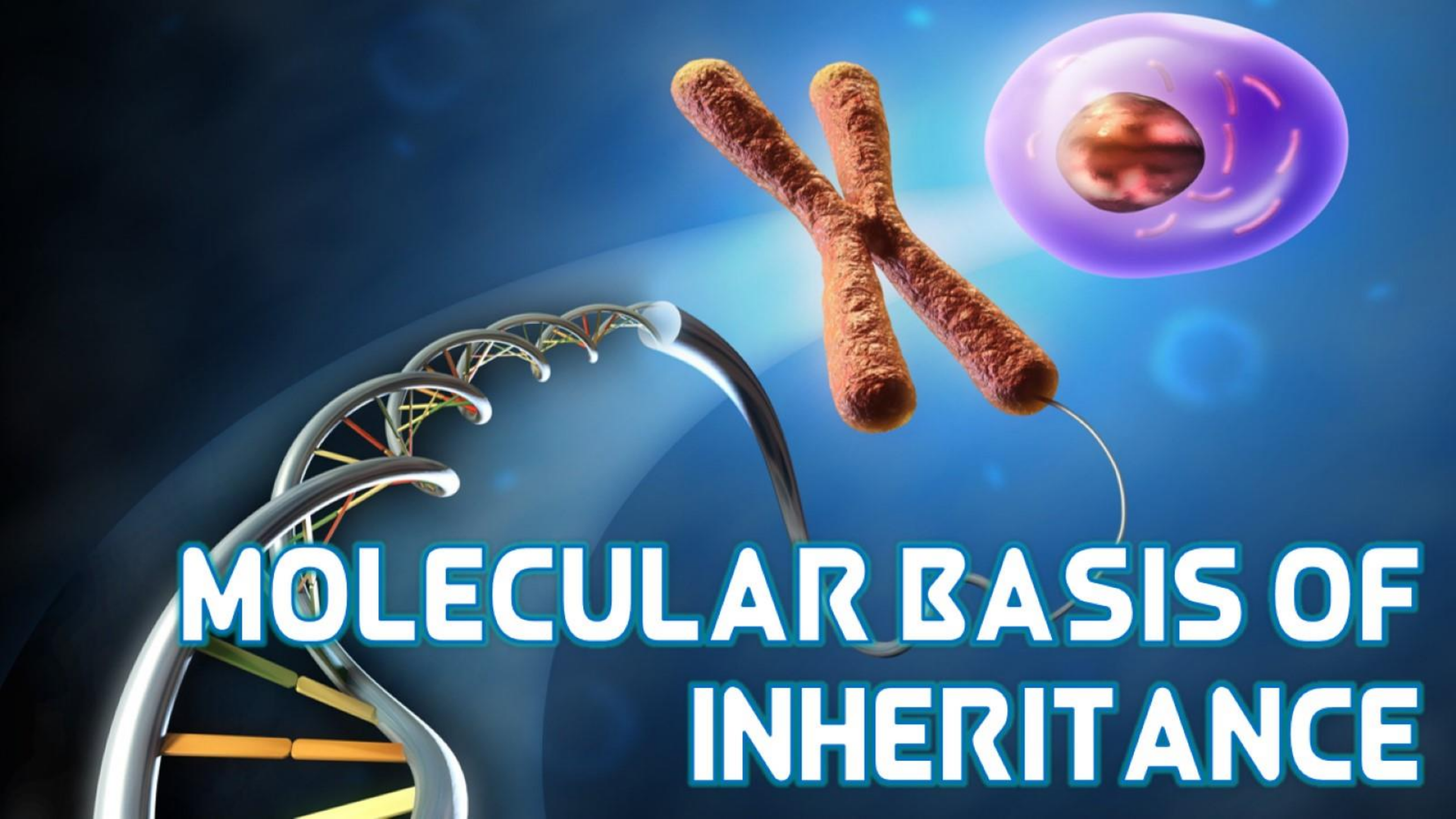
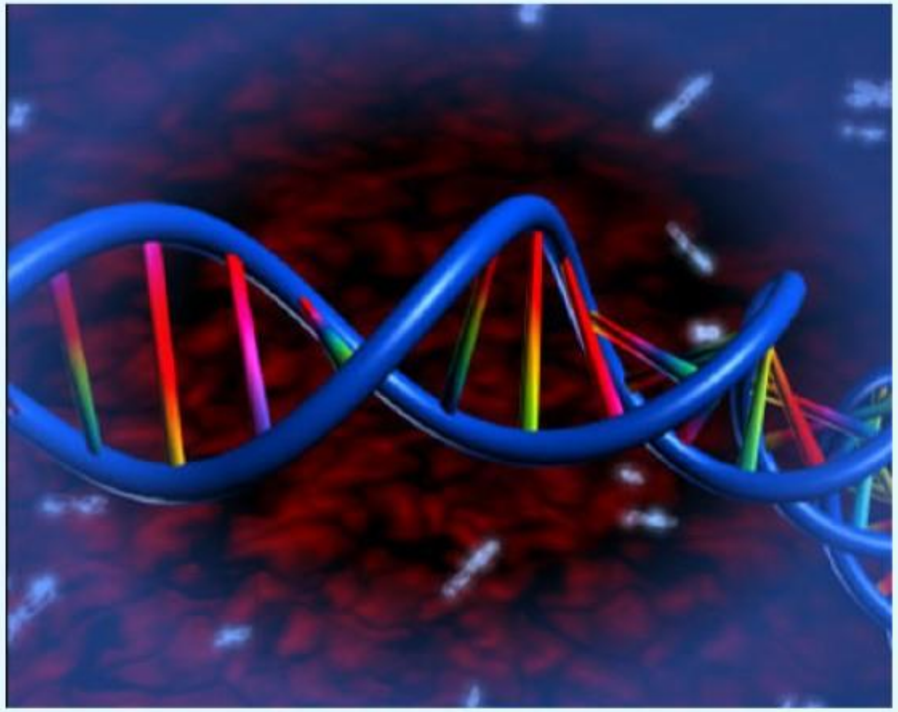
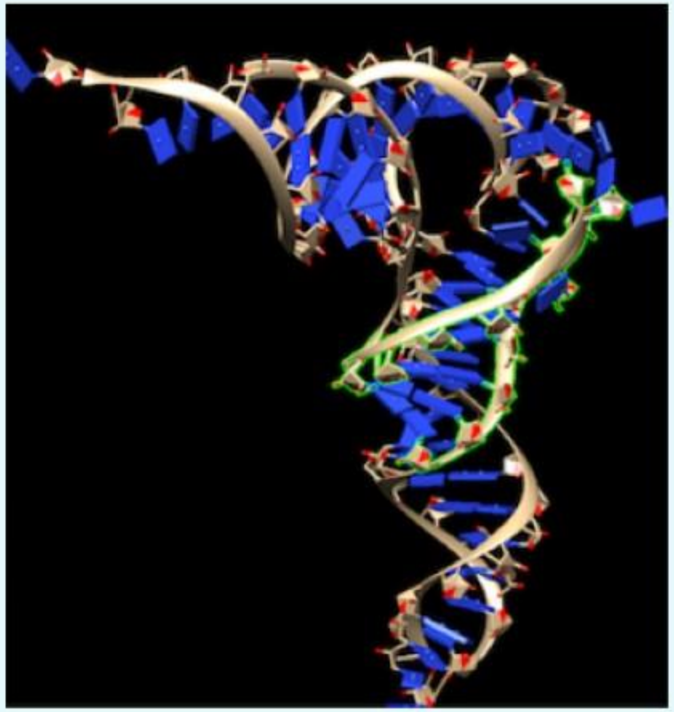

MOLECULAR BASIS OF
INHERITANCE



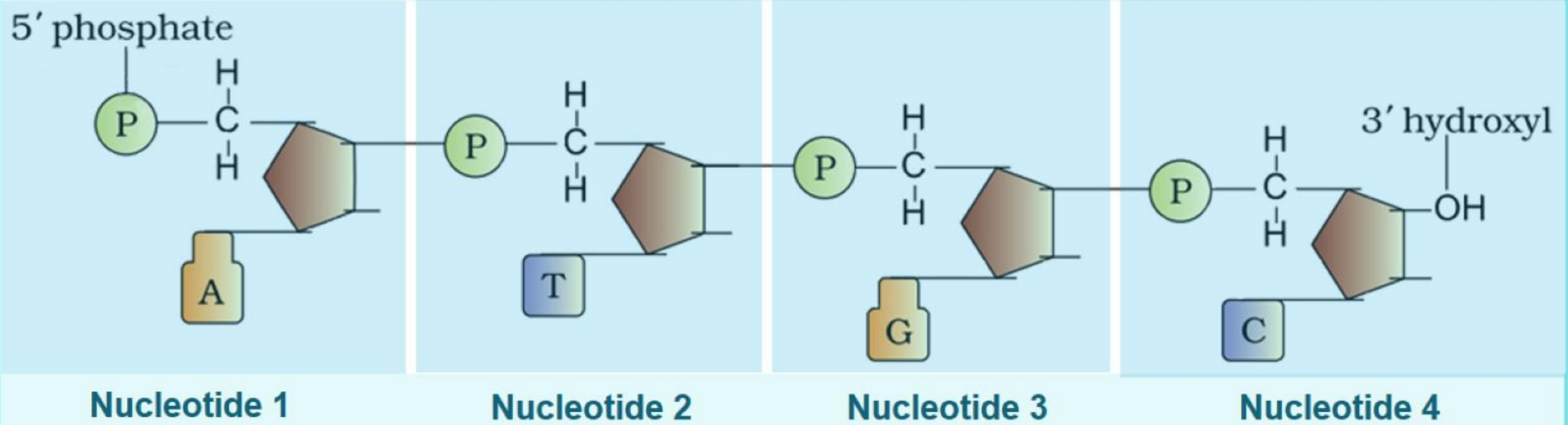


- **Nucleic acids (DNA and RNA)** are the building blocks of genetic material.
- **DNA** is the **genetic material** in most of the organisms.
- **RNA** is the genetic material in some **viruses.**
- **RNA** mostly functions as **messengers.**

THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

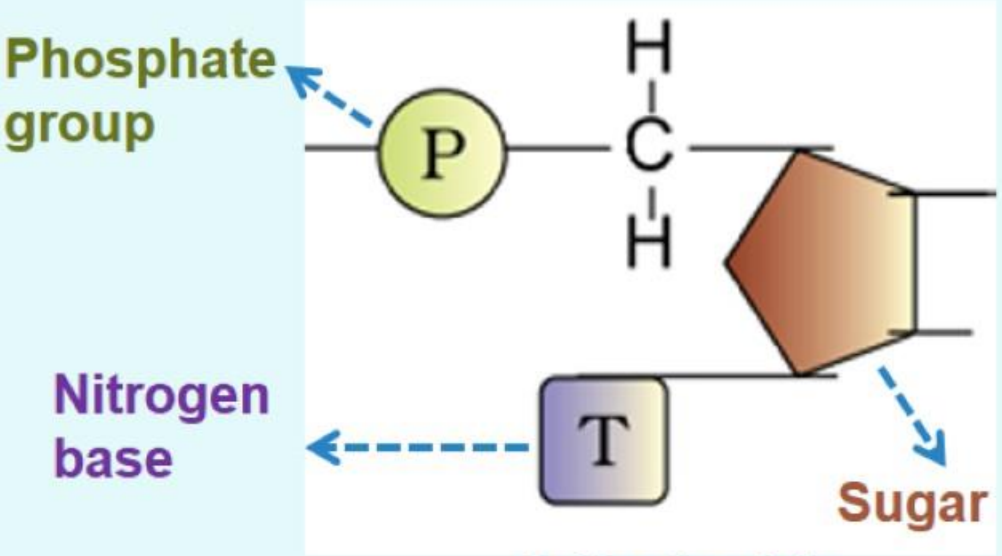
- **Polynucleotides** are the polymer of **nucleotides.**
- **DNA and RNA are Polynucleotides.**



THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

- **Polynucleotides** are the polymer of **nucleotides.**
- DNA and RNA are Polynucleotides.



A Nucleotide

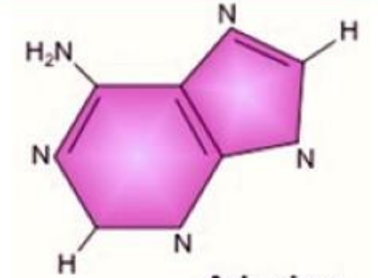
A nucleotide has 3 components

- A nitrogenous base
- A pentose sugar (Ribose in RNA & deoxyribose in DNA)
- A phosphate group

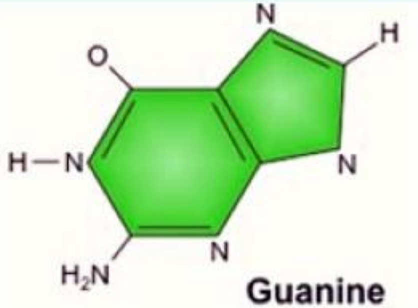
THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

- **NITROGEN BASES**
  - **PURINES**
    - ADENINE
    - GUANINE
  - **PYRIMIDINES**
    - CYTOSINE
    - THYMINE
    - URACIL

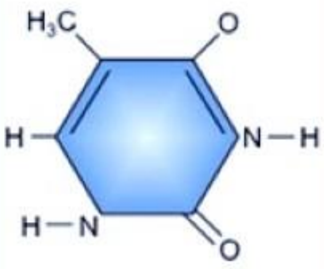


Adenine



Guanine

Cytosine



Thymine

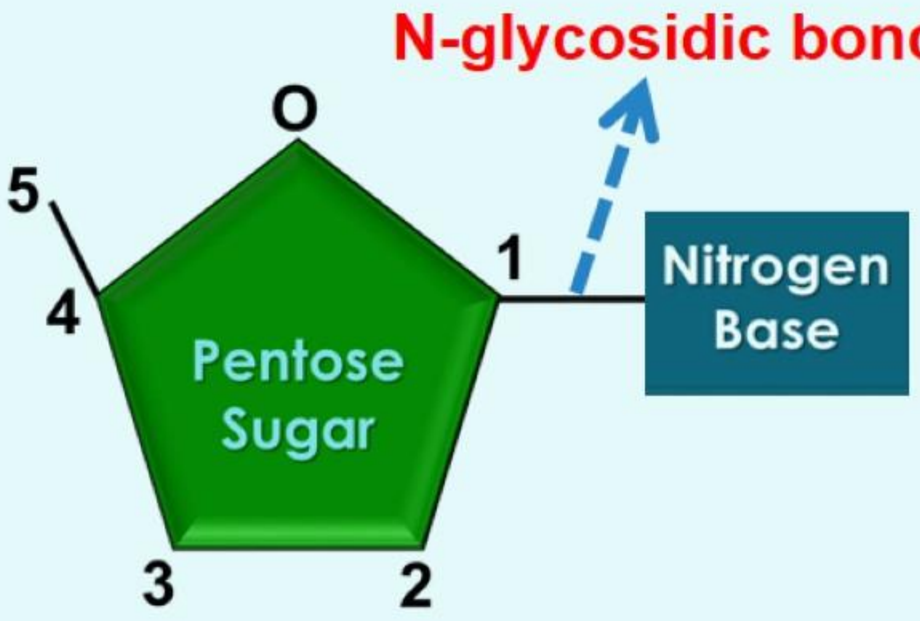
Uracil

Thymine (5-methyl Uracil) present only in DNA and Uracil only in RNA.

THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

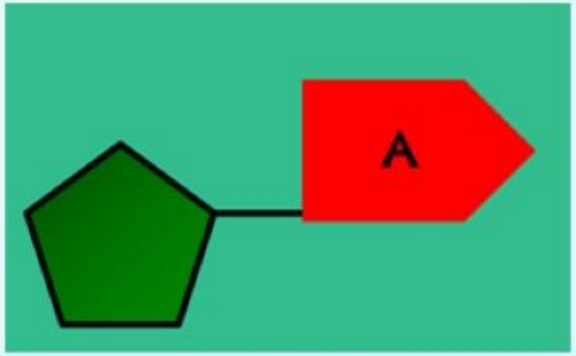
A **nitrogenous base** is linked to the **pentose sugar** through a **N-glycosidic linkage** to form **nucleoside.**



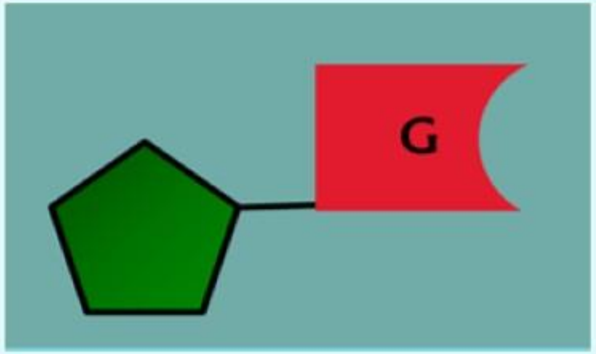
THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

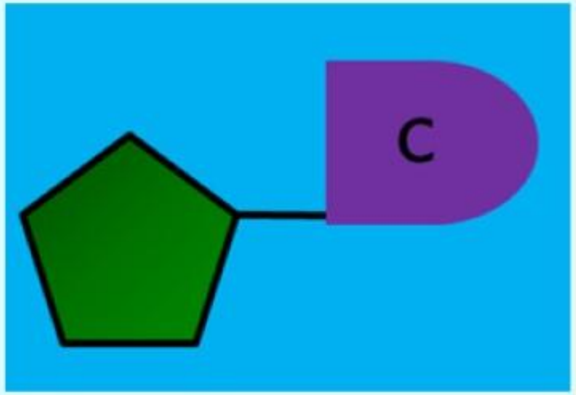
Nucleosides in RNA	Nucleosides in DNA
Adenosine	Deoxyadenosine
Guanosine	Deoxyguanosine
Cytidine	Deoxycytidine
Uridine	Deoxythymidine



