MENDELIAN GENETICS

What is Heredity?

Heredity is a process of transmission of traits from parents to their offspring's either via asexual reproduction or sexual reproduction. These characteristics or traits are located on the chromosomes in the form of genes.

Gregor Johann Mendel- "Father of Genetics"

Mendel was born in 1822 in Heinzendorf, which was a part of Czechoslovakia. His genetic experiments were conducted on garden pea, *Pisum sativum* in 1856 in the garden at the monastery. Mendel used the pea plant for his experiments because of the following reasons:

- Life span of pea plant is short
- Flowers are self-pollinated.
- Flowers were hermaphrodite as well as bisexual.

Mendel's Laws

There were 3 laws that were proposed by Mendel after different experiments on Pea plant.

1. **Law of dominance**- The effect of recessive allele is masked by the dominant allele. Only dominant allele expresses its phenotype.

   For example: "Allele for tallness is dominant over allele for dwarfism".
2. **Law of segregation of genes**-

Each individual possesses two alleles of a gene and each allele separates or segregates at the time of meiosis, that is, during the formation of gametes. The monohybrid cross (cross of single trait) was used to explain the law of segregation of genes. **(See Fig. 1).**

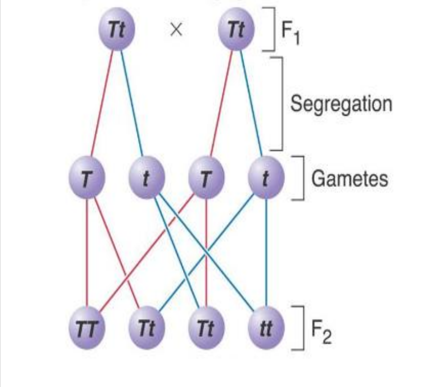

Fig.1. Example of law of segregation of alleles. In this A is dominant over a.

3. Law of independent assortment –

It states that alleles for separate traits are passed independently from parents to the offspring's. Mendel used dihybrid (cross of two different traits) cross in order to explain independent assortment. (**See Fig. 2**)

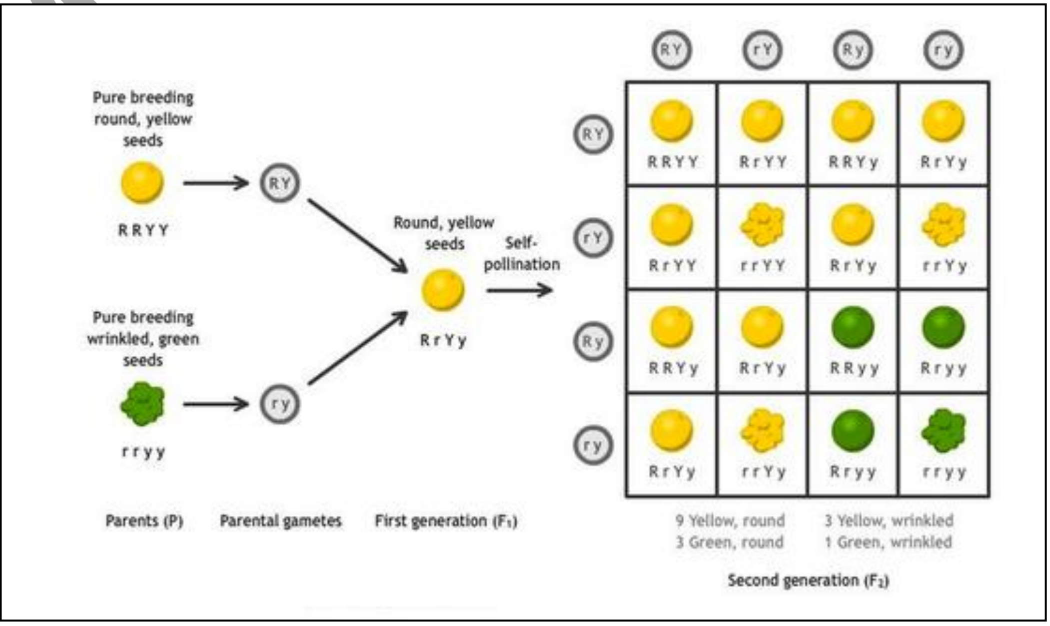

Fig. 2. Law of independent assortment. Yellow round is dominant to green wrinkled.

Test Cross

A cross between first generation (F1) hybrids with its homozygous recessive parent is described as Test Cross. It determines whether dominant phenotype is homozygous or heterozygous in nature. **(See Fig.3)**

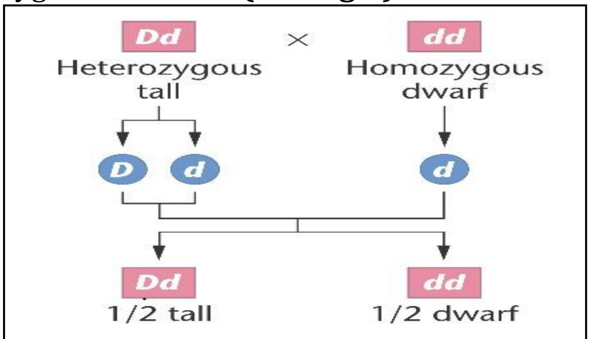

Fig. 3. Test Cross of a Monohybrid Cross

Incomplete Dominance

When a dominant allele is not completely dominant over recessive allele and the F1 hybrid forms after crossing is intermediate between the two parents, the phenomenon is called incomplete dominance.

