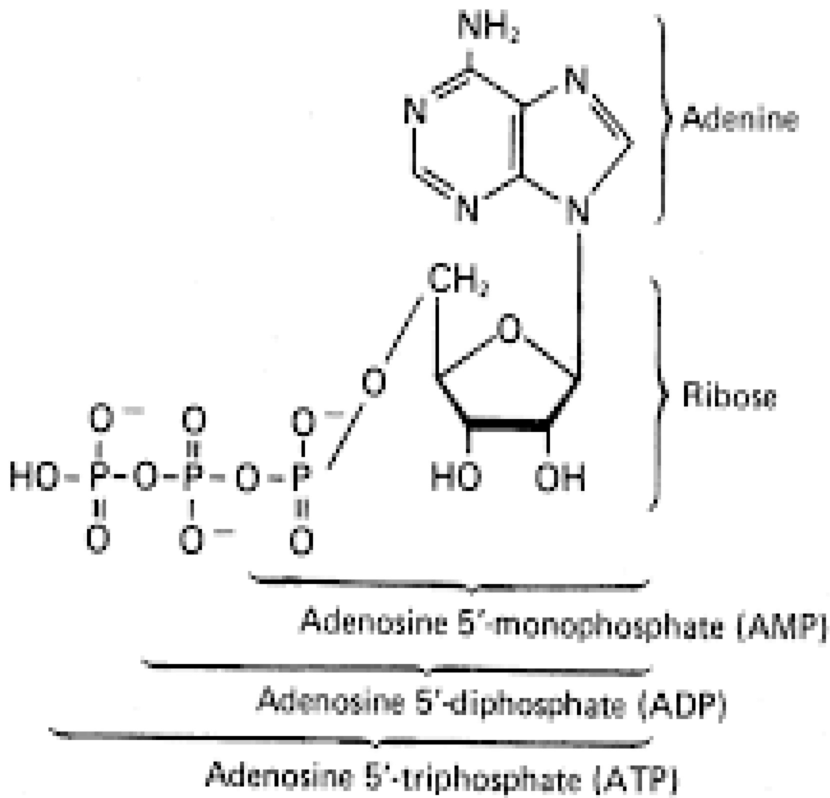
- A nucleoside consists of a nitrogen base linked by a glycosidic bond to C1’ of a ribose or deoxyribose
- Nucleosides are named by changing the nitrogen base ending to *-osine* for purines and *–idine* for pyrimidines
- A nucleotide is a nucleoside that forms a phosphate ester with the C5’ OH group of ribose or deoxyribose
- Nucleotides are named using the name of the nucleoside followed by *5’-monophosphate*
- Building blocks for DNA and RNA
- Intracellular source of energy - Adenosine triphosphate (ATP)
- Second messengers - Involved in intracellular signaling (e.g. cyclic adenosine monophosphate [cAMP])
- Intracellular signaling switches (e.g. G-proteins)