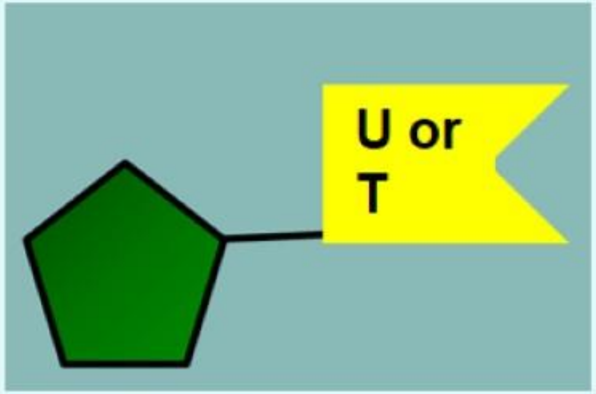
Adenosine / Deoxyadenosine



Guanosine / Deoxyguanosine



Cytidine / Deoxycytidine



Uridine / Deoxythymidine

THE DNA

STRUCTURE OF POLYNUCLEOTIDE CHAIN

Nitrogen base

+

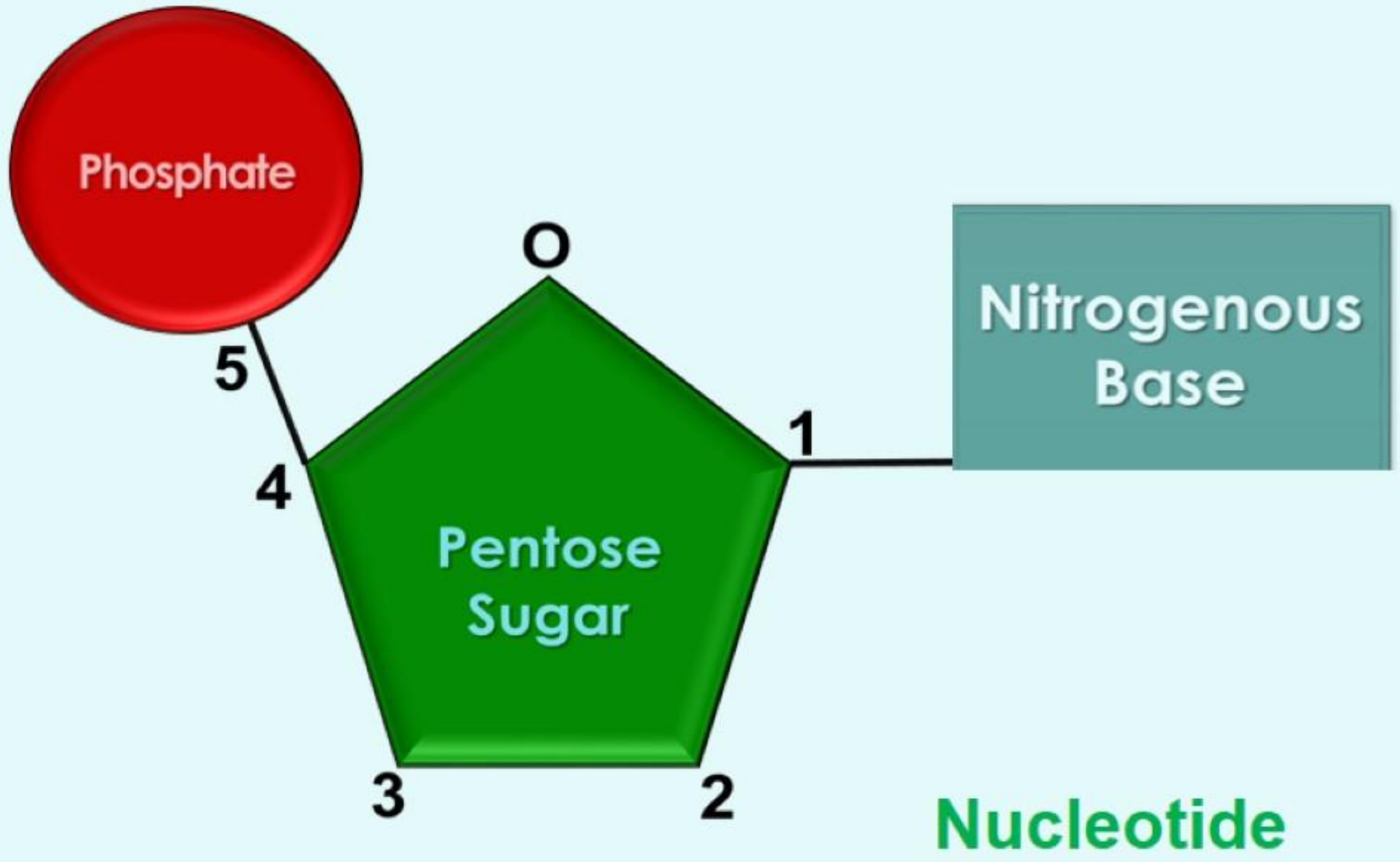
Sugar

+

Phosphate group

⬇

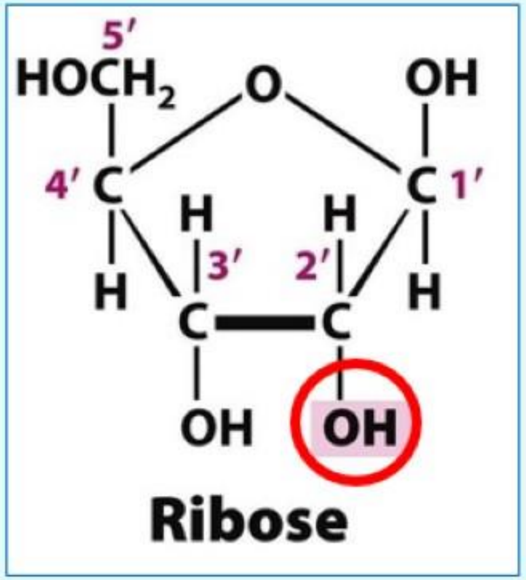
Nucleotide (deoxyribonucleotide)

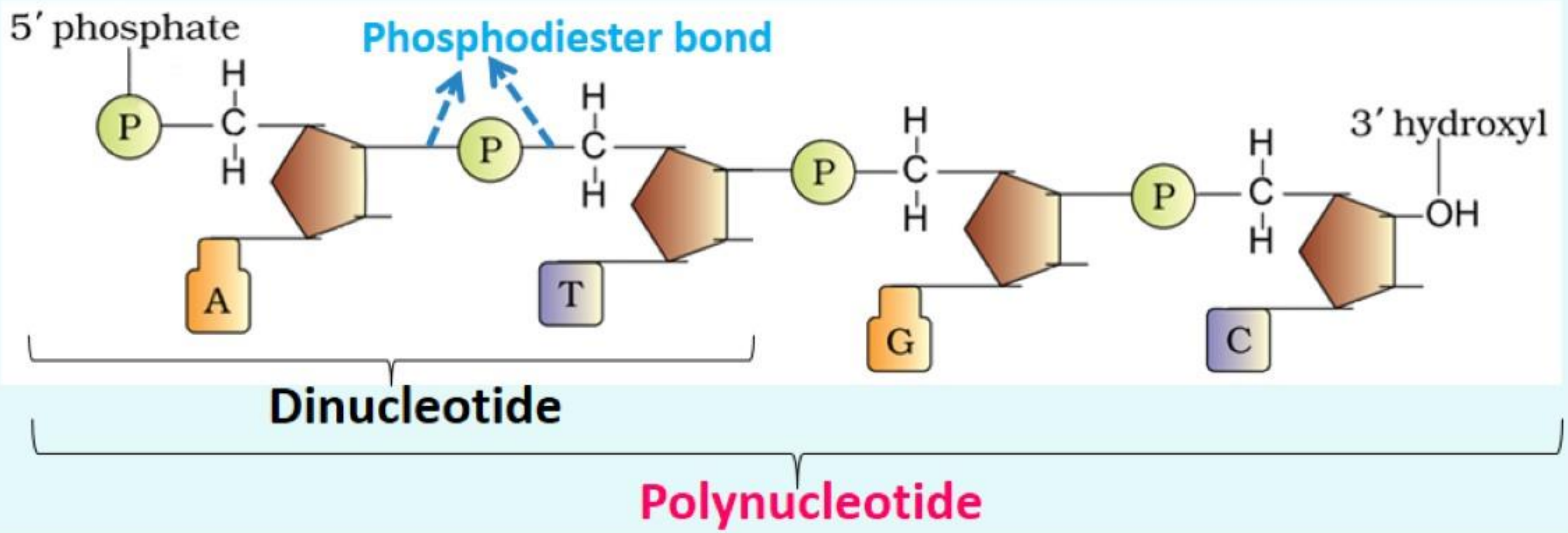


THE DNA

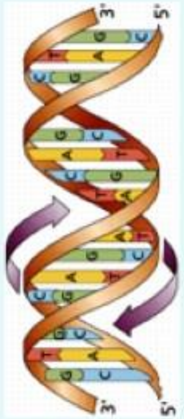
STRUCTURE OF POLYNUCLEOTIDE CHAIN

- In RNA, each nucleotide has an additional –OH group at 2'-position of ribose (2’- OH).
- 2 nucleotides are linked through 3’-5’ phosphodiester bond to form dinucleotide.
- When more nucleotides are linked, it forms polynucleotide.



