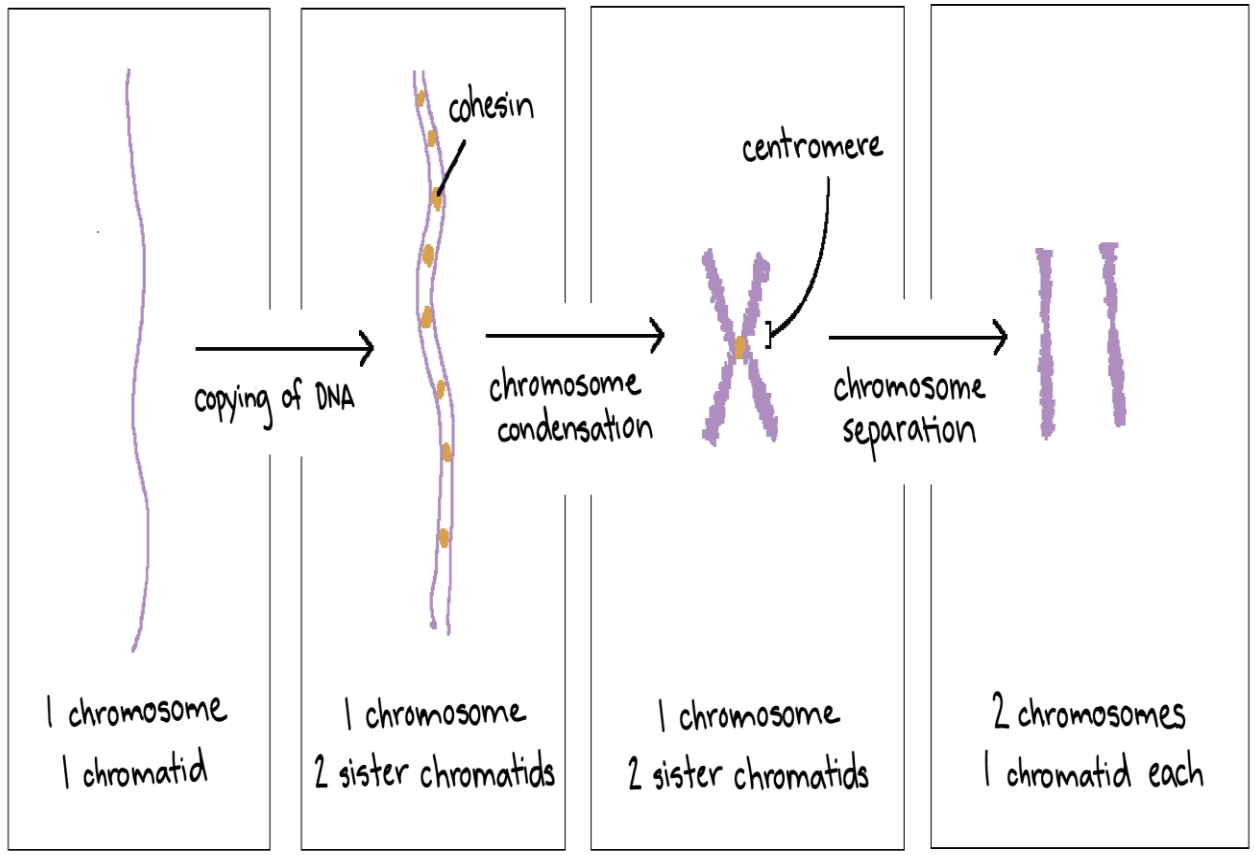
Unit-VII : Genetics and Evolution

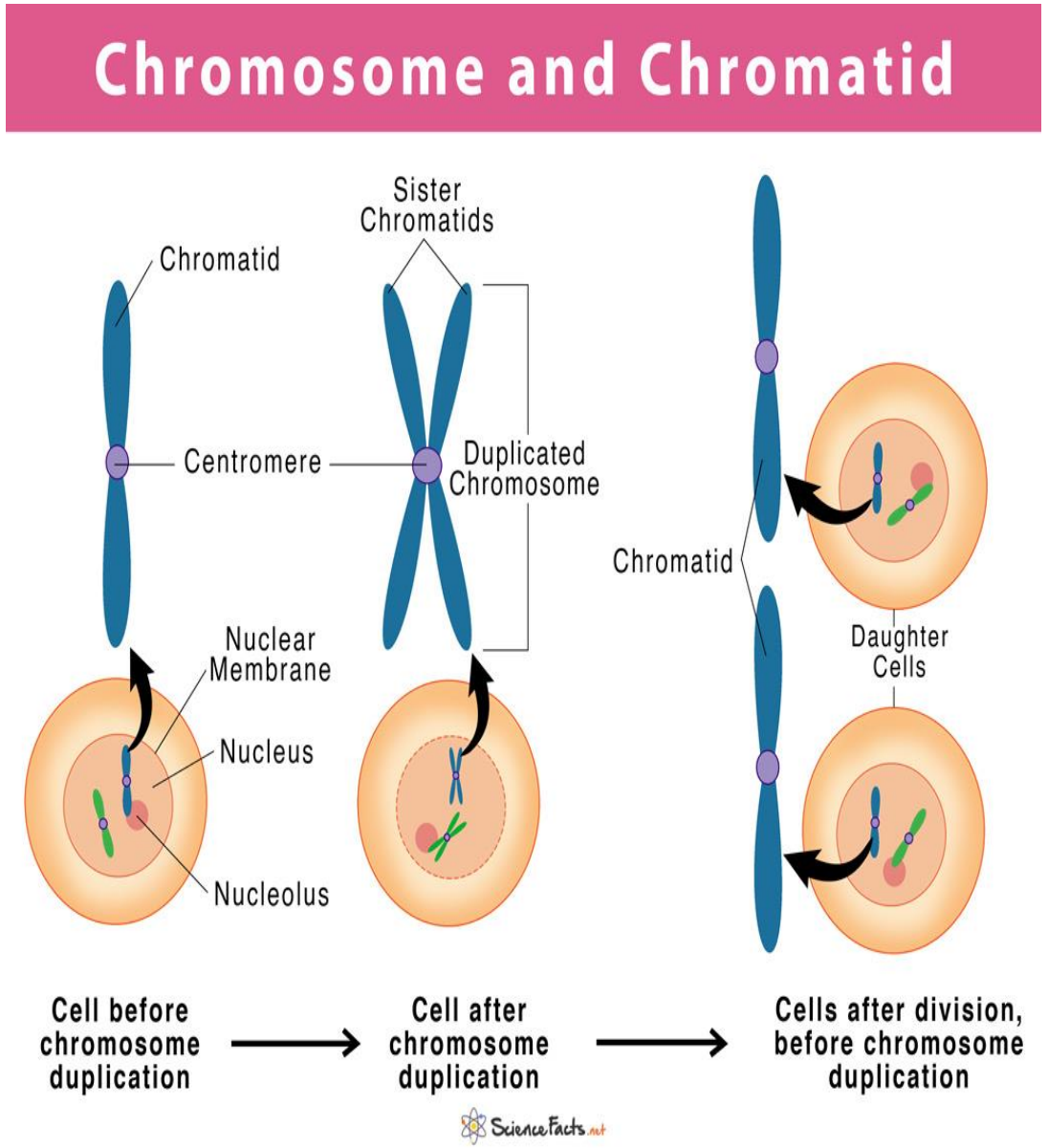
Chapter 5
MOLECULAR BASIS OF INHERITANCE

