

## CHROMOSOME NUMBER

### Haploid, Diploid

- Diploid cells ( $2N$  where  $N$ - chromosome number) have two homologous copies of each chromosome.
- The body cells of animals are diploid.
- Haploid cells ( $N$ ) have only one copy of each chromosome.
- In animals, gametes (sperm and eggs) are haploid.

### Homologous Chromosomes

- Diploid organisms have two copies of each chromosome (except the sex chromosomes). Both the copies are ordinarily identical in morphology, gene content and gene order and hence known as homologous chromosomes.
- Each pair of chromosomes made up of two homologs.
- Homologous chromosome is inherited from separate parents; one homolog comes from the mother and the other comes from the father.

### Chromosome Number

- The number of chromosomes in a given species is generally constant.
- Chromosomes come in pairs.
- Different organisms have different numbers of chromosomes. Normally all individual of a species have the same chromosome number.
  - [Diploid Chromosome number in Livestock](#)
  - [Diploid Chromosome number in Wild & Laboratory Animals](#)
  - [Diploid Chromosome number in different species of Birds](#)

#### • DIPLOID CHROMOSOME NUMBER IN LIVESTOCK

Sl. No.	Common Name	Genus and Species	Diploid Chromosome Number
1	Cat	<i>Felis catus</i>	38
2	Cattle	<i>Bos taurus, Bos indicus</i>	60
3	Dog	<i>Canis familiaris</i>	78
4	Donkey	<i>Equus asinus</i>	62
5	Goat	<i>Capra hircus</i>	60
6	Horse	<i>Equus caballus</i>	64
7	Human	<i>Homo sapiens</i>	46
8	Pig	<i>Sus scrofa</i>	38
9	Rabbit	<i>Oryctolagus cuniculus</i>	44
10	River buffalo	<i>Bubalus bubalis</i> (riverine type)	50
11	Swamp buffalo	<i>Bubalus bubalis</i> (swamp type)	48
12	Sheep	<i>Ovis aries</i>	54
13	Llama	<i>Lama glama</i>	74
14	Mule	(Hinny, hybrids of horse and ass)	63
15	African buffalo or Cape buffalo	<i>Syncerus caffer</i>	52

## DIPLOID CHROMOSOME NUMBER IN WILD AND LABORATORY ANIMALS

Sl. No.	Common Name	Genus and Species	Diploid Chromosome Number
1	Alligator	<i>Alligator mississippiensis</i>	32
2	Bison	<i>Bison bison</i>	60
3	Camel	<i>Camillus bactrianus</i> (Bactrian-two humped) and <i>Camillus dromedaries</i> (Dromedari-single humped)	74
4	Chimpanzee	<i>Pan troglodytes</i>	48
5	Deer	<i>Cervus elaphus</i>	68
6	Elephant	<i>Elephas maximus</i> (Asian) and <i>Loxodonta Africana</i> (African)	56
7	Golden hamster	<i>Mesocricetus auratus</i>	44
8	Gorilla	<i>Gorilla gorilla</i>	48
9	Guinea pig	<i>Cavia cobaya</i>	64
10	Hare	<i>Lepus nigricollis</i>	48
11	Lion	<i>Panthera leo</i>	38
12	Mouse	<i>Mus musculus</i>	40
13	Musk ox	<i>Ovibus moschatus</i>	48
14	Rat	<i>Rattus norvegicus</i>	42
15	Reindeer	<i>Rangifer tarandus</i>	70
16	Syrian hamster	<i>Mesocricetus auratus</i>	44
17	Tiger	<i>Panthera tigris</i>	38
18	Honey bee	<i>Apis mellifera</i>	32, 16
19	House fly	<i>Musca domestica</i>	12
20	Common fruit fly	<i>Drosophila melanogaster</i>	8

## DIPLOID CHROMOSOME NUMBER IN DIFFERENT SPECIES OF BIRDS

<b>Sl. No.</b>	Common Name	Genus and Species	Diploid Chromosome Number
1	Chicken	<i>Gallus domesticus</i>	78
2	Domestic duck	<i>Anas platyrhyncha</i>	80

3	Emu	<i>Dromaius novaehollandiae</i>	80
4	Goose	<i>Anser anser</i>	80
5	Guinea fowl	<i>Numida meleagris</i>	74
6	Japanese quail	<i>Coturnix japonica</i>	78
7	Muscovy duck	<i>Cairina moschata</i>	80
8	Ostrich	<i>Struthio camelus</i>	80
9	Pigeon	<i>Columba livia</i>	80
10	Ring-necked pheasant	<i>Phasianus colchicus</i>	82
11	Turkey	<i>Meleagris gallopavo</i>	80

## STRUCTURE OF CHROMOSOME

### Chromosome Morphology

- The chromosome morphology changes during cell division and mitotic metaphase is the most suitable stage for studies on chromosome morphology.
- The DNA of eukaryotic cells is tightly bound to small basic proteins (histones) that package the DNA in an orderly way in the cell nucleus.
- The complexes between eukaryotic DNA and proteins are called chromatin, which typically contains about twice as much protein as DNA.
- The major proteins of chromatin are the histones - H1, H2A, H2B, H3, and H4 which are very similar among different species of eukaryotes.
- The shape of the eukaryotic chromosomes is changeable from phase to phase in the continuous process of the cell growth and cell division.
- Chromosomes are thin, coiled, elastic, thread-like structures during the interphase.
- As cells enter mitosis, their chromosomes become highly condensed so that they can be distributed to daughter cells.
- In mitotic metaphase chromosomes, the following structural features can be seen under the light microscope.

