Heredity:

- ❑ Heredity is the process of passing traits (characteristics) from parents to offspring through genes.
- ❑ Every living organism inherits traits from its parents.
- ❑ These traits may include physical features (height, eye color, shape of nose), physiological traits (blood group, ability to digest food), and even behavioral tendencies.

Heredity ensures that:

- ❖ Basic body design is preserved – e.g., all humans have two eyes, two hands, one nose.
- ❖ Small differences (variations) exist – e.g., one person is tall, another is short, eye color may differ.

Gregor Johann Mendel: Father of Genetics (1822–1884). Experimented on pea plants.

Why Pea Plants?

- ❑ Easily available.
- ❑ Short life cycle.
- ❑ Produced many seeds.
- ❑ Clear contrasting traits (e.g., tall/short, round/wrinkled).
- ❑ Could be both self-pollinated & cross-pollinated.

Mendel Concept: Monohybrid (Single Trait)

(Diagram)

First Experiment:

- ❑ Parents (P generation): Tall (TT) × Short (tt).
- ❑ F1 Generation (First Filial): All plants were Tall (Tt).
- ✓ Only one trait appeared → Tallness.
- ✓ This showed that tall trait is Dominant.
- ✓ Short trait was hidden → Recessive.

Second Experiment:

- ❑ F2 Generation (Second Filial):
- ✓ Combination: TT, Tt, Tt, tt.
- ✓ Ratio: 3 Tall: 1 Short.
- ❑ This proved that the short trait, though hidden in F1, was still inherited and reappeared in F2.

Terms:

1. Trait:

- ❑ A characteristic of an organism.
- ❑ Can be physical (height, flower color, seed shape) or physiological (blood group, enzyme activity).

2. Alleles

- Different forms of a gene for the same trait. Example: T (tall) and t (short) are alleles of height gene.

3. Gene:

- A unit of inheritance; segment of DNA that codes for a protein.
- Controls expression of traits. Example: Gene for height.

4. Dominant Trait:

- Trait that expresses itself even if only one allele is present.
- Represented by capital letter. Example: Tallness (T).

5. Recessive Trait:

- Trait that is hidden by dominant allele and expresses only when both alleles are recessive.
- Represented by small letter. Example: Shortness (t).

6. Homozygous:

- When both alleles are same for a trait. Example: TT (homozygous tall), tt (homozygous short).

7. Heterozygous:

- When two alleles are different for a trait. Example: Tt (heterozygous tall).

8. Genotype:

- The genetic makeup of an organism. Example: TT, Tt, tt.

9. Phenotype:

- The observable character/appearance. Example: Tall or Short plant.

Dihybrid Cross:

A dihybrid cross is a cross between two individuals considering two different traits at the same time.

Mendel used seed shape (round/wrinkled) and seed color (yellow/green).

Diagram….

Parents (P Generation): Round Yellow (RRYY) × Wrinkled Green (rryy)

F1 Generation

- All offspring were Round Yellow (RrYy).
- Round (R) is dominant over Wrinkled (r).
- Yellow (Y) is dominant over Green (y).

F2 Generation (Selfing of F1: RrYy × RrYy)

- Four types of gametes form: RY, Ry, rY, ry.
- On crossing, combinations appear.

Ratio = 9:3:3:1

9 Round Yellow

3 Round Green

3 Wrinkled Yellow

1 Wrinkled Green

Mendel's law of inheritance:

1. Law of Dominance

- One trait dominates over the other in F1 generation.
- Dominant = expressed; Recessive = hidden.
- Example: Tall (T) dominates Short (t).

2. Law of Segregation

- A pair of alleles separates during gamete formation.
- Each gamete receives only one allele.
- Alleles combine again at fertilization.

3. Law of Independent Assortment

- Traits are inherited independently.
- Crossing two traits produces new combinations.

How do traits gets expressed?

Traits are expressed through the functioning of DNA in our cells. DNA carries the information for making proteins, and a specific segment of DNA that codes for a protein is called a gene. These proteins act as enzymes or hormones, which control different characteristics of an organism. For example, in pea plants, tallness depends on the production of a growth hormone. If the gene produces an efficient enzyme, more hormone is formed and the plant grows tall. If the gene is altered and produces a less efficient enzyme, less hormone is formed and the plant remains short. Thus, genes control traits by controlling the formation of proteins.

Sex Determination:

In humans, sex determination is genetically controlled by the sex chromosomes. Humans have 23 pairs of chromosomes, of which 22 pairs are autosomes and one pair is sex chromosomes. Females have two X chromosomes (XX) while males have one X and one Y chromosome (XY). During reproduction, the mother always contributes an X chromosome to the child. The father can contribute either an X or a Y chromosome. If the father passes on an X chromosome, the child will be a girl (XX), and if he passes on a Y chromosome, the child will be a boy (XY). Thus, the sex of the child is determined by the chromosome inherited from the father, with equal chances of being male or female.

1. How do Mendel's experiments show that traits may be dominant or recessive?

Mendel crossed pure tall pea plants (TT) with pure short pea plants (tt). In the first generation (F_1), all plants were tall (Tt). The short trait did not appear, which shows that tallness is a dominant trait and shortness is a recessive trait. When the F_1 plants were self-pollinated, the short trait reappeared in the second generation (F_2) in the ratio 3 tall: 1 short. This proved that traits may be dominant or recessive.

2. How do Mendel's experiments show that traits are inherited independently?

Mendel performed a dihybrid cross using pea plants with two traits – seed shape (round/wrinkled) and seed colour (yellow/green). When pure round yellow (RRYY) plants were crossed with wrinkled green (rryy), all F_1 plants were round yellow (RrYy). In the F_2 generation, plants showed new combinations like round green and wrinkled yellow along with the parental types. The ratio obtained was **9:3:3:1**, which proved that traits like shape and colour are inherited independently of each other.

3. A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits – blood group A or O – is dominant? Why or why not?

No, this information is not enough to decide which trait is dominant. Blood group inheritance is controlled by **multiple alleles** (I^A, I^B, and i)**,** not just simple dominance. A man with blood group A may have genotype I^AI^A or I^Ai, while a woman with group O has **ii**. Their daughter with blood group O must be ii**,** which means the father's genotype was I^Ai. However, since blood groups are not determined by a single pair of contrasting traits like in Mendel's experiments, we cannot conclude dominance only from this case.

4. How is the sex of the child determined in human beings?

Humans have 23 pairs of chromosomes, of which 22 are autosomes and one pair is sex chromosomes. Females have **XX** sex chromosomes, while males have **XY**. During fertilization, the mother always contributes an X chromosome. The father contributes either X or Y. If the sperm carrying X fertilizes the egg, the child will be a girl (XX). If the sperm carrying Y fertilizes the egg, the child will be a boy (XY). Thus, the sex of the child is determined by the father's chromosome**,** with equal chances (50% boy, 50% girl).

5. A study found that children with light-coloured eyes are likely to have parents with light-coloured eyes. On this basis, can we say anything about whether the light eye colour trait is dominant or recessive? Why or why not?

No, we cannot conclude whether the light eye colour trait is dominant or recessive only on the basis of this information. This is because the study only shows that children resemble their parents, which is expected in heredity. To decide dominance or recessiveness, we need to observe how traits appear in successive generations, as Mendel did with pea plants. Without controlled crosses and the appearance of traits in F_1 and F_2 generations, it is not possible to determine whether light eye colour is dominant or recessive.