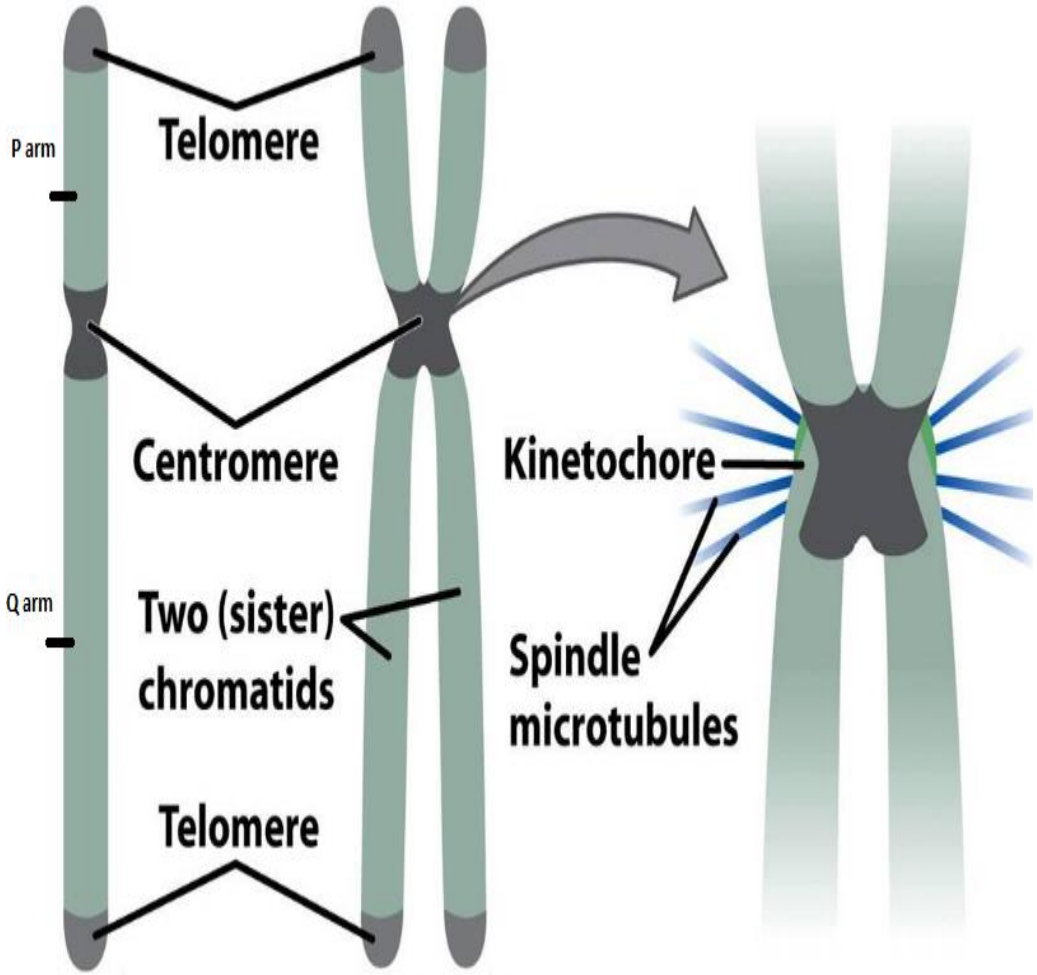
TOPIC: 2
PACKING OF DNA & CHROMOSOME

Sarojmoni Sonowal
Dept of Zoology
Asstt. Professor
Pub Kamrup College

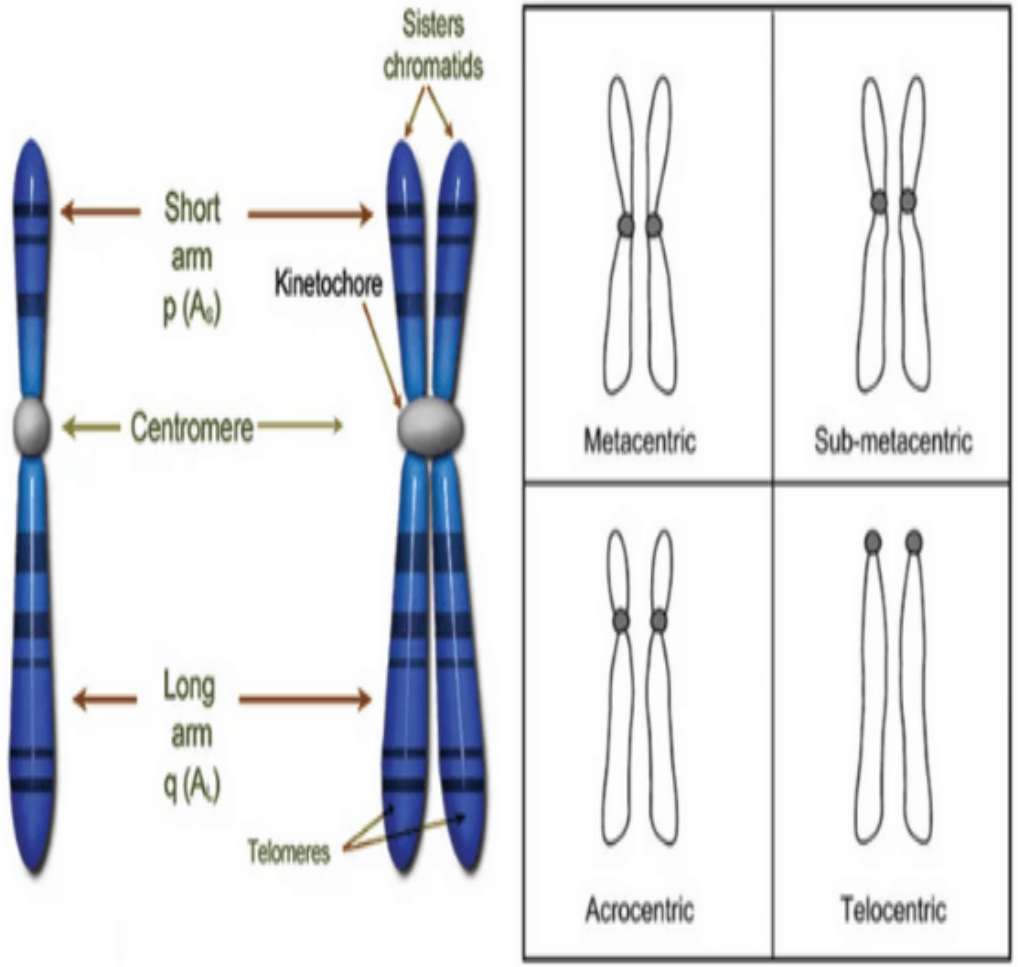
CHROMOSOME


cohesin
centromere
copying of DNA
chromosome condensation
chromosome separation
1 chromosome
1 chromatid
1 chromosome
2 sister chromatids
1 chromosome
2 sister chromatids
2 chromosomes
1 chromatid each


Chromosome and Chromatid
Sister Chromatids
Chromatid
Centromere
Duplicated Chromosome
Nuclear Membrane
Nucleus
Nucleolus
Chromatid
Daughter Cells
Cell before chromosome duplication
Cell after chromosome duplication
