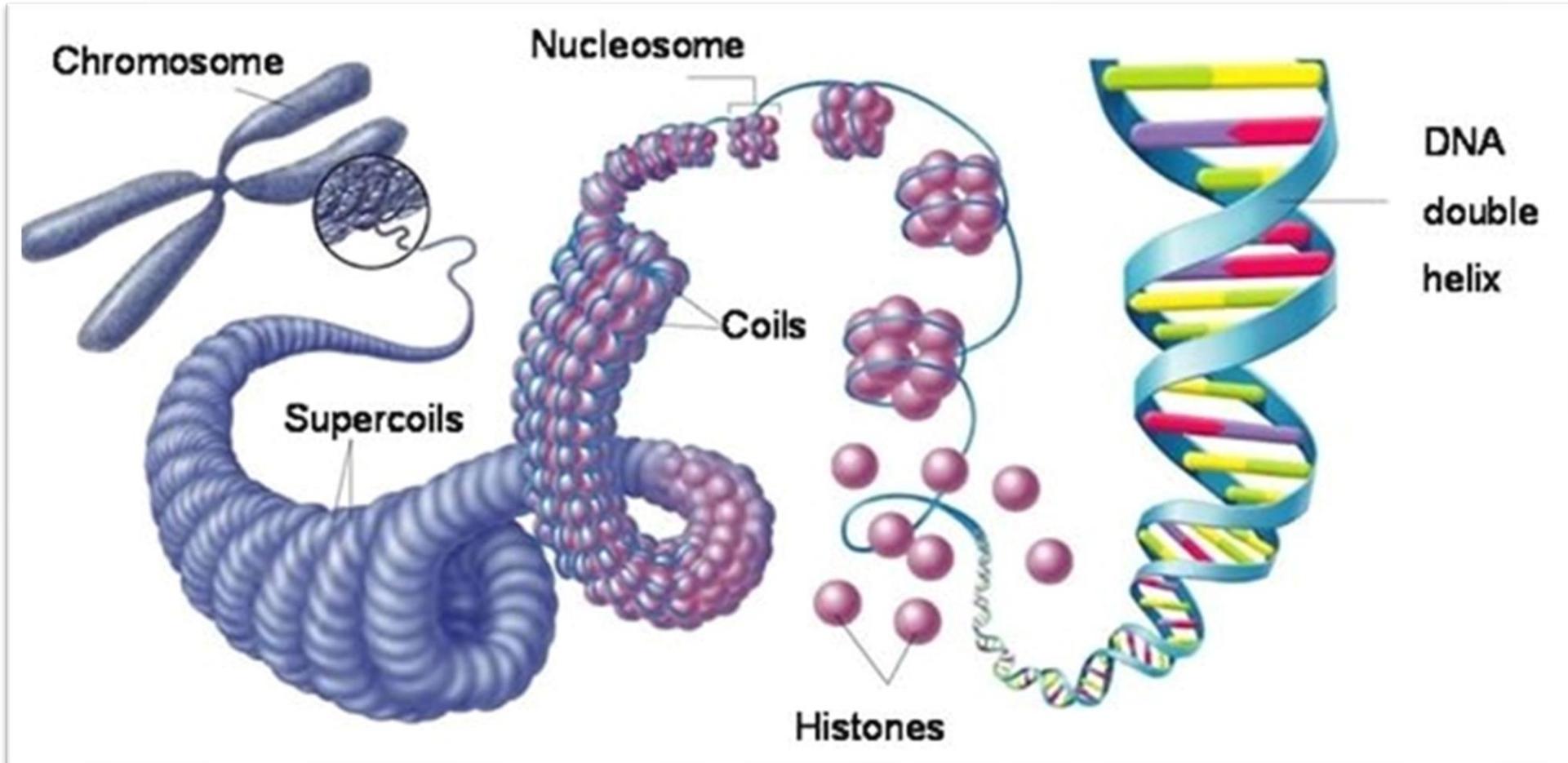


DNA & chromatin structure



By:

Dr/ Aya El-Hanafy

Associate Prof. Of Biochemistry & Molecular Biology

Learning outcomes

By the end of lecture, students should be able to:

- ❖ *Identify the structure of DNA*
- ❖ *Describe how DNA is organized inside nucleus*

Structure of DNA



DNA

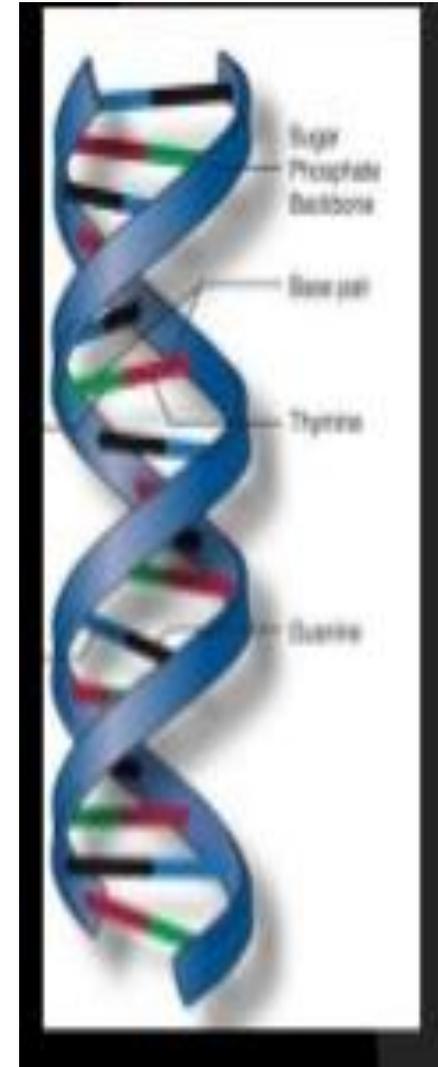
DNA is **the hereditary material** in humans and almost all other organisms.

Site

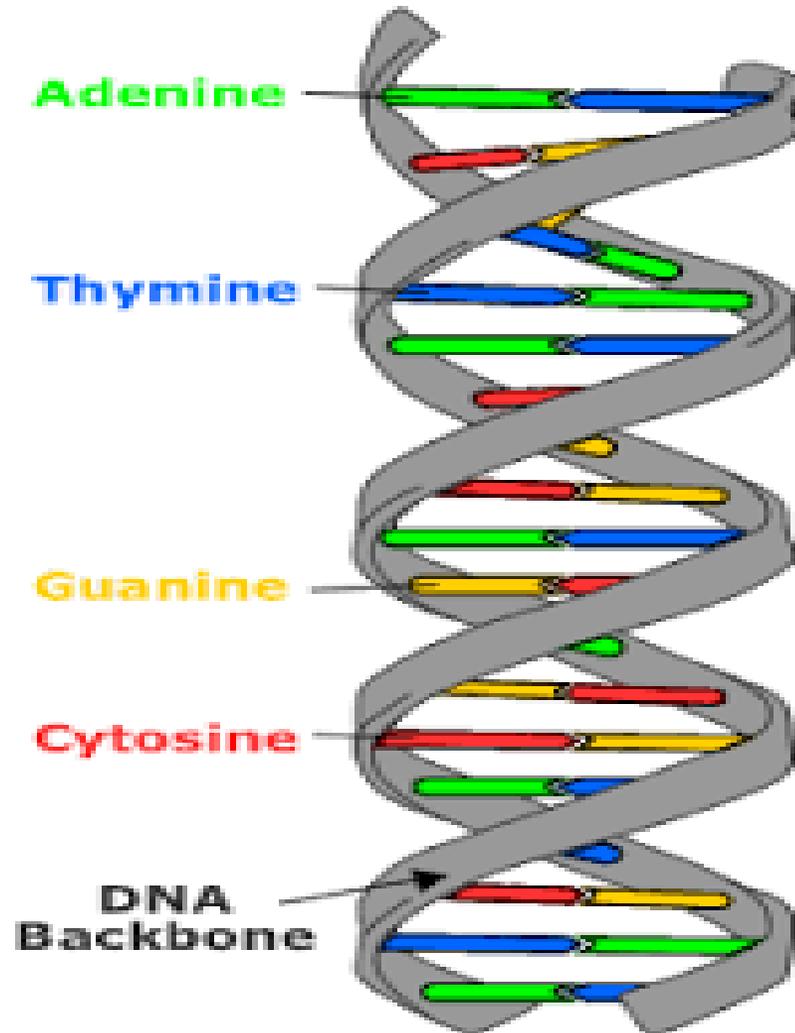
Most DNA is located in the **cell nucleus** (nuclear DNA)