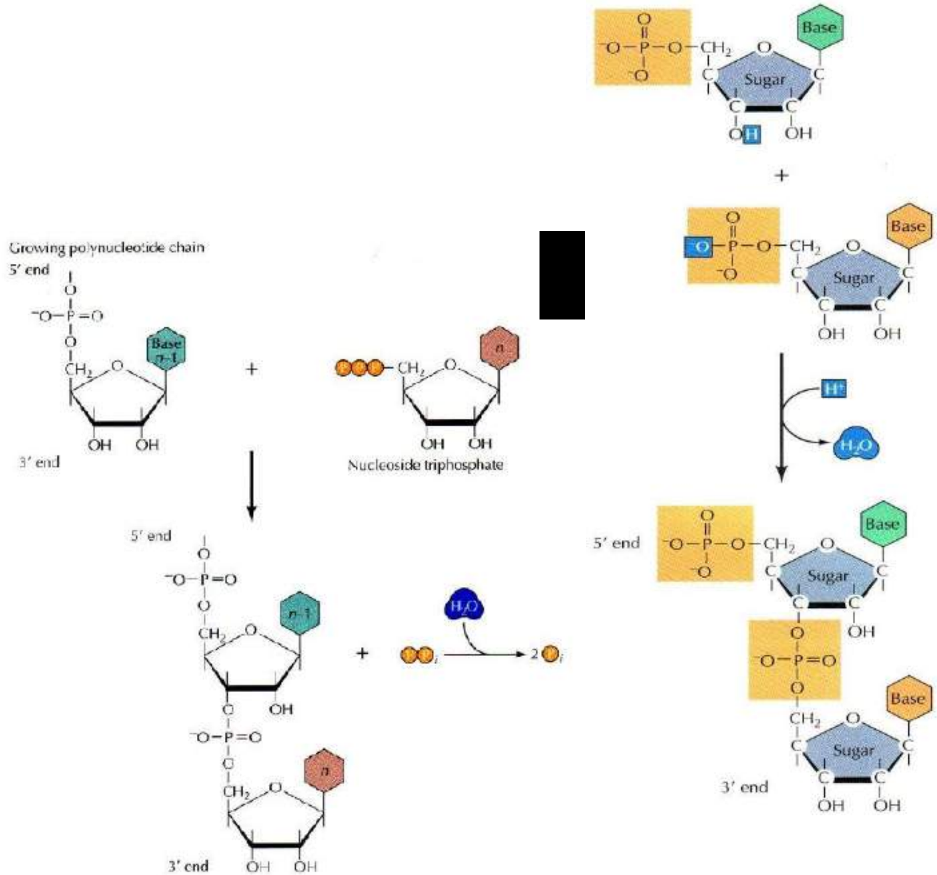
Base	Nucleosides	Nucleotides
RNA		
Adenine (A)	Adenosine (A)	Adenosine 5'-monophosphate (AMP)
Guanine (G)	Guanosine (G)	Guanosine 5'-monophosphate (GMP)
Cytosine (C)	Cytidine (C)	Cytidine 5'-monophosphate (CMP)
Uracil (U)	Uridine (U)	Uridine 5'-monophosphate (UMP)
DNA		
Adenine (A)	Deoxyadenosine (A)	Deoxyadenosine 5'-monophosphate (dAMP)
Guanine (G)	Deoxyguanosine (G)	Deoxyguanosine 5'-monophosphate (dGMP)
Cytosine (C)	Deoxycytidine (C)	Deoxycytidine 5'-monophosphate (dCMP)
Thymine (T)	Deoxythymidine (T)	Deoxythymidine 5'-monophosphate (dTMP)

AMP, ADP and ATP

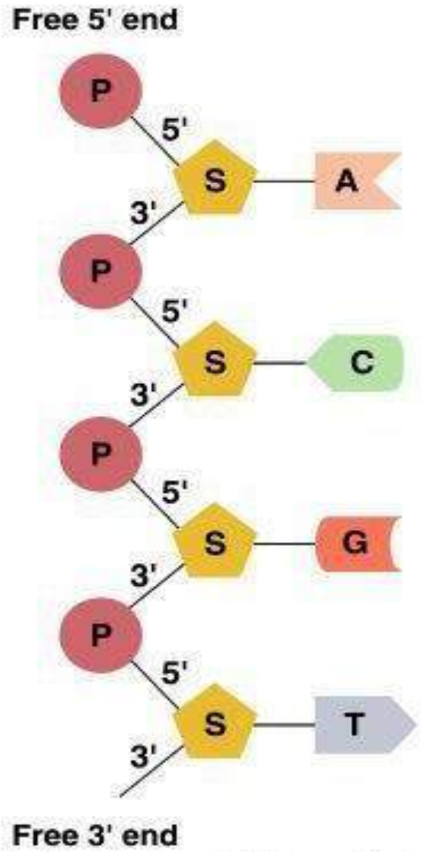


Linear Polymerization of Nucleotides

- **Nucleic acids are formed of nucleotide polymers.**
- **Nucleotides polymerize together by *<u>phospho-diester bonds</u>* via condensation reaction.**
- **The phospho-diester bond is formed between: 5' phosphate group of one nucleotide and 3' hydroxyl group of another nucleotide.**
- **Polynucleotide chains are always synthesized in the 5' to 3' direction, with a free nucleotide being added to the 3' OH group of a growing chain.**