Cells after division, before chromosome duplication
ScienceFacts.net

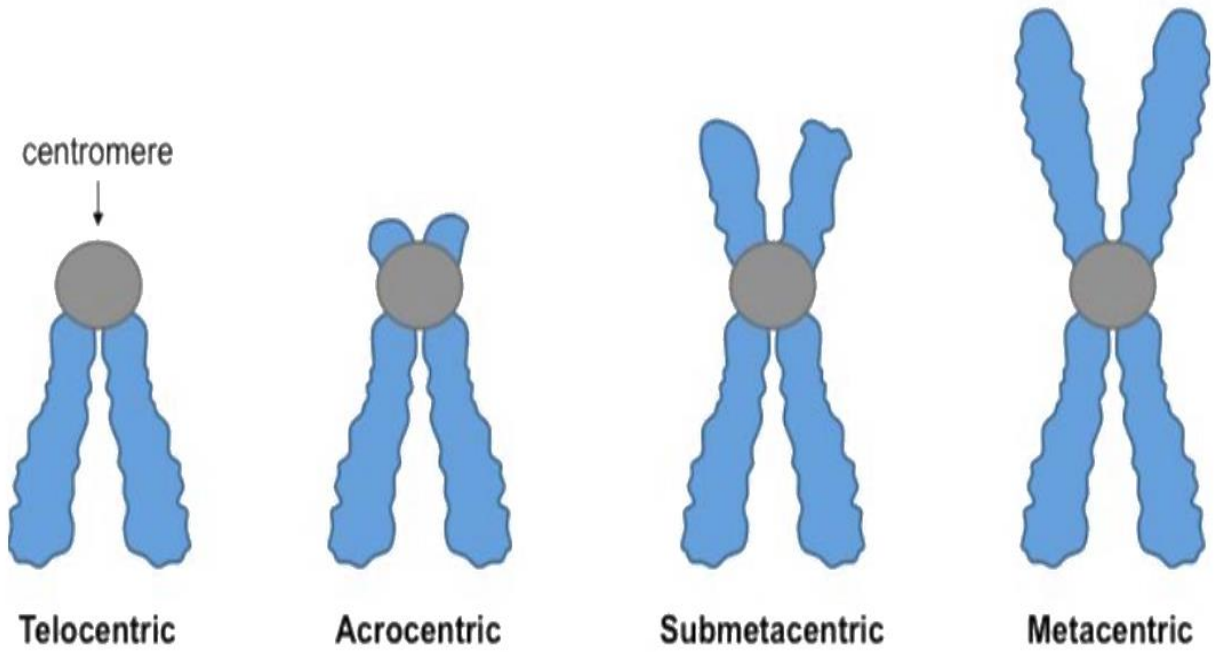


Chromosome Structure



The type of chromosomes based on the position of centromere are of the following four types :

1) **Metacentric chromosome:** Centromere in middle forming two equal arms.
2) **Sub-metacentric chromosome:** Centromere placed near to one end resulting in one shorter and one long arm.
3) **Acrocentric chromosome:** Centromere placed close to one end forming one extreme short and one extreme long arm.
4) **Telocentric chromosome:** Terminally placed centromere.