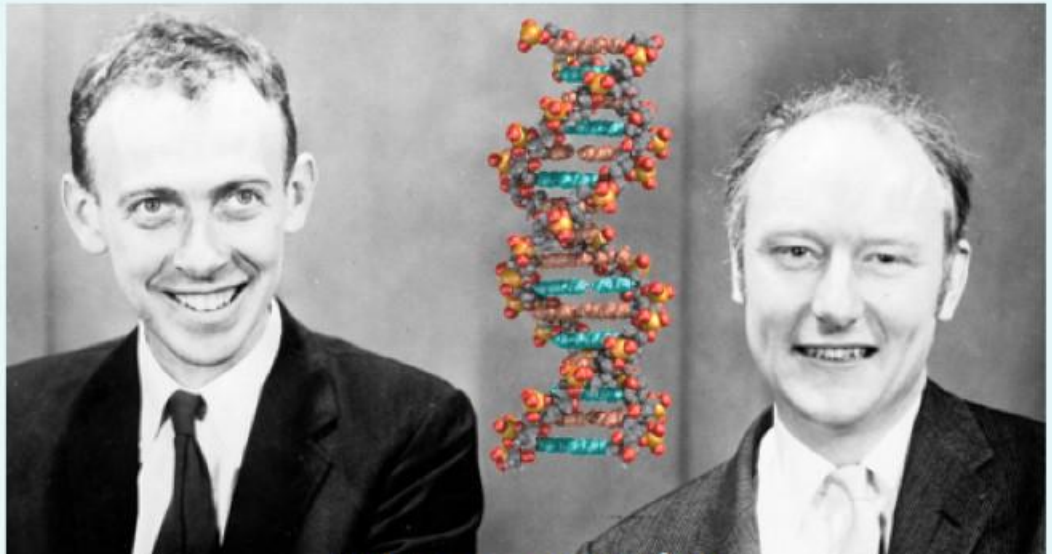


THE DNA



- **Friedrich Meischer (1869):** Identified DNA and named it as 'Nuclein'.
- **James Watson & Francis Crick** proposed **double helix model of DNA.**
- It was based on X-ray diffraction data produced by **Maurice Wilkins & Rosalind Franklin.**

F. Meischer

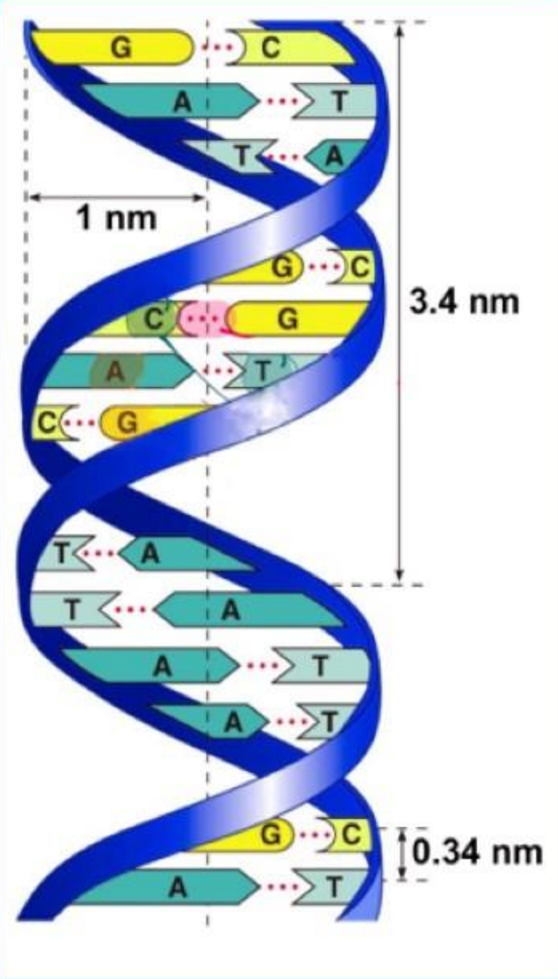


Watson and Crick

Maurice Wilkins & Rosalind Franklin

THE DNA

STRUCTURE OF DNA

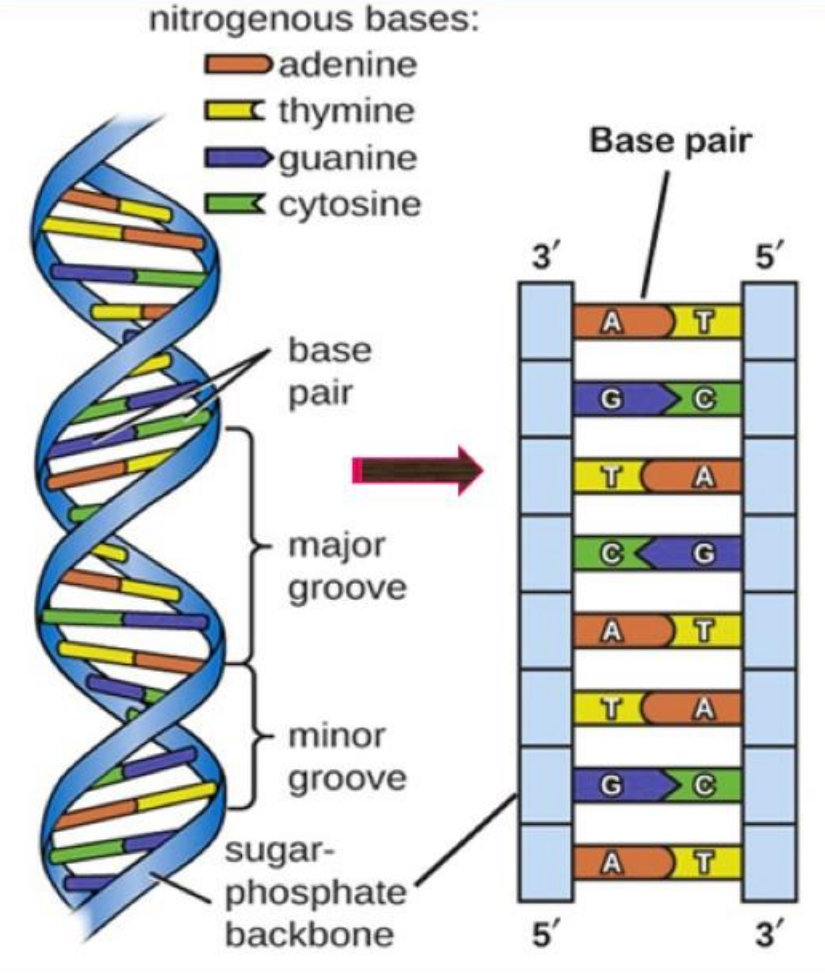


- DNA is made of **2 polynucleotide chains** coiled in a right-handed fashion.
- Pitch of the helix= **3.4 nm (34 Å)**
- Number of base pairs in each turn= **10**
- Distance b/w adjacent base pairs= **0.34 nm (3.4 Å)**

