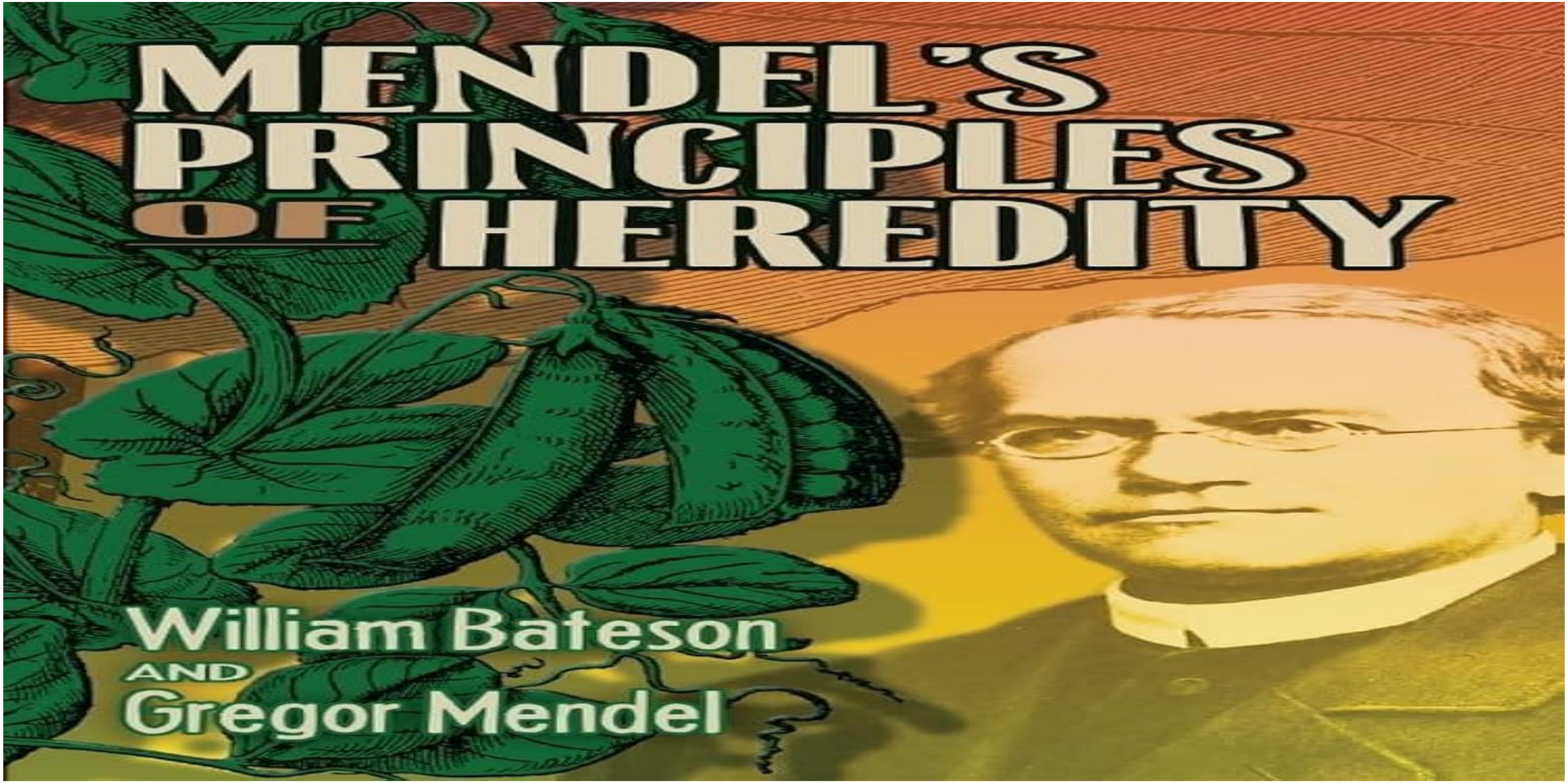


Assist. Prof. Dr. Mujahid Kh. Ali

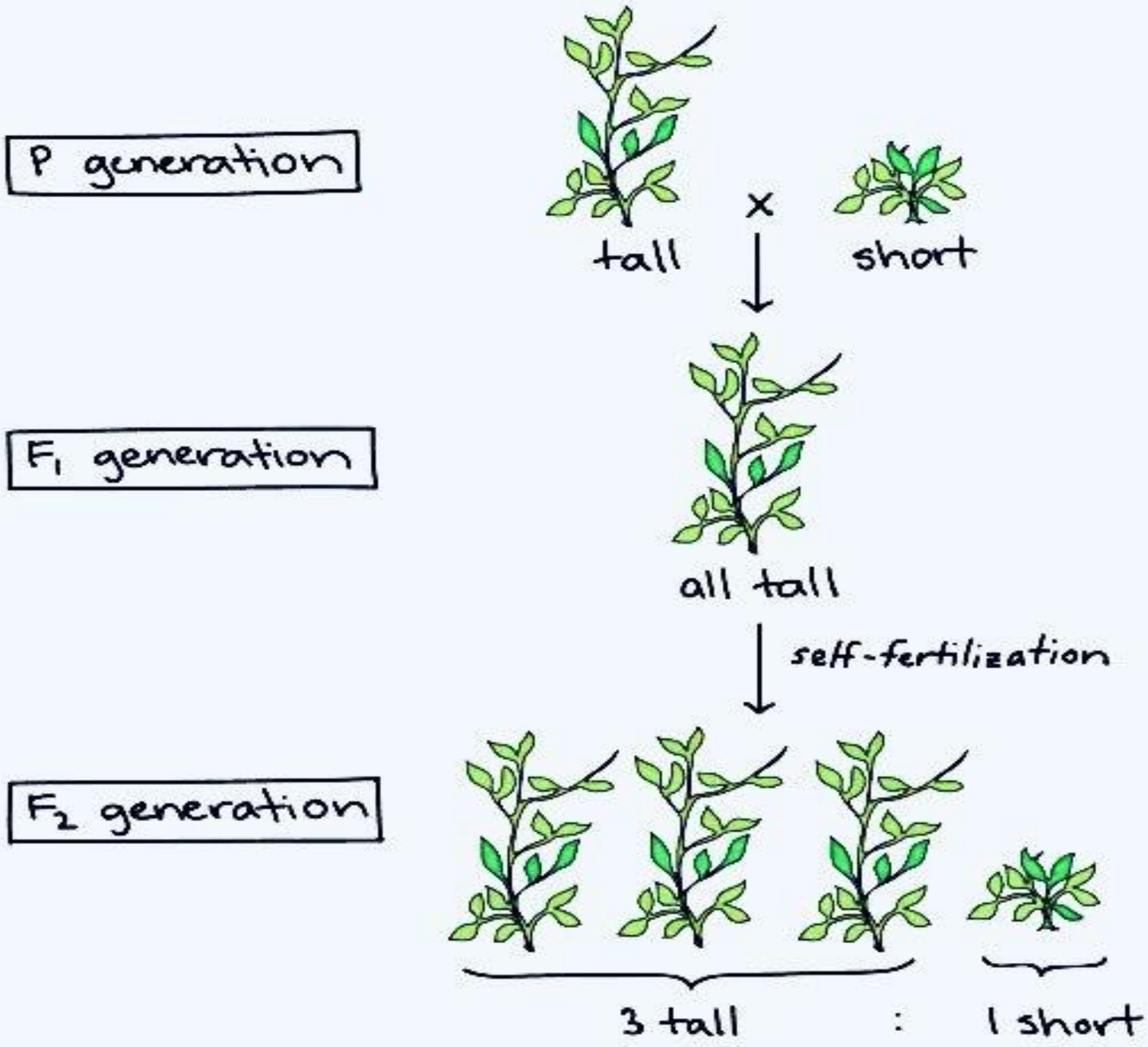
General Objectives:

1. To understand Mendelian inheritance principles and the basic laws governing trait transmission.
2. To explain the Law of Segregation (Mendel's First Law).
3. To explain the Law of Independent Assortment (Mendel's Second Law).
4. To differentiate between key concepts: Dominant and recessive traits, Homozygous and heterozygous, Genotype and Phenotype.
5. To understand non-Mendelian inheritance patterns like Incomplete Dominance and Codominance.

What do we mean by Genetics

Genetics is concerned with the transmission, expression, and evolution of genes, the molecules that control the function, development, and ultimate appearance of individuals.

In this part, we will look at the rules of transmission that govern genes and affect their passage from one generation to the next. Gregor Johann Mendel discovered these rules of inheritance.


P generation
F1 generation
F2 generation
tall
x
short
all tall
self-fertilization
3 tall
:
1 short

What are the following terms?

1. **Self-Fertilization**: fusion of male and female gametes (sex cells) produced by the same individual. Self-fertilization occurs in bisexual organisms, including most flowering plants, numerous protozoans, and many invertebrates.
2. **Cross-Fertilization:** he fusion of male and female gametes (sex cells) from different individuals of the same species. Cross-fertilization must occur in dioecious plants (those having male and female organs on separate individuals) and in all animal species in which there are separate male and female individuals
3. **Filial Generation:** a successive generation that results from the genetic controlled cross made between two parents. It is represented by the alphabet "F". The generation of parents is represented by the symbol "P", parental generation
4. **Hybrids:** the offspring resulting from combining the qualities of two organisms of different varieties, subspecies, species or genera through sexual reproduction

6. Dominant Trait: refers to the inheritance of traits that are typically passed vertically from parent to child where both the parent and the child are affected by the trait or disorder that is related to that gene

7. Recessive Trait: is one that is only expressed when an organism has two recessive alleles for that trait. They are less common than dominant traits in most populations because dominant traits will appear in those with both homozygous dominant and heterozygous alleles

8. Gamete: is a reproductive cell or sex cell that contains the haploid set of chromosomes.

9. Zygote: refers to fertilized egg cell that results from the union of a female gamete (egg) with a male gamete (sperm).

10. Homozygote: refers to having inherited the same versions (alleles) of a genomic marker from each biological parent.