### Chromatid

- Each metaphase chromosome appears to be longitudinally divided into two identical parts each of which is called chromatid. Both the chromatids of a chromosome appear to be joined together at a point known as centromere. The two chromatids of chromosome separate from each other during mitotic anaphase (and during anaphase II of meiosis) and move towards opposite poles.
- Since the two chromatids making up a chromosome are produced through replication of a single chromatid during synthesis (S) phase of interphase, they are referred to as sister chromatids. In contrast, the chromatids of homologous chromosomes are known as non-sister chromatids.

### Centromere (Primary constriction)

- Each chromosome has a constriction point called the centromere (Synonym: Kinetochore), 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.

## Telomere

- The sequences at the ends of eukaryotic chromosomes, called telomeres, play critical roles in chromosome replication and maintenance.

## Secondary constriction

- In addition to centromere / primary constriction, one or more constrictions in the chromosome are present termed secondary constrictions.

## Satellite

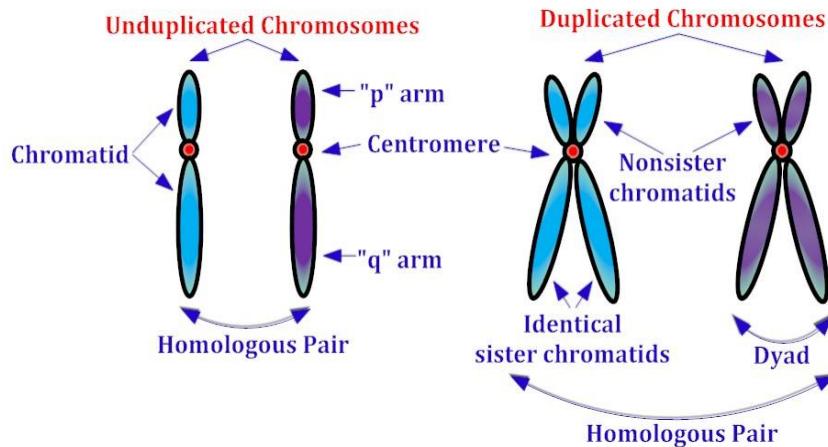
- A small chromosomal segment separated from the main body of the chromosome by a secondary constriction is called Satellite.

## CENTROMERE POSITIONS

### Size of the chromosome

- The size of the chromosome shows a remarkable variation depending upon the stage of cell division. The chromosomes are the longest and thinnest during interphase (resting stage) and hence not visible under light microscope. Chromosomes are the smallest and thickest during mitotic metaphase.
- Chromosome size is not proportional to the number of genes present on the chromosome.

- The location of the centromere on each chromosome gives the chromosome its characteristic shape.



### Centromere position

- Chromosomes are classified according to the centromere position: it is at one end (acrocentric), closer to one end than the other (submetacentric) or in the middle (metacentric).
- Each chromosome has two arms, labeled p (the shorter of the two) and q (the longer).
- The p arm is named for "petite" meaning 'small'; the q arm is named q simply because it follows p in the alphabet. (According to the NCBI, "q" refers to the French word "queue")
- Metacentric**
- The centromere is localized approximately midway between each end and thereby two arms are roughly equal in length.
- Metacentric chromosome takes V shape during anaphase.