THE DNA

STRUCTURE OF DNA

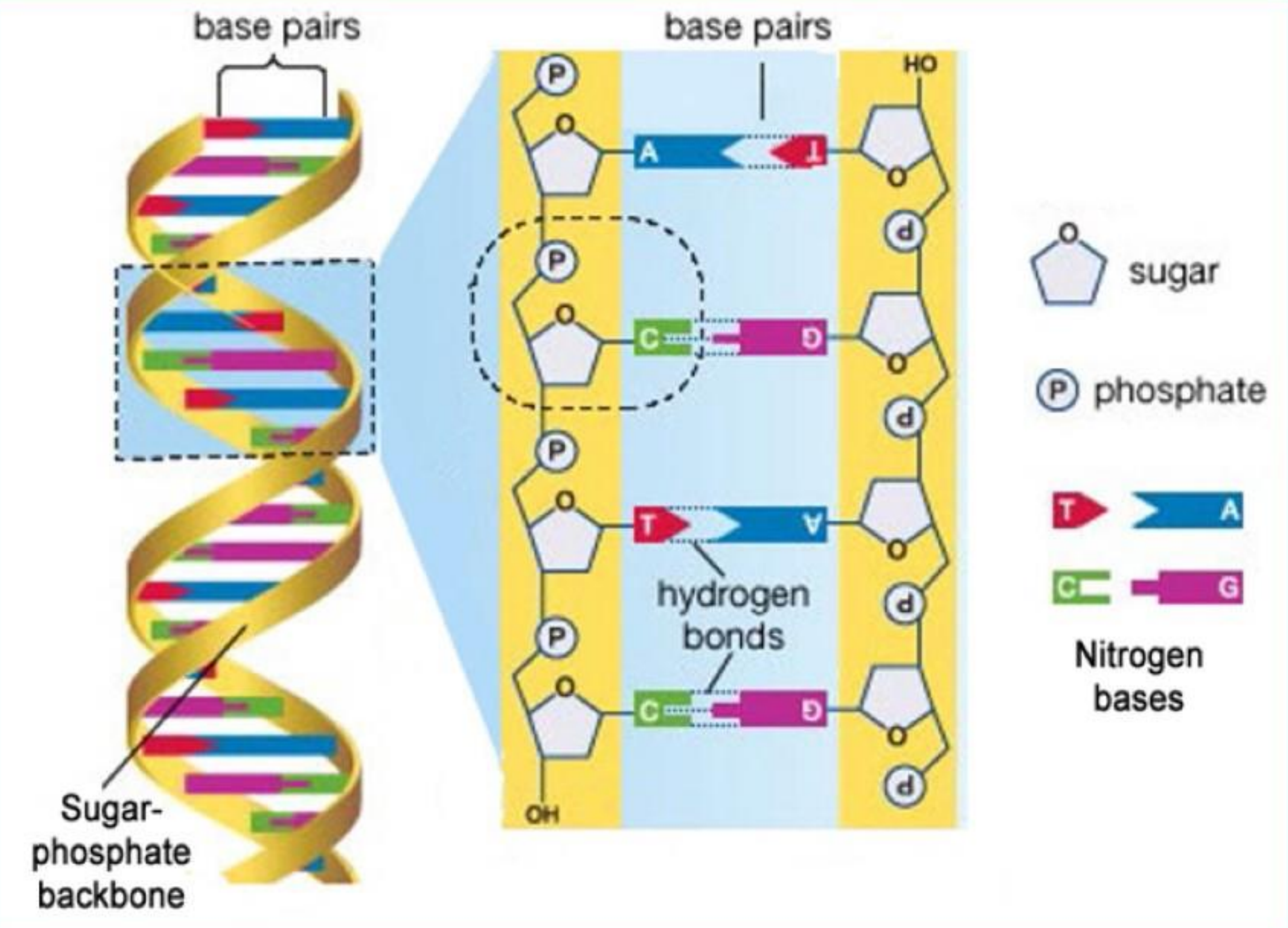
- **Backbone of DNA is formed of sugar & phosphates.**
- **The bases project inside.**
- **The 2 chains have anti-parallel polarity, i.e. one chain has the polarity 5'→3' and the other has 3'→5'.**



THE DNA

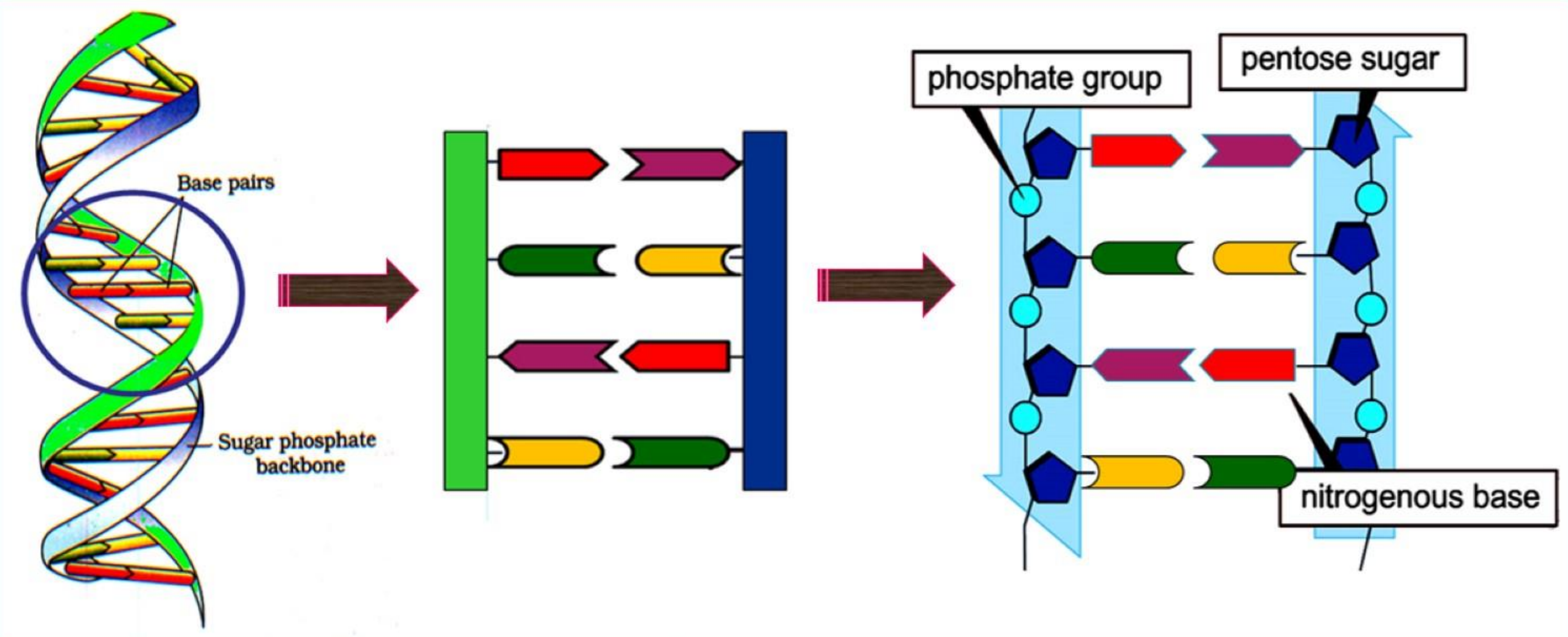
STRUCTURE OF DNA

- The bases in 2 strands are paired through **H-bonds** forming **base pairs (bp).**
- **A=T** (2 hydrogen bonds)
  C≡G (3 hydrogen bonds)
- **Purine** comes opposite to a **pyrimidine.** This generates uniform distance between the 2 strands.



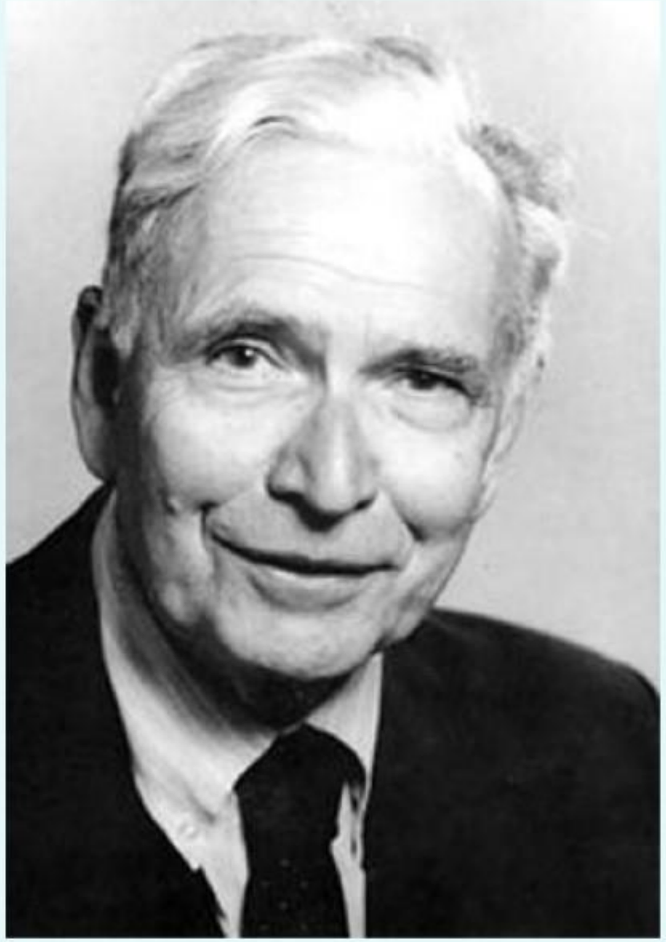
THE DNA

STRUCTURE OF DNA



THE DNA

ERWIN CHARGAFF'S RULE



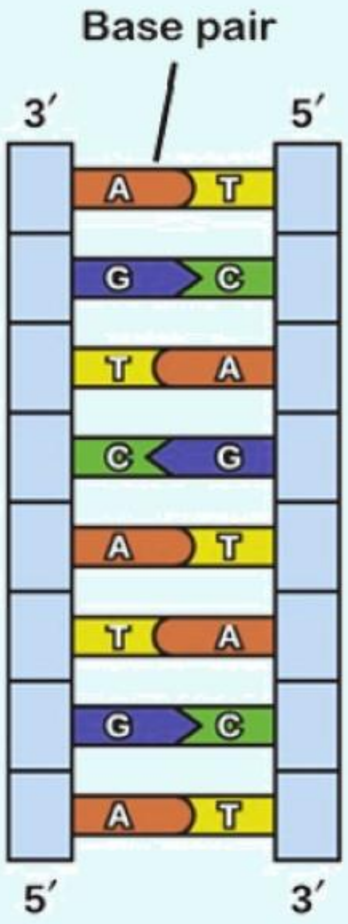
In DNA, the proportion of **A is equal to T** and the proportion of **G is equal to C.**