Function of DNA:

1. DNA **stores** an organism **genetic information**
2. DNA is essential for the synthesis of **proteins**.



DNA structure

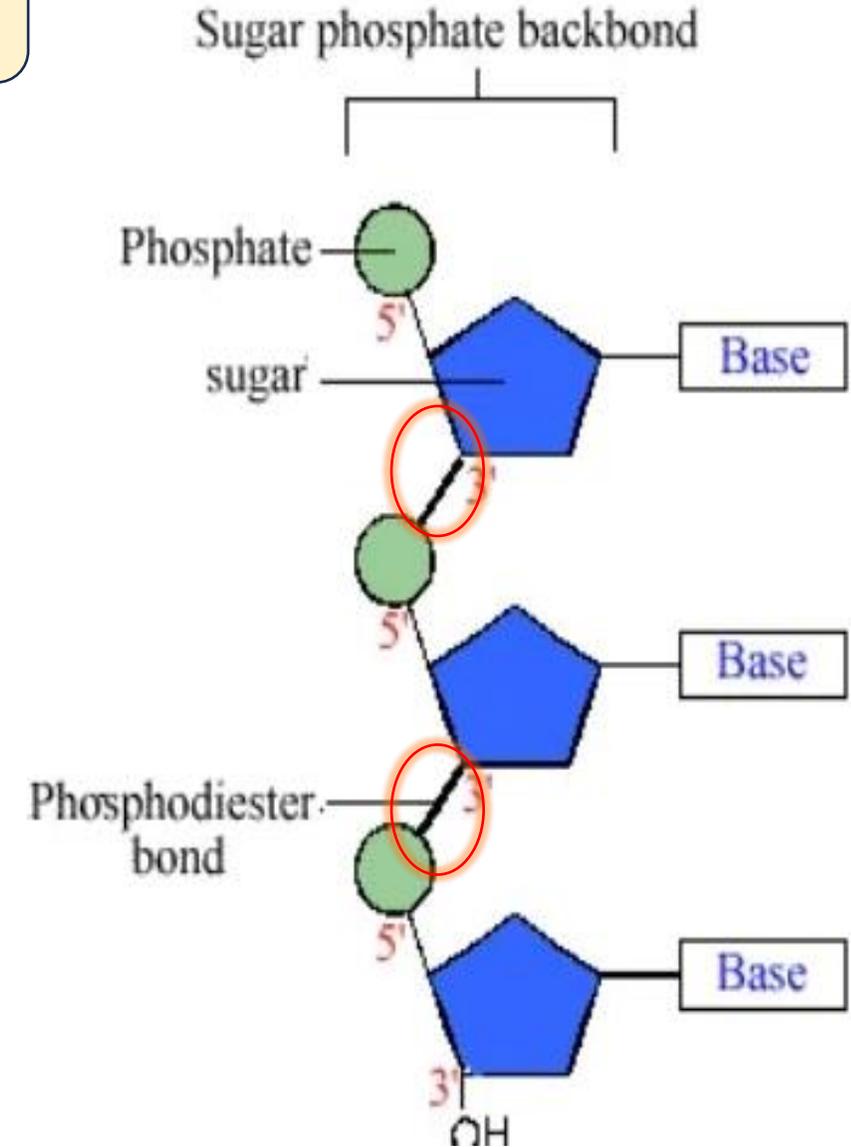


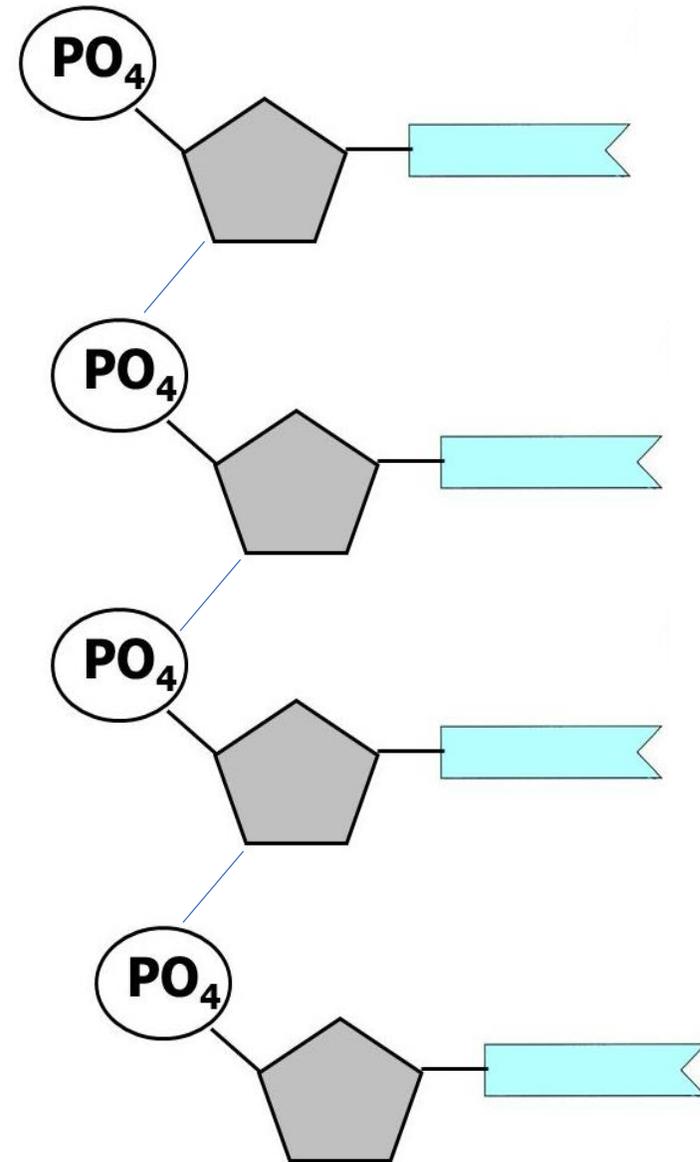
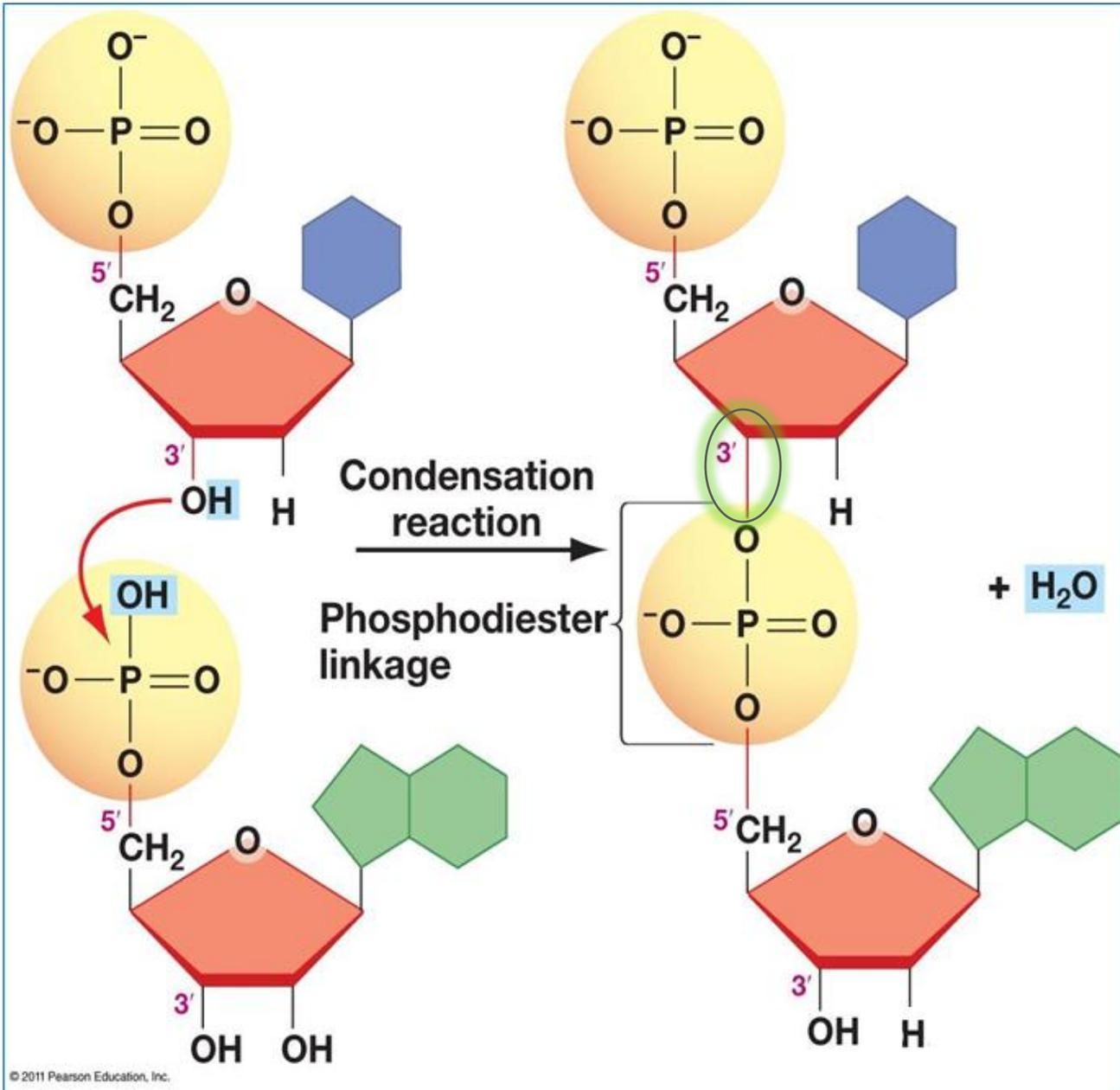
DNA is **two chains of deoxyribonucleotides** that are twisted into a double helix structure.

