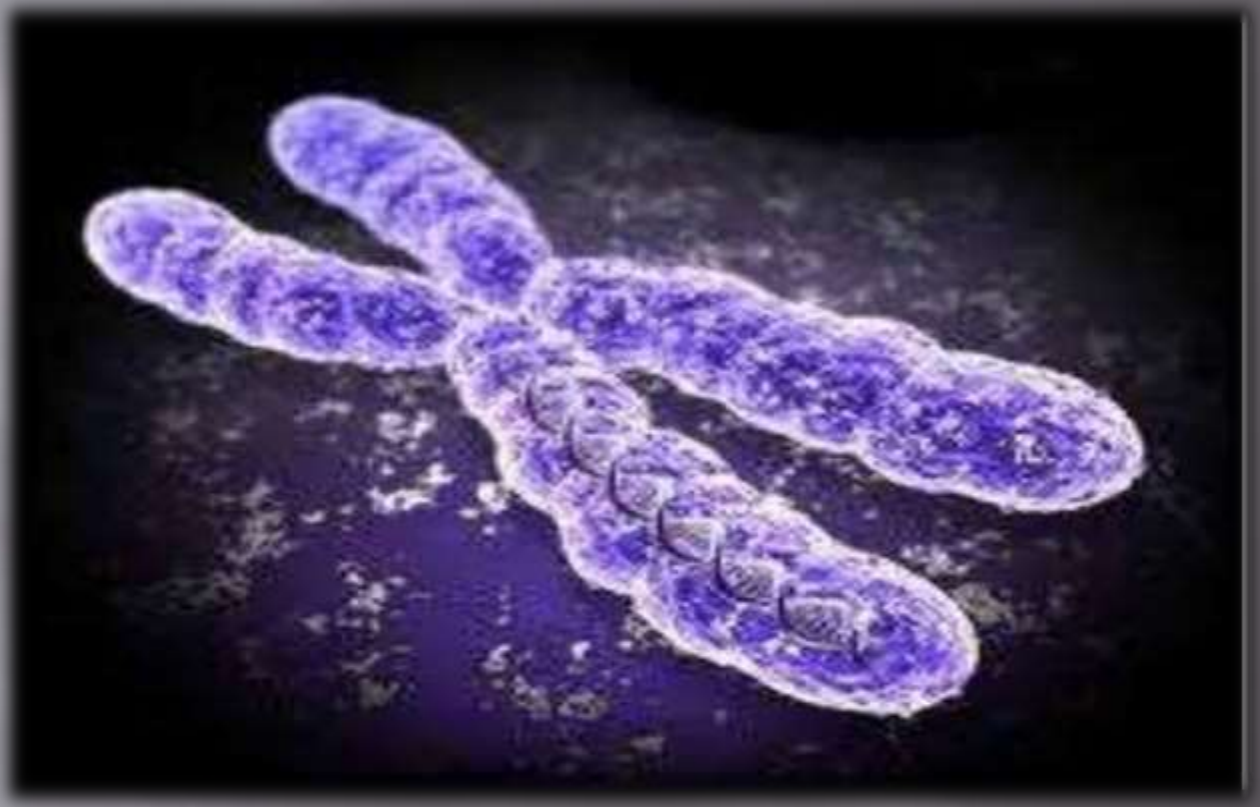

STRUCTURE AND FUNCTION OF CHROMOSOMES

Chromosome

Chromosomes are organized structure of DNA and proteins found in cells. Each chromosome is made up of DNA tightly coiled many times around proteins called histones that support its structure.

They **are thread-like structures located inside the nucleus of animal and plant cells**.

Chromosomes are passed on from parents to offspring.

Chromosome

The term **chromosome** is derived from a Greek word '**chroma**' which means 'color' and '**soma**' which means 'body'.

The **chromosomes** are named so because they are cellular structures or cellular bodies and **they are strongly stained by some dyes** used in research.

Morphological structure of chromosome

Chromatid is the structural and functional unit of chromosomes. At Metaphase, each chromosome appears to the longitudinally divided into two identical parts, each of which is known a 'Chromatid'.

The attached, duplicated chromosomes are commonly called sister chromatids.

The two ends of a chromosomes are known **as'Telomeres'.**

Morphological structure of chromosome

Kinetochores are the attachment point for spindle fibers which helps to pull apart the sister chromatids as the mitosis process proceeds to anaphase stage.