Therefore,

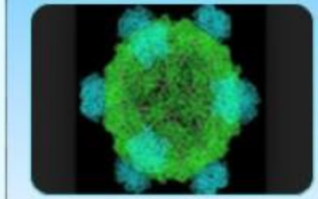
[A] + [G] = [T] + [C]

OR

[A] + [G] / [T] + [C] =1



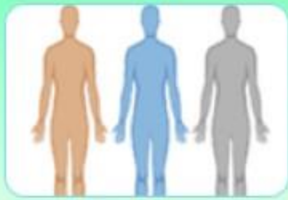
THE DNA



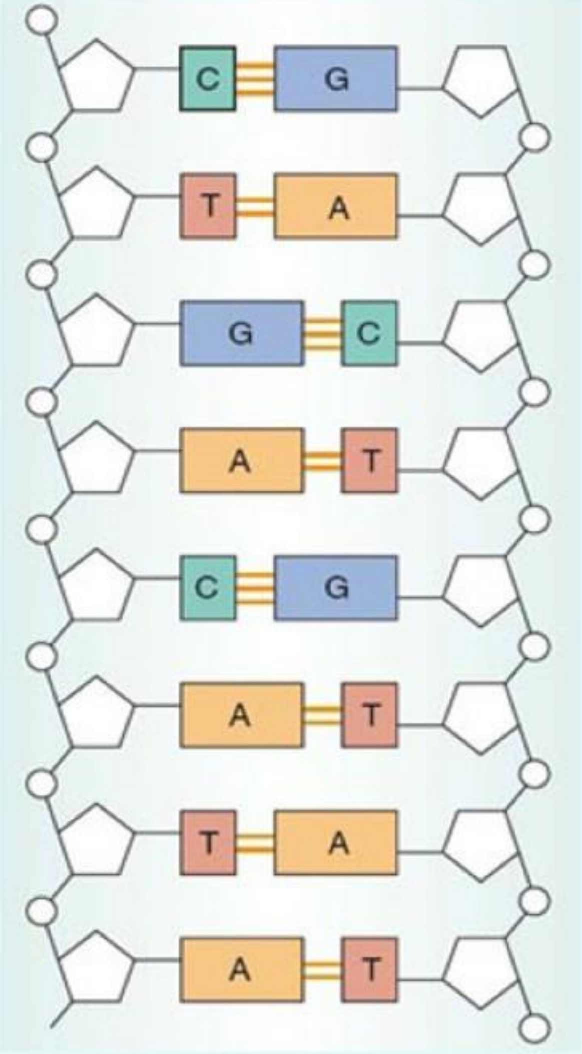
Φ 174 (a bacteriophage) has 5386 nucleotides.

Bacteriophage lambda has 48502 base pairs (bp).

E. coli has 4.6×10^6 bp.



Haploid content of human DNA is 3.3×10^9 bp.



THE DNA

CALCULATION OF LENGTH OF DNA

Length of DNA = number of base pairs X distance b/w 2 adjacent base pairs.

Examples:

- Number of base pairs in human = 6.6×10^9

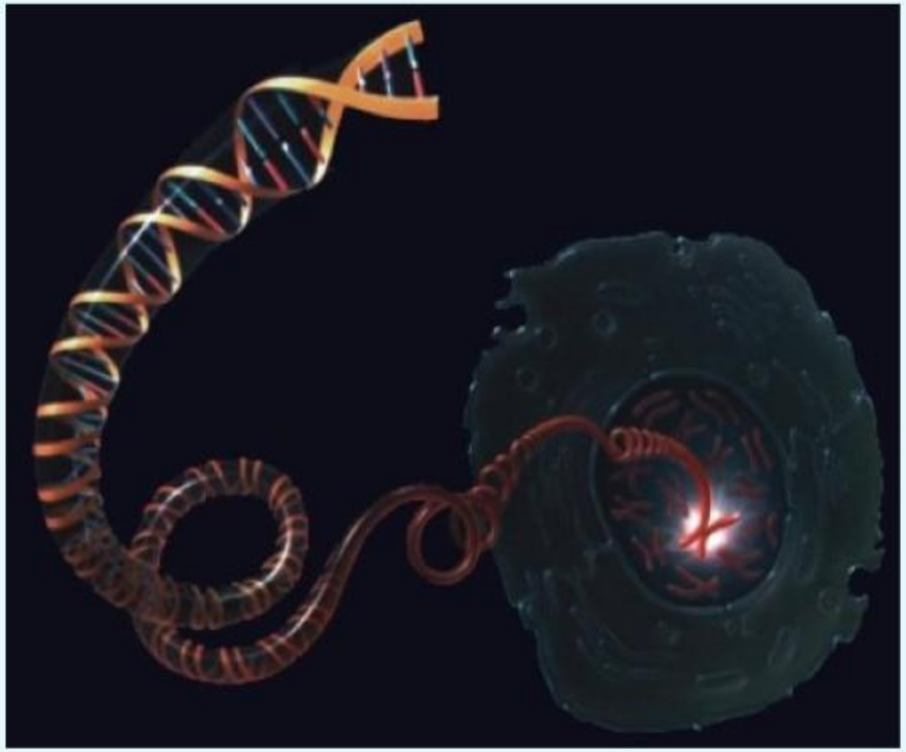
  Hence, the length of DNA = $6.6 \times 10^9 \times 0.34 \times 10^{-9}$

  = **2.2 m**

- In *E. coli*, length of DNA =1.36 mm (1.36×10^{-3} m)