A-Primary structure

- DNA is a long chain of deoxyribonucleotides (dAMP, dGMP, dTMP, dCMP).
- The nucleotides are joined by 3', 5' phosphodiester bond

“ C3 of the sugar in one nucleotide and phosphate group on the C5 of the sugar of the next nucleotide”





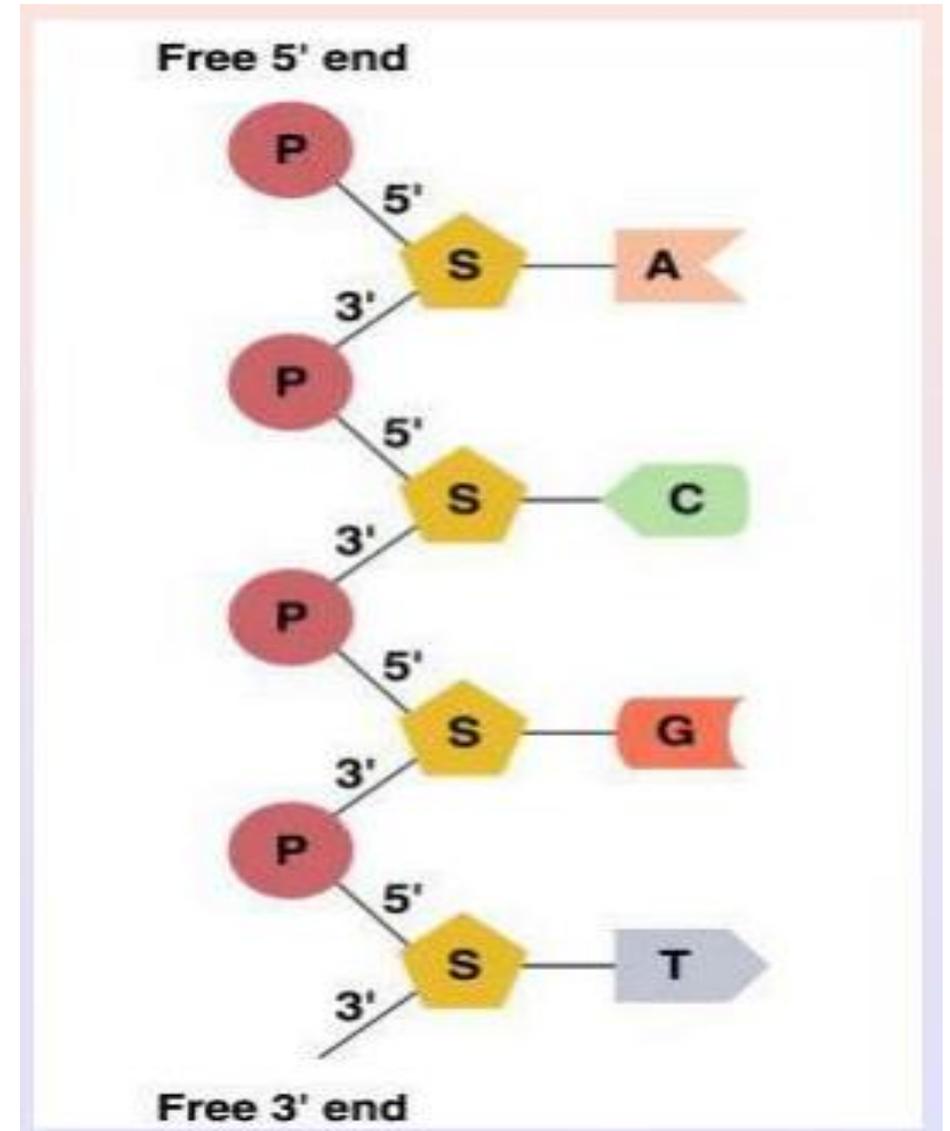
Characters of the primary structure

1-**Sugar-phosphate** forms asymmetrical backbone.

2-**Nitrogenous bases** are inside of the 2 strands, with right angle

3-**Polarity** : each strand has 2 ends, one end (5`end) with free phosphate and the other (3`end) with free (OH).

4- The DNA sequence is read from the 5` to 3` (ex:- 5`—A—C—G—T—3`



Secondary structure (B-form of DNA)

Waston and Crick proposed DNA structure as a double helix (B-form) .