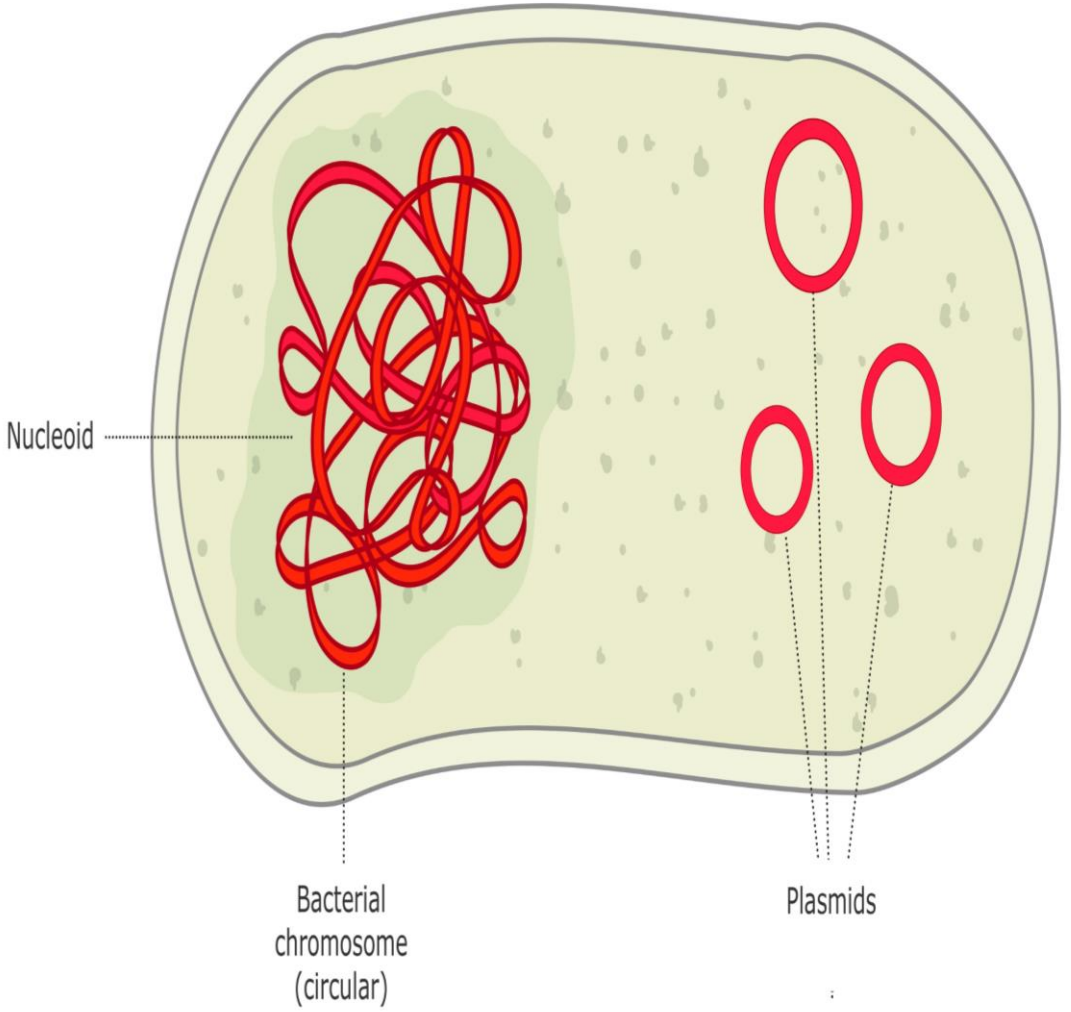
	metacentric chromosome 1、3、16、19、20
	submetacentric chromosome 2、4、5、6、7、8、9、10、11、12、17、18、X、
	acrocentric chromosome 13、14、15、21、22、Y

PACKING OF DNA HELIX

- **Packing Of Prokaryotic DNA**
- **Packing Of Eukaryotic DNA**

PACKING OF PROKARYOTIC DNA

- In prokaryotes like E.Coli, don't have a definite nucleus. The DNA is not scattered throughout the cell.
- DNA (**being negatively charged**) is held with **some proteins** (that have **positive charge**) and confined to a definite region of cytoplasm.
- Region appears as a distinct clump **called nucleoid**
- The DNA in nucleoid is organized in large loops. Ends of the loop likely to be held by proteins.
- Many bacteria contains additional DNA- small circular molecules **called plasmids**
- *E.Coli* chromosome- single DNA with approx. 4.64 million bps



