UNIT 1 - ORGANISATION OF CHROMOSOMES

1.2. Organisation of Eukaryotic chromosome Nucleosome as functional Particle, 30 nm Chromatin fibre, higher order structure of chromatin.

Eukaryotic chromosome - An Eukaryotic cell has genetic material in the form of genomic DNA enclosed within the nucleus. Genes are the hereditary units located on the chromosomes existing as chromatin network in the non dividing cell.

German biologist Walter Fleming in 1880s revealed that during cell division the nuclear material organize themselves into a visible thread like structure which were named as chromosomes which stains deep with basic dyes. The term chromosome was coined by W. Waldeyer in 1888. chrome is coloured and soma is body, hence they mean "coloured bodies" and can be defined as higher order organized arrangement of DNA and Proteins. It contains many genes or hereditiary units Regulatory elements and other nucleotide sequences. chromosomes also contain DNA bound Proteins, which serve in packaging the DNA and control its function. Benden and Bovery in 1887 reported that the number of chromosomes in each species is constant. W.S. sutton and T. Boveri in 1902 suggested that chromosomes are the physical structures which carry the hereditiary messages.

Structure of chromosomes - At the time of cell division chromatin becomes condensed into chromosomes and various components that

can be visualized in mitotic chromosomes. They have following structural features —

(1) Chromatid → At metaphase each chromosome consists of two symmetrical structures the chromatids, each one of which contains a single DNA molecule. The chromatids are attached to each other only by the centromere and become seperated by each at the start of anaphase, when the sister chromatids migrate to opposite poles.

(2) chromonema(ta) - A single linear DNA molecule with its associated proteins in coils is called chromonemata.

(3) chromomere — These are bead like accumulations of chromatin material that are sometimes visible among along the chromonema.

4) Centromere — These are the region of the chromosome that becomes attached to the mitotic spindle. The centromere lies within a thinner segment of the chromosome the primary constriction regions flanking the centromere frequently contain highly repetitive DNA and stain with basic dyes.

5) Kinetochore — This component is a disc shaped protein structure that is attached to the centromeric chromatin. The Kinetochore has a dense outer layer, a middle layer of low density and a dense inner layer tightly attached to the centromere. Between 4 and 40 microtubules become attached to the Kinetochore and provide the force for chromosomal movement during mitosis. The function of the Kinetochore is to provide a centre of assembly for microtubules. A chromosome may be monocentric acentric or dicentric on the basis of number of centromeres.

Telomere - The tips of the chromosomes, having distinct cytological properties are called telomeres. Telomeres contain the ends of the long linear DNA molecule contained in each chromatid which does not allows the chromosomes to fuse with other. Ends of chromosomes without telomeres become sticky and fuse with other broken chromosomes. Thus telomeres prevents the mingling of chromosomes with each other.

Secondary Constrictions → Other morphological characteristics are the secondary constrictions constant in their position and extent. These constrictions are useful in identifying particular chromosome in a set.

Secondary constrictions are different from primary constrictions by the absence of marked angular deviations of the chromosomal segments.

Nucleolar Organizers - These area are part of secondary constrictions which contain the genes coding for 18S and 28S ribosomal RNA which induces the formation of nucleoli. The secondary constrictions arises because the rRNA genes are transcribed very actively interfering with chromosomal condensation.

In human beings, the nucleolar organizers are located in the secondary constrictions of chromosomes 13, 14, 15 21 and 22 all of which are acrocentrics and have satellites.

Satellites → Another morphological element present in certain chromosomes is the satellite which is a rounded body seperated from rest of the chromosomes by a secondary

constrictions. The Satellite and the constrictions are constant in shape and size for each particular chromosome.

Types of chromosomes - Four categories of chromosomes are recognized, depending on the position of the centromere There are called

1) Metacentric - If the centromere is near the middle of the chromosome, the two arms of chromosome are nearly equal. The chromosome appears V shaped during anaphasis movement.

2. Submetacentric - If the centromere is situated some distance away from the middle one arm of chromosome will be shorter than the other. Such a chromosome will appear L-shaped during anaphasic movement.

3. Acrocentric - when the centromere is situated near the end of the chromosome, it appears rod shaped.

4. Telocentric - If the centromere is situated at the tip of chromosome, it is a very rare type reported by Marks (1957) in some species of plants, Protozoa and Mammals.

In human being three types of Chromosomes are found Metacentric, Sub metacentric and acrocentric

Polycentric chromosomes → Generally the chromosomes have only one centromere but in some animals (insects, hemipterans) is not located at one point but lies diffused along the length of chromosome it is also called diffused centromere, and the chromosomes is said to be polycentric.

