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# CHROMOSOMES

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# CHROMOSOMES

The chromosomes are darkly stained small bodies present in the nucleus and determine the mechanism of inheritance

Chromosomes are the physical structures which act as messenger of heredity.

After specific staining, it can be clearly seen during mitotic cell division during the metaphase.



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In all eukaryotic organisms including fishes, the DNA molecules in the nucleus are combined into proteins, mainly histones, to make chromosomes.

Genes are located on structures called “chromosomes”, which are located in the nucleus of every cell.



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# Diploid chromosome

The chromosome number in the cells of the body is normally made up of two sets, one of maternal (female) and one of paternal (male) origin, is denoted by  $2n$



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# Haploid chromosome

A single set of chromosomes found in a mature egg or in a spermatozoa is known as a *haploid set* is denoted by " $n$ ".

A haploid set of chromosome is called *genome*.

When more than two sets of chromosomes occur in cells, the condition is termed *polyploidy*.



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# Structure of a chromosome

The material of chromosomes is called *chromatin*.

It contains *euchromatin* which stains but lightly and *heterochromatin* which stains darkly.

Euchromatin is believed to contain the genes in a linear array like beads on a string



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Heterochromatin is mostly made up of highly repeated simple sequences of DNA, *satellite DNA*

Heterochromatin is usually found near the *centromere* and on the ends of each chromosome.



# Chromosome classification by centromeric position

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Metacentric

Sub- metacentric

Sub- telocentric

Acrocentric or telocentric





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## **Metacentric**

*Centromere* is located approximately at the centre of the chromosome.

Their arms are approximately equal and they appear U or V shape during movement.

## **Sub- metacentric**

When the centromere lies a little distance away from the middle of the chromosomes may be called sub-metacentric.



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## **Sub- telocentric**

Centromere is located at sub-terminal position of the chromosome.

One arm is much longer than the other.

They appear J or L-shaped during movement.

## **Acrocentric or telocentric**

Centromere is located at the end (terminal) of the chromosome.

This is the most common karyotypes among fish species, and also it is found in a variety of distantly related fish taxa.



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Each chromosome contain two identical parallel structures or *chromatids*

*Centromere* or *kinetochore* divides the chromosomes in to two parts.

The position of centromere varies from chromosome to chromosome

The chromosomal ends are known as *telomeres*



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# Chromosome classification by centromeric position

Type	Centromeric position	Symbol	Centromeric index (range)
Metacentric	Nearly median	m	46-49
Submetacentric	Submedian	sm	26-49
Acrocentric	Subterminal	st	15-30
Telocentric	Terminal	t	<15



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The portions of the chromosomes on their side of the centromere are called as the *chromosome arms*

The total number of chromosome arms in a karyotype is called as *fundamental arm number (FN)*.



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# Centromeric index

The length of the shorter of the two chromosome arms multiplied by 100 and divided by the length of the whole chromosome and expressed as percentage.



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# Arm ratio

The length of the longer arm of the chromosome divided by the length of the shorter arm. It is always greater than 1.

It is an alternative method to centromeric index for describing the position of the centromere and the relative lengths of two arms.



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# Relative length

The length of the whole chromosome multiplied by 100 and divided by the total length of all the chromosomes in the haploid set including one being measured and expressed as a percentage.





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# Karyotypes

The complete set of chromosomes arranged according to their size

Karyotype of different species differ in size, shape, and number of chromosomes.

Within a species, the males and females may have minor dissimilarity in the karyotypes.

Pair of chromosomes which are very much similar are called as *autosomes*.



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# Fish chromosomes

The work on fish chromosomes began with the studies of Retziat (1890) and Katschenko (1890).

- A revolution in the fish chromosome cytology took place when pre-treatment with colchicine coupled with squashing (Roberts, 1964) and the flame–drying method (Denton and Howell, 1969) were made.



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The first investigations of chromosomes were made by means of *histological sections* in the late nineteenth century

Then, *squash techniques* were performed which permitted a more accurate count of chromosome number.

*the air-drying technique* combined with *colchicine and hypotonic* treatment greatly increased our knowledge not only of chromosome number, but also of chromosome morphology.



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<b>Species</b>	<b>chromosome numbers</b>
Catla, Rohu, Mrigal, Magur	50
Grass carp, Silver carp	48
Common carp, gold fish	104
<i>H.fossilis</i>	56
<i>O.mossambicus, O.niloticus</i>	44
<i>C. Striatus</i>	40
<i>C.gachua</i>	78
<i>C.punctatus</i>	32
<i>M. rosenbergii</i>	118
<i>Penaeus monodon</i>	88



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# Karyotyping

Pairing of the chromosomes according to their size and morphology, then became feasible.

Recent development of new differential staining techniques has allowed the characteristic banding of chromosomes that have led to a better understanding of the fine characterization of individual chromosomes.



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# The diploid (2n) chromosome number of fishes

Catla, rohu, mrigal	-50
grass carp and silver carp	-48
common carp, gold fish	-104
Tiger barb ( <i>Puntius tetrazona</i> )	-48
<i>Tor khudree</i>	-100
<i>Clarias batrachus</i>	-50
<i>Heteropneustes fossilis</i>	- 56