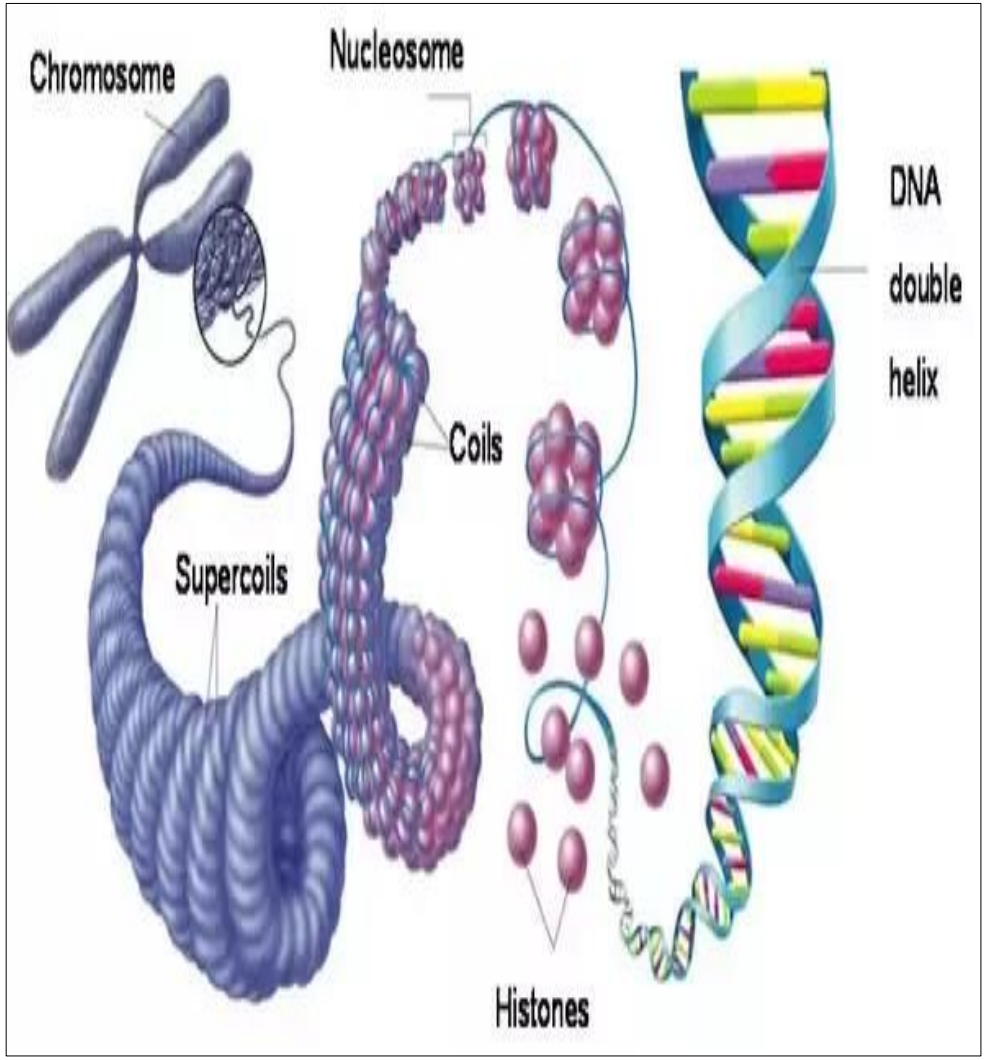
EUKARYOTIC CHROMOSOME

- Eukaryotic chromosome consists of single, extremely long molecule of DNA.
- Human cell contains **6 billion bps of DNA-** approx. **2m when stretched.**
- Stretched 14,000 times the length of the nucleus.
- **DNA molecules must be tightly packed to fit into such small spaces**.
- The **packing of DNA is not static** but changes regularly in response to cellular process-Replication & transcription

Eukaryotic DNA is closely associated with proteins forming **CHROMATIN**

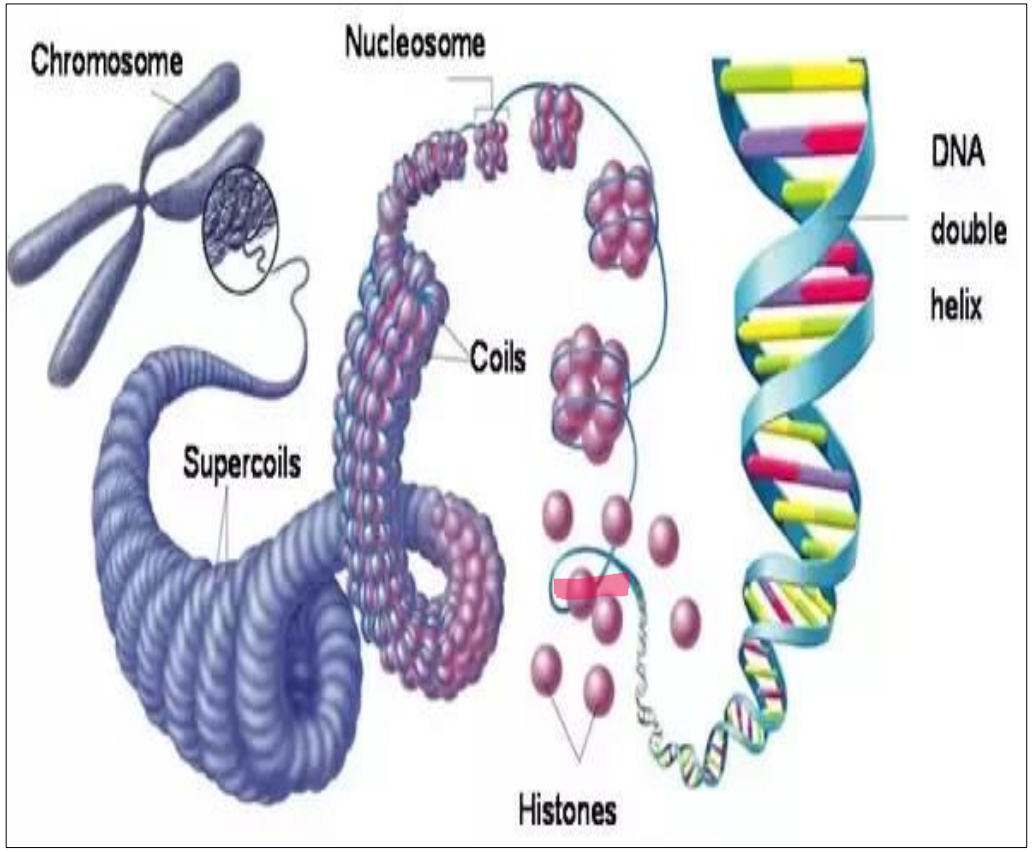
(long, fine thread like filamentous structure of DNA +PROTEIN)

During Cell division, chromatin fibers becomes thick, short thread like structure known as chromosomes.

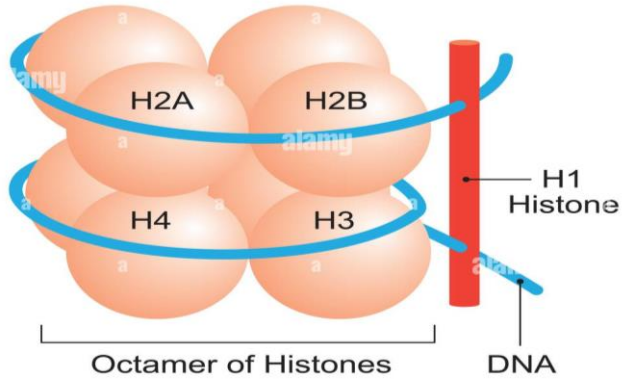


PACKING OF EUKARYOTIC DNA

- In Eukaryotes**, this organization is much more complex.**
- **There is a set of proteins** called as **Histones**, which are small and positively.
- Positive charge in Histone proteins is due to high percentage of basic amino acids --arginine and lysine.
- Proteins are of 5 major types: **H2A, H2B, H3 H4 (core part) & H1**
- Histones are organized to form a **unit of 8 molecules called <u>Histone Octamer.</u>**
- The Negative charged DNA is wrapped around the Positively charged histone Octamer to form a structure called **<u>Nucleosome.</u>**



