

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
Dominant	At least one dominant allele present	Tall (T)
Recessive	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