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Topic: chromosomes

Chromosomes

- ❖ The chromosomes of a cell are in the cell nucleus. They carry the genetic information.
- ❖ Chromosomes are made up of DNA and protein combined as chromatin.
- ❖ Each chromosome contains many genes.
- ❖ Chromosomes come in pairs: one set from the mother; the other set from the father.
- ❖ Chromosomes are present in every cell nucleus with very few and special exceptions.
- ❖ This means they are found in all eukaryotes, since only eukaryotes have cell nuclei. When eukaryote cells divide, the chromosomes also divide.
- ❖ Prokaryotic chromosome consists of a single DNA molecule ,that is usually circular, with only a small amount of associated proteins.
- ❖ Each chromosome has a single origin of DNA replication.
- ❖ Eukaryotic chromosomes were discovered by **Hofmeister (1848)** in the pollen mother cells of *Tradescantia*.

- ❖ **W. Waldeyer**, a German cytologist, (1888) introduced the term chromosome (Gr. Chroma- colour, soma- body).

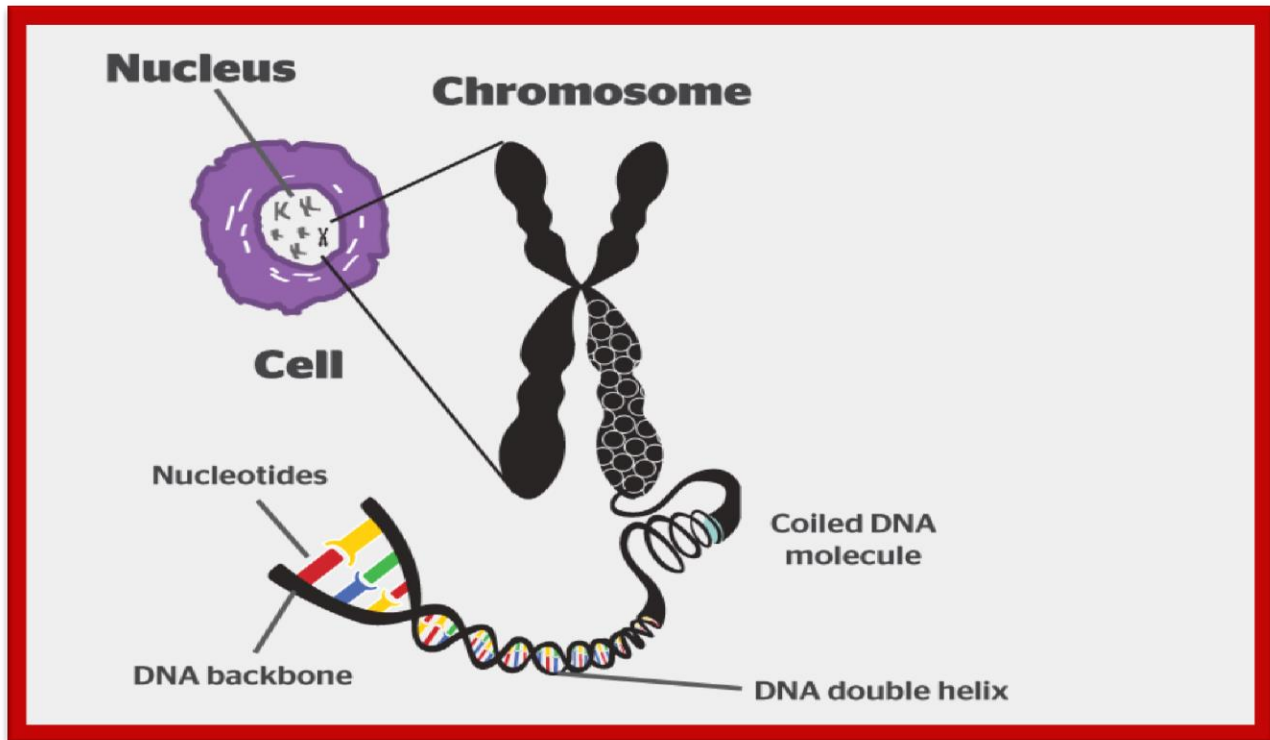


Fig: chromosomes

Chromosome morphology

- ❖ A chromosome consists of chromonema, chromomere, centromere, secondary constriction, telomere, satellite, etc.
- ❖ **Chromonemata** are filaments constituting a chromosome.
- ❖ Chromomeres are linearly arranged bead – like and compact segments described by J.Bellings. They are identified by their characteristic size and linear arrangement along a chromosome.
- ❖ **Centromere** is the site at which the spindle attaches during cell division . It is concerned with anaphase movement of chromosomes to poles. It is the last part to get duplicated in a dividing chromosome. Normally centromere

consists of highly repeated satellite DNA. Position of centromere determines the shape of the chromosomes. Four morphologic types of chromosomes according to the position of centromere are;