### Submetacentric

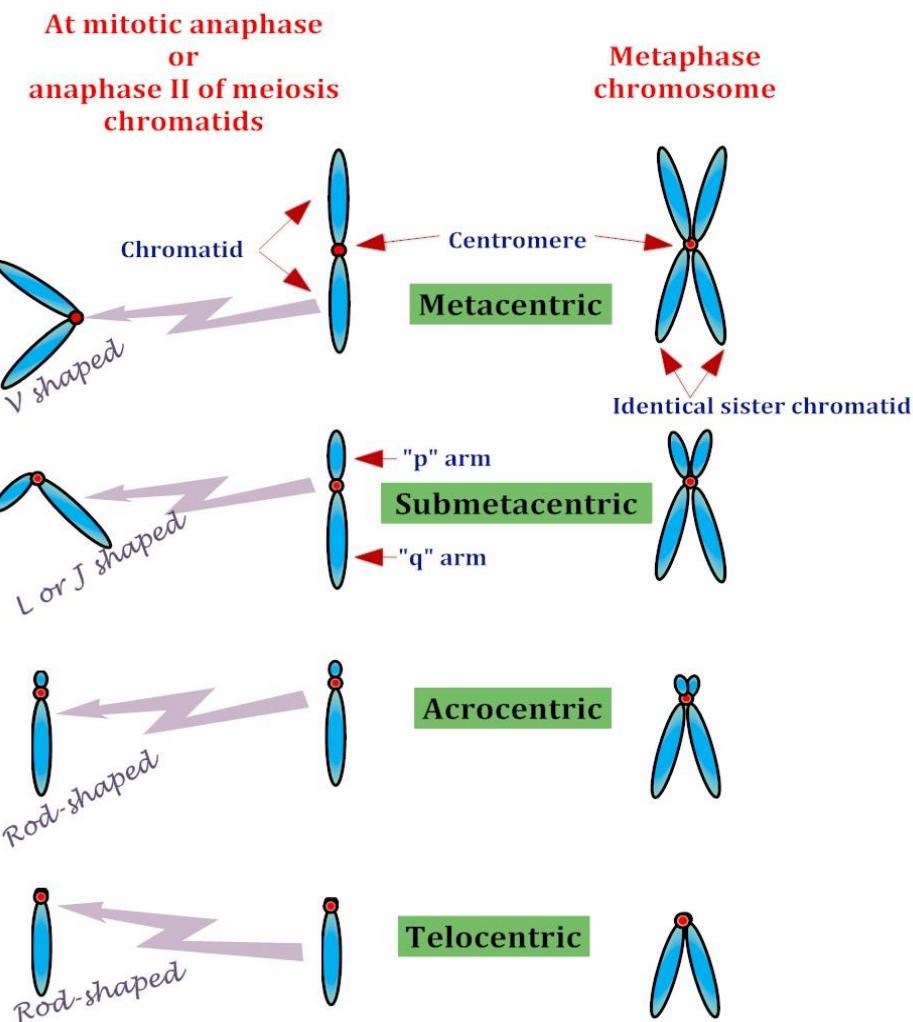
- Centromere is submedian, giving one longer and one shorter arm.
- Submetacentric chromosome may be J or L shaped during anaphase.

### Acrocentric

- The centromere is more terminally placed and forms very unequal arm length (The "acro-" in acrocentric refers to the Greek word for "peak").
- The p (short) arm is so short that it is hard to observe, but still present.
- Acrocentric chromosome may be rod shaped during anaphase.

### Telocentric

- Centromere lies at one end.
- Telocentric chromosome may be rod shaped during anaphase.



- According to the number of the centromere the eukaryotic chromosomes may be acentric (without any centromere), mono centric (with one centromere), dicentric (with two centromeres) or polycentric (with more than two centromeres).

## SPECIAL TYPES OF CHROMOSOMES

### Polytene chromosomes

- Polytene chromosomes are giant chromosomes common to many dipteran (two-winged) flies.
- These were first discovered by E. G. Balbiani in 1882 in Dipteran salivary glands and hence commonly called salivary gland chromosomes.
- They begin as normal chromosomes, but through repeated rounds of DNA replication without any cell division (called endoreplication), they become large, banded chromosomes (see figure).
- For unknown reasons, the centromeric regions of the chromosomes do not endorePLICATE very well.
- As a result, the centromeres of all the chromosomes bundle together in a mass called the chromocenter.
- Polytene chromosomes are usually found in the larvae, where it is believed these many-replicated chromosomes allow for much faster larval growth than if the cells remained diploid.

- Simply because each cell now has many copies of each gene, it can transcribe at a much higher rate than with only two copies in diploid cells.
- The polytene chromosomes at the right are from the salivary glands of the fruit fly *Drosophila melanogaster*.
- The bands on each chromosome are like a road map, unique to each chromosome and well defined enough to allow high resolution mapping of each chromosome.
- The Drosophila Genome Project uses polytene chromosomes as a framework for the map.

### **Lampbrush chromosomes**

- It was first observed by W. Flemming in 1882 and was described in detail in oocytes of sharks by Rukert in 1892.
- It consists of an axis from which paired loops extend in opposite directions, giving the appearance of a lamp brush. Hence the name Lamp Brush Chromosomes.
- It is found in the Oocytes of amphibians and in some insects.
- They are formed during the active synthesis of mRNA molecules for the future use by the egg during cleavage when no synthesis of mRNA molecules is possible due to active involvement of chromosomes in the mitotic cell division.
- It is larger in size. Hence it is called a giant chromosome.

### **B-chromosomes**

- B-Chromosomes (also called supernumerary chromosomes, accessory chromosomes, accessory fragments, etc.) are without obvious genetic function and usually have a normal structure, are somewhat smaller than the autosomes.

### **Holokinetic chromosomes**

- The chromosomes with a non-localized centromere are called as either holocentric or holokinetic chromosomes.