Heredity and evolution

Dihybrid and Mendel's Laws

❖ HEREDITY AND VARIATIONS OF INTRODUCTION

It is commonly seen that members of a species are largely alike. An elephant resembles other elephants, a rose plant looks alike other rose plants, and children resemble their parents, even grandparents or great grandparents. This resemblance among the individuals of a species has given rise to a general truth **'like begets like'** which implies continuity of life. It is, however, not absolutely true as the members of a species are seldom exactly alike. For instance, in human beings, the children often have some individual characters in which they differ from one another, and also from their parents. In fact, their differences are as marked as their resemblances. This is true about other species as well.

The similarities and differences among the members of a species are not coincidental. They are received by the young ones from their parents. The hereditary information, in fact, is present in the gametes (egg and sperm) which fuse to form the fertilized egg or zygote during sexual reproduction. The zygote then develops into an organism of a particular type. For instance, fertilized eggs of sparrows hatch into sparrows only and the fertilized eggs of pigeons hatch into pigeons only. Similarly, a cow gives birth to calves only. The wheat plant gives rise to seeds which, in turn, develop into wheat plants.

❖ Heredity:

The transmission of characters [or traits] from one generation to another generation.

or

The transmission of characters from the parents to their off springs.

❖ Variations:

The differences in the characters [or traits] among the individuals of a species are called variations. **e.g. Plant height -** Tall, dwarf & middle.

Ear lobe in human being: The lowest part of our ear is called earlobe.

In most of the people, the ear lobe is hanging and it is called free earlobe.

In some people, the earlobe is closely attached to the side of the head and it is called attached ear lobe.

❖ ACCUMULATION OF VARIATIONS DURING REPRODUCTION

Heredity involves inheritance of basic body design (similarities) as well as subtle changes (variations) in it from one generation to the next generation, i.*e.,* from parents to the offspring. When individuals of this new generation reproduce, the off springs of second generation will have the basic body design, the differences that they inherit from first generation as well as newly developed differences.

Asexual reproduction involves single parent. When a single individual reproduces asexually, the resultant two individuals again after sometime reproduce to form four individuals. All these individuals would be similar. However, there would be only very minor differences between them. These very minor differences arise due to small inaccuracies in **DNA** copying.

Sexual reproduction, on the other hand, generates even greater diversity. This is so because sexual reproduction involves two parents (father and mother) and every offspring receives some characters of father and some characters of mother. Since, different off springs receive different combination of characters of their parents (father and mother), they show distinct differences (variations) among themselves as well as from their parents. The variations accumulate and pass on to more and more individuals with each generation.

❖ HEREDITY AND VARIATION

(a) Heredity: It includes those traits or characters which are transmitted from generation to generation and are therefore fixed for a particular individual.

- **Genetics :** Study of heredity and variations is said to be known as genetics. The term genetics was first of all used by W. Bateson in 1905. An Austrian monk namely Gregor Johann Mendel was the first person to study genetics. He was therefore regarded as the 'Father of Genetics'.

(b) Variations: Variation is concerned with the difference between the individuals of same species and also between the off springs of the same parents.

Variations could be of two types:

(i) Somatic variation

(ii) Germinal variation

(i) Somatic variation:

Somatic variation affects the somatic cells of an organism. It is neither inherited from parents nor transmitted to next generation. It is acquired by individual during it's own life and is lost with it's death. It is therefore also called as acquired variation. Somatic variations are due to:

(I) **Environment**: This includes the factors that affect the organisms such as food, air, pressure, humidity, water etc.

- **Light:** Strong sunlight affects the human skin by increasing the dark pigment melanin in the epidermal cells. Melanin protects the underlying cells by absorbing the ultra violet rays of the sun.
- **Habitat:** It also affects the genetic make – up of an individual and leads to variations.
- **Nutrition:** It is also one of the various factors that cause variations.

(II) **Use and disuse of organs:** Continuous use of an organ makes it better developed whereas constant disuse makes it reduced.

(III) **Conscious efforts:** Conscious efforts by man produce somatic variations in humans themselves, in domestic animals and plants.

(ii) Germinal variation:

This variation affects the germ cells of an organism and is consequently inheritable. It is received by the individual from the parents and is transmitted to the next generation.

Significance of Variation:

- Variation enables the organisms to adapt themselves to the changing environment.
- It forms raw material for evolution.
- It enables the organisms to face the struggle for existence in a better way.
- It helps men in improving the races of useful animals and plants.
- It is the basis of heredity.
- It also leads to the existence of new traits.

