# CHROMOSOMES

- Chromosomes are long strings of DNA (contain instructions to make a proteins, which are the functional unit of an organism), wrapped around proteins (Histones) to make them compact.
- Humans typically have 23 pairs of chromosomes for a total of 46 chromosomes.
- The first 22 pairs are called autosomes and the last pair are sex chromosomes.
- All body cells, except red blood cells and platelets, carries copies of our chromosomes.

## Autosomes

- There are 22 pairs of chromosomes in our body called Autosomes. That is inherit from each biological parent.
- Autosomes have 750 to 2,800 genes (segments of DNA) that give instructions to our body to function.
- Generally we need two copies of each set of instructions to live.
- Only in very rare cases can someone survive with only one of any given autosome. Some people have three of certain autosomes (like chromosome 21). But most conditions that cause extra autosomes aren't survivable.

## Sex chromosomes

- Sex chromosomes can either be an X or a Y.
- Everyone gets an X chromosome from their biological mother.
- Females get an additional X from their biological father.
- Males get a Y from their biological father.
- Hence, 23rd pair of chromosomes is typically either two Xs or an X and a Y. But some people have:

→ More than one Y
→ More than two Xs

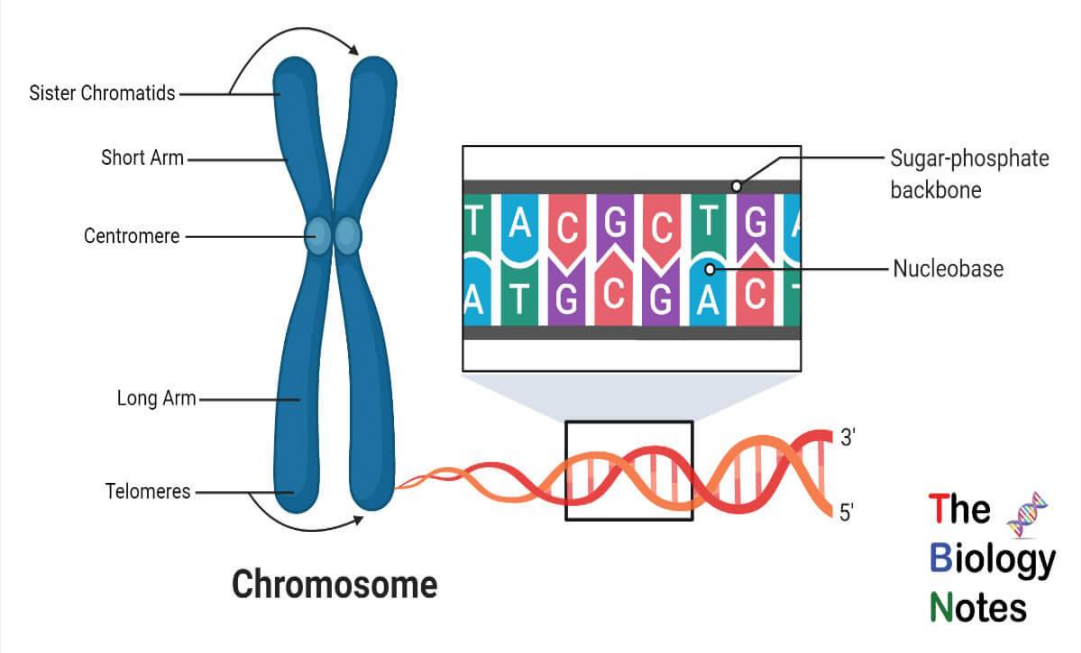
→ Two Xs and a Y
→ Only one X

- X is similar to an autosome. It has over 1,000 genes, and we can't survive without at least one X chromosome.
- The Y chromosome has far fewer genes than the X chromosomes or autosomes. Its main role is in developing the male reproductive system.

## STRUCTURE OF EUKARYATIC CHROMOSOME:

- In eukaryotes the chromosomes are multiple large, linear and are present in the nucleus of the cell.
- Each chromosome typically has one centromere and one or two arms that project from the centromere.
- Structurally, each chromosome is differentiated into three parts—

1. Pellicle
2. Matrix
3. Chromonemata




### PELLICLE:

- It is the outer envelope around the substance of chromosome.
- It is very thin and is formed of achromatic substances.

**MATRIX:**

- It is the ground substance of chromosome which contains the chromonemata.
- It is also formed of non-genic materials.

**CHROMONEMATA:**

- Embedded in the matrix of each chromosome are two identical, spirally coiled threads, the chromonemata.
- The two chromonemata are also tightly coiled together that they appear as single thread of about 800A thickness.
- Each chromonemata consists of about 8 microfibrils, each of which is formed of a double helix of DNA.