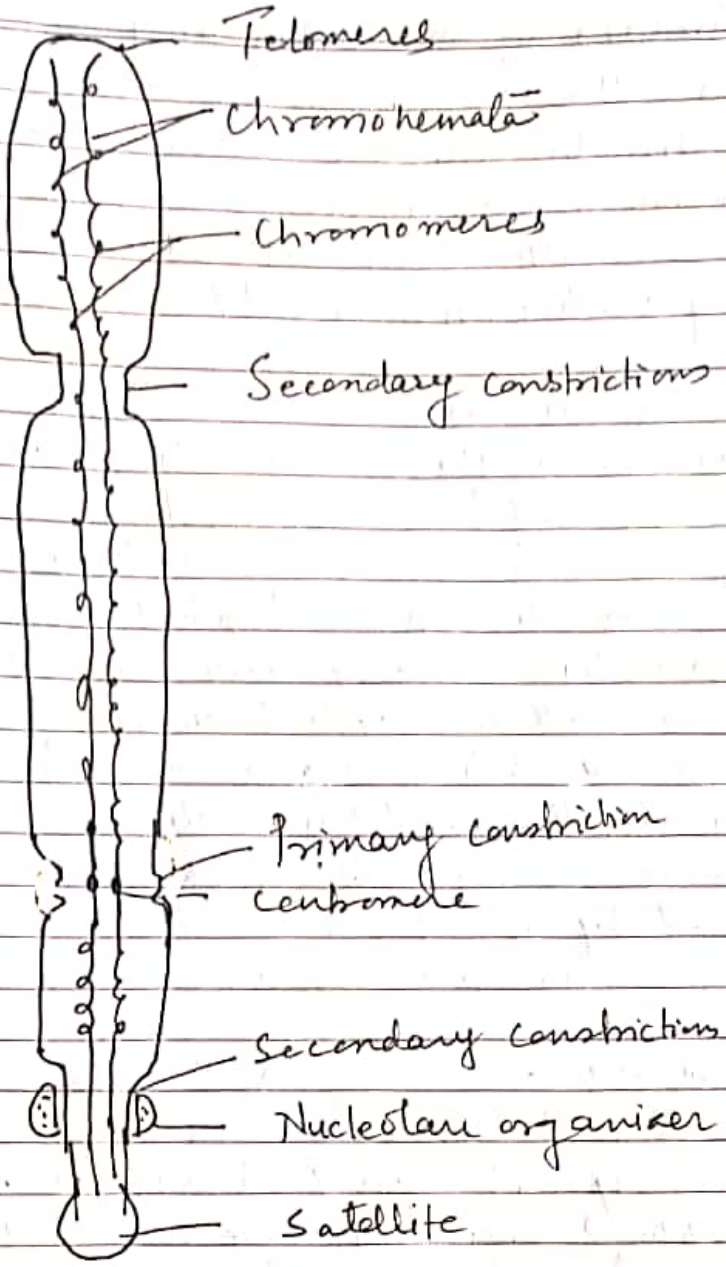
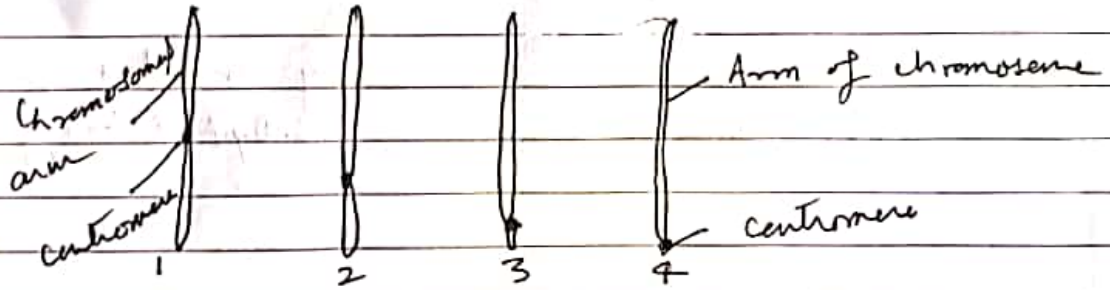


Fig - Structure of a typical chromosome



1- Metacentric 2) - Submetacentric
3 Acrocentric 4. Telocentric.

Types of chromosomes in human body —

1) Autosomes - The chromosomes found in body or somatic cells are called autosomes.

2) Sex chromosomes - (Heterosomes) - They are present in reproductive cells like sperm and ova they are two types X and Y.

Number of chromosomes - The number of chromosomes in the individuals of same species are called similar and a complete set of chromosomes is called euploidy. It includes haploids, diploids, triploid, tetraploids etc. Gametes normally have one set of chromosomes called haploid number, somatic cells contain two sets of chromosomes (diploid) Triploids have three, and tetraploids have 4 chromosomes, the single set of chromosome is represented by (n) if the chromosomes are present in multiples they are called Polyploids.

Size of chromosome — The length of chromosom vary from 1 micron to 30 microns.
There are special types of chromosomes which are upto 2 mm long these are special types of chromosomes called giant chromosomes or polytene chromosomes.

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