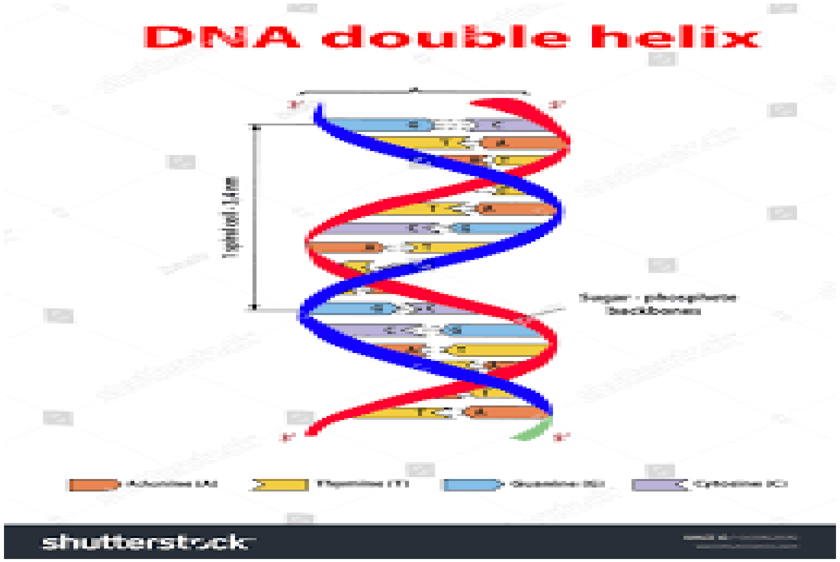
- **The following examples represent the orientation of the DNA strand from 5^{-} to 3^{-}**
- **5^{-} A-C-G-T 3^{-}**



Watson and Crick

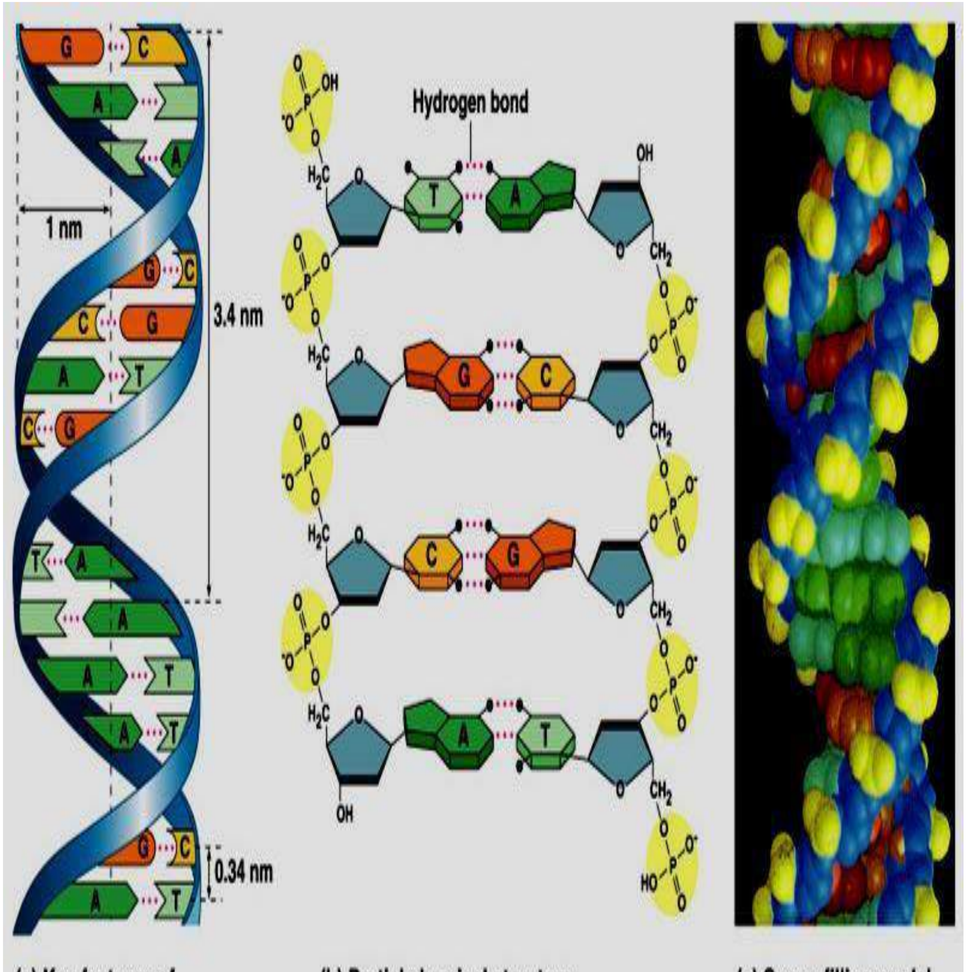
- **DNA molecules have two polynucleotide strands** (double strand) **that spiral around تدور حلزونيا to form a double helix .** حلزون مزدوج
- **The sugar-phosphate backbones of the two polynucleotides are on the outside of the helix.**
- **The orientation of nitrogen bases are to interior of DNA molecules**