❖ MENDEL'S EXPERIMENT:

Mendel chose garden pea as plant material for his experiments, since it has following advantages:

- Short life cycle.
- Well defined characters
- Bisexual flowers

- Predominantly self – fertilization
- Easy hybridization
- Cross fertilization is possible

➢ **Reasons for Mendel's success:**

- He selected true breeding [pure] pea plant for his experiment.
- He studied single trait at a time.
- He kept an accurate mathematical record of his breeding experiments and noted down the number of each type of offspring produced in each cross.
- He was lucky enough to select the seven traits, as the gene for these traits are located on four different chromosomes Character A recognisable feature of human beings or any other organisms are called characters.

eg. (i) Height

(ii) Complexion

(iii) Shape of hair

(iv) Colour of eyes

(v) Shape of nose

Traits: - Various forms of a character are called **traits.**

S. No.	Character	Dominant	Recessive
1.	Length of Plant	Tall	Dwarf
2.	Flower position	Axial	Terminal
3.	Shape of pod	Inflated	Constricted
4.	Colour of pod	Green	Yellow
5.	Shape of seed	Round	Wrinkled
6.	Colour of cotyledon	Yellow	Green
7.	Colour of flower	Violet	White

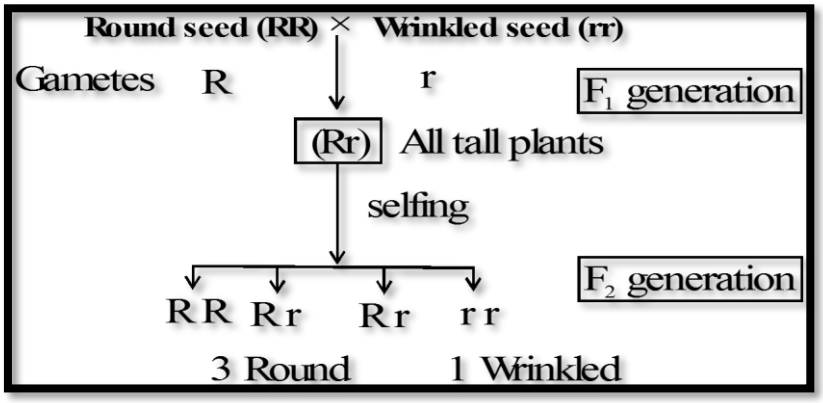
➢ **MENDEL'S MONOHYBRID CROSS**

A breeding experiment dealing with **a single character is called a monohybrid cross.**

Mendel first selected **'pure line' plants** (i.e., the plants that produced similar traits generation after generation). He, then, cross pollinated such plants having the contrasting traits, considering one trait at a time. For instance, in one such cross

breeding experiment, he cross bred garden pea plant having round seeds with plant having wrinkled seeds. In this monohybrid cross, the pollen grains from the flower of the desired plant raised from round seeds were transferred over the previously emasculated flower of a plant raised from wrinkled seeds or vice-versa. After the transfer of pollen grains, the cross-pollinated flower was properly covered and seeds produced were allowed to mature. All the seeds of **F_1 generation** were carefully observed. Mendel observed that all the seeds of F_1 generation were of round type and there were no intermediate characteristics.

He raised plants from F_1 seeds and allowed the flowers to self-pollinate to produce the seeds of F_2 generation. The flowers were kept covered from the beginning to avoid unwanted pollens to reach these flowers. In F_2 generation, Mendel observed the appearance of both round and wrinkled seeds in approximately 3 : 1 proportion.



- **MENDEL'S DIHYBRID CROSS**

A cross involving two pairs of contrasting characters.

OR

A cross in which two pair of contrasting characters are studied at a time.

In one such cross, Mendel considered **shape** as well as **colour of the seeds** simultaneously. He selected pure line plants and then cross-pollinated flowers raised from seeds of round shape and yellow colour with those from wrinkled seeds and green colour. Mendel observed that in F_1 generation all seeds had the features of only one parental type, i.e., round shape and yellow colour. He raised plants from F_1 generation seeds and allowed the flowers to self-pollinate to produce the seeds of F_2 generation. These flowers were kept covered from the beginning. In F_2 generation, Mendel observed the appearance of four types of combinations. These included two **parental types** (round

shaped and yellow-coloured seeds, and wrinkled shaped and green coloured seeds) and **two new combinations** (round shape d and green coloured seeds, and wrinkled and yellow-coloured seeds) in approximately same proportion.

	RY	Ry	rY	ry
RY	RRYY Round Yellow	RRYy Round Yellow	RrYY Round Yellow	RrYy Round Yellow
Ry	RRYy Round Yellow	RRyy Round Green	RrYy Round Yellow	Rryy Round Green
rY	RrYY Round Yellow	RrYy Round Yellow	rrYY Wrinkled Yellow	rrYy Wrinkled Yellow
ry	RrYy Round Yellow	Rryy Round Green	rrYy Wrinkled Yellow	rryy Wrinkled Green

Mendel's Laws of Inheritance:

(i) **The principle of paired factors:** Each character in an individual is governed by two factors called as gene. The alternative form of gene is called as alleles or allelomorphs. If an individual consists of similar types of alleles, they are called as homozygous e.g. TT, tt while those having different types of alleles are called as heterozygous e.g. Tt etc.

(ii) **The principle of dominance or law of dominance:** When two homozygous individuals with one or more sets of contrasting characters are crossed the characters that appear in the F1 hybrids are dominant characters and those which do not appear in F1 are recessive characters.

(iii) **The principle of segregation or law of segregation:** [Law of purity of gametes] The law of segregation states that when a pair of contrasting factors or genes or alleles are brought together in a heterozygous condition, the two remains together without being contaminated but when gametes are formed from them the two separate out from each other. This is also known as Mendel's first law of heredity.

(iv) **The principle of independent assortment or law of independent assortment:** If the inheritance of more than one pair of characters is studied simultaneously, the factors or genes for each pair of characters as sort out independently. It is called as Mendel's second law of heredity.