Secondary constriction It is present in short arm near one end, or in many chromosomes they are located in the long arm nearer to the centromere.

Morphological structure of chromosome

Chromosomes during Prophase I of meiosis, particularly during pachytene stage, show small head like structures called **'Chromomeres'.**

Centromere is the region where the two sister chromatids of a chromosome appeared to held together.

Morphological structure of chromosome

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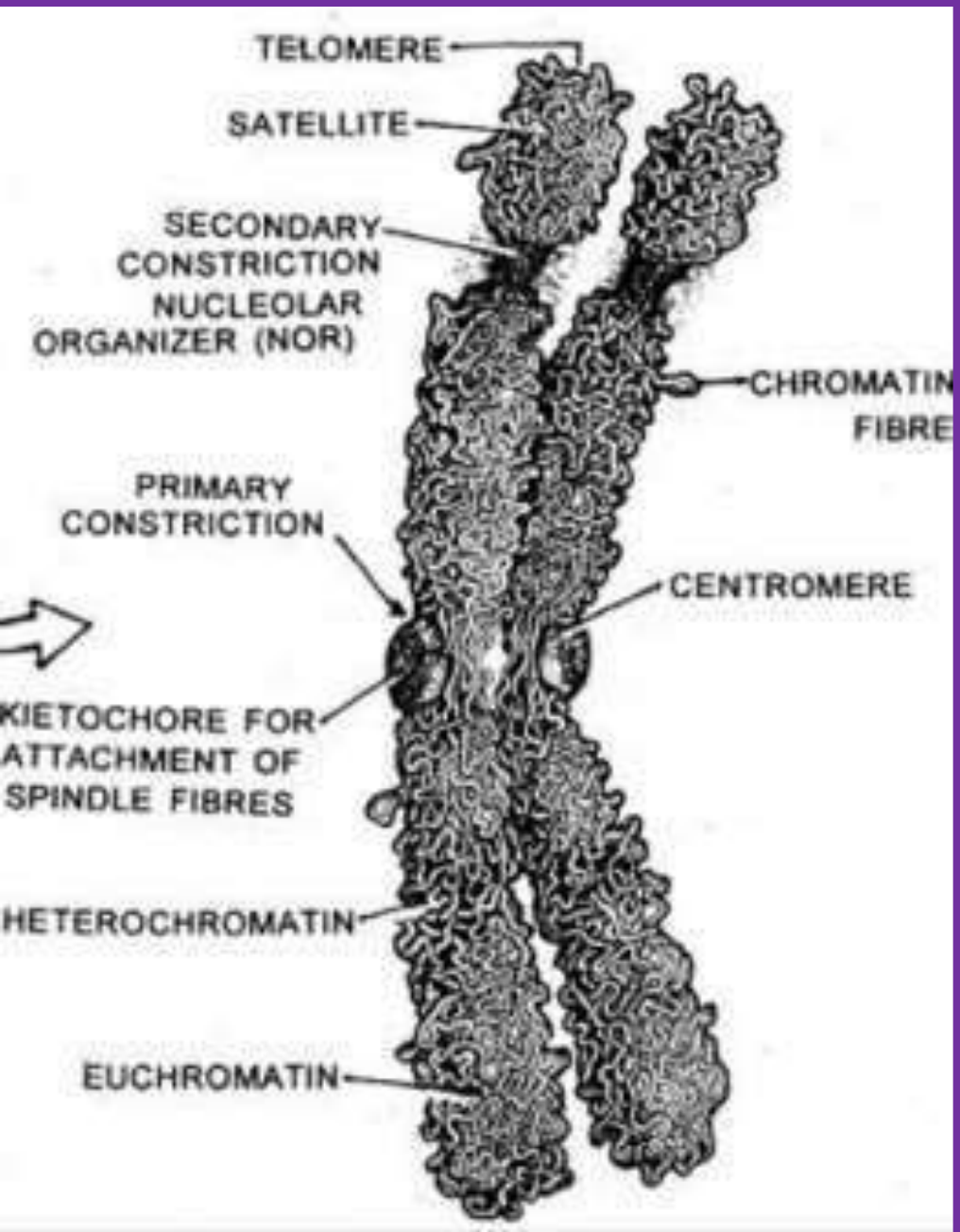


Morphological structure of chromosome

Centromere

Centromeres are those condensed regions within the chromosome that are responsible for the accurate segregation of the replicated chromosome during mitosis and meiosis.

