

## Chapter-4

### ► Heredity

= Heredity is the transmission of **traits (characters)** from **parents to offspring**.

### ► Genes

= A **gene** is the **basic unit of heredity** made up of **DNA**, which determines specific characteristics.

- Located on **chromosomes**
- Control traits like height, eye color, etc.

### ► Genetics

= Genetics is the **branch of science** that studies **heredity and variation**.

## 2. Cell Division

= Cell division is the process by which a **parent cell divides** into two or more **daughter cells**.

### ► Somatic Cells vs. Gametogenic Cells

Feature	Somatic Cells	Gametogenic Cells
Also called	Body cells	Sex cells (sperm/egg)
Chromosomes	Diploid (2n)	Haploid (n)
Cell division	Mitosis	Meiosis
Role	Growth and repair	Reproduction

## 3. Types of Cell Division

### Mitosis (Equational Cell Division)

- Occurs in **somatic cells**
- Produces **two identical daughter cells**
- Each daughter cell has the **same number of chromosomes** as the parent cell ( $2n \rightarrow 2n$ )

### Main Features of Mitosis

- One division only
- No change in chromosome number
- Four phases: **Prophase, Metaphase, Anaphase, Telophase**

### Significance of Mitosis

- Growth of organisms
- Repair and regeneration of tissues
- Asexual reproduction

## Meiosis (Reduction Division)

- Occurs in **gametogenic cells**
- Produces **four haploid daughter cells** ( $2n \rightarrow n$ )
- Involves **two successive divisions**

### Two Main Stages of Meiosis:

1. **Meiosis I** – Homologous chromosomes separate
2. **Meiosis II** – Sister chromatids separate

### Main Features

- Chromosome number is halved
- Introduces **genetic variation**
- Four non-identical cells produced

### Significance of Meiosis

- Maintains chromosome number in species
- Creates genetic diversity through recombination

## 4. DNA (Deoxyribonucleic Acid)

### Structure of DNA

- Double helix (like a twisted ladder)
- Made of **nucleotides**: phosphate, sugar (deoxyribose), nitrogen base
- Bases: **Adenine (A)**, **Thymine (T)**, **Cytosine (C)**, **Guanine (G)**
  - A pairs with T, C pairs with G

### Functions of DNA

- Stores genetic information
- Directs **protein synthesis**
- Passes traits to the next generation

## 5. RNA (Ribonucleic Acid)

### Structure of RNA

- Single-stranded
- Sugar: **Ribose**
- Bases: A, **Uracil (U)**, C, G  
(No thymine)

### Functions of RNA

- Helps in **protein synthesis** (mRNA, tRNA, rRNA)
- Carries messages from DNA to ribosomes

## 6. Chromosomes

### Structure of Chromosomes

- Thread-like structures made of **DNA and proteins**
- Visible during **cell division**

### Types of Chromosomes

- **Autosomes** – Body chromosomes (in humans: 22 pairs)
- **Sex chromosomes** – Determine sex (1 pair)

### Number of Chromosomes

- **Humans:** 46 chromosomes (23 pairs)
  - 44 autosomes
  - 2 sex chromosomes (XX in females, XY in males)

## 7. Sex Determination

- Determined by **sex chromosomes**
- Male: **XY**, Female: **XX**
- Male sperm determines the sex of the baby

 **Mnemonic:** "XY means a guy"

## 8. Mendelism and Genetic Technology

### Gregor Mendel's Work

- **Father of Genetics**
- Conducted experiments on **pea plants**

### Mendel's Material:

- **Garden pea (*Pisum sativum*)**

### Why Pea Plants?

- Short life cycle
- Easily distinguishable traits
- Can self- or cross-pollinate
- Easy to grow and maintain

### Dominant and Recessive Traits

Type	Expressed When	Example
<b>Dominant</b>	At least one dominant allele present	Tall (T)
<b>Recessive</b>	Only when both alleles are recessive	Dwarf (tt)

