Genetics

Biology Dept.3rd stage

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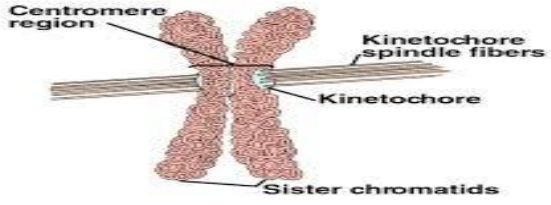
Lec-5- What is a chromosome?

In the nucleus of each cell, the DNA molecule is packaged into thread-like structures called chromosomes. Each chromosome is made up of DNA tightly coiled many times around proteins called histones that support its structure.

Chromosomes are not visible in the cell's nucleus—not even under a microscope—when the cell is not dividing. However, the DNA that makes up chromosomes becomes more tightly packed during cell division and is then visible under a microscope. Most of what researchers know about chromosomes was learned by observing chromosomes during cell division.

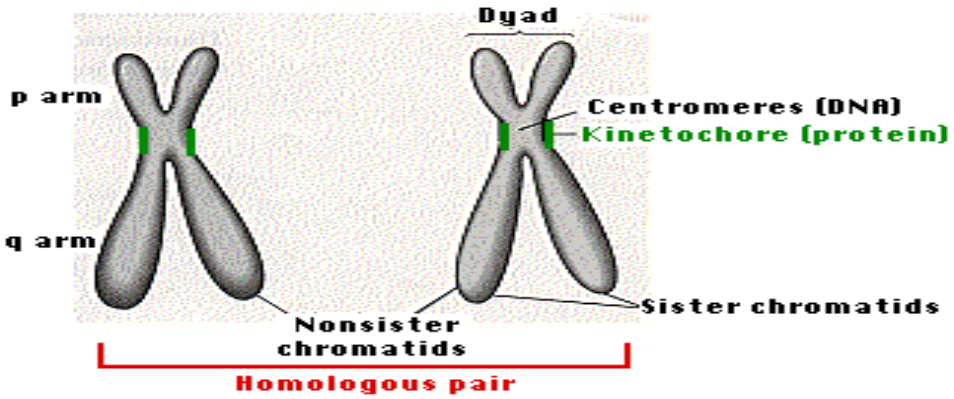
Each chromosome has a constriction point called the centromere, which divides the chromosome into two sections, or "arms." The short arm of the chromosome is labeled the "p arm." The long arm of the chromosome is labeled the "q arm." The location of the centromere on each chromosome gives the chromosome its characteristic shape, and can be used to help describe the location of specific genes



Structure

- For most of the life of the cell, chromosomes are too elongated and tenuous to be seen under a microscope.

- Before a cell gets ready to divide by mitosis, each chromosome is duplicated (during S phase of the cell cycle).
- As mitosis begins, the duplicated chromosomes condense into short (~ 5 µm) structures which can be stained and easily observed under the light



microscope.

- When first seen, the duplicates are held together at their **centromeres**. In humans, the centromere contains 1–10 million base pairs of DNA. Most of this is repetitive DNA: short sequences (e.g., 171 bp) repeated over and over in tandem arrays.
- While they are still attached, it is common to call the duplicated chromosomes **sister chromatids**.
- The **kinetochore** is a complex of >80 different proteins that forms at each centromere and serves as the attachment point for the spindle fibers that will separate the sister chromatids as mitosis proceeds into anaphase.
- The shorter of the two arms extending from the centromere is called the **p arm**; the longer is the **q arm**.

- Staining with the trypsin-giemsa method reveals a series of alternating light and dark bands called **G bands**.
- G bands are numbered and provide "addresses" for the assignment of gene loci.

Chromosome Numbers

- All animals have a characteristic number of chromosomes in their body cells called the **diploid** (or **2n**) number.
- These occur as **homologous pairs**, one member of each pair having been acquired from the gamete of one of the two parents of the individual whose cells are being examined.
- The gametes contain the **haploid** number (**n**) of chromosomes.

Total Number of Chromosomes of some Organisms

1.	Roundworm	2	8.	Rice	24
2.	Mosquito	6	9.	Frog	26
3.	Garden pea	14	10.	Sunflower	34
4.	Onion	16	11.	Rat	42
5.	Tiger	38	12.	Humans	46
6.	Lion	38	13.	Guinea pig	64
7.	Maize	20	14.	Gold fish	100

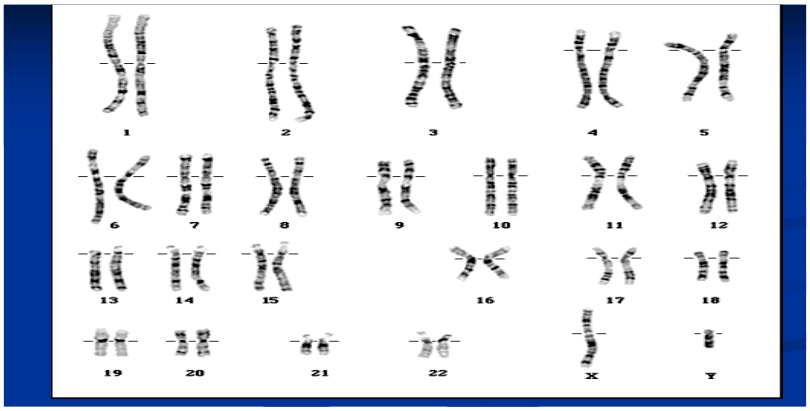
* The chromosomes bear genes which are composed of the DNA. Genes are responsible for the transmission of hereditary characteristics from one generation to another.