- **The nitrogenous bases arranged perpendicular are far away from each other**



WATSON AND CRICK MODEL

- The sister strands of the DNA molecule run in opposite directions (**antiparallel**)
- They are joined by the bases
- Each base is paired with a specific partner:

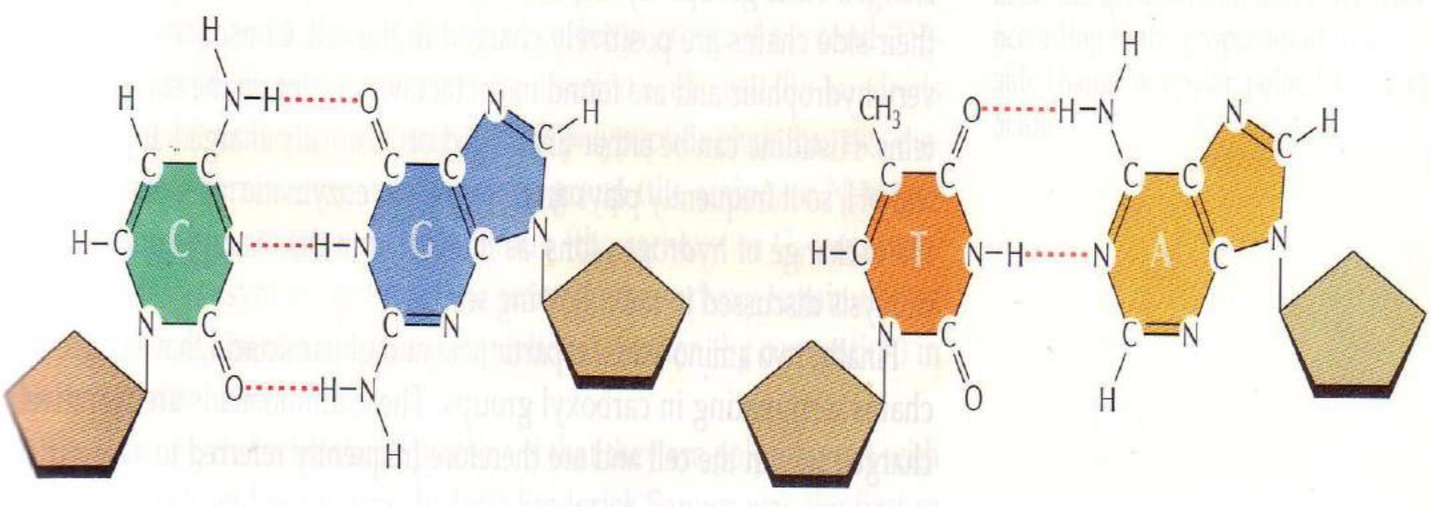


(a) Key features of DNA structure (b) Partial chemical structure (c) Space-filling model

•**A** is always paired with **T by double H-bond and G** is always paired with **C by triple H-bond .**

•Each base pair consist of Purine with Pyrimidine**,**Thus the sister strands are **complementary** but **<u>not</u>** identical

•The bases are joined by **hydrogen bonds**, individually weak but collectively strong.



