

## **1. PRE and POST MENDELIAN CONCEPTS of HEREDITY:**

Various views were prevailing about heredity before rediscovery of Mendel's laws of inheritance. Some of the important theories or concepts about heredity which were proposed by various scientists prior to the discovery of Mendel are:

### **(i) Preformation theory:**

This theory was proposed by two Dutch biologists, Swammerdam and Bunnell (1720-1793). This theory states that a miniature human called homunculus was already present in egg and sperm. In other words, a miniature human was performed in the gametes. The development of zygote resulted only in the growth of miniature human who was already present in the egg and sperm. However, this theory was soon given up because this could not be proved scientifically.

### **(ii) Theory of epigenesis:**

This theory was advocated by Wolff (1738-1794), a German biologist. This theory states that egg or sperm cells do not contain miniature human. In other words, egg or sperm cells are undifferentiated. The differentiation into various organs or parts takes place only after fertilization from the zygote resulting into development of adult tissues and organs. This concept is known as epigenesis which is universally accepted.

### **(iii) Theory of acquired characters:**

This concept was proposed by Lamarck (1744-1829), a French biologist. This theory states that a new character once acquired by an individual shall pass on to its progeny. It means if a man develops a strong muscle by exercise all his children will have strong muscle. On the other hand, if a person becomes weak all his children will be weak. This theory was disproved by Weismann. He cut the tail of mice for 22 successive generations and always got the baby mice with tail. Thus, this theory was soon given up.

### **(iv) Theory of pangenesis:**

This theory was proposed by Charles Darwin (1809-1882), an English naturalist. This theory states that very small, exact but invisible copies of each body organ and component (called gemmules) are transported by the blood stream to the sex organs. These invisible copies of each body organ are called gemmules. These

gemmules are assembled in the gametes. After fertilization, these gemmules move out to different parts of the body resulting in the development of respective organ. A defective gemmule will lead to the development of defective organ in an individual. This theory was given up because it did not have scientific basis.

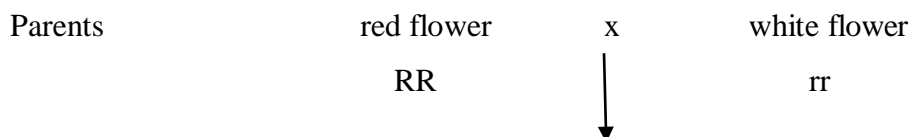
(v) **Germplasm theory:** this theory was advocated by August Weismann (1889), a German biologist. This theory states that body tissues are of two types, *viz.*, germplasm and somatoplasm. The germplasm refers to the reproductive tissues or cells which produce gametes. The somatoplasm includes all other body tissues which are not related to sexual reproduction. Thus, transmission of characters from one generation to other generation takes place only through germplasm. Any change in the germplasm will lead to change in the next generation. This theory is accepted in broad sense.

### **POST-MENDELIAN CONCEPTS OF HEREDITY: (EXTENSIONS OF MENDELIAN CONCEPTS)**

The basic principles of heredity were initially discovered by Mendel in 1886 and rediscovered by de Vries, Correns and Tschermak in 1900. Later on these principles were clarified and confirmed by several researchers and some new concepts were investigated. Some of the new concepts were at variance with the findings of Mendel. These are called as Mendelian deviations or exceptions or anomalies. Such investigation includes:

#### **1. Incomplete dominance:**

Mendel always observed complete dominance of one allele over the other for all the seven characters which he studied in garden pea. Later on cases of incomplete dominance were reported. For example, in four 'O' clock plant (*Mirabilis Jalapa*) there are two types of flowers, *viz.*, red and white. A cross between red and white flowered plants produced plants with intermediate flower colour, *i.e.*, pink colour in  $F_1$  and a modified ratio of 1 red: 2 pink: 1 white was observed in  $F_2$ .



F<sub>1</sub> Rr pink flower  
F<sub>2</sub> 1 red (RR): 2 pink (Rr): 1 white (rr)

### **Incomplete dominance in *Mirabilis Jalapa***

#### **2. Codominance:**

In case of co dominance both alleles express their phenotypes in heterozygote. The example is AB blood group in human. The people who have blood type AB are heterozygous exhibiting phenotypes for both the I<sup>A</sup> and I<sup>B</sup> alleles. In other words, heterozygotes for co- dominant alleles are phenotypically similar to both parental types. The main difference between co -dominance and incomplete dominance lies in the way in which genes act. In case of co- dominance, both alleles are active, while in case of incomplete dominance only one allele (dominant) is active.

#### **3. Multiple alleles:**

Mendel always observed two allelic forms of a gene. Now cases are known where a gene has more than two allelic forms, although only two can exist in a diploid cell at a time. Existence of more than two alleles for a gene is called multiple alleles. Examples of multiple alleles are ABO blood group alleles in human, coat colour in rabbit and self incompatibility alleles in tobacco.

#### **4. Linkage:**

Mendel always observed independent assortment of genes. Later on cases of linkage were reported by Bateson and Punnett in 1906 in pea, Hutchinson in maize and Morgan (1910) in *Drosophila*. In a dihybrid test cross, they observed higher frequencies of parental types than recombinants instead of 1:1:1:1 ratio. This led to modification of the concept of independent assortment.

#### **5. Lethal genes:**

Genes which cause death of its carrier when in homozygous condition is called lethal gene. Mendel's findings were based on equal survival of all genotypes. In the presence of lethal genes, the normal segregation ratio of 3:1 is modified into 2:1 ratio. Lethal genes have been reported in both animals as well as plants. In mice, allele for yellow coat colour is dominant over grey. When a cross is made

between yellow and grey, a ratio of 1:1 for yellow and grey mice was observed. This indicated that a yellow mouse is always heterozygous, because yellow homozygotes are never born because of homozygous lethality. Such genes were not observed by Mendel. He always got 3:1 ratio in F<sub>2</sub> for single gene character.

#### **6. Gene interactions:**

When the expression of an allele of one gene pair depends on the presence of a specific allele of another pair, it is known as gene interaction. Mendel always observed 9:3:3:1 ratio in F<sub>2</sub> from a dihybrid cross. Later on many deviations of this phenotypic ratio was observed in dihybrid crosses. The modified ratios include 9:7, 9:3:4, 12:3:1, 13:3, 15:1 and 9:6:1 in different crop plants.

#### **7. Pleiotropic gene effects:**

Mendel observed that one gene controls the expression of only one character. Later, cases were observed in which one gene was found to govern the expression of two or more characters. Examples is white eye allele in drosophila. This allele affects eye colour, shape of spermathica, fecundity and testicular membrane.

#### **8. Polygenes:**

Mendel always observed that each character is governed by a single gene. Later on Nilsson Ehle observed that some characters are controlled by several genes and each of such gene has additive effect in the expression of character. This concept led to the foundation of polygenic inheritance. East (1916) demonstrated that polygenic characters were perfectly in agreement with mendelian segregation and later on Fisher and Wright provided a mathematical basis for the genetic interpretation of polygenic characters.

#### **9. Environmental effects:**

Genes can interact not only with other genes but also with the environment to produce the final phenotype. Thus, phenotype is the result of the interaction between genotype and environment. It leads directly to the concepts of penetrance and expressivity. The importance of environment was first realised by johannsen. He coined the terms genotype and phenotype.

**10. Maternal effects:**

Mendel did not observe any difference between direct and reciprocal crosses. Later investigations revealed the presence of significant difference in the reciprocal crosses, which led to the concept of cytoplasmic inheritance.