PRINCIPLES OF INHERITANCE AND VARIATION

MENDEL'S LAWS OF INHERITANCE

MENDELS LAWS OF INHERITANCE

MENDELISM :

Experiments performed by Mendel on genetics and description of mechanisms of hereditery processes and formulation of principles are known as Mendelism.

Gregor Johann Mendel (1822 – 1884) : Mendel was born on july 22, 1822 at Heinzendorf in Austria a Silesia village. Mendel worked in Augustinian Monastery as monk at Brunn city, **Austria.**

In 1856-57, he started his historical experiments of heredity on pea (pisum sativum) plant. His experimental work continued on pea plant till 1865 (19th century)

The results of his experiments were published in the science journal, **"Nature For schender varien"** in 1866.

This journal was in Germen language. Title was **"verschue uber Pflangen Hybridan"**.

This journal was published by **'Natural History society of Bruno'.**

A paper of Mendel by the name of ''Experiment in plant Hybridization'' published in this journal. Mendel was unable to get any popularity. No one understood of him. He died in 1884 without getting any credit of his work due to kidney disease (Bright disease)

After 16 years of Mendel's death in 1900, Mendel's postulates were rediscovered. Rediscovery by three scientists independently.

- **Carl Correns** : Germany (Experiment on Maize)
- **Hugo deVries** (Holland) (Experiment on Evening Primerose)

  He republished the Mendel's results in 1901 in **Flora** magazine
- **Erich von Tschermak Seysenegg** - (Austria) (Experiment on different flowering plants)

  The credit of rediscovery of Mendelism goes to three scientists.

  Correns given two laws OF Mendelism

MENDEL RESULTS REMAIN HIDDEN DUE TO :

- At that time Darwin's book ''Origin of Species'' published. Scientists were busy in discussion with this book.
- Medel's ideas were ahead of that time.
- Mendel used higher statistical calculation in his experiments so the results were complicated to understand.
- Mendel also performed his experiments on Hawkeweed (hieracium) and beans (Lablab) plant on suggestion of Karl Nageli but mendel did not get succeed in Heriacium, Parthenogenesis is present in it.

REASONS FOR MENDEL'S SUCCESS :

- Mendel studied the inheretance of one or two characters at a time unlike his predecessors who had considered many characters at a time (Kolreuter-Tobacco plant, John Goss & Knight-Pea plant).
- Selection of Material (Pea plant - Pisum sativum)
- Selection of garden pea plant is suitable for studies. Which have following advantage.
- Pea plant is annual plant with short life cycle of 2-3 months so large number of offsprings can be analysed within a short period of time.
- It has many contrasting traits.
- Natural self pollination is present in pea plant so purity of character is maintained in it.
- Cross pollination can be performed in it artificially so hybridization can be made possible.
- Pea plant easy to cultivate.
- Pea seeds are large. In addition to pea, Mendel worked on rajama.
- Mendel quantitatively analyse the inheritance of qualitative characters.
- He maintained the statistical records of all the experiments.

Mendel's work : Mendel studied 7 characters or 7 pairs of contrasting traits.

Actual data obtained by Mendel in F_2 progenies in garden pea				
S.No.	**Character (Chromosomal position)**	**Dominant**	**Recessive**	**Ratio**
1	Length of plant (4)	787 (tall)	277 (dwarf)	2.84:1
2	Colour of flower (1)	705 (violet)	224 (white)	3.15:1
3	Pod or flower position (4)	651 (axial)	207 (terminal)	3.14:1
4	Shape of pod (4)	882 (inflated)	299 (constricted)	2.94:1
5	Colour of pod (5)	428 (green)	152 (yellow)	2.82:1
6	Shape of seed (7)	5,474 (round)	1850 (wrinkled)	2.96:1
7	Colour of cotyledon (1)	6,022 (yellow)	2,001 (green)	3.01:1
Average of all traits studied				2.98:(=3:1)

TECHNIQUE OF MENDEL

He developed a technique **Emasculation and Bagging** for hybridization in plants.

Flowers of pea plant are bisexual. In this method one considered as male and another as female.

The plant used as female, stamens of this plant are removed at juvenile stage, this is called Emasculation.

Emasculation is done to prevent self pollination.

Emasculated flowers covered by bags, this is called bagging.

Bagging is only used to prevent undersirable cross pollination.

Mature pollen grains are collected from male plants and spread over emasculated flower.

Seeds are formed in the female flower after pollination.