Discovering structure of DNA BY Chargaff

- Chargaff discovered two rules that helped lead to the discovery of the double helix structure of DNA.
- The first rule was that in DNA the number of guanine units is equal to the number of cytosine units, and the number of adenine units is equal to the number of thymine units. This hinted at the base pair makeup of DNA.
- The second rule was that the relative amounts of guanine, cytosine, adenine and thymine bases vary from one species to another. This hinted that DNA rather than protein could be the genetic material.

DNA Denaturation

- The process of breaking double-stranded DNA into single strands is known as DNA denaturation, or DNA denaturing.
- The temperature at which the DNA strands are half denatured, meaning half double-stranded, half single-stranded, is called the melting temperature(Tm).
- The amount of strand separation, or melting, is measured by the absorbance of the DNA solution at 260nm.
- Nucleic acids absorb light at this wavelength because of the electronic structure in their bases, but when two strands of DNA come together, the close proximity of the bases in the two strands quenches some of this absorbance. When the two strands separate, this quenching disappears and the absorbance rises 30%-40%.This is called Hyperchromicity. The Hypochromic effect is the effect of stacked bases in a double helix absorbing less ultra-violet light.

C.Causes of Denaturation.

Denaturation can occur when proteins and nucleic acids are subjected to :

1-elevated **temperature.**

2-extremes of **pH.**

3-nonphysiological concentrations of salt, organic solvents, urea, or other chemical agents.

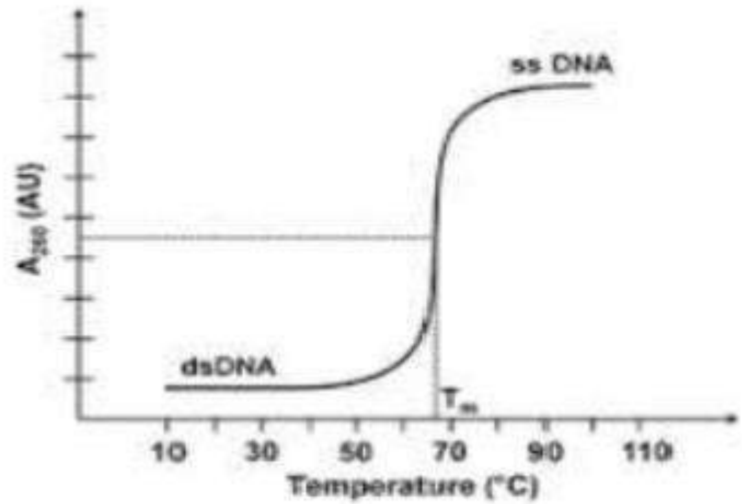
C.1-elevated temperature.

The most common type of denaturation is thermal denatuation.

Tm : temp at which DNA is half denatured.

*above Tm DNA is single strands.

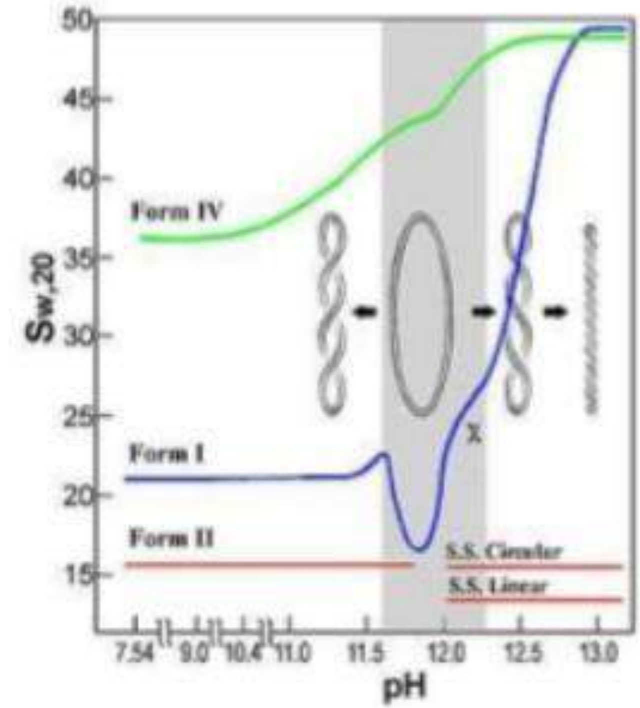
*below tm DNA is double strands.