In mitotic metaphase chromosomes, the following structural feature (except chromomere) can be seen under the light microscope:

(1) Chromatid,

(2) Chromonema,

(3) Chromomeres,

(4) Centromere,

(5) Secondary constriction or Nucleolar organizer,

(6) Telomere and

(7) Satellite.

**CENTROMERE:**

- A small structure in the chromonema, marked by a constriction which is recognised as permanent structure in the chromosome is termed as the centromere.
- At this point the two chromonemata are joined together.
- It is known as centromere or kinetochore or primary constriction.
- It 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."
- Its position is constant for a given type of chromosome and forms a feature of identification.
- In thin electron microscopic sections, the kinetochore shows a trilaminar structure, i.e., a 10 nm thick dense outer protein aceous layer, a middle layer of low density and a dense inner layer tightly bound to the centromere.
- The chromosomes are attached to spindle fibres at this region during cell division.

**SECONDARY CONSTRICTION OR NUCLEOLAR ORGANISER:**

- The chromosome besides having the primary constriction or the centromere possesses secondary constriction at any point of the chromosome.
- Constant in their position and extent, these constrictions are useful in identifying particular chromosomes in a set.
- The chromosome region distal to the secondary constriction i.e., the region between the secondary constriction and the nearest telomere is known as satellite.
- Therefore, chromosomes having secondary constrictions are called satellite chromosomes or sat-chromosomes.
- Nucleolus is always associated with the secondary constriction of sat-chromosomes. Therefore, secondary constrictions are also called nucleolus organiser region (NOR) and sat-chromosomes are often referred to as nucleolus organiser chromosomes.

**TELOMERE:**

- These are specialized ends of a chromosome which exhibits physiological differentiation and polarity.
- Each extremity of the chromosome due to its polarity prevents other chromosomal segments to be fused with it. The chromosomal ends are known as the telomeres.
- If a chromosome breaks, the broken ends can fuse with each other due to lack of telomere.

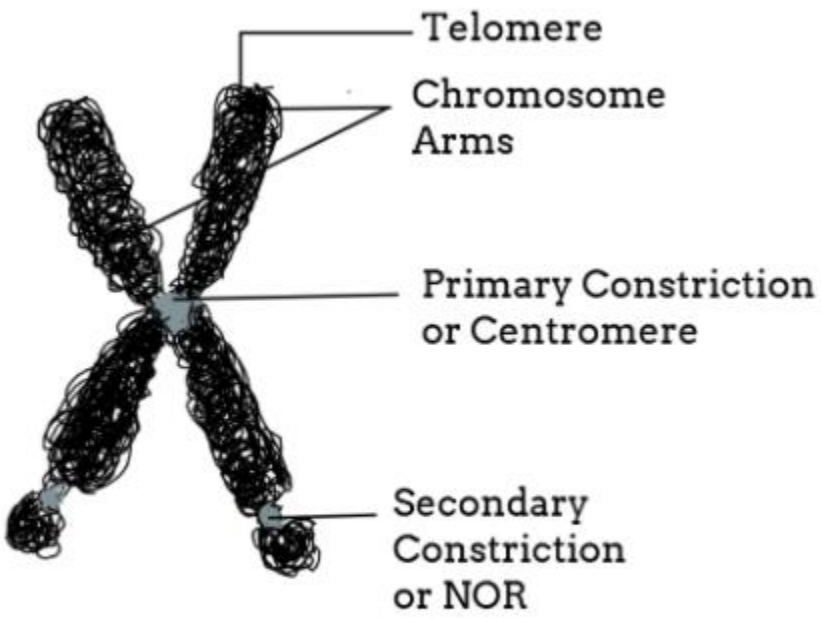



Figure: A chromosome showing Nucleolar Organizing Region (NOR).

Based on the number of centromeres the chromosome can be fall into the following types:

1. **Monocentric** with one centromere.
2. **Dicentric** with two centromeres.
3. **Polycentric** with more than two centromeres
4. **Acentric** without centromere. Such chromosomes represent freshly broken segments of chromosomes which do not survive for long.

5. **Diffused or non-located** with indistinct centromere diffused throughout the length of chromosome.

Based on the location of the centromere the chromosome can be fall into the following types:

1. **Telocentric** are rod-shaped chromosomes with centromere occupying the terminal position, so that the chromosome has just one arm.
2. **Acrocentric** are also rod-shaped chromosomes with centromere occupying a sub-terminal position. One arm is very long and the other is very short.
3. **Sub-metacentric** chromosomes are with centromere slightly away from the mid-point so that the two arms are unequal.
4. **Metacentric** are V-shaped chromosomes in which centromere lies in the middle of chromosome so that the two arms are almost equal.