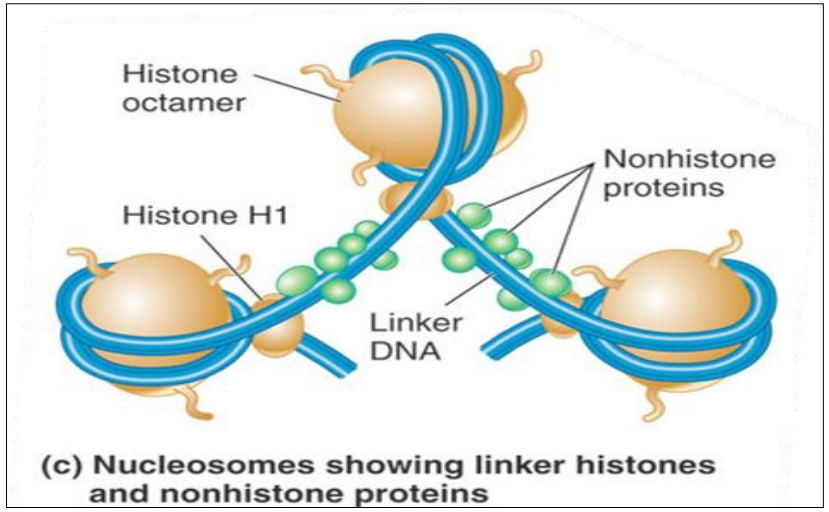
Histone Structure

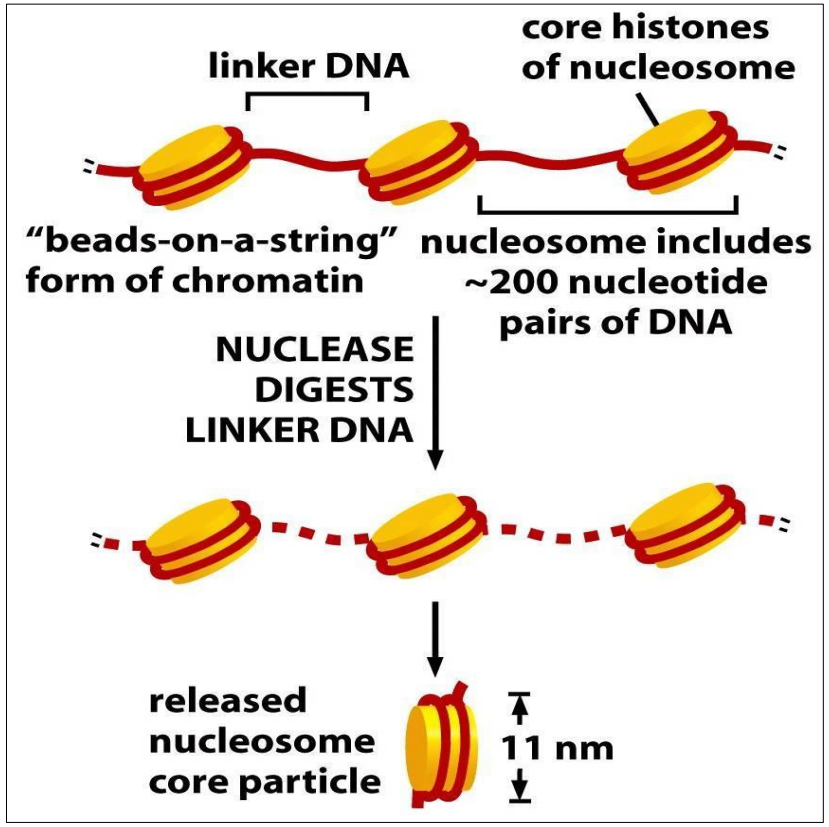


PACKING OF EUKARYOTIC DNA

(Cont…)

- **A** typical Nucleosome **contains 200 bp (base pairs**) of DNA helix.
- Nucleosome is the **repeating unit of a structure in a nucleus called chromatin** (which appears as thread like stained bodies in nucleus)
- The nucleosomes in chromatin appears **as "beads on string"** structure when observed under microscope.