- Tm depends on:
  - base composition
  - length
  - ionic strength
  - pH
  - denaturing agents

C.2-extremes of pH

At high PH the hydroxide ions ((negatively charged ions)) can pull hydrogen ions from base pairs – forming H bond between two strands – causing them to separate.



C.3 non physiological salts

Low salt concentration could also denature DNA double-strands <u>by removing ions that stabilize the negative charges on the two strands from each other.</u>

D. Characters of Denatured DNA

1. **Hyperchromic** : increase the absorbance (A260) upon denaturation.

2. The rate of **increase** in absorbance is directly proportional to the rate of denaturation.

3. **Viscosity** decrease upon denaturation.

Are Mutations Helpful or Harmful?

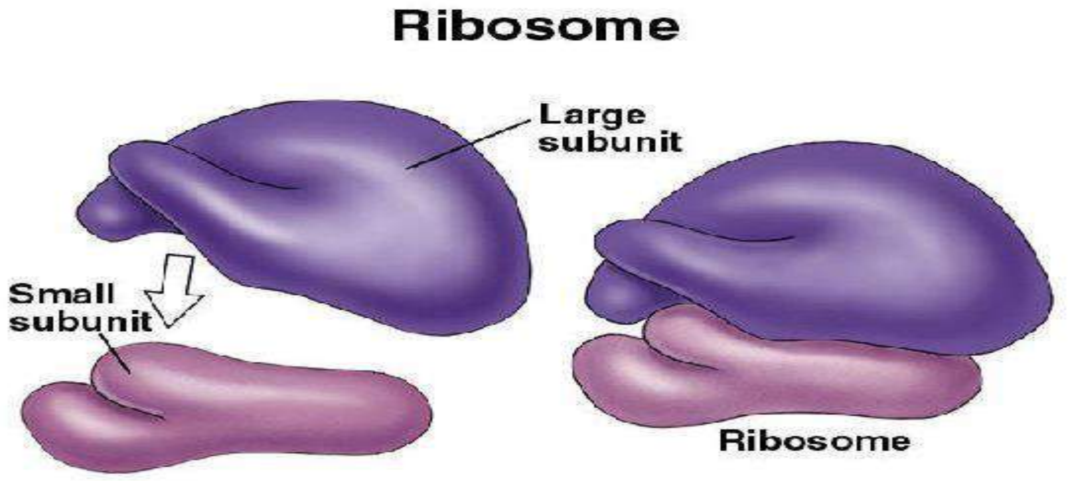
- ***Mutations happen regularly***
- ***Almost all mutations are neutral***
- ***Chemicals & UV radiation cause mutations***
- ***Many mutations are repaired by enzymes***

- **Ribonucleic acid** (**RNA**) is a biologically important type of molecule that consists of a long chain of nucleotide units. Each nucleotide consists of a nitrogenous base, a ribose sugar, and a phosphate.
  - SUGAR
    - Ribose
  - Phosphate group
  - Nitrogen containing base
    - Adenine
    - Guanine
    - Cytosine
    - Uracil

In all, there are **three differences** between RNA and DNA

RNA	**DNA**
1. Ribose sugar	**Deoxyribose sugar**
2. Uracil as a base **GCAU**	**Thymine as a base** **GCAT**
3. Single strand	**Double strand**

The **ribosome** is a complex molecular machine, found within all living cells, that serves as the site of biological protein synthesis(translation).
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 .



mRNA

- **Messenger RNA (mRNA)** is a large family of RNA molecules that transport genetic information from DNA to the ribosome, where they specify the amino acid sequence of the protein products of gene expression

Transfer RNA (tRNA)

- tRNA is a small molecule (~80 nucleotides).
- Single stranded and folded into a clover leaf shape with one end of the chain slightly longer.
- This longer section is attached to an amino acid.
- Each tRNA can carry a different amino acid.
- 3 bases at the opposite end of the tRNA are called an anticodon.
- Each amino acid has a different anticodon.
- The anticodon pairs with the complementary codon on the mRNA.

Structure of tRNA