SCIENCE

(Biology)

Chapter 4: Heredity and Evolution

Heredity and Evolution

Heredity and Variation

- Living organisms have certain recognisable heritable features such as height, complexion, colour of hair and eyes, shape of nose and chin etc. These are called **characters**.
- The alternative forms of a character are called **traits**. The inheritable characteristics or traits may be morphological, anatomical, physiological or reproductive.
- The transmission or passing of genetically based characters or traits from the parents to their offspring is called **heredity**.
- The occurrence of small differences or changes among the individuals of a species is called **variation**. Hereditary variations are of great importance in the process of **evolution** of a new species.
- Asexual reproduction results in a small amount of variation as compared to sexual reproduction.
- **Genes** are the specific parts of chromosomes or deoxyribonucleic acid (DNA) segments which determine hereditary characteristics.
- Every gene has two alternative forms for a character, each of which produces different effects in an organism. These alternative forms are called **alleles**. Example: In case of pea plants, the stem height is controlled by two alleles-one for tallness and the other for dwarfness.
- Of the two alleles of a gene, one is dominant, i.e. super ruling and the other is recessive, i.e. subordinate or submissive. A **dominant** allele is the allele which hides or masks the expression of its corresponding allele, which in turn becomes **recessive**.
- A contrasting pair of alleles constitutes an **allelomorph**.
- The genetic constitution of an organism is called its **genotype**. It is the description of genes present in an organism. The genotype of a tall plant could be TT or Tt, while that of a dwarf plant is tt.
- **Phenotype** refers to the observable characteristics or the expressed shown character of an organism. Example: Tall and dwarf are the phenotypes of a plant because these traits are visible to us.
- When two parents are crossed to produce progeny, their progeny is called the **first filial generation**
- or **F_1 generation**.
- When the first generation progeny or F_1 progeny is crossed amongst themselves to produce a second generation progeny, this progeny is called the **second filial generation** or **F_2 generation**.
- A new form of plant resulting from a cross of different varieties of a plant is known as a **hybrid**.

Types of Variations

Somatic Variation

- It takes place in the body cell.

- It is neither inherited nor transmitted.
- It is also known as acquired traits.
- Examples: cutting of tails in dogs, boring of pinna etc.

Gametic Variation

- Takes place in the gametes/Reproductive cells.
- Inherited as well as transmitted.
- Also known as inherited traits.
- Example: human height, skin colour.

Rules for Inheritance of Traits

Mendel's work

Gregor Johann Mendel, known as 'Father of Genetics', was an Austrian Monk who worked on pea plants to understand the concept of heredity.

His work laid the foundation of modern genetics.

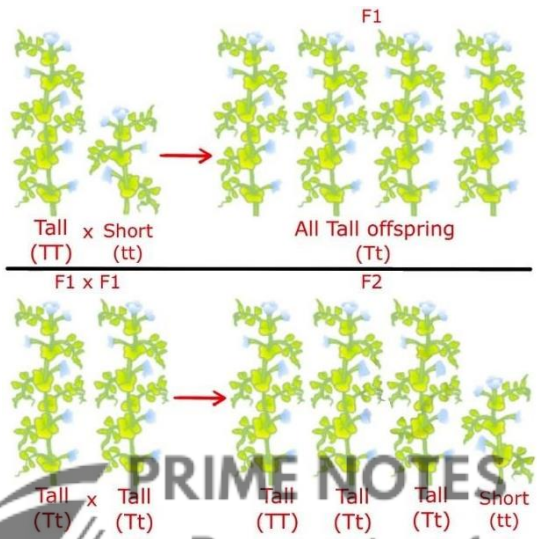
He made three basic laws of inheritance - The Law of Dominance, The Law of Segregation and The Law of Independent Assortment.

Traits	Shape of seeds	Colour of seeds	Colour of pods	Shape of pods	Plant height	Position of flowers	Flower colour
Dominant trait	Round 	Yellow 	Green 	Full 	Tall 	At leaf junction 	Purple 
Recessive trait	Wrinkled 	Green 	Yellow 	Flat, constricted 	Short 	At tips of branches 	White 

Seven pairs of contrasting traits in pea plant

Monohybrid Inheritance:

- A cross which involves only a single pair of contrasting characters is called a **monohybrid cross**. Example: A cross between a tall pea plant (TT) and a dwarf pea plant (tt).
- **Observations of Monohybrid Cross**
  - (i) All F1 progeny were tall, no medium height plant. (Half way characteristic)
  - (ii) F2 progeny ¼ were short, ¾ were tall.
  - (iii) Phenotypic ratio F2 – 3 : 1 (3 tall : 1 short)



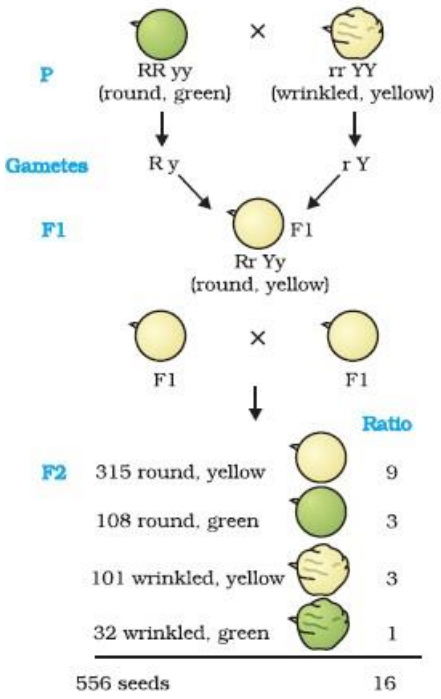
Phenotypic ratio: 3 : 1

Genotypic ratio: 1 : 2 : 1

- The results of the monohybrid cross enabled Mendel to formulate his first law of inheritance, which is called the **law of segregation**. It states that- 'The characteristics or traits of an organism are determined by internal factors, which occur in pairs. Only one of a pair of such factors can be present in a single gamete'.

Dihybrid Inheritance

- A cross which involves plants with two pairs of contrasting characters is called a **dihybrid cross**. Example: A cross of pea plants having round and yellow seeds (RRYY) and plants with wrinkled and green seeds (rryy).
- **Observations**
  (i) When RRyy was crossed with rrYY in F1 generation all were Rr Yy round and yellow seeds.
  (ii) Self pollination of F1 plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.



Phenotypic ratio: 9 : 3 : 3 : 1
Genotypic ratio: 1 : 4 : 1 : 1 : 1 :2 : 2 : 2 : 2

- The results of the dihybrid cross enabled Mendel to formulate his second law of inheritance, which is called the **law of independent assortment**. It states that- 'In the inheritance of more than one pair of traits in a cross simultaneously, the factors responsible for each pair of traits are distributed independently to the gametes'.
- **DNA** (Deoxyribonucleic acid) is a highly complex molecule with a spirally coiled, double helical structure which appears like a ladder.

How do These Traits Get Expressed?

The DNA present in the cell is responsible for making the proteins. A section of this DNA that provides information for one protein is termed the gene for that specific protein.

The proteins that are thus synthesized are essential in many of the biochemical reactions that are responsible for the expression of a trait and they are controlled by specific enzymes.

Any alterations in them will lead to a variation in that trait, and hence genes control the traits in such a way. If the traits are to be inherited independently from both the parents, then they need to be present separately.

Therefore each gene set is present as separate independent pieces that are called as chromosomes, with each cell having two sets, one each from both the parents.

When these two germ cells combine, they tend to restore the number of chromosomes and