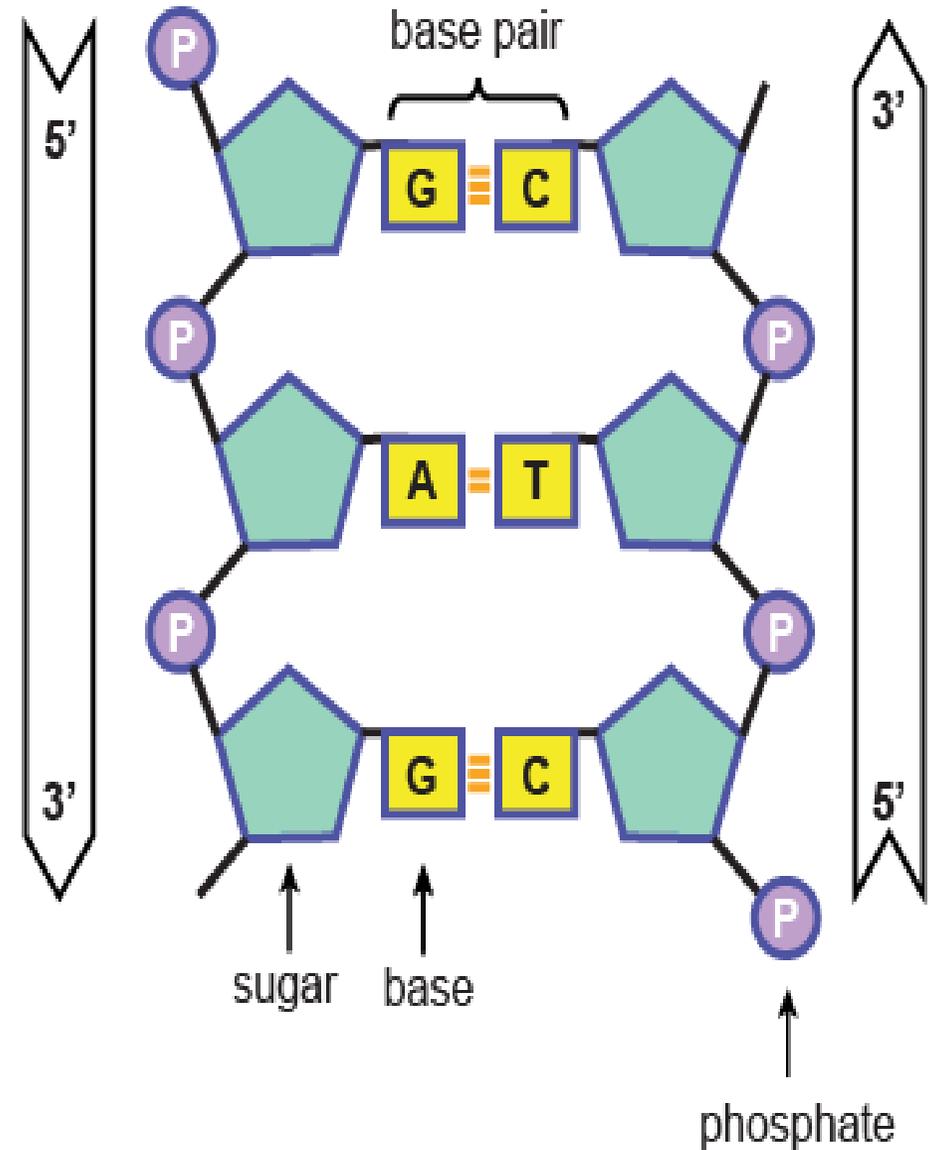
Characters of 2ry structure

1- Right handed helix (2 nm)

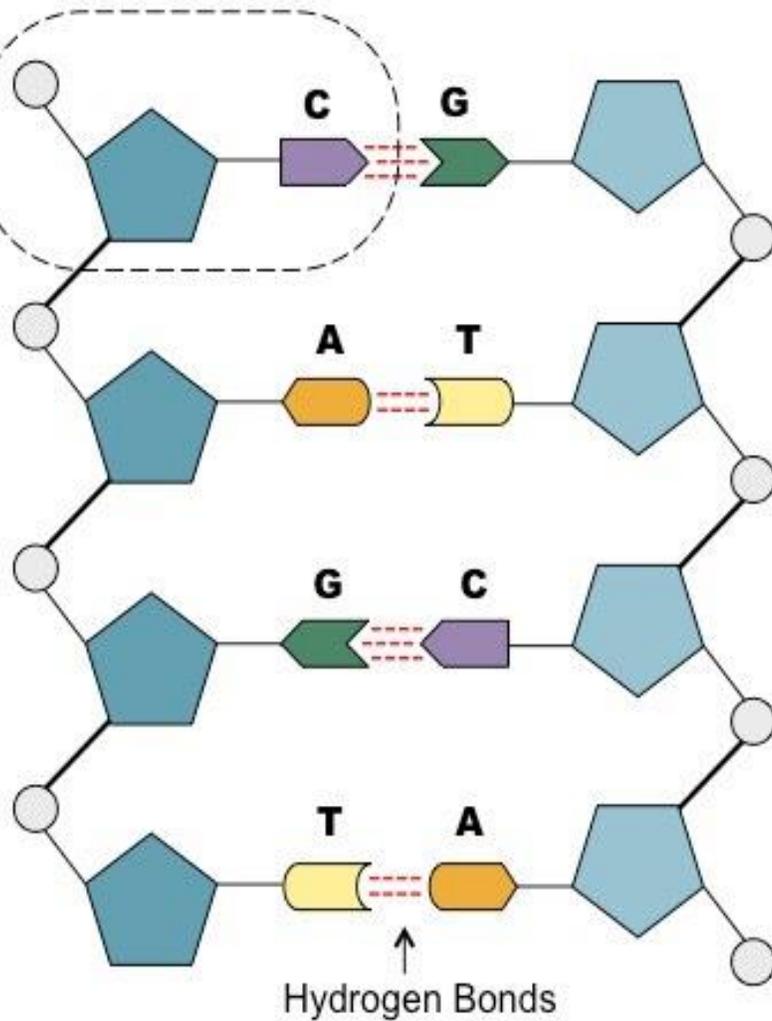
The two chains are coiled around a common axis called the axis of symmetry.

2-Anti-parallel :one runs in the 5' to 3' direction , the other strand runs in the 3' to 5' direction .

3-Complementary base pairing: through hydrogen bonds ((A=T) , (G≡C).



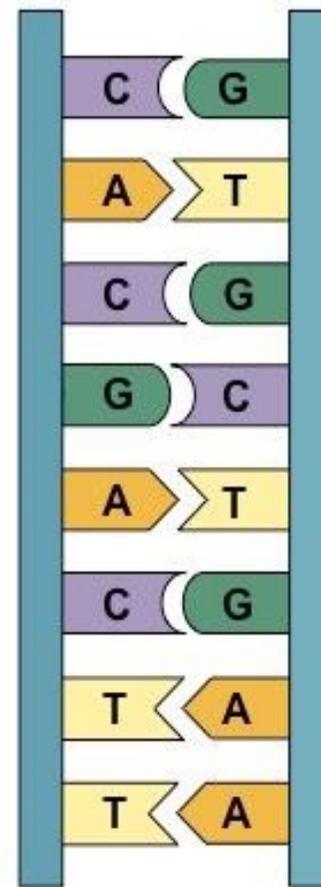
Nucleotide



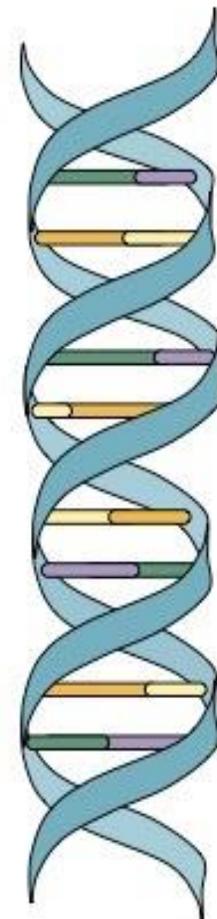
Key:

- Adenine
- Thymine
- Guanine
- Cytosine

Sugar-Phosphate
Backbones



Double Helix



DNA structure : Animation



Organization of DNA



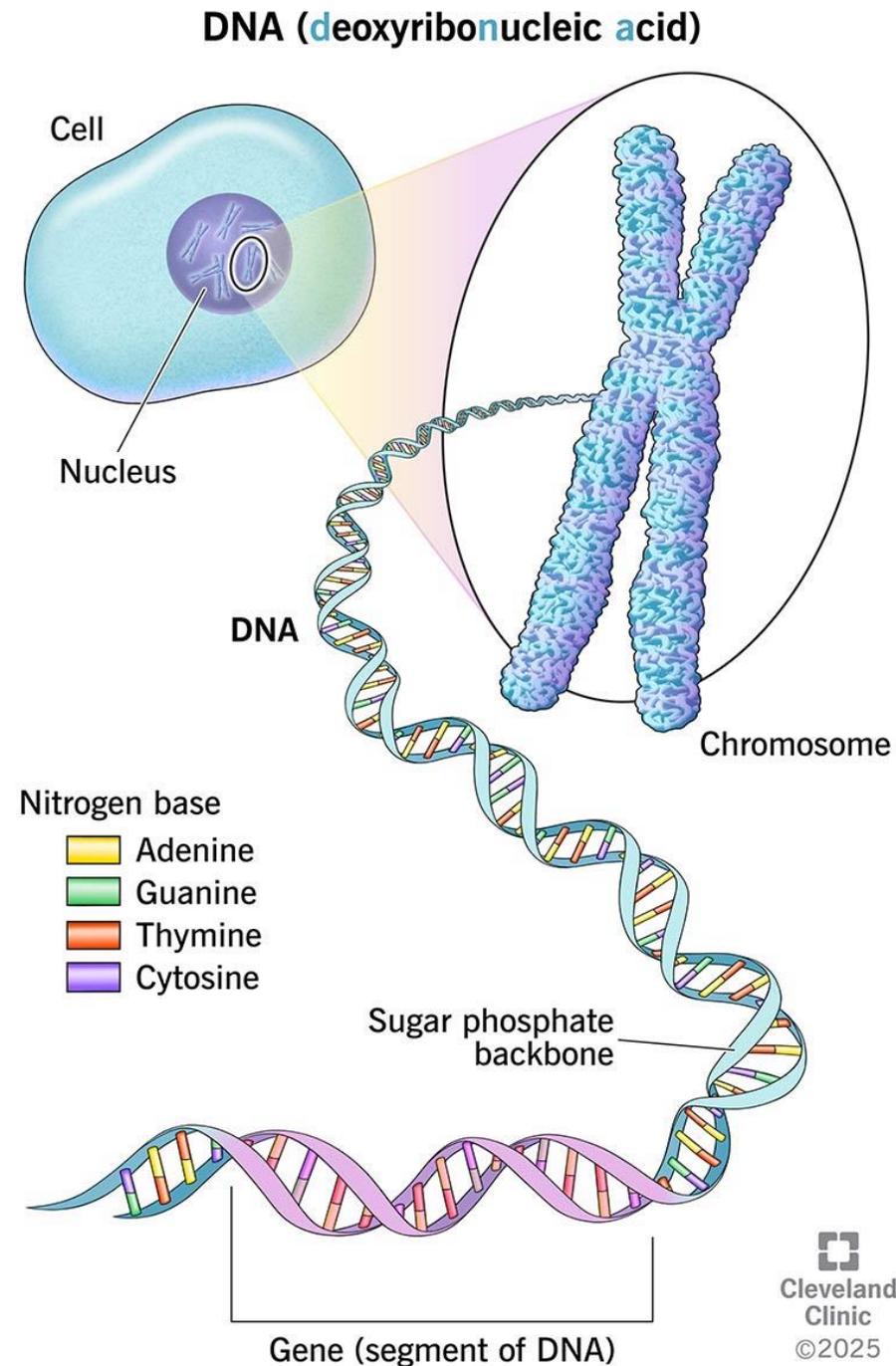
Eukaryotic DNA Organization (DNA Packing- DNA supercoiling)

- Eukaryotic DNA is too long (**about 1.7 meter**)
- To get DNA into the cell nucleus, it must be packaged into a more **compacted structure** about $10\ \mu\text{m}$ long and $1\ \mu\text{m}$ in diameter.
- To do, this requires **the interaction of DNA with large numbers of proteins (Histone)**

1.7 m

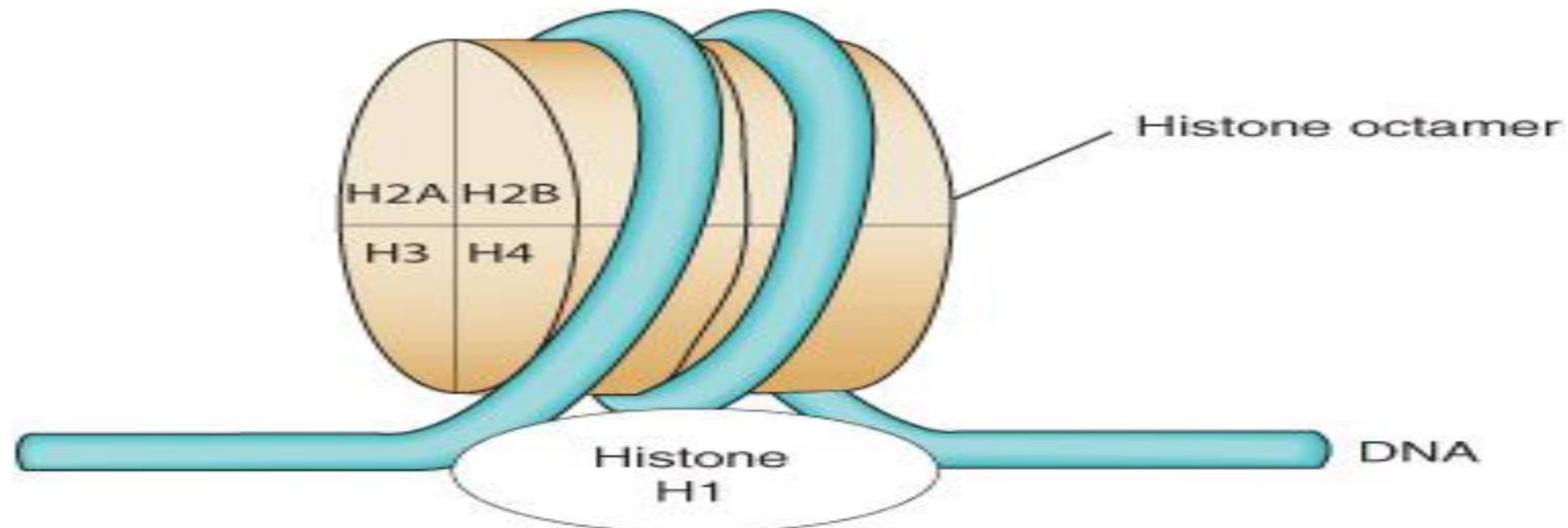


$10\ \mu\text{m}$



Histone

- They are small proteins that are positively charged as a result of their high content of **lysine and arginine**.
- They Bind to phosphate (negatively charged) along the DNA backbone
- They are five classes of histones, designated **H1, H2A, H2B, H3, and H4**.



The first level of supercoiling:

Nucleosomes

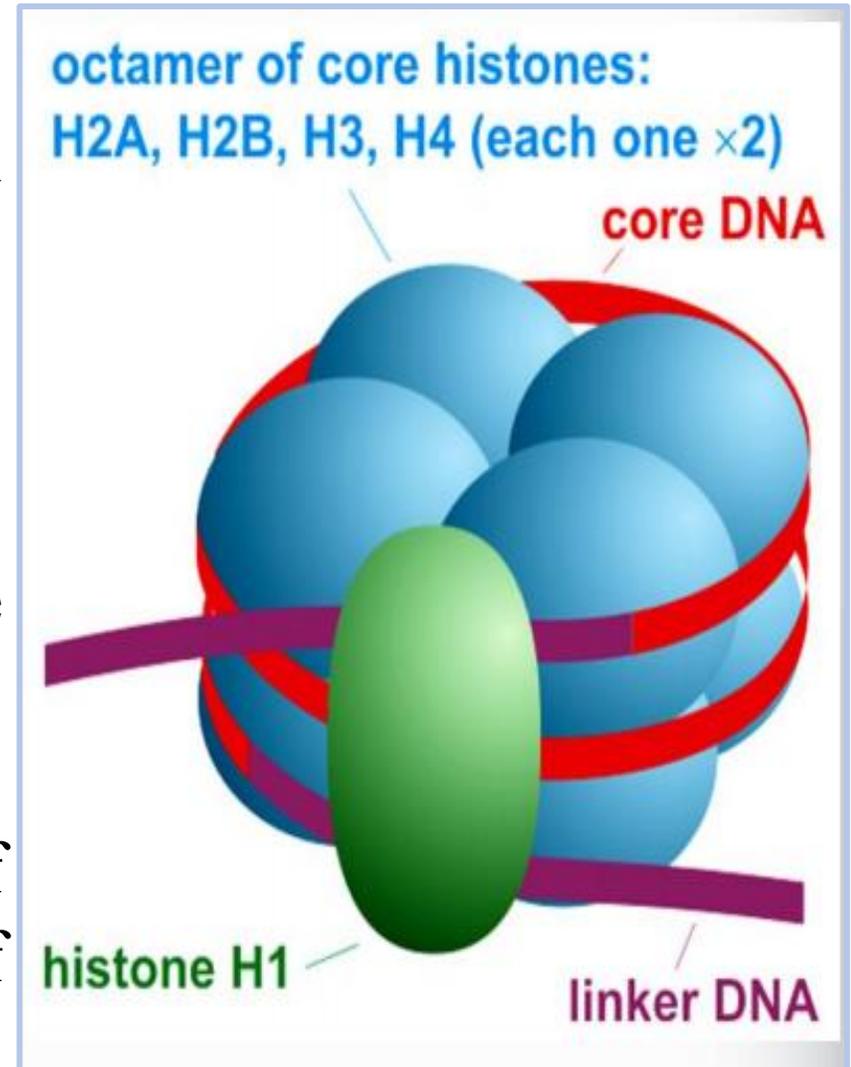
Packing ratio of 10

- It is **double-stranded DNA wrapped around an octamer of histone proteins**

Octamer = 8

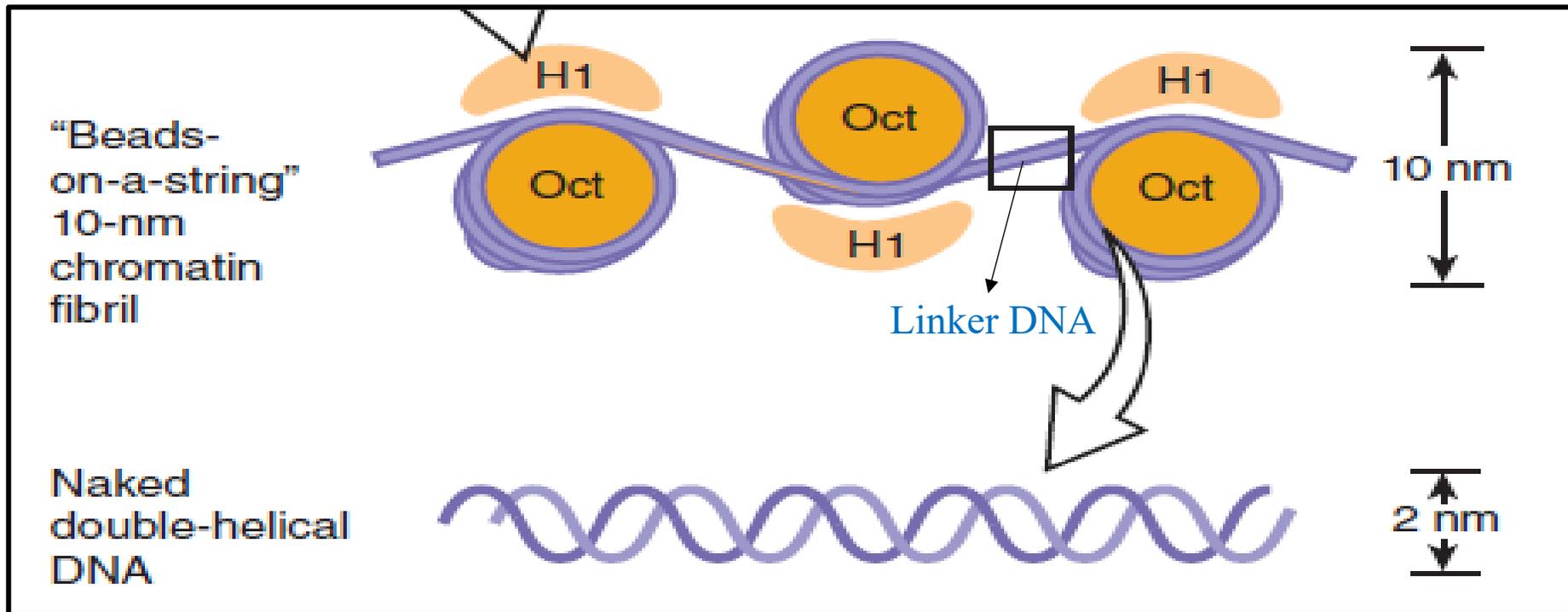
“ 2 molecules each of (H2A, H2B, H3, and H4) ”.

- Around this core, a segment of the DNA double helix is wound nearly **twice**.
- Packing around histone octamer in the form of nucleosomes produces a **ten fold shortening** of the length of DNA (**10 nm chromatin fibril**).



Nucleosomes

- One nucleosome is joined to the next by DNA segment called “Linker DNA”.
-Linker DNA is bound to one molecule of **H1**



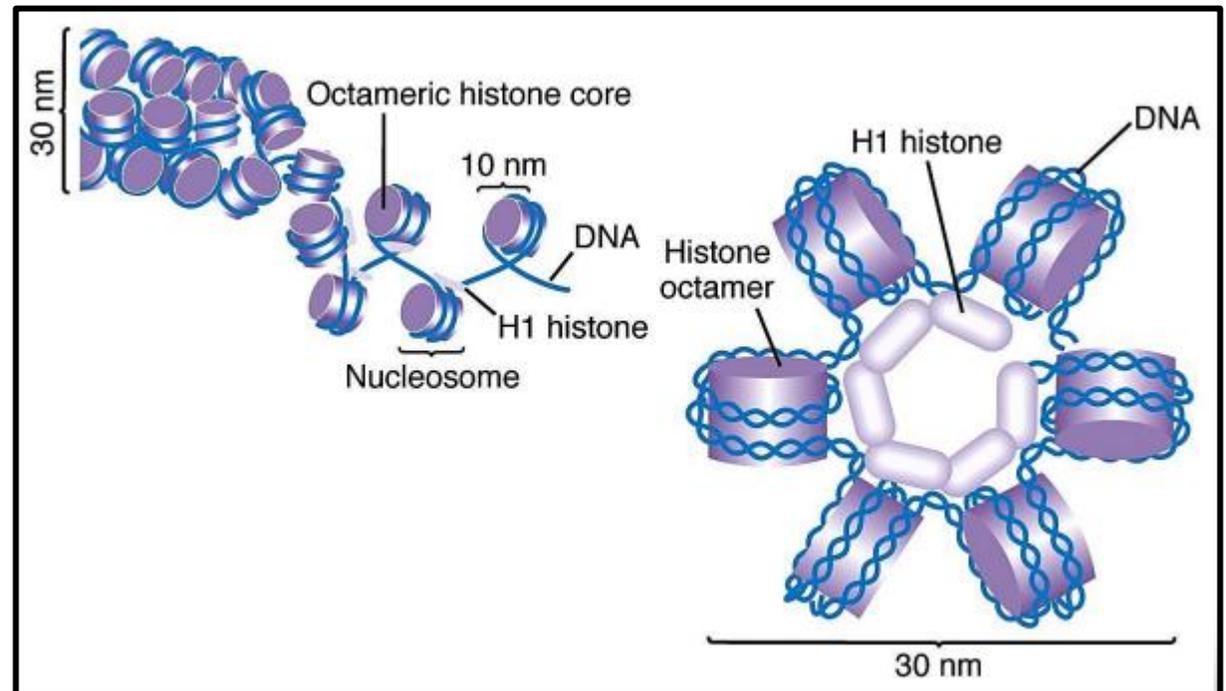
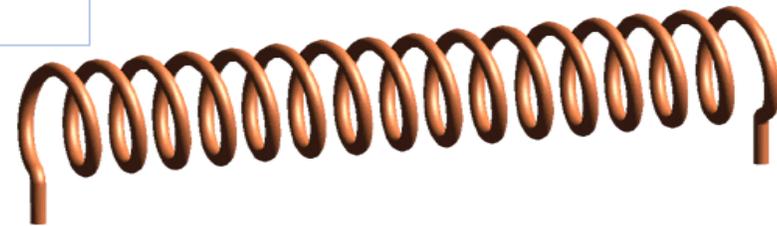
The overall structure resemble (Beads on string)