"For example: Flower color in Mirabilis jalapa, (4'O clock plant). When homozygous red (RR) flower is crossed with white (rr) flower, the F1 offsprings form will have pink flowers (Rr). The phenotypic ratio as well as genotypic ratio in F2 generation is 1:2:1".**See Fig. 3(a)**

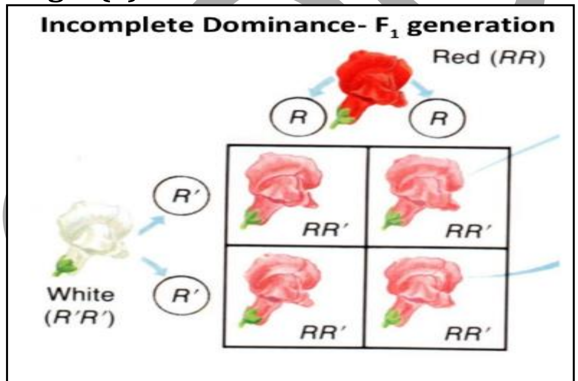

Fig.3(a). Incomplete Dominance

Multiple Allelism or Co-dominance

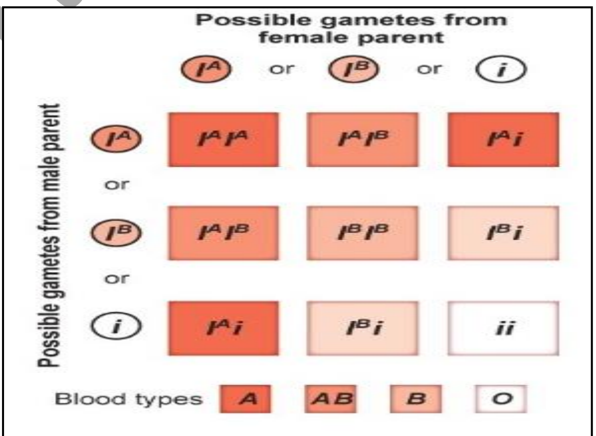

Fig.4. Multiple alleles

When a gene exists in more than two allelic forms, the phenomenon is known as multiple allelism. "For example: multiple alleles is the inheritance of A, B and O blood groups in human being". The gene for blood group occurs in three allelic forms

I^A, I^B and i. An individual can possess any two of these alleles. The gene I^A codes for glycoprotein A which is responsible for A blood group and gene I^B codes for glycoprotein B which is responsible for blood group B.

The gene 'i' do not produce any glycoprotein and so the person who is homozygous for it, will have O group blood. The genes I^A and I^B are dominant over 'i'. I^A and I^B alleles are equally dominant and produce both glycoproteins A and B and the blood group is AB. Such alleles are known as co-dominant alleles. (**See Fig. 4)**

Chromosome theory of Inheritance

This theory was proposed by Sutton and Boveri in1902. This theory is also known as Boveri-sutton theory after the name of the scientist who proposed the theory.

Important Characteristics of Chromosome theory of Inheritance

- Both chromosomes as well as genes exists in pairs in the diploid cells.
- Gamete contains only one chromosome of particular type and only one of the two alleles of a character.
- Fertilization restores diploid condition.
- Homologous chromosomes separate at the time of meiosis.
- Chromosomes segregates and assort independently.

Sex Determination in Different Organisms

Chromosomes that are involved in the determination of sex of an individual are called sex chromosomes or allosomes while the other chromosomes are called autosomes. There are different sex chromosomes that determine the sex of different organisms as explained below-

1) XX – XY type

For example: Drosophila (fruit fly) and mammals including human beings. The females have 2 X chromosomes as sex chromosomes, thus **homomorphic** (morphologically identical homologous chromosomes) in nature. The males are heteromorphic, that is, they have one X and one Y chromosomes as sex chromosomes. For maleness Y chromosome is essential. Thus the presence or absence of Y chromosome decide whether the child will be male or female.

2) ZZ – ZW type

For example: birds and reptiles. The males are represented as ZZ (homomorphic) and females are heteromorphic, that is ZW.

3) XX – XO type

For example: roundworms and insects. The females have two sex chromosomes, XX, while the males have only one sex chromosomes X. Therefore, the males are labelled as XO.

Sex Determination in Humans

Humans have 22 pairs of autosomes and one pair of sex chromosomes or allosomes. All the eggs formed by female possess only X chromosomes as they are homogametic/homomorphic in nature. The male gametes produced by human males are of two types, that is, they either contain X chromosome or Y chromosome.