- ❖ **Metacentric:** chromosomes with equal arms.
- ❖ **Submetacentric:** chromosomes with unequal arms. The shorter arm is called the **p arm** and longer arm is called the **q arm**.
- ❖ **Acrocentric :** chromosome with sub terminal centromere with a very small and very large arm.
- ❖ **Telocentric:** chromosome having strictly terminal centromere and with only one arm.

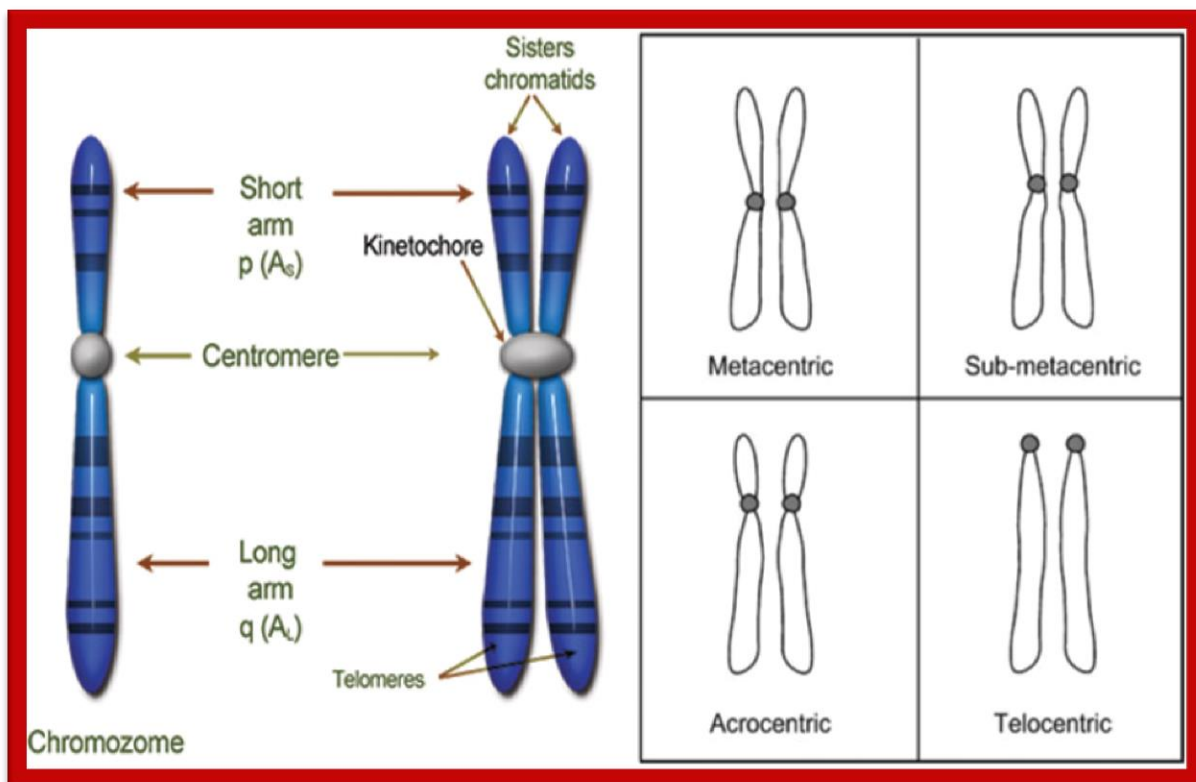


Fig: Four types of chromosomes based on the position of centromere

- ❖ **Karyotype:** refers to the complete diploid set of chromosomes of a particular species.
- ❖ **Telomere:** the term applied to the specialized structures present at each end of a chromosome . It contains multiple repeats of simple , short DNA sequences like TTAGGG. Specific proteins bind to telomere region which prevent recombination between the ends of different chromosomes.
- ❖ **Telomerase:** an enzyme which maintain telomere length . It is a protein that contains RNA complementary to the telomere repeat DNA sequence. Telomerase is absent from somatic cells but reappears in tumour cells.
- ❖ **Nucleolar organizer regions (NORs) :** are usually found at secondary constrictions.

