Ratna Sagar

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Education, Our Mission

As per the latest ICSE syllabus 2022

Ratna Sagar
Education, Our Mission!

Revised and Updated

LIVING SCIENCE BIOLOGY

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EDUCATION, OUR MISSION

ICSE
Living Science
Biology

Class 10

Chapter 2 Human Chromosomes

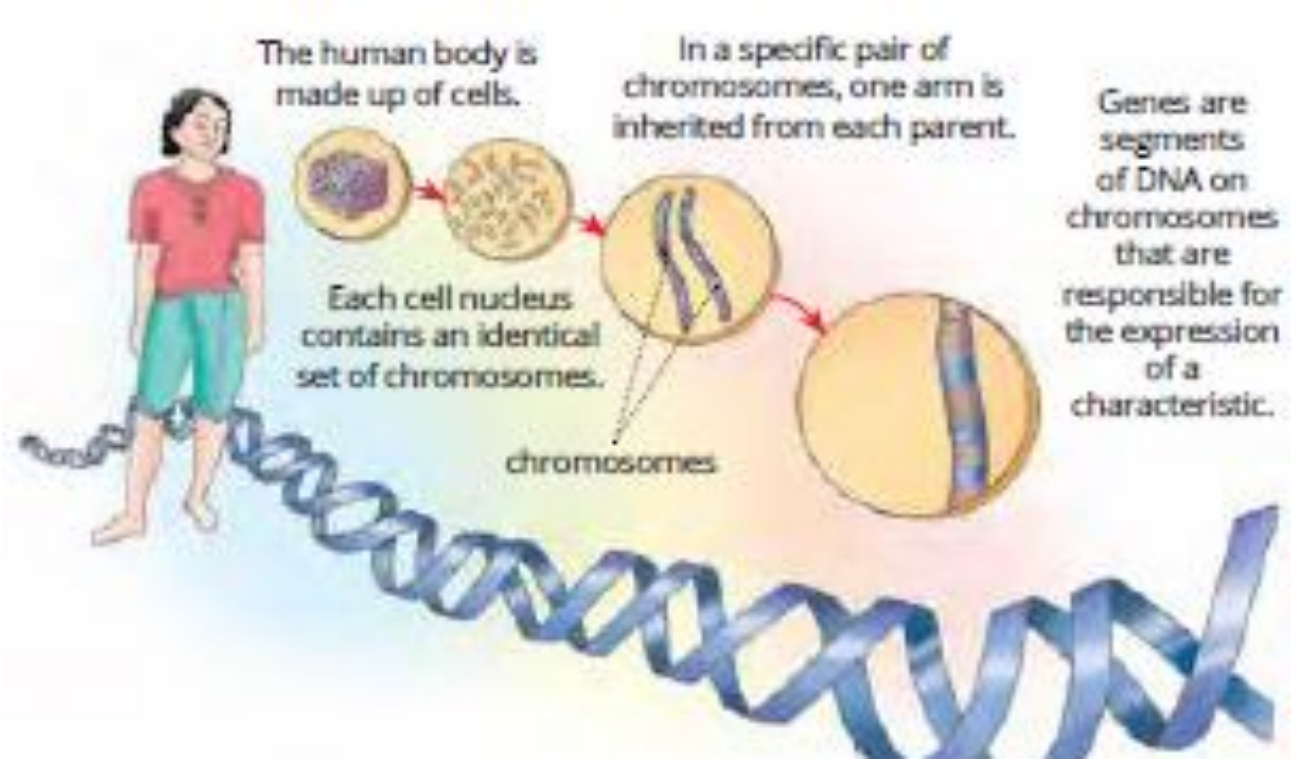
LEARNING OBJECTIVES

Chromosomes – The Carriers of Heredity

- Number of chromosomes in an individual
- Structure of chromosomes
- Chromatin fibre
- Structure of DNA molecule
- How are new DNA strands formed?
- Types of chromosomes
- Sex chromosomes and autosomes
- Functions of chromosomes

Chromosomes – the Carriers of Heredity

Chromosome is a strand of DNA molecule associated with proteins found in the nucleus of a cell. The chromosomes contain genes,thus, they are carriers of heredity. The genes are composed of DNA and proteins. DNA (Deoxyribonucleic acid) functions as the genetic material and forms the chemical basis of heredity. **A gene** is a segment of DNA that **codes for the synthesis of a specific protein** which controls the expression of a particular characteristic in an individual. A gene is the basic unit of heredity found on a chromosome.