When chromosomes are stained they typically show a dark-stained region that is the **centromere.**

During the cell divisions at anaphase the microtubules of the spindle are get attached with the chromosomal **centromeres** and move them towards the opposite poles of cell.

Types of chromosomes

There are four types of chromosomes based upon the position of the **centromere**

1) **Metacentric**: In this type of chromosome the centromere occurs in the centre. Chromosomes have to equal sized arms. appear as **v** shaped structures at metaphase. amphibian have Metacentric Chromosome. Chr: and 3 of human are Metacentric

.

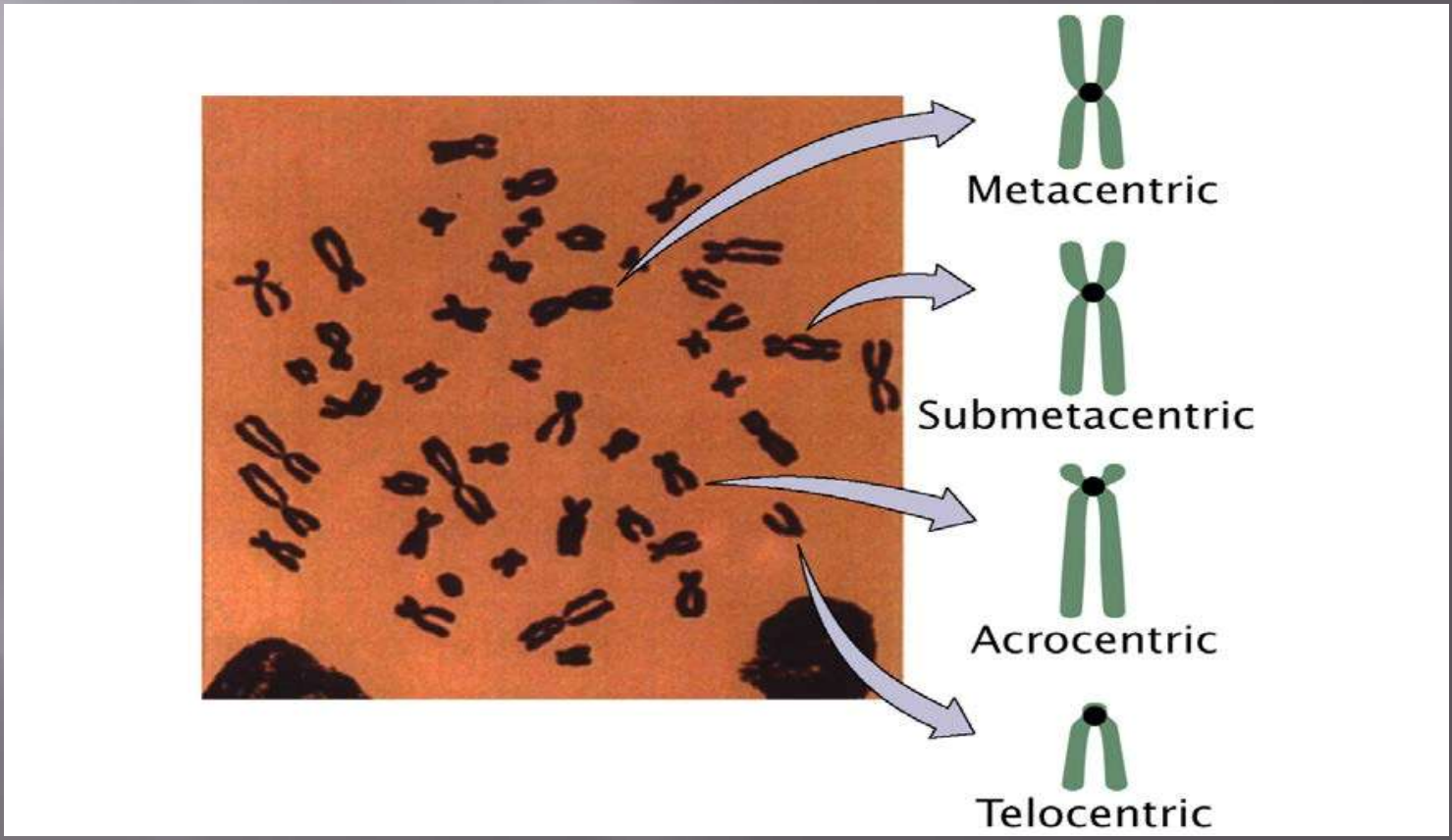
Types of chromosomes

2) **Submetacentric**: In this type of chromosome the centromere is a little away from the centre .Chromosomes will have unequal arms. Appear as **L** shaped structures at metaphase. Majority of human are Submetacentric.

