Topic: Mendelism

B.Sc. Botany (Sub.) I

Group: B

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In 1886, Gregor Mendel published the results of a series of experiments that would lay the foundation for the formal discipline of genetics. In the ensuing years the concept of gene as a distinct hereditary unit was established, and the ways in which genes are transmitted to offspring and control traits were clarified. Since about 1950 that studies in genetics, particularly at the molecular level, have remained continually at the forefront of biological research since that time

Gregor Johann Mendel, known as father of Genetics was born in a farmer family near Brunn in Austria in 1822. He graduated in Philosophy in 1840 and became a priest in St. Augustinian Monastery in 1847. Later he went to University of Vienna for studying natural science.

After return, he was engaged in school teaching. He started his experiment with garden pea, and in 1865, presented a paper entitled "Experiments in plant hybridization" before the Natural History Society of Brunn. He died in 1884.

The implication of his work, which forms the basis of genetics, was realized in 1900 when

Derives in Holland, Correns in Germany and Tschermak in Austria, working independently, obtained similar findings.

Mendel Experiment

The selected garden pea plant as a sample for following reasons-

- Pea is available in many varieties on a large scale to observe alternate traits.
- Peas are self-pollinated and can be cross-pollinated also to prevent self-pollination.
- These are annual plants with a short life cycle. So, several generations can be studied within a short period.
- Pea plants could easily be raised, maintained and handled.
- Many varieties are available with distinct characteristics. Which plants provide many easily detectable contrasting characters.

Mendel conducted artificial pollination/cross-pollination experiments using several true-breeding pea lines. A true-breeding line refers to one that have undergone continuous self-pollination and showed stable trait inheritance and expression for several

generations. Mendel selected 14 true-breeding pea plant varieties, as pair, which were similar except for one character with contrasting traits.

A List of Contrasting Traits studied by Mendel in Pea Plant

Mendel's Procedure:

- Mendel observed one trait at a time. For example, he crossed tall and dwarf pea plants to study the inheritance of one gene.
- He hybridised plants with alternate forms of a single trait (monohybrid cross). The seeds produced by this cross were grown to develop into plants of Fillial$_1$ progeny or F_1-generation (F_1-plants).
- He then self-pollinated the tall F_1 -plants to produce plants of Fillial$_2$ progeny or F_1-generation.
- In later experiments, Mendel also crossed pea plants with two contrasting characters known as dihybrid cross.

A List of Contrasting Traits Studied by Mendel in Pea plant

S.No.	Characters	Contrasting Traits	
		Dominant	Recessive
1.	Stem height	Tall	Dwarf
2.	Flower colour	Violet	White
3.	Flower position	Axial	Terminal
4.	Pod shape	Inflated	Constricted
5.	Pod colour	Green	Yellow
6.	Seed shape	Round	Wrinkled
7.	Seed colour	Yellow	Green

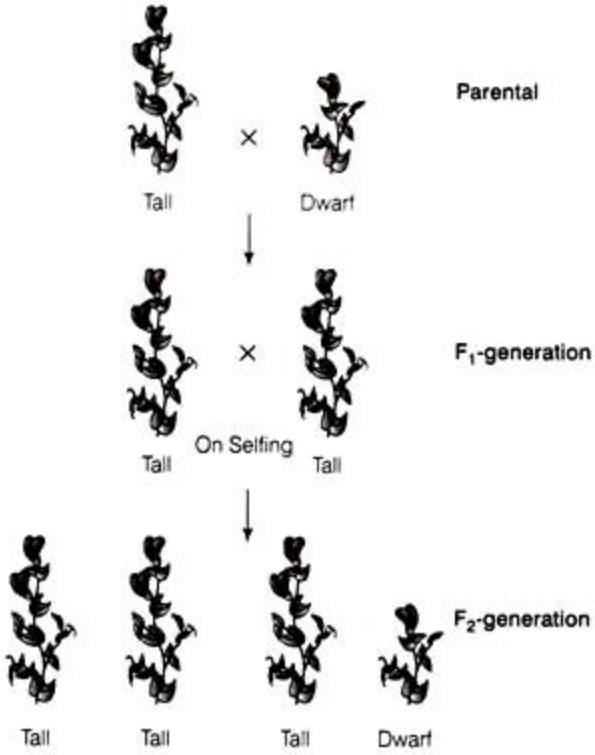


Fig. 5.1 Diagrammatic representation of monohybrid cross

Mendel's Observations

- In F_1generation, Mendel found that all pea plants were tall and none was dwarf.
- He also observed other pair of traits and found that F_1 always resembled either one of its parents and the traits of other parent was not found in this generation.
- In F_2-generation, he found that some of the offsprings were 'dwarf, i.e., the character which were not seen in F_1-generation was expressed in F_2.
- These contrasting traits (tall/dwarf) did not show any mixing either in F_1 or in F_2-generation.
- Similar results were obtained with the other traits that he studied. Only one of the parental traits was expressed in F_1-generation, while at F_2 stage, both the traits were expressed in the ratio of 3:1.
- Mendel also found identical results in dihybrid cross as in monohybrid cross.
- The trait that appeared in the F_1 is called dominant trait, while the other trait is recessive trait.
- In tall/dwarf traits, tallness is dominant over dwarfness that is recessive.

Mendel's Inferences

The Following inferences were made by Mendel based on his observations-

- He proposed that some factors pass down from parent to offsprings through the gametes. Now-a-days these factors are known as genes.

(a) Genes are hence, the units of inheritance.

(b) Genes which code for a pair of contrasting traits are known as alleles, i.e., they are slightly different forms of the same gene.