The gene is the basic unit of heredity found on chromosomes.

Number of chromosomes in an individual

The number of chromosomes is constant for all individuals in a species and each one of them has a fixed and equal number of chromosomes.

❖ A human body cell has 46 chromosomes. These 46 chromosomes are arranged into 23 pairs of homologous chromosomes.

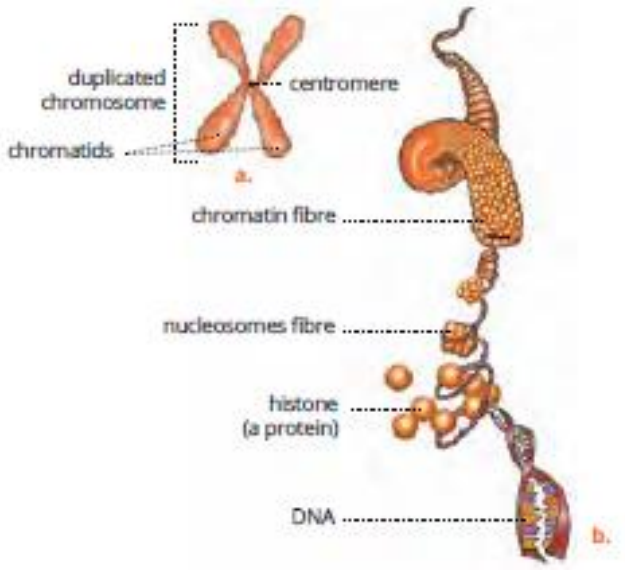
❖ We inherit half our chromosomes from our mother and half from our father. Thus, we inherit 23 unpaired chromosomes from each parent.

Structure of chromosomes

❖ A chromosome is a diffuse, thread-like structure within nucleus of a cell.

❖ At the time of cell division they condense and become visible under the microscope.

❖ A chromosome at the start of cell division consists of **two chromatids** joined at some point along the length. At the point of joining a constriction is formed called **centromere**



a. A highly magnified view of the structure of a chromosome **b.** The chromatin fibre and DNA

The **spindle fibres** are also attached to the centromere at the time of cell division. These spindle fibres contract and help in separation of two sister chromatids towards the opposite poles in a dividing cell. On completion of cell division (mitosis followed by meiosis), the chromatids become chromosomes. These chromatids decondense and form the very thin thread-like chromatin fibres. Each chromatin fibre is made up of DNA and histones with small amount of RNA.

Chromatin fibre

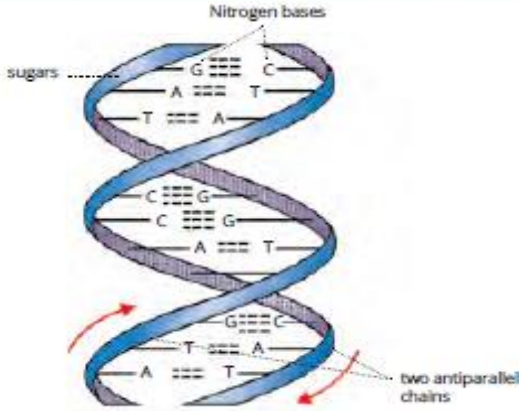
Chromatin is the complex of DNA and proteins found in nucleus. The chromatin material consists largely of two strands of deoxyribonucleic acid (DNA) and proteins (mainly histones).

DNA–histone (protein) complex is called **chromatin**. It is shown that the DNA helix combines with groups of eight histone molecules to form a structure known as nucleosome. In a human cell, there are about two million nucleosomes among 46 chromosomes.