The second level of supercoiling

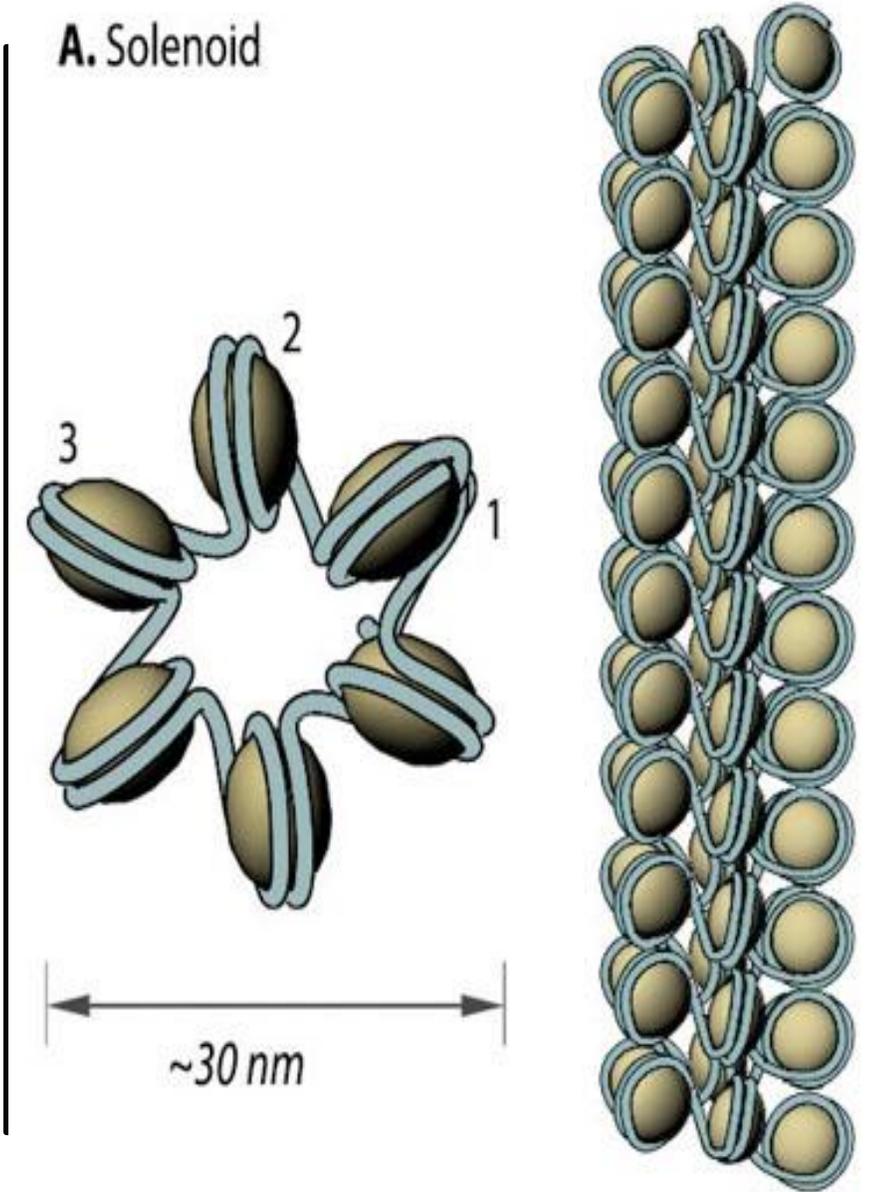
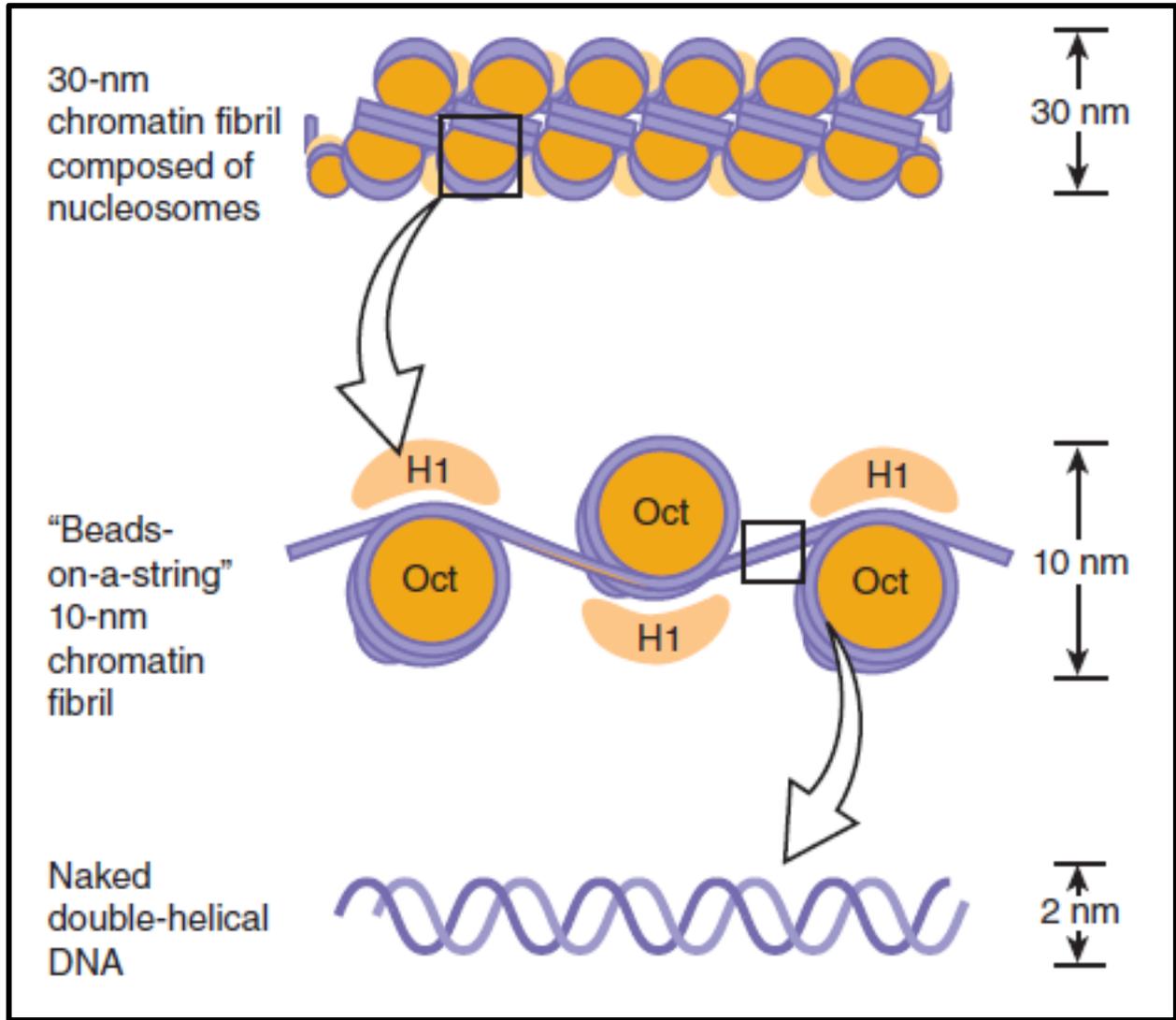
Solenoid

Packing ratio of 50

- Nucleosomes can be packed more tightly (6-7 Nucleosomes per turn) to form **30 nm fiber** which look like **solenoid** (**cylindrical coil**).