- Genes occur in pairs in which, one dominates the other called dominant factor and expresses itself, while the other remains hidden and is recessive.
- Allele can be similar in case of homozygote TT or tt and dissimilar in case of heterozygote Tt.
- In a true-breeding tall or dwarf pea variety, the allelic pair of genes for height are identical or homozygous.
- TT and tt are called genotype of the plant, while the term tall and dwarf are the phenotype.

- When the tall and the dwarf plant produce gametes by the process of meiosis, the alleles of the parental pair segregate and only one of the allele gets transmitted to a gamete. Thus, there is only a 50% chance of a gamete containing either allele, as the segregation is a random process.
- During fertilisation, the two alleles, T from one parent and t from other parent are united to produce zygote, that has one T and one t allele or the hybrids have Tt.
- Since, these hybrids contain alleles which express contrasting traits, the plants are heterozygous.

Punnett Square

It is a graphical representation to calculate the probability of all possible genotypes of off springs in a genetic cross. The production of gametes by the parents, the formation of zygote, the F_1 and F_2 germinations can be explained by Punnett square. It was developed by British geneticist RC Punnett.

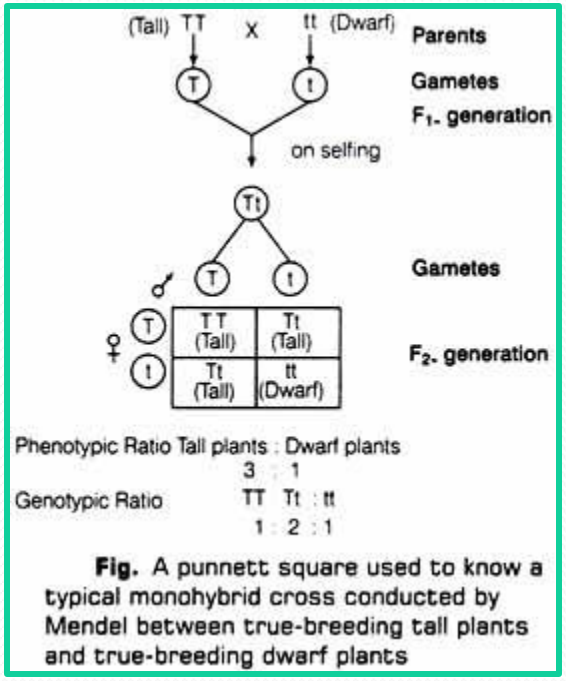
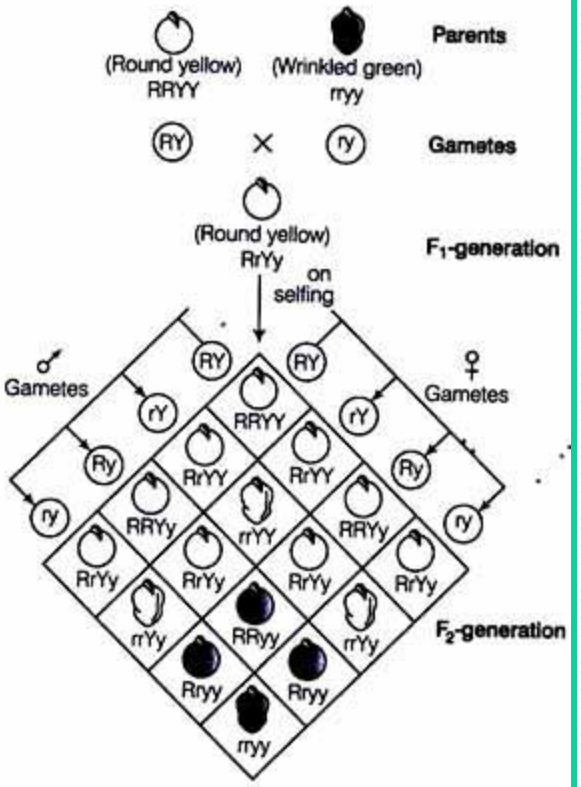


Fig. A punnett square used to know a typical monohybrid cross conducted by Mendel between true-breeding tall plants and true-breeding dwarf plants



Phenotypic Ratio **Round yellow** : **Round green** : **Wrinkled yellow** : **Wrinkled green** = 9 : 3: 3 : 1

Genotypic Ratio 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 :1

Fig. Result of dihybrid cross where the two parents differed in two pairs of contrasting traits seed colour and seed shape

Mendel's Law

Mendel's laws of inheritance are based on his observations on monohybrid crosses.

The following laws of inheritance are-

1. Law of Dominance (First Law):

The law of dominance states that when two alternative forms of a trait or character (genes) are present in an organism, only one factor expresses itself in F_1-progeny and is called dominant, while the other that remains masked is called recessive.

This law is used to explain the expression of only one of the parental characters in a monohybrid cross in the F_1 -generation and the expression of both in the F_2-generation. It also explains the proportion of 3:1 obtained in theF_2-generation.

2. Law of Segregation (Second Law):

This law states that the alleles do not show any blending and both the characters are recovered as such in the F_2-generation, though one of these is not seen in the F_1 -generation.

Due to this, the gametes are pure for a character. The parents contain two alleles during gamete formation.

The factors or alleles of a pair segregate from each other such that a gamete receives only one of the two factors.

3. Law of Independent Assortment (Third Law):

This law states that when two pairs of traits are combined in a hybrid, segregation of one pair of character is independent of the other pair of characters at the time of gamete formation.

It also get randomly rearranged in the offsprings producing both parental and new combinations of characters. The law was proposed by Mendel, based on the results of dihybrid crosses, where inheritance of two traits were considered simultaneously.