* Chromosomes control the synthesis of structural proteins and thus help in cell division, cell repair, cell growth and cell differentiation.

Chromosomes in eukaryotes and prokaryotes are different

PROKARYOTES	EUKARYOTES
single chromosome plus plasmids	many chromosomes
circular chromosome	linear chromosomes
made only of DNA	made of chromatin, a nucleoprotein (DNA coiled around histone proteins)
found in cytoplasm	found in a nucleus
copies its chromosome and divides immediately afterwards	copies chromosomes, then the cell grows, then goes through mitosis to organise chromosomes in two equal groups

Sex Chromosomes and Autosomes



The human species has 23 pairs of chromosomes.

Out of the 23 pairs, a specific pair, the 23rd pair of chromosomes determines the sex of the individual. These are called the sex chromosomes.

All other chromosomes are called autosomes or autosomal chromosomes.

1. The two members of each pair of chromosomes are alike, except one pair. The exception is the pair which determines sex, always referred to as the X chromosomes.

2. The somatic cells of females always have a true pair XX (homomorphic).

The somatic cells of males have a pair of sex chromosomes which are not alike, XY (Y being much smaller than X, hence heteromorphic).

3. As a result of meiosis, each reproductive cell gets only one sex chromosome.

The Structure of the Chromosome

The DNA is tightly wound and folded on a protein core. How tightly? Well, the DNA in a typical human cell has to fit inside a nucleus only 0.005 millimeter (.0002 of an inch) in diameter. If you could fully extend it, it would stretch to almost two meters, or around six feet.

This is when chromosomes become readily visible with staining. , different species have different numbers of chromosome pairs

In humans, there are 23 pairs. The first 22 pairs, called the *autosomes*,

are labeled according to length, longest to shortest, 1 through 22. The 23rd pair are the sex chromosomes—the X and Y chromosomes mentioned earlier.

The *centromere*, vital to the proper alignment of the chromosome pairs before cell division, divides the chromosome into two arms of varying lengths.

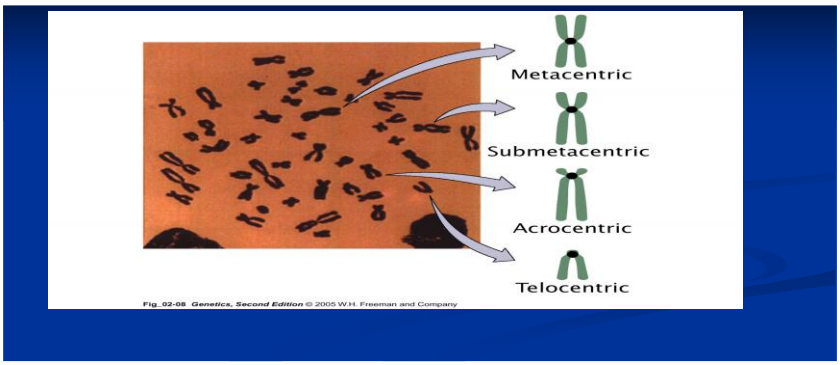
Its location varies from chromosome to chromosome. If it's near the center, the chromosome will have two arms of almost equal length and is called *metacentric.* Ifit's slightly off-center, one arm will be longer than the other, and the chromosome is *submetacentric.* If it's greatly off-center, the size difference between the arms will be even greater, and the chromosome is called *acrocentric.* In those cases, the shorter arm is called the *p* arm and the longer arm is called the *q* arm. Finally, if the centromere is at or very near the end of the chromosome, the chromosome is called *telocentric* .

Chromosomes may differ in the position of the **Centromere**, the place on the chromosome where spindle fibers are attached during cell division.

In general, if the centromere is near the middle, the chromosome is **metacentric**

If the centromere is toward one end, the chromosome is **acrocentric** or **submetacentric**

If the centromere is very near the end, the chromosome is **telocentric**.



The centromere divides the chromosome into two arms, so that, for example, an acrocentric chromosome has one short and one long arm,

While, a metacentric chromosome has arms of equal length.

All house mouse chromosomes are telocentric, while human chromosomes include both metacentric and acrocentric, but no telocentric

Human chromosomes are divided into 7 groups & sex chromosomes

- A 1-3 Large metacentric 1,2 or submetacentric
- B 4,5 Large submetacentric, all similar
- C 6-12, X Medium sized, submetacentric - difficult
- D 13-15 medium-sized acrocentric plus satellites
- E 16-18 short metacentric 16 or submetacentric 17,18
- F 19-20 Short metacentrics
- G 21,22,Y Short acrocentrics with satellites. Y no satellites.