The plants that are obtained from these seeds are called First Filial generation or F_1 generation according to mendel.

Mendel was great plant breeder (true breeder)

TERMINOLOGY :

1. **Factor :** Mendelian factor is a unit of inheritance, which passes from one generation to the next through the gamete and controls the expression of a character in the organisms.In modern genetics, It is called **'Gene'** which consists of DNA and genes are responsible for the inheritance and expression of a character.
2. **Allele or Allelomorph :** Contrasting forms of a gene which are found on the same locus in the two homologous chromosomes & control the expression of a trait are called alleles. **Ex : Tallness (T) and dwarfness (t).**
3. **Phenotype :** It represents the expression of external appearance like colour, shape etc. of an individual.
   Ex: Red colour, tallness or dwarfness etc.
4. **Genotype :** It indicates the genetic constitution of an individual. **Ex: The genotype of hybrid tall pea plants is Tt, pure tall TT and dwarf tt.**

- **Johannson** (1911) firstly used the term '**Phenotype** 'and' **Genotype**'.

5. **Homozygous :** It is an individual which contains identical alleles of a gene or factor of a character on its homologous chromosome **Ex: TT and tt**
6. **Heterozygous :** It is an individual which contains the two contrasting factor of a character or two different alleles of a gene on its homologous chromosomes. **Ex : Tt**
7. **Hybrid :** The organism produced after crossing two genetically different individual is called hybrids.
8. **Hybridization:** The process of obtaining hybrids is called hybridization.
9. **Reciprocal cross :** If in one cross individual 'A' is used as male and 'B' as female and in the next cross 'B' is used as male and 'A' as female, It is called as reciprocal cross.
10. **Homologous pair :** Zygotic pair is called Homologous pair.
11. **Back Cross :** It is a cross between F_1 hybrid and one of its parents. Back cross includes test cross.
12. **Test cross :** It is a cross between F_1 hybrid and recessive parent to know whether an individual is homozygous or heterozygous for dominant character.
13. **Out cross :** If cross is performed between F_1 hybrid and dominant parent then it is called **Out cross'** All the offsprings obtain from this cross have dominant characters.
14. **Genome :** A complete set of chromosomes found in each nucleus of given species is called genome. A single genome is present in haploid cell(n).

15. **Gene Pool :** Sum of all the genes and their alleles present in an interbreeding population is called gene pool.
16. **Phenocopy :** When the different genotypes produce the same phenotypes due to different environments, then one is called the phenocopy of the other **Ex: All seeds irrespective of their genotypes, germinating in dark develop yellow leaves.** Phenocopy is not inheritable. The term **phenocopy** was introduced by Goldschmidt in 1935.
17. **Pure line :** The term was coined by Johannson in 1900. It is a strain of genetically pure true breeding individuals which have devised by a single self fertilized homozyous ancestor or indentical homozyous ancestors.
18. **Checker Board :** It was firstly used by C. Punnett. The analysis of generation is represented in the form of symbols of squares. Female gametes arrange vertically and male gametes

TECHNIQUE OF MENDEL :

Monohybrid cross :

It is cross between two organisms of a species, that are different in a pair of contrasting characters.

Ex: height of plant.

Firstly Mendel selected long and dwarf plants of garden pea.

Mendel removed stamens of the.flower of tall plants in bud condition. It is called **'Emasculation'**. A Bag tied over the flower for the prevention of cross-pollination. This is called **'Bagging'.**

Dwarf plant took as male plant and their flower covered through bag.

On dehiscence or maturity, the pollen grains of dwarf plant sprayed over the stigma of long plant and It again covered through bag.

Seeds collected through long plant. After ward Mendel obtained F_1 generation through the sowing of former. This process called **'Hybridization'** and **F_1 generation called 'Hybrid'.**

Mendel obtained only tall plants in F_1 generation.

Mendel applied reciprocal cross but the results did not affect.

After this process, Mendel obtained F_2 generation through the sowing of those seeds which obtained from self pollination of F_1 plants In F_2 generation, Tall and dwarf plants obtained in 3 : 1 ratio. It is proved that the character of tallness in the plants of F_1 generation does not pure.

Mendel used this technique for other six characters in their experiment and obtained same results.

The phenotypic ratio of F_2 generation in Monohybrid cross is 3 : 1 and genotypic ratio is 1 : 2 : 1.

The plant possesses two factors of each character. The term **'Factor'** was fIrstly used by **Correns** Which was called **determinor** or **element** by **Mendel**.