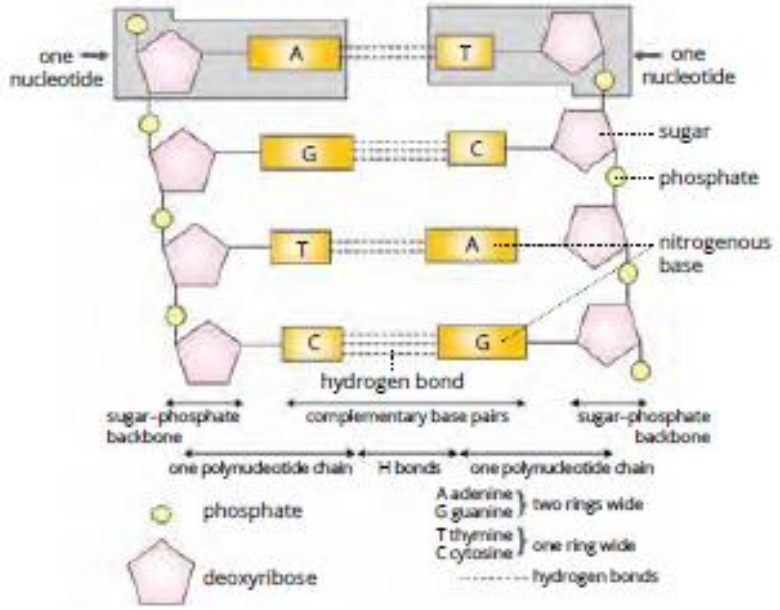
Structure of DNA molecule

DNA is a large molecule (macromolecule) consisting of two polynucleotide strands, complimentary in nature, wound around each other in a double helix.

The strands run in opposite directions, i.e. they are antiparallel. Each single DNA strand is composed of repeating nucleotides. **Nucleotides** are made of three components, a phosphate, a sugar (pentose) arranged lengthwise and a nitrogenous base attached to the sugar inwards.



Diagrammatic structure of DNA

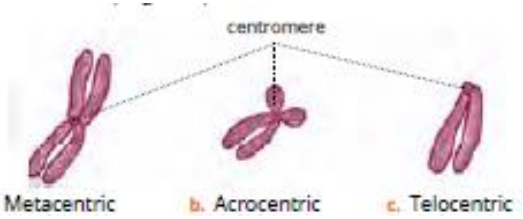


The sugar–phosphate backbone has nitrogenous bases arranged at right angles giving a ladder-like arrangement. There are two purine bases and two pyrimidine bases. The bases are **guanine** (G), **thymine** (T), **adenine** (A) and **cytosine** (C). The guanine is complementary to cytosine and thymine to adenine

Diagrammatic structure of straightened chains

Types of chromosomes

The chromosomes may differ in the position of the centromere. Centromere is the point on the chromosome marked by a constriction where sister chromatids are attached during cell division. If the centromere is near the middle, the chromosome is **metacentric**.



Structural forms of chromosomes

Sex chromosomes and autosomes

In human beings, out of 23 pairs of chromosomes, a specific pair, i.e. the 23rd pair of chromosome, determines the sex of the individual. These are called **sex chromosomes** or **allosomes**. All other 22 pairs of chromosomes are termed as **autosomal chromosomes or autosomes**. The autosomes carry genes which control somatic traits and play no role in sex determination.

In human males, one sex chromosome is smaller than the other. The larger one is known as **X chromosome** and the smaller one as **Y chromosome**. Thus, the condition in the male may be briefly expressed as **XY** and in female as **XX**.The sex chromosomes of human females are described as **homomorphic** and that of human males are **heteromorphic**

Functions of chromosomes

❖ Chromosomes are hereditary vehicles that contain genes. All the hereditary information is located on the genes.

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

❖ By directing the synthesis of enzymatic proteins, chromosomes control cell metabolism.

❖ Chromosomes guide development and control cell differentiation.

❖ Sex chromosomes (XX and XY or XX and XO chromosomes) determine the sex of individuals.

What is a gene?

❖ A gene is a basic unit of heredity or inheritance of a character passed from parents to offsprings via chromosomes.

❖ A gene is a segment of DNA on a chromosome that encode a particular protein which is expressed in the form of a particular characteristic of the body.

❖ Genes are located on specific position (locus) on the chromosome.

❖ Genes are transmitted from parents to offsprings through the gametes.

SUMMARY...

❖ A chromosome is a thread-like strand of DNA molecule associated with proteins found in nucleus. Chromosomes carry genes and are referred as hereditary vehicles.

❖ Genes are located on chromosomes.

❖ The number of chromosomes is constant for a species. Human beings have 46 chromosomes.

❖ Depending upon the location of centromere, chromosomes can be metacentric, acrocentric and telocentric.

❖ DNA–histone complex in chromosomes is called chromatin.

❖ DNA molecule is a double-helical structure. Each single DNA strand is composed of repeating nucleotides.

❖ Formation of new DNA molecule is called DNA replication.

❖ There are two kinds of chromosomes in human beings – sex chromosomes (chromosomes that decide the sex of an individual) and the autosomes (rest of the chromosomes, somatic chromosomes are same in males and females).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