Types of chromosomes

3) Acrocentric: In this type of chromosome the centromere is located closer to one end of chromatid therefore the chromatids on opposite side are very long. Appear as **J** shaped structures at metaphase. Acrididae group (grasshopper) shows this type of chromosomes. Chr: 13, 15, 21and 22 of human are **acrocentric.**

4) Telocentric: In this type of chromosome the centromere is placed at one end of the chromatid and hence only one arm. Appear as **I** shaped structures at metaphase. Such telocentric chromosomes are not seen in human cells.

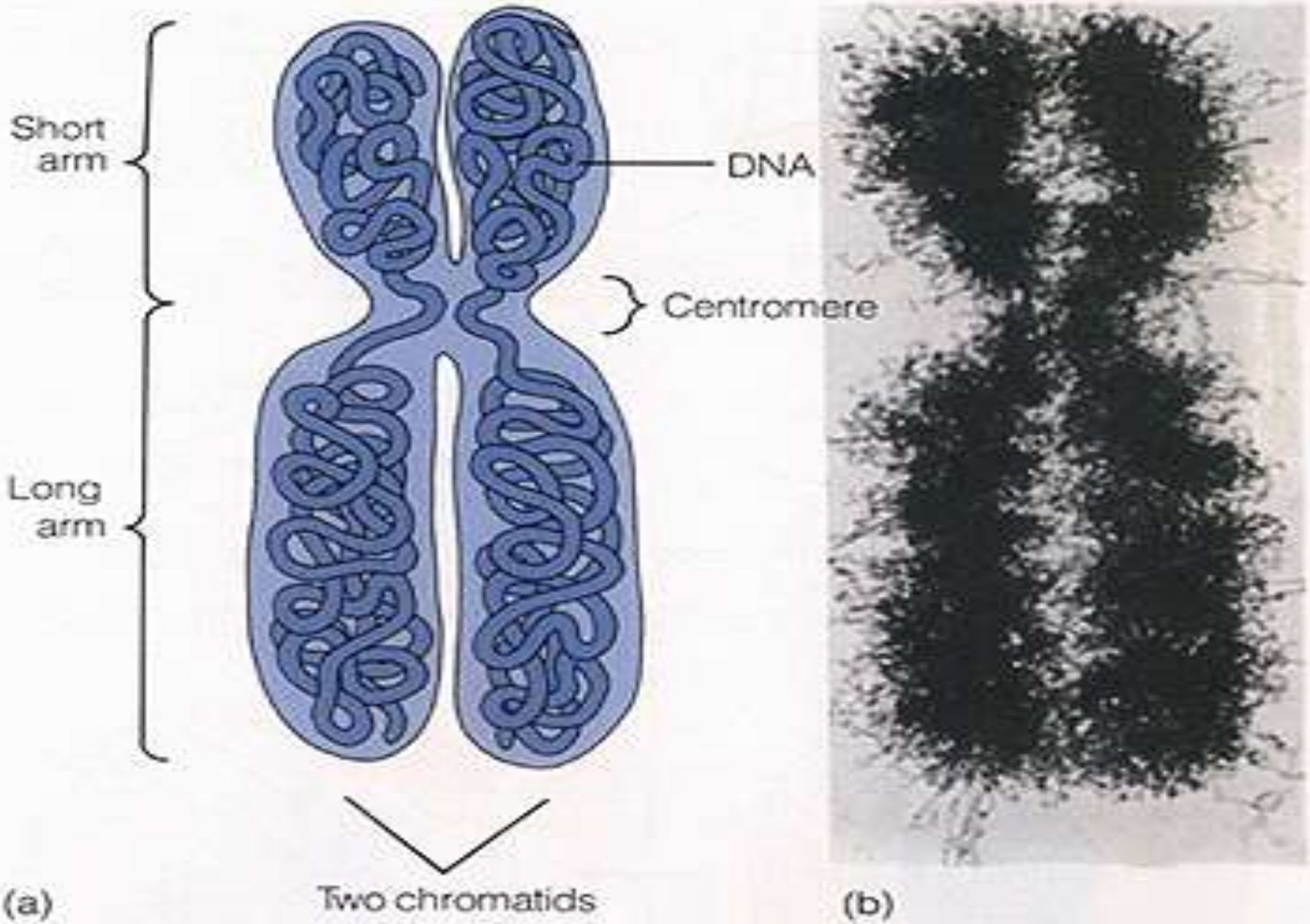


Arm of the chromosome

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.


