11. Chromosomal Basis of Inheritance

Mechanism of heredity at cellular level

The heredity material in the form of DNA is present inside the nucleus of a cell. The segment of DNA, which gives information for synthesis of protein inside a cell, is called the geneof that protein. These proteins control all the characteristics of an organism.

We have already studied that in both plants and animals, growth or height of the body is controlled by hormones.

Formation of short and tall plants

Thus, the height of a plant depends upon the quantity and type of a specific plant hormone. This quantity and type of hormone depends upon enzymes present to trigger the rate of production of hormones.

It is ultimately a gene that controls the amount of enzymes. If more enzymes are produced, then the plant grows taller.

If any variation or alternation in a gene occurs, then the enzyme produced is less efficient. Hence, the plant is short in height.

Chromosomal theory of inheritance

- It was proposed by Sutton and Boveri.
- Mendel's law was extended as chromosomal theory of inheritance after it was known that genes are located on the chromosomes.

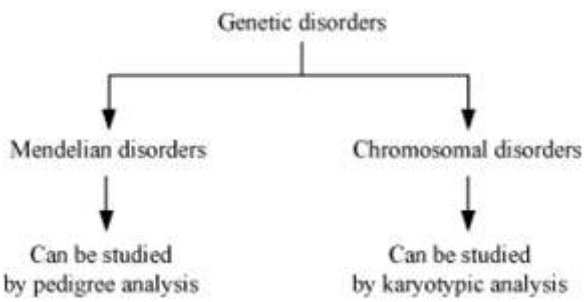
- **Morgan** worked on *Drosophila* and found that genes are linked.
- **Linkage:** It is the co-existence of two or more genes on the same chromosome. If the genes lie together, they are inherited together and are said to be linked genes.
- **Recombination:** It is the mixing of the maternal and paternal characters in a sexually reproducing organism so as to bring genetic variation in the offspring.

- **Sex determination**

- **Female heterogamy:** Presence of two kinds of sex chromosomes in the female; only one kind is present in the male; for example, birds (the female has ZW sex chromosome while the male has ZZ sex chromosome).
- **Male heterogamy:** Presence of two kinds of sex chromosomes in the male; only one kind is present in the female; for example, humans, Drosophila (the female has XX sex chromosome while the male has XY sex chromosome).
- **In humans**, the genetic make up of the sperm determines the sex of the baby.

- **Sex determination in honey bees**
  - Show a special mechanism of sex determination called the haplo-diploidy.
  - Unfertilized eggs develop into males.
  - Fertilized eggs develop into females.
- **Sex-Linked Inheritance**
  - The appearance of a trait because of the presence of an allele either on X chromosome or Y chromosome is called Sex-linked Inheritance.
- **Diseases observed in X-linked Inheritance**
  - Haemophilia
  - Colour-Blindness
- **Criss-Cross Inheritance**
  - The transfer of a gene from mother to son or father to daughter is called as criss-cross inheritance. For e.g. in X-chromosome linkage

Genetic Disorders



- **Examples of Mendelian disorder:**

1. **Haemophilia – Sex-linked recessive disorder**
2. **Sickle-cell anaemia** – Autosome-linked recessive disorder
3. **Phenylketonuria –** Inborn error of metabolism; autosomal-recessive disorder

- **Examples of chromosomal disorder:**

1. **Aneuploidy is the presence of abnormal number of chromosomes in an individual.**

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    - **Down's syndrome –** Characterised by trisomy of the 21st chromosome; chromosomes increase from 46 to 47
    - **Klinefelter's syndrome** – Characterised by the presence of an additional X-chromosome; Karyotype – 47, XXY
    - **Turner's syndrome –** Characterised by monosomy of sex chromosomes. Karyotype – 45, XO