  ∴ The number of base pairs = $\frac{1.36 \times 10^{-3}}{0.34 \times 10^{-9}}$

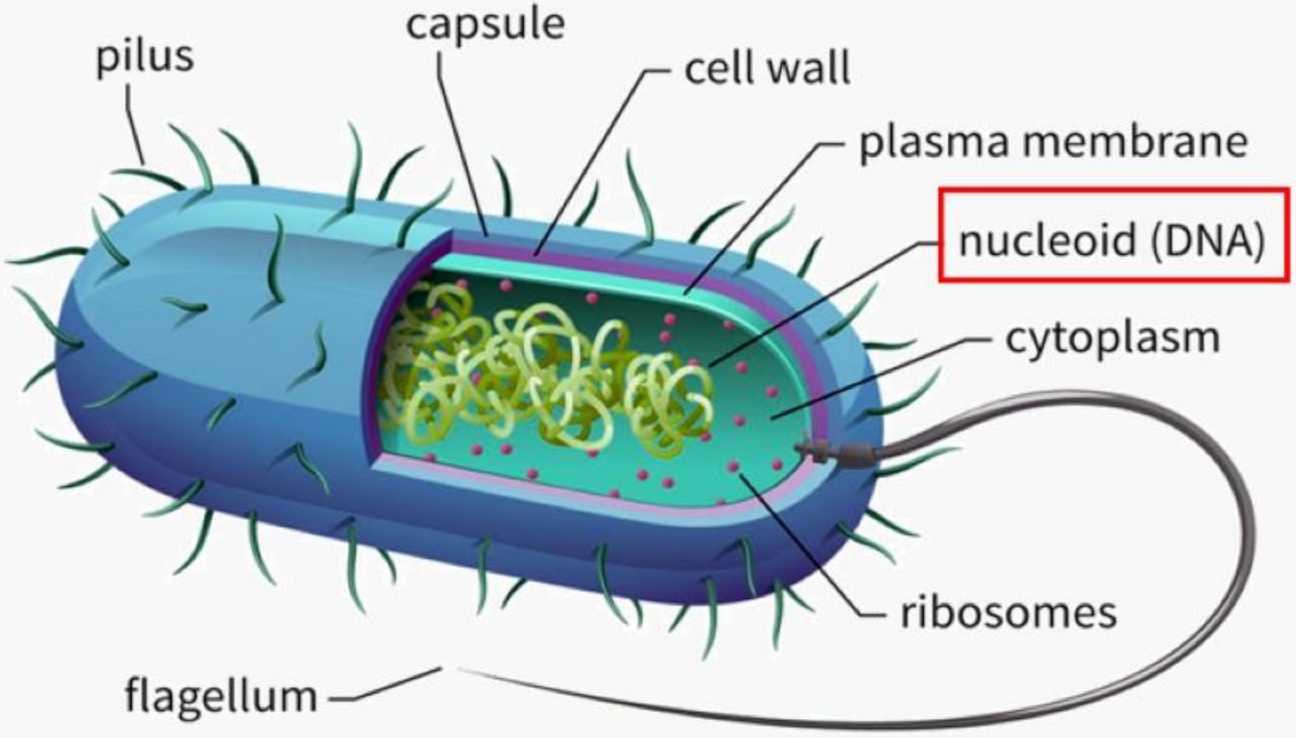
  = **4×10^6 bp**

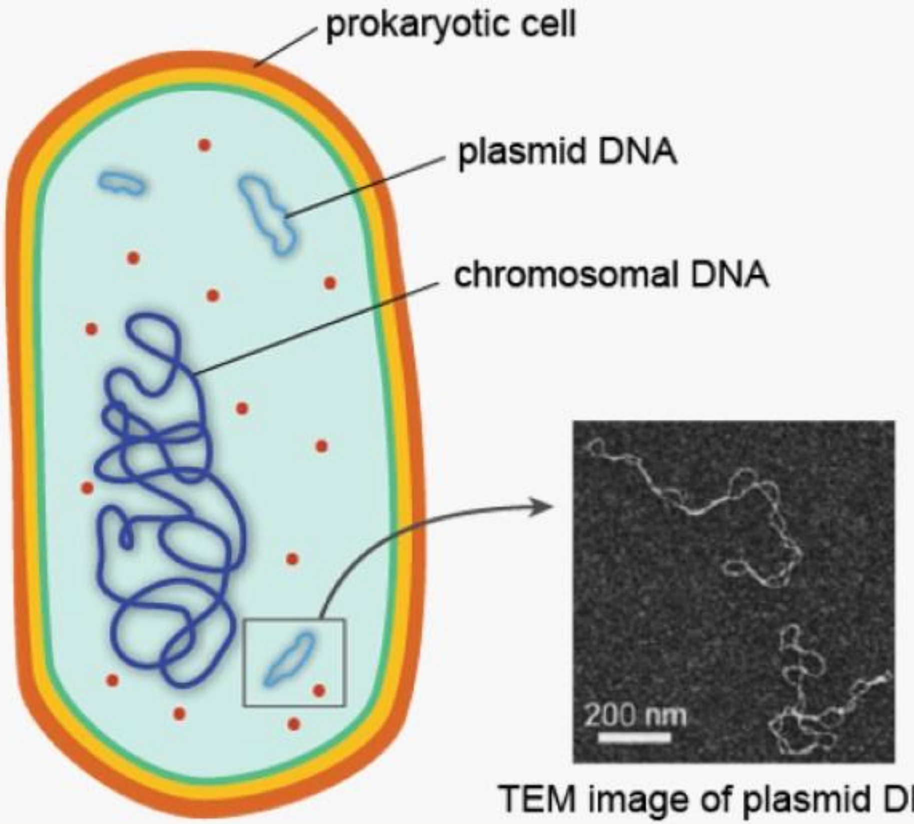



PACKAGING OF
DNA HELIX

PACKAGING OF DNA HELIX IN PROKARYOTES

- In prokaryotes (E.g. *E. coli*), the DNA is not scattered throughout the cell.
- DNA is **negatively charged.** So it is held with some positively charged proteins to form **nucleoid.**

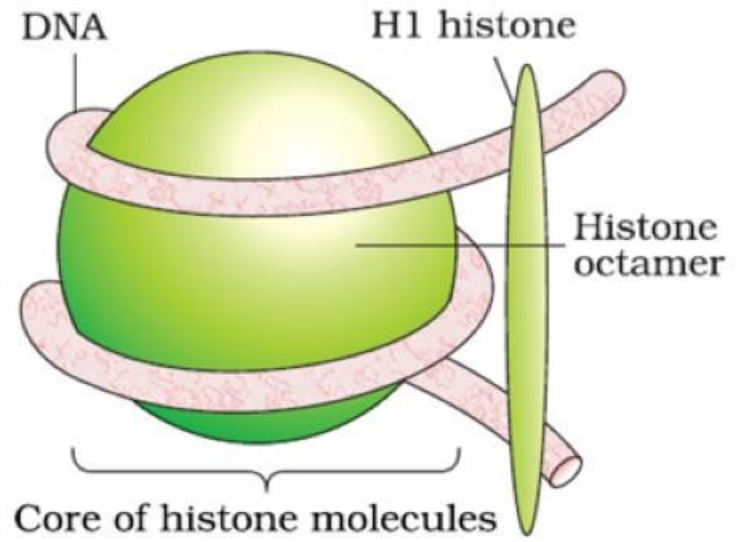




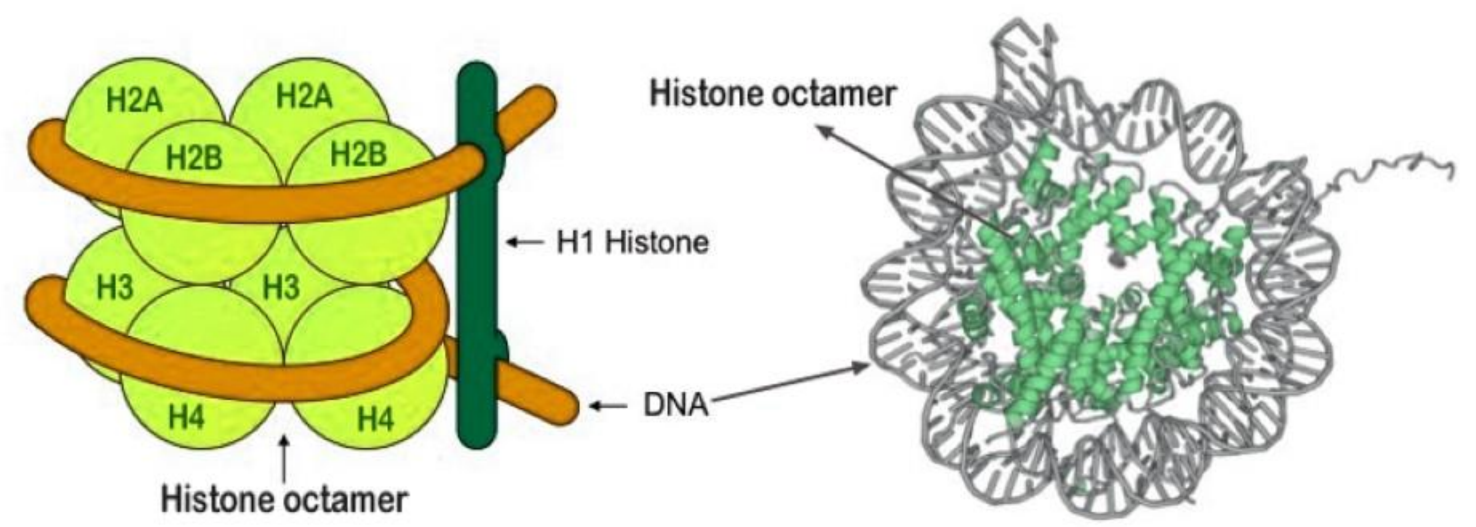
TEM image of plasmid DNA

PACKAGING OF DNA HELIX IN EUKARYOTES

- In eukaryotes, there is a set of positively charged, basic proteins called **histones.**
- Histones are rich in positively charged basic amino acid residues **lysines & arginines.**
- 8 histones form **histone octamer.**
- Negatively charged DNA is wrapped around histone octamer to give **nucleosome.**



Nucleosome



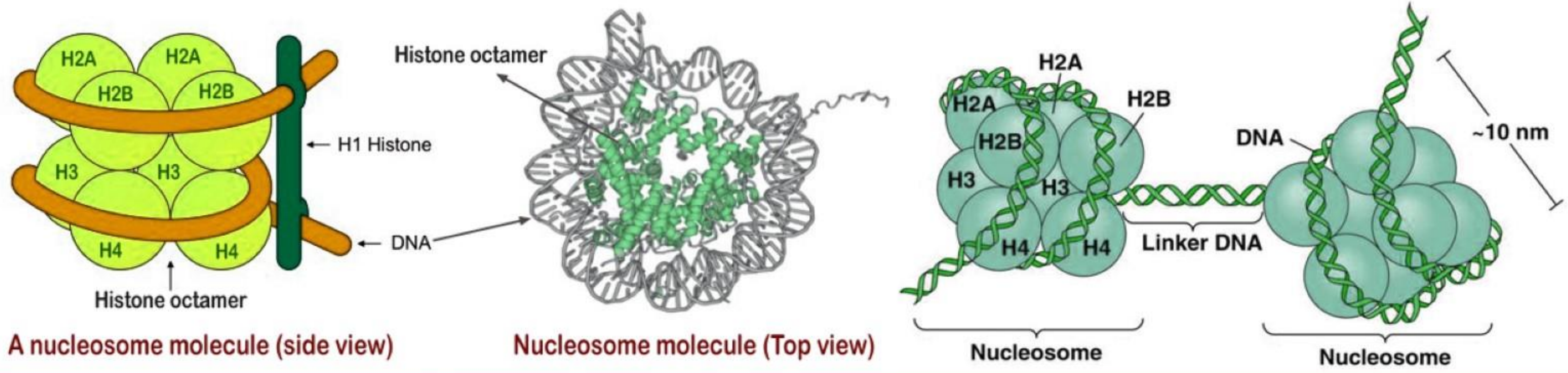
A nucleosome molecule (side view)