Short arm
Long arm
DNA
Centromere
Two chromatids
(a)
(b)

Telomere

Telomeres are "caps" at the end of the chromosome formed by **repetitive DNA sequences that:**

Prevent fusions of chromosomes with each others .

Stabilize chromosomes structures

- Sometimes the chromosomes **bear round, elongated or knob like appendages** known as **satellites.**
- The satellite remains connected with the rest of the chromosomes by a thin chromatin filament.

Size

The size of chromosome is normally measured at mitotic metaphase and may be as short as 0.25µm in fungi and birds to as long as 30 µm in some plants such as Trillium.

However, most mitotic chromosome falls in the range of 3µm in Drosophila to 5µm in man and 8-12µm in maize.

The monocots contain large sized chromosomes as compared to dicots. Organisms with less number of chromosomes contain comparatively large sized chromosomes. The chromosomes in set vary in size.

Chromosome number:

- Chromosomes vary both in number and structure among organisms and the number of chromosomes is characteristic of every species. 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 acted as messengers of heredity. genes.

Chromosome number:

- There are normally two copies of each chromosome present in every somatic cell. The number of unique chromosomes (N) in such a cell is known as its **haploid number,** and the total number of chromosomes (2N) is its **diploid number.** The suffix ‘ploid’ refers to chromosome ‘sets’

Chromosome number:

- The haploid set of the chromosome is also known as **the genome.** Structurally, eukaryotes possess large linear chromosomes unlike prokaryotes which have circular chromosomes. In Eukaryotes other than the nucleus chromosomes are present in mitochondria and chloroplast too.

Chromosome number:

The number of chromosomes in each somatic cell is same for all members of a given species. The organism with lowest number of chromosome is the nematode, *Ascaris megalocephalusunivalens* which has only two chromosomes in the somatic cells (2n=2).

Autosomes and sex chromosomes:

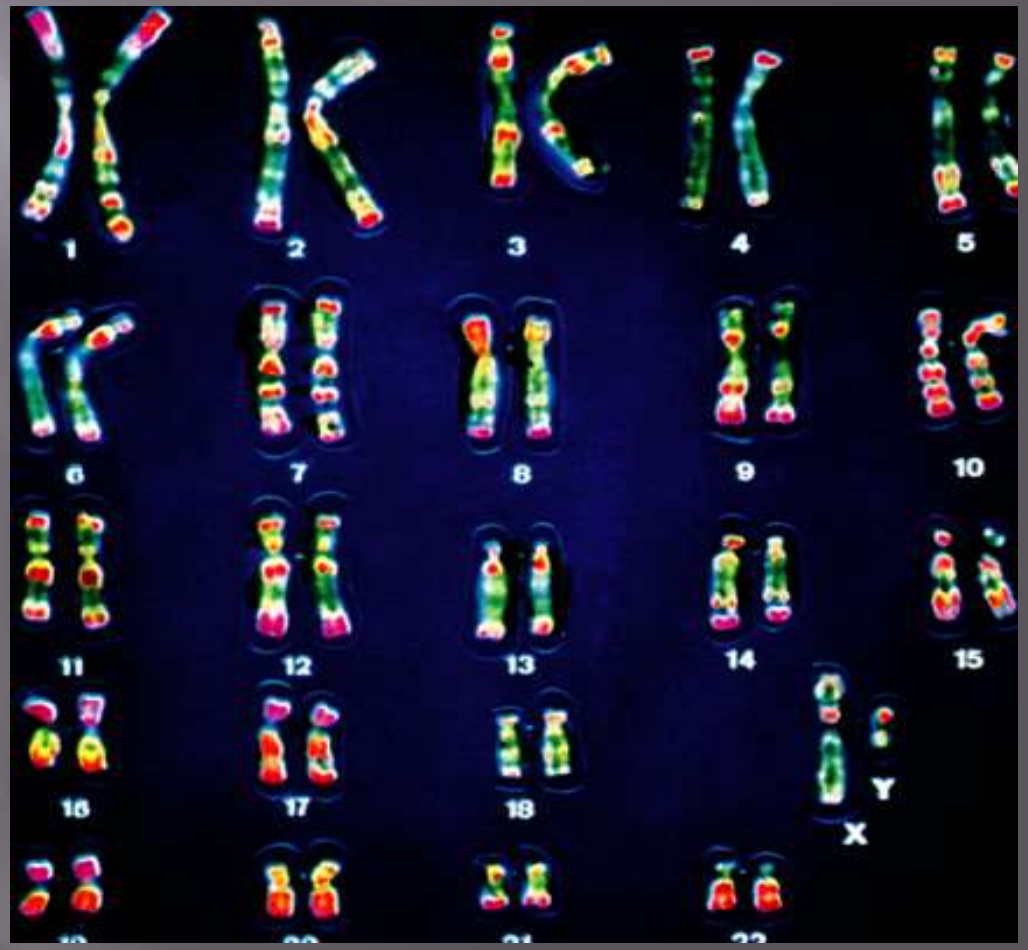
In a diploid cell, there are two of each kind of chromosome (termed homologus chromosomes) except the sex chromosomes. In humans one of the sex has two of the same kind of sex chromosomes and the other has one of each kind. In humans there are 23 pairs of **homologous chromosomes** (2n=46).