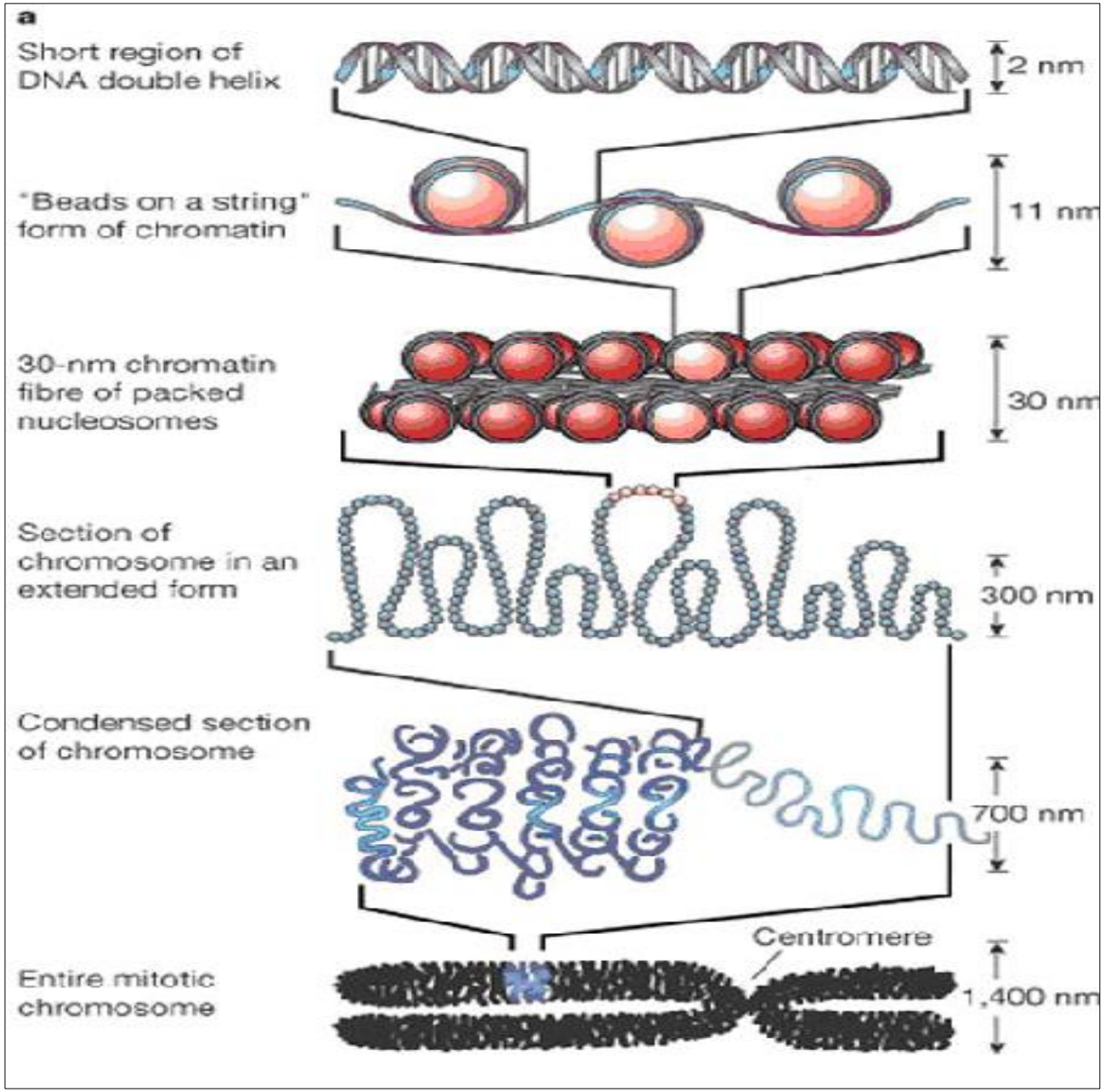




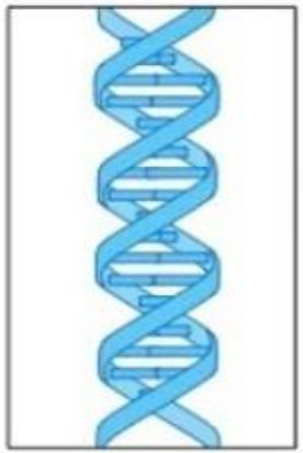
PACKING OF EUKARYOTIC DNA

(Cont…)

- The beads on string structure in chromatin is packed to form chromatin fibers that are further condensed at a metaphase stage of cell division to form chromosome.
- The packing of chromatin at higher level requires additional set of proteins that are collectively called **Non Histone Chromosomal (NHC) proteins** make up about half of the proteins mass of the chromosome.
- Non histone chromosomal proteins helps in structural roles and replication and transcriptions

