Heredity

Introduction

Heredity is a fundamental concept in biology that explains how traits and characteristics are passed from parents to their offspring. During reproduction, new individuals are formed that resemble their parents but are not exactly identical. This similarity along with slight differences is the result of heredity and variation.

For example, children often have features like eye color, hair type, or height similar to their parents, but they are not exact copies.

Heredity

Heredity is the process by which traits and characteristics are transmitted from parents to their offspring through genes.

Example:

A child inherits traits such as skin color, blood group, and facial features from parents.

Variation and Its Importance

Variation refers to the differences seen among individuals of the same species. These variations may arise during reproduction and can be hereditary.

- Variations increase the chances of survival.
- Some variations provide advantages in specific environments.

Example:

Bacteria that can survive high temperatures will continue to live during a heat wave, while others may die.

Asexual vs Sexual Reproduction

Asexual reproduction: Offspring are almost identical to the parent (very little variation).

Example: Amoeba dividing into two.

Sexual reproduction: Offspring show more variation due to mixing of genes.

Example: Humans.

Inherited Traits

Inherited traits are characteristics passed from parents to offspring.

Example:

A child has two eyes, ears, and limbs like all humans but may have different eye color or height compared to parents.

Genetic Contribution from Parents

In humans, both mother and father contribute equal genetic material to the child.

Example:

A child receives one set of chromosomes from the mother and one from the father.

Gregor Johann Mendel (Father of Genetics)

Gregor Johann Mendel (1822–1884) conducted experiments on pea plants and discovered the basic laws of inheritance. Therefore, he is called the **Father of Genetics**.

He studied contrasting traits such as:

- Tall vs short plants
- Round vs wrinkled seeds
- Violet vs white flowers

Important Terms in Mendel's Experiments

(i) Factor (Gene)

Mendel used the term **factor** for what we now call genes.

Example: The gene controlling plant height.

(ii) Hybridization

The process of crossing two different organisms to produce offspring.

Example: Crossing a tall plant with a short plant.

(iii) Hybrid

The offspring produced from hybridization.

Example: Offspring of tall × short plant.

(iv) First pogany Generation (F1)

The first generation obtained from crossing two parents.

Example: Tall × dwarf plant → all tall plants (F1).

(v) Dominant and Recessive Traits

- **Dominant trait:** Expressed in offspring
- **Recessive trait:** Hidden in presence of dominant trait

Example: Tallness (T) is dominant over dwarfness (t).

(vi) Genotype

The genetic makeup of an organism.

Example: TT, Tt, tt

(vii) Phenotype

The physical appearance of an organism.

Example: Tall or short plant.

(viii) Alleles

Different forms of the same gene.

Example: T (tall) and t (short)

(ix) Homozygous and Heterozygous

- **Homozygous:** Same alleles (TT or tt)
- **Heterozygous:** Different alleles (Tt)

(x) Back Cross

Crossing F1 hybrid with one of its parents.

Example: Tt × TT

(xi) Monohybrid Cross

Cross involving one pair of contrasting traits.

Example: Tall × dwarf plant.

(xii) Dihybrid Cross

Cross involving two pairs of contrasting traits.

Example: Seed shape and seed color.

(xiii) Pure Variety

Organisms that produce the same trait generation after generation.

Example: Pure tall plants (TT).

(xiv) Test Cross

Cross between a hybrid and a recessive parent.

Example: Tt × tt

Law of Unit Character

Each character in an organism is controlled by a pair of genes, one from each parent.

Example: Height is controlled by two genes: one from mother and one from father.

Gene

A gene is a segment of DNA that provides information for a specific protein.

Example: Gene for eye color.

Mendel's Laws of Inheritance

(i) Law of Dominance

When two contrasting traits are crossed, only one (dominant) is expressed in F1 generation.

Example: Tall (T) × short (t) → All tall (Tt)

(ii) Law of Segregation

Alleles separate during gamete formation, so each gamete carries only one allele.

Example: Tt produces gametes T and t separately.

(iii) Law of Independent Assortment

Different traits are inherited independently of each other.

Example: Seed colour inheritance does not affect seed shape inheritance.

Sex Determination

Sex determination varies among species.

In humans:

- XX = Female
- XY = Male

The father determines the sex of the child:

- X chromosome → Girl
- Y chromosome → Boy

Example:

- If sperm carries X → girl
- If sperm carries Y → boy