Autosomes and sex chromosomes:

The human female has 44 non sex chromosomes, termed **autosomes** and one pair of **homomorphic sex chromosomes** given the designation XX. The human male has **44 autosomes** and one pair of heteromorphic sex chromosomes, one X and one Y chromosome.

Chromosome Arrangement

- In a cell, chromosomes are arranged in pairs.
- A photograph or chart of chromosomes arranged in pairs is called a **karyotype**.



CHEMICAL STRUCTURE

Chemically, the eukaryotic chromosomes are composed of deoxyribonucleic acid (DNA),ribonucleic acid (RNA), histone and non-histone proteins and certain metallic ions.

histone proteins have basic properties and have significant role in controlling or regulating the functions of chromosomal DNA.

non histone proteins are mostly acidic and have been considered more important than histones as regulatory molecules.

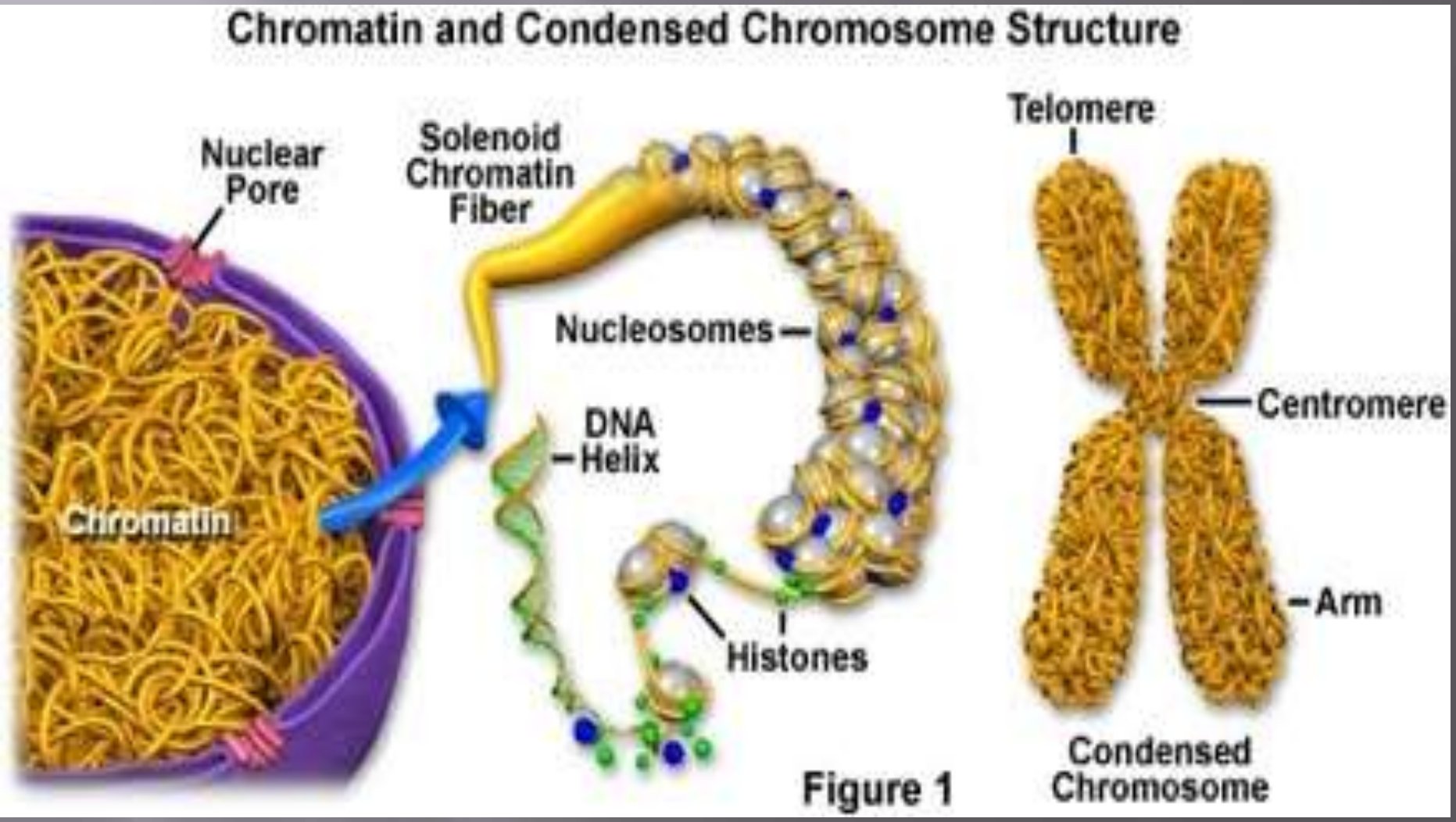
CHEMICAL STRUCTURE

Some non-histone proteins also have enzymatic activities.

The most important enzymatic proteins of chromosomes are phosphoproteins, DNA polymerase, RNA-polymerase, DPN-pyropbosphorylase, and nucleoside triphosphatase.

- **metal ions** as Ca+ and Mg+ are supposed to maintain the oragnization of chromosomes intact.

- In eukaryotes to fit the entire length of DNA in the nucleus it **undergoes condensation** and the degree to which DNA is condensed is expressed as its **packing ratio** which is the **length of DNA divided** by the **length into which it is packaged into chromatin** along with proteins.


Chromatin and Condensed Chromosome Structure
Nuclear Pore
Solenoid Chromatin Fiber
Telomere
Nucleosomes
Centromere
DNA Helix
Chromatin
Histones
Arm
Condensed Chromosome
Figure 1

❖ Chromosomes in prokaryotes and eukaryotes