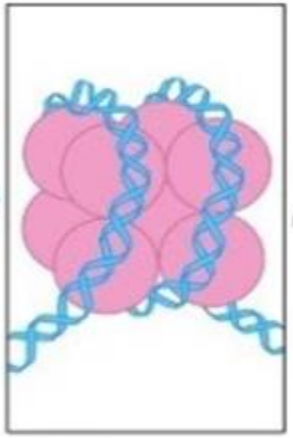


PACKING OF DNA



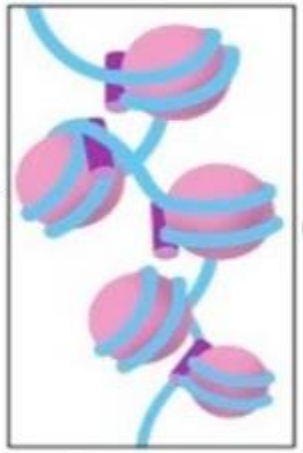
DNA

1.8m



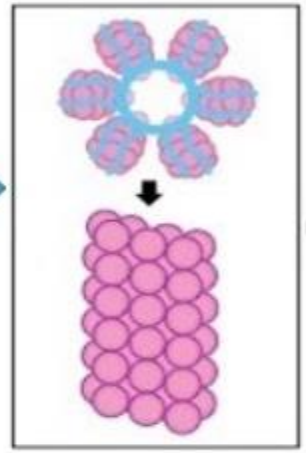
Nucleosome

11 nm

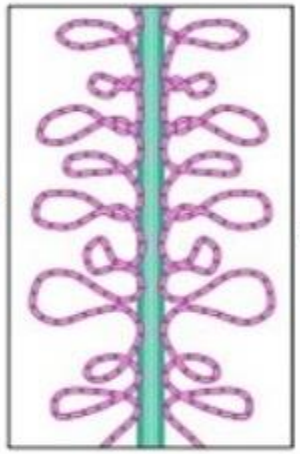


Chomatosomes

6 chromatosomes per turn



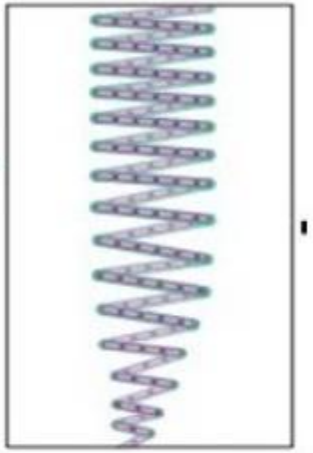
Solenoid



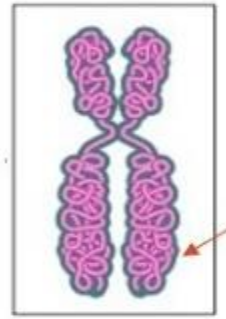
30 nm fibre

Loops, which are compressed and folded around a protein scaffold

200nm



Chromatin

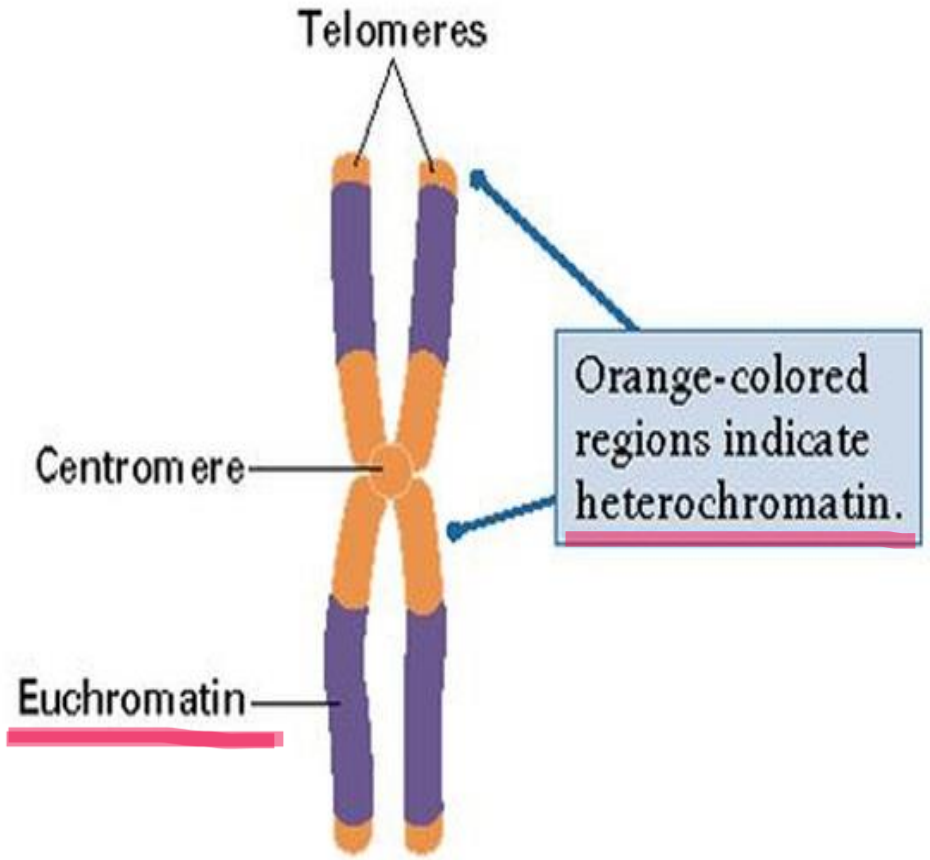


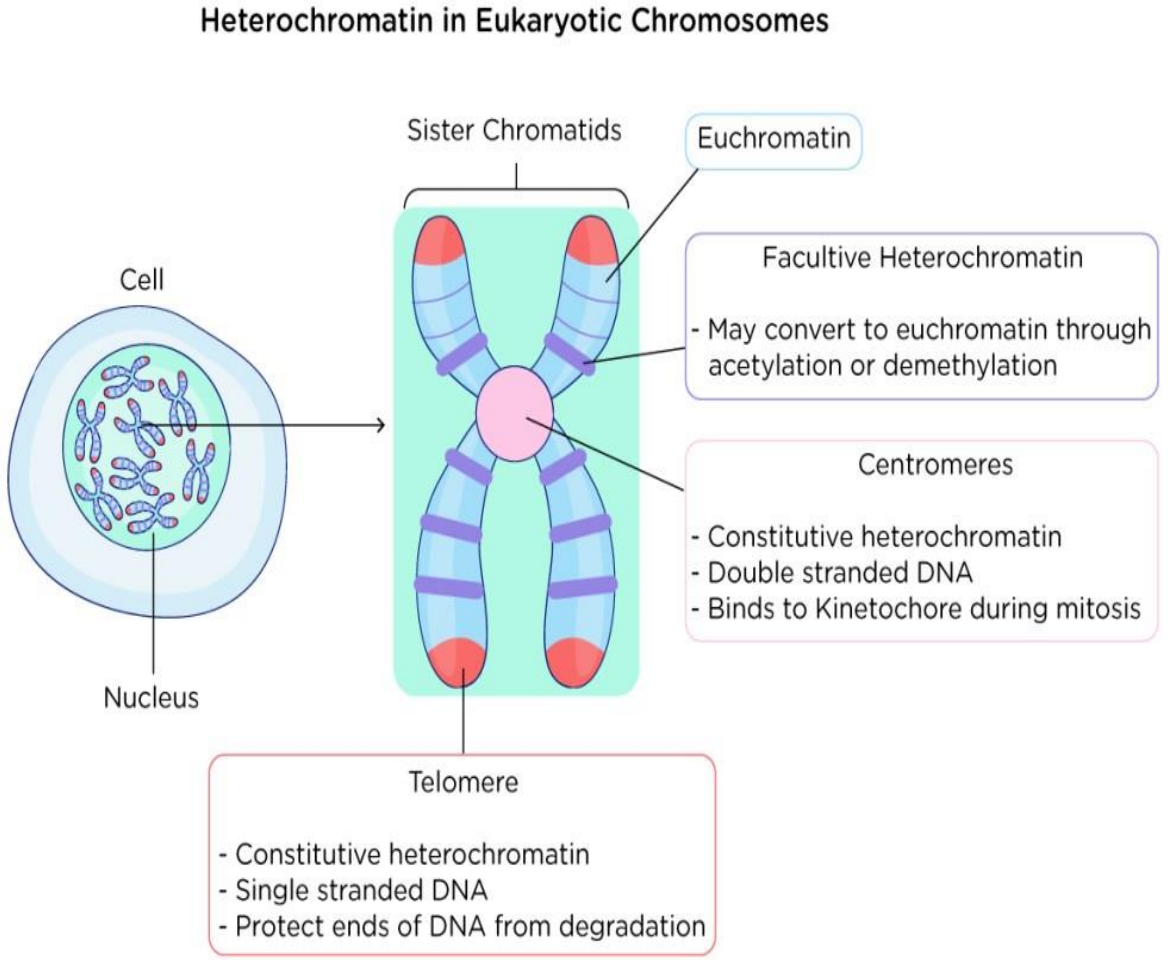
700nm

Chromosome

TWO TYPES OF CHROMATIN

(Euchromatin & Heterochromatin)





TWO TYPES OF CHROMATIN ---Cont..

(Euchromatin & Heterochromatin)

1) Euchromatin:

- In a typical nucleus, some region of the chromatin that are **loosely packed and stains light in color** are referred to as **Euchromatin.**

- Euchromatin is said to be transcriptionally active chromatin

1) Heterochromatin:

- The region of the chromatin that is more densely packed and stains dark are called heterochromatin.

- Heterochromatin is said to be transcriptionally inactive.

DIFFERENCE

Euchromatin	Heterochromatin
• Light areas	• Dark areas
• Stained light	• Stained dark
• Lightly packed	• Tightly packed
• Enriched in genes	• Gene regulation, protection, dense packing of DNA
• Active transcription of DNA to mRNA products	• Genetically Inactive satellite sequences
• 92% of the human genome is euchromatic	• Centromeres, telomeres, barr body,chromosome 1, 9, 16 of humans.

THANK YOU