Nucleosome molecule (Top view)

PACKAGING OF DNA HELIX IN EUKARYOTES

- A typical nucleosome contains **200 bp.**
- Therefore, total number of nucleosomes in human =

$$\frac{6.6x10^9 bp}{200} = 3.3x10^7$$

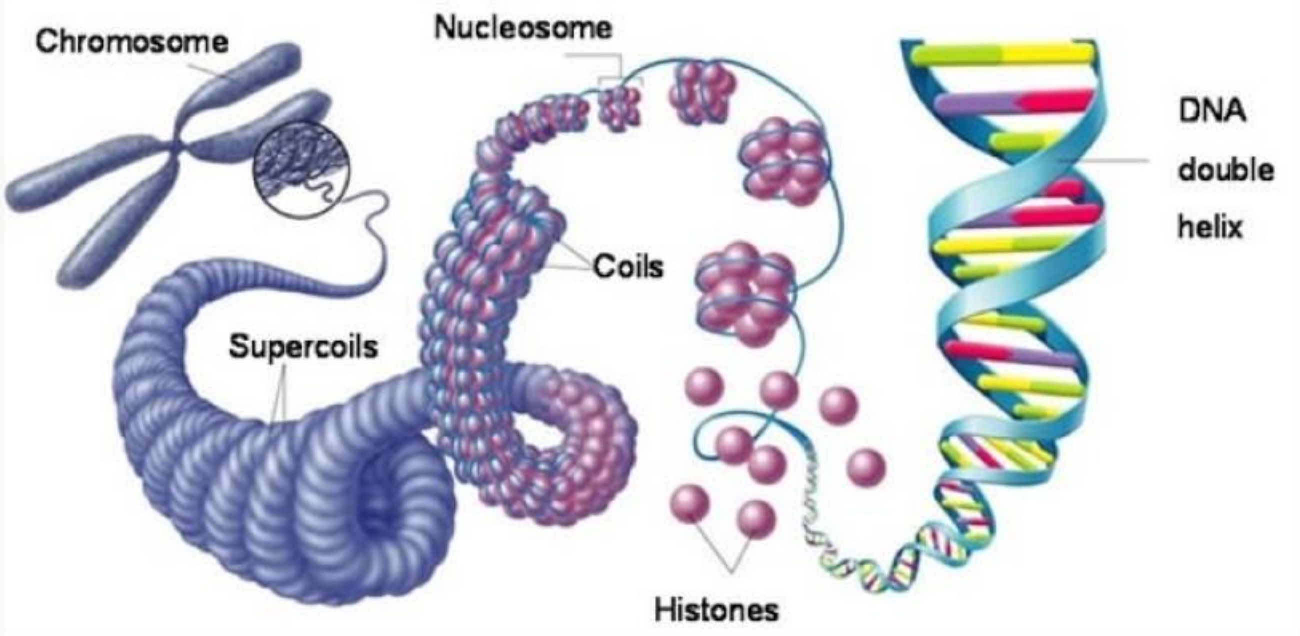


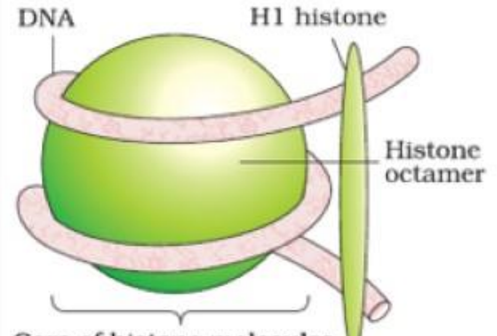
A nucleosome molecule (side view)

Nucleosome molecule (Top view)

PACKAGING OF DNA HELIX IN EUKARYOTES

- Nucleosomes constitute the repeating unit to form chromatin.
- Chromatin is the thread-like stained bodies.
- Nucleosomes in chromatin = 'beads-on-string'.





Nucleosome

Beads-on-string form of chromatin

PACKAGING OF DNA HELIX IN EUKARYOTES

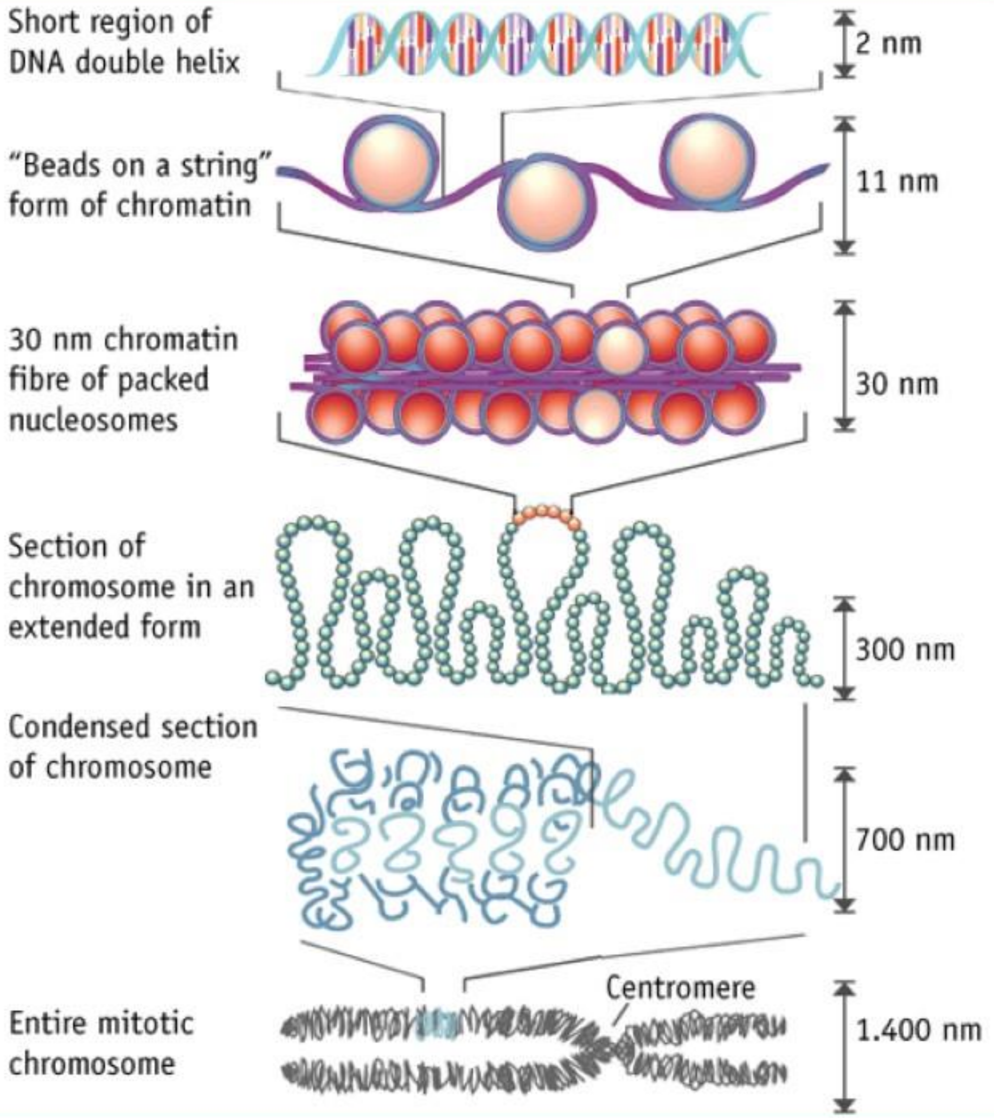
Chromatin is packaged

Chromatin fibres

Coiled and condensed at metaphase stage

Chromosomes

Higher level packaging of chromatin requires non-histone chromosomal (NHC) proteins.



PACKAGING OF DNA HELIX IN EUKARYOTES

Chromatin has 2 forms

Euchromatin

Loosely packed, transcriptionally active region of chromatin. It stains light.

Heterochromatin

Densely packed, inactive region of chromatin. It stains dark.