prokaryotic chromosome	Eukaryotic chromosome
The typical chromosome formation is absent	The genetic material is organised as distinct structural entities
Only single chromosome per cell	Always two to many chromosomes per cell
Is comparatively shorter	Larger than that of prokaryotes
Contains a covalently closed circular DNA	Contains linear DNA with 2 ends
Chromosomes codes for few proteins	Codes for a large number of proteins
Free in the centre of the cell and not covered by the nucleus	Are always enclosed in the nucleus
Stay in direct contact with the cytoplasm	Separated from the cytoplasm by the nuclear membrane
Sometimes associated with the mesosomes of the plasma membrane	Cannot be associated with the plasma membrane
DNA is not associated with histone proteins	DNA is associated with histone proteins

Nucleosomes are not formed	Association of DNA with histone produces nucleosomes
Contains a single origin of replication	Contains many origins of replications
The negative charge is nullified by Mg ions	The negative charge is nullified by histone protein
Centromere, kinetochore, chromosomal arms are not formed	Centromere, kinetochore, chromosomal arms are formed

FUNCTION OF CHROMOSOMES

- I- **The chromosomes are capable of self-duplication**. During duplication process the DNA strands unwind. As unwinding starts, each template of DNA forms its complementary strand in double-helix nature. The conversion of the old DNA molecule into two new molecules, helps in duplicating the chromosomes.

Function of chromosomes (continued)…

- ✓ II- They help in expression of different characters in an organism by synthesizing proteins in cells. A definite protein is accumulated to produce a definite character.

Questions