## Genotype vs. Phenotype

Term	Meaning	Example
Genotype	Genetic makeup	TT, Tt, tt
Phenotype	Physical appearance	Tall or Dwarf

## Monohybrid Cross

- Cross between parents with **one pair of contrasting traits**  
e.g., Tall (TT) × Dwarf (tt)

## Dihybrid Cross

- Cross involving **two pairs** of contrasting traits  
e.g., Round Yellow × Wrinkled Green seeds

## Mendel's Laws

1. **Law of Dominance**  
Dominant allele masks the effect of a recessive allele.
2. **Law of Segregation**  
Alleles segregate during gamete formation and reunite during fertilization.

## 9. Introduction to Genetic Technology

### Definition

= Genetic technology involves **manipulating genes** to improve or modify organisms.

### Methods:

- DNA testing
- Genetic engineering
- Gene therapy
- Recombinant DNA techniques

### Advantages of Genetic Technology

- Cure genetic diseases
- Improve crop and animal breeds
- Solve paternity and crime investigations
- Produce insulin, vaccines, etc.

## 10. Role of DNA Testing

- Paternity testing
- Crime investigations
- Identification of genetic diseases
- Research in ancestry and evolution

## 11. Selective Breeding

### Definition:

= Breeding organisms with desirable traits to produce better offspring.

### Advantages:

- Improves yield
- Enhances resistance to diseases
- Better quality meat, milk, crops

### Disadvantages:

- Reduces genetic variation
- Risk of inherited diseases

## 12. Methods of Selective Breeding

### Inbreeding

- Mating between **closely related individuals**
  - Fixes traits
  - Can increase genetic disorders

### Line Breeding

- Inbreeding with less close relatives
- Maintains useful traits with less risk

### Self-Pollination

- Fertilization within the **same flower**
  - Maintains purity
  - No variation

### Cross-Pollination

- Fertilization between **different flowers**
  - More variation
  - Risk of unwanted traits

## 13. Cross Breeding

### Advantages

- Increases genetic variation
- Improves productivity and resistance

## **Disadvantages**

- Unpredictable traits
- May lose some desired traits

## **Examples of Cross-Bred Organisms**

- **Mule** (Donkey × Horse)
- **Triticale** (Wheat × Rye)

## **14. Artificial Insemination (AI)**

### **Definition**

Introducing **sperm** into the female's uterus without natural mating.

### **Advantages:**

- Controlled breeding
- Disease-free sperm
- High-quality offspring

### **Disadvantages:**

- Costly and technical
- Not always successful

## **15. In-Vitro Fertilization (IVF)**

- Fertilization **outside the body**, in a lab
- Egg and sperm are combined in a test tube

### **About Louise Brown**

- First baby born through IVF in **1978**, UK

### **Procedure:**

1. Eggs and sperms collected
2. Fertilization done in a lab
3. Embryo inserted into uterus

### **Advantages**

- Helps infertile couples
- Increases chances of pregnancy

### **Disadvantages**

- Expensive
- Ethical issues

- May lead to multiple births

## Interesting Facts about Heredity

- Humans share about **98.8% DNA** with chimpanzees!
- One strand of DNA is **2 meters long** when uncoiled.
- **Gregor Mendel** used **over 28,000 pea plants** in his experiments.
- There are **about 20,000–25,000 genes** in the human genome.

## Quick Revision Summary

- Heredity passes traits; genes carry information
- Mitosis (growth), Meiosis (reproduction)
- DNA stores info, RNA helps make proteins
- Chromosomes: 46 in humans, determine traits & sex
- Mendel discovered inheritance laws via pea plants
- Genetic tech helps improve organisms
- Selective breeding, AI, IVF help enhance reproduction

## Common Mistakes Students Make

- 🚫 Confusing mitosis and meiosis
- 🚫 Assuming both parents decide baby's sex (only sperm decides!)
- 🚫 Mixing genotype with phenotype
- 🚫 Forgetting function of royal jelly
- 🚫 Assuming artificial insemination and IVF are the same