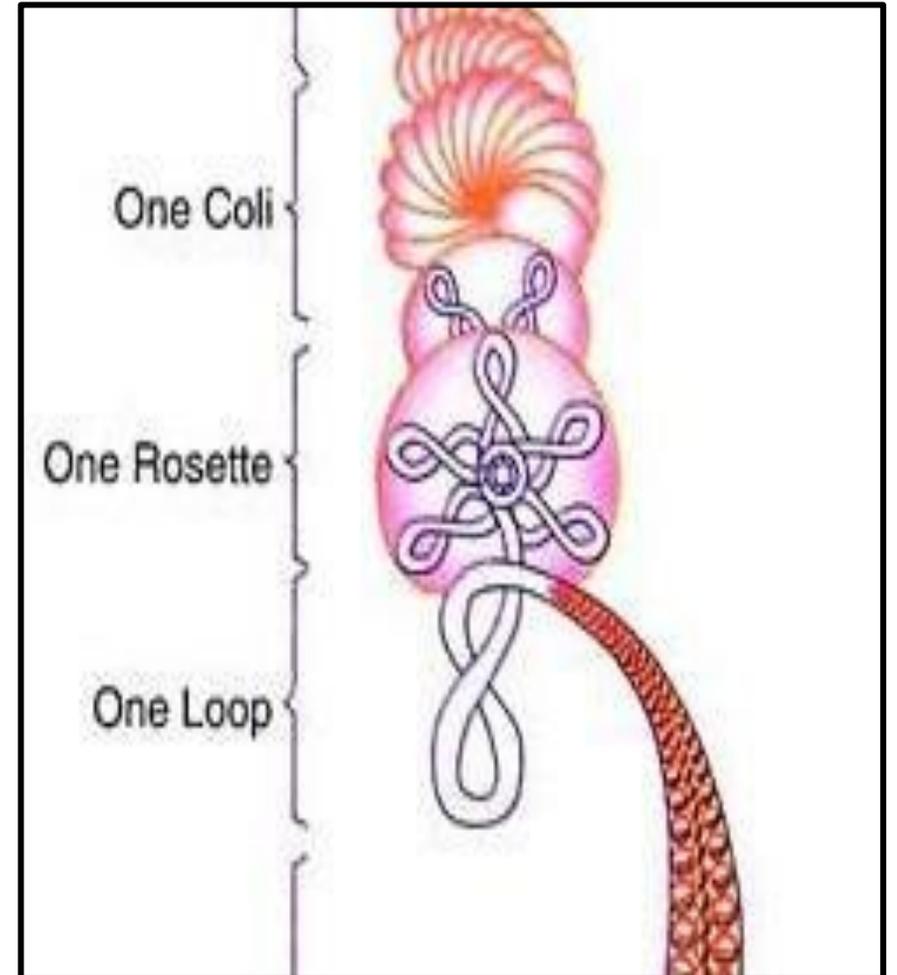
Solenoid



The third level of supercoiling

Loops → Rosette → Coils → Chromatid → Chromosome

- Coiling of the 30 nm fiber into twisted Looped structure
- Twisted loop attached to scaffold protein to form Rosette, each rosette contain 6 loops.
- Rosettes → Coils (30 rosettes = one turn of a coil).
- Coils form Chromatids → final Chromosome structure (1400 nm)



The final chromosome structure is composed of **2 identical chromatids** connected by **centromere**

Two chromatids (10 coils each)

One coil (30 rosettes)

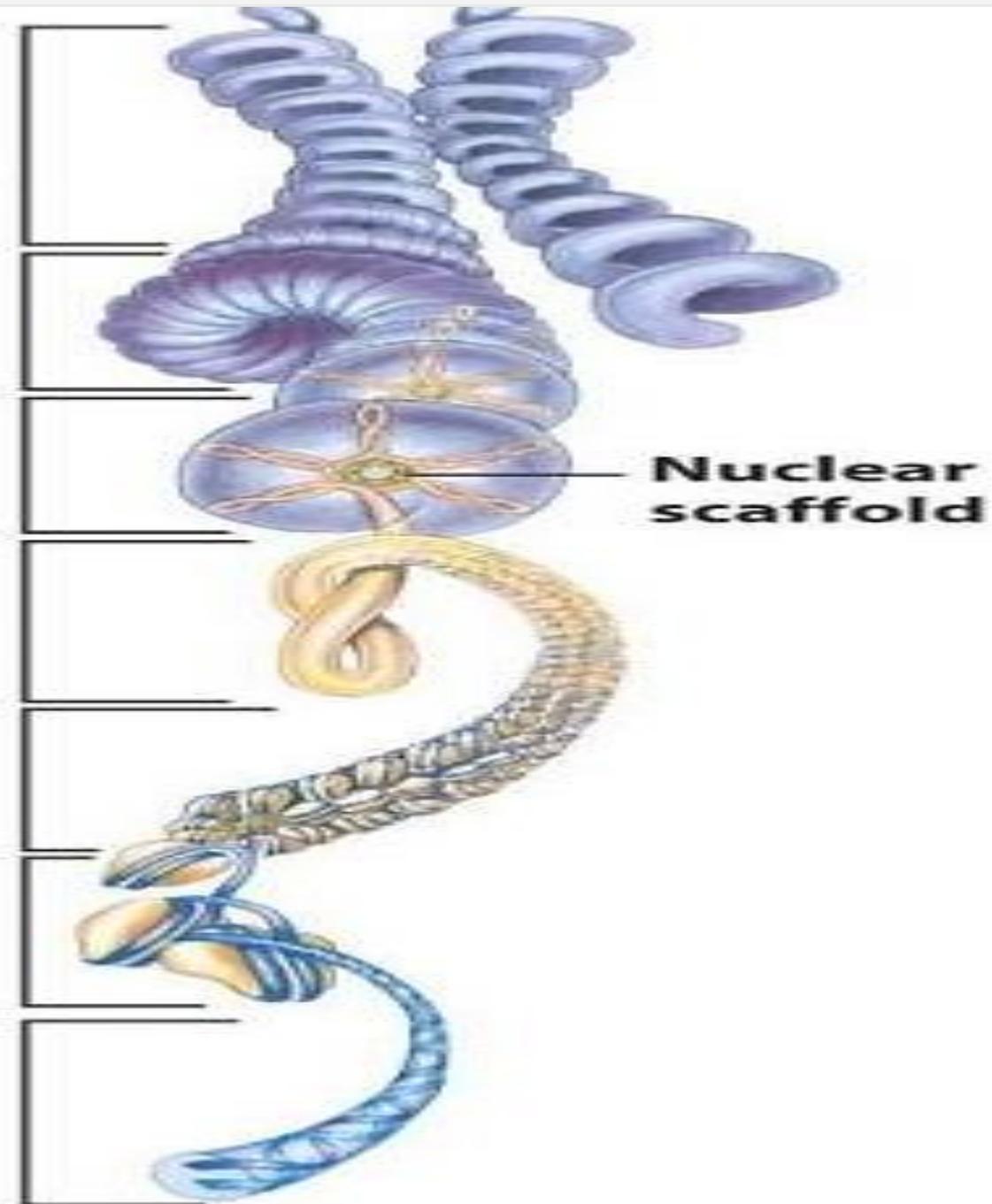
One rosette (6 loops)

One loop (~75,000 bp)

30 nm Fiber

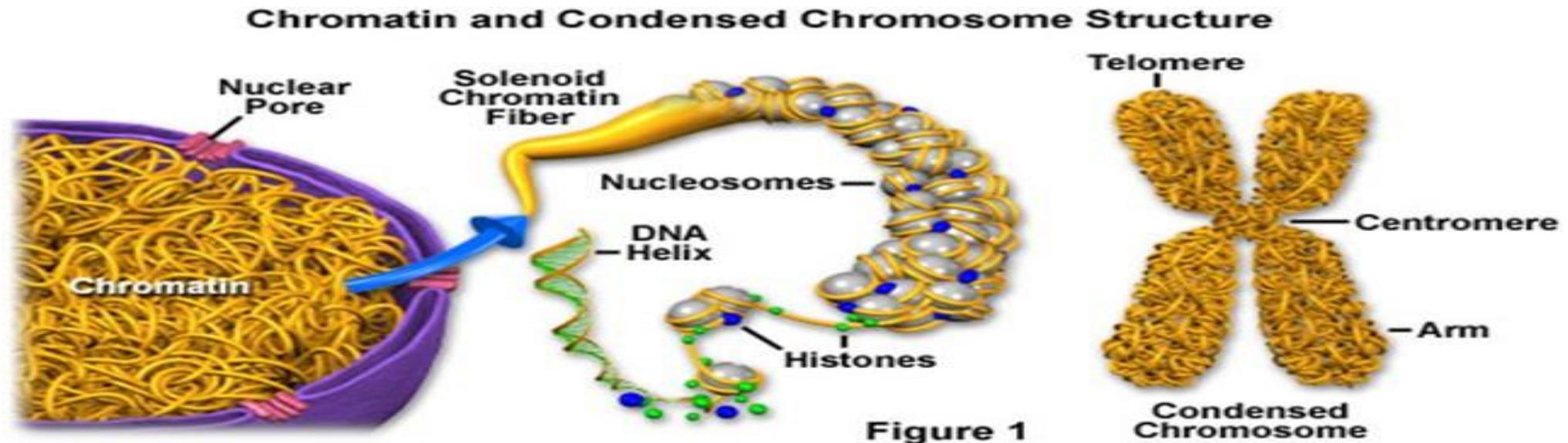
"Beads-on-a-string" form of chromatin

DNA



Chromosome

- ❑ A chromosome is molecule of **DNA** packed with **histone protein**.
- ❑ It is a thread-like structure that acts as a carrier unit of inheritance in the form of nuclear DNA.



DNA packing into chromosome



www.dnalc.org



Thank
you