SEX CHROMOSOMES AND AUTOSOMES:-

- ❖ In animals and some plants there are differences in the chromosome complement of male and female cells.
- ❖ One sex has a matched pair of **sex chromosomes** (allosomes, heterochromosomes) chromosomes related to the sex of organism; the other sex has unmatched pair or a single sex chromosome.
- ❖ Chromosomes other than sex chromosomes are called **autosomes**.

CHROMATIN :-

- ❖ Chromatin is the term given to the association of DNA and proteins that composes chromosomes.
- ❖ **W. Flemming** (1879) coined the term chromatin.
- ❖ Two types of chromatin present in the cell are : **heterochromatin and euchromatin**.

- ❖ Heterochromatin appears denser than euchromatin and stains darker; it exists as **constitutive heterochromatin and facultative heterochromatin**.

Molecular structure of chromosome:-

- ❖ Chromosomes of eukaryotes are composed of mainly DNA and proteins.
- ❖ The mixture of DNA and protein is called **chromatin**.
- ❖ The proteins are divided into two classes, **histones** (basic positively charged at neutral pH) and **nonhistones** (acidic, negatively charged at neutral pH).
- ❖ Histones are rich in amino acids **lysine** or **arginine** or both.
- ❖ In sperm of some animals, the histones are replaced by another class of small basic proteins called **protamines**.
- ❖ The chromosome (chromatin) is formed of a series of repeating units called **nucleosomes**.
- ❖ The nucleosomal organization provides a chromatin fibre approximately 10 nm in thickness.

Chromosome Number:-

- ❖ In higher organisms, each somatic cell contains chromosomes inherited from the **maternal**(female) parent and a comparable set of chromosomes from the **paternal** (male) parent.
- ❖ The number of chromosomes in this dual set is called the **diploid (2n)** number.
- ❖ The suffix “ – **ploid**” refers to chromosomes “set”.
- ❖ The members of a chromosome pair that contain the same genes and that pair at meiosis are called **homologous chromosomes**.
- ❖ Sex cells or gametes are **haploid** with only one set of chromosomes.

- ❖ The complete complement of genetic information in a haploid chromosome set is called the **genome**.
- ❖ Chromosome number of is unrelated to the size or biological complexity of an organism, with most species containing between 10 and 40 chromosomes in their genome.

Chromosome Replication:-

- ❖ Three elements essential for replication of eukaryotic chromosomes are:
 1. Origins or replication,
 2. Telomere and
 3. Centromeres.
- ❖ Each chromatid contains a single, linear DNA molecule. DNA replication can occur simultaneously at numerous places in each such chromosome.
- ❖ Each of these independent “replication units” is called **replicon**.
- ❖ The ends of chromosomes are maintained by special ribonucleoprotein enzymes called **telomerases**.
- ❖ The proteinaceous region of the centromere called the **kinetochore** attaches to microtubules bundles of spindle.
- ❖ Each sister chromatid has its own kinetochore.

Special types of chromosomes:

- ❖ Giant chromosomes are very large chromosomes reported from few special types of cells.
- ❖ Two main types of giant chromosomes are lampbrush chromosomes and polytene(salivary gland) chromosomes.

1. Lampbrush chromosomes:-

- Lampbrush chromosomes were discovered by **Ruckert** (1892) in the oocytes of shark.
- Lampbrush chromosomes are given this name because their structure under light microscope resembles the brushes once used to clean the chimneys of oil-burning lamps.
- Lampbrush chromosomes are much larger than the polytene chromosomes and they occur in the **diplotene stage** of meiosis during oogenesis.
- Lampbrush chromosomes are commonly present in many vertebrates, particularly amphibians.
- Lampbrush chromosomes are up to 800 µm long; their large size provides favourable material for cytological analysis.
- Each lampbrush chromosome contains a central axial region where the two chromatids are highly condensed and numerous pairs of lateral loops.
- Lampbrush chromosomes have uncoiled DNA that reveals a looping structure.
- The uncoiled DNA is correlated with the synthesis of RNA and represents sites of gene expression.

2. Polytene chromosomes:

- Polytene chromosomes were discovered by the Italian cytologist **E. G. Balbiani** in the salivary gland cells of *Chironomus* larva.
- In the 1930s **Theophilus Painter** found salivary gland chromosomes in *Drosophila* larvae.
- All the centromeres of *Drosophila* polytene chromosomes appear to be attached together by a darkly staining **chromocentre**.

- Polytene chromosomes are extremely large chromosomes, easily seen under the light microscope.
- Polytene chromosomes are formed by replication of DNA without cell division.
- When polytene chromosomes are viewed with a light microscope, distinct alternating dark and light bands are visible.
- Expanded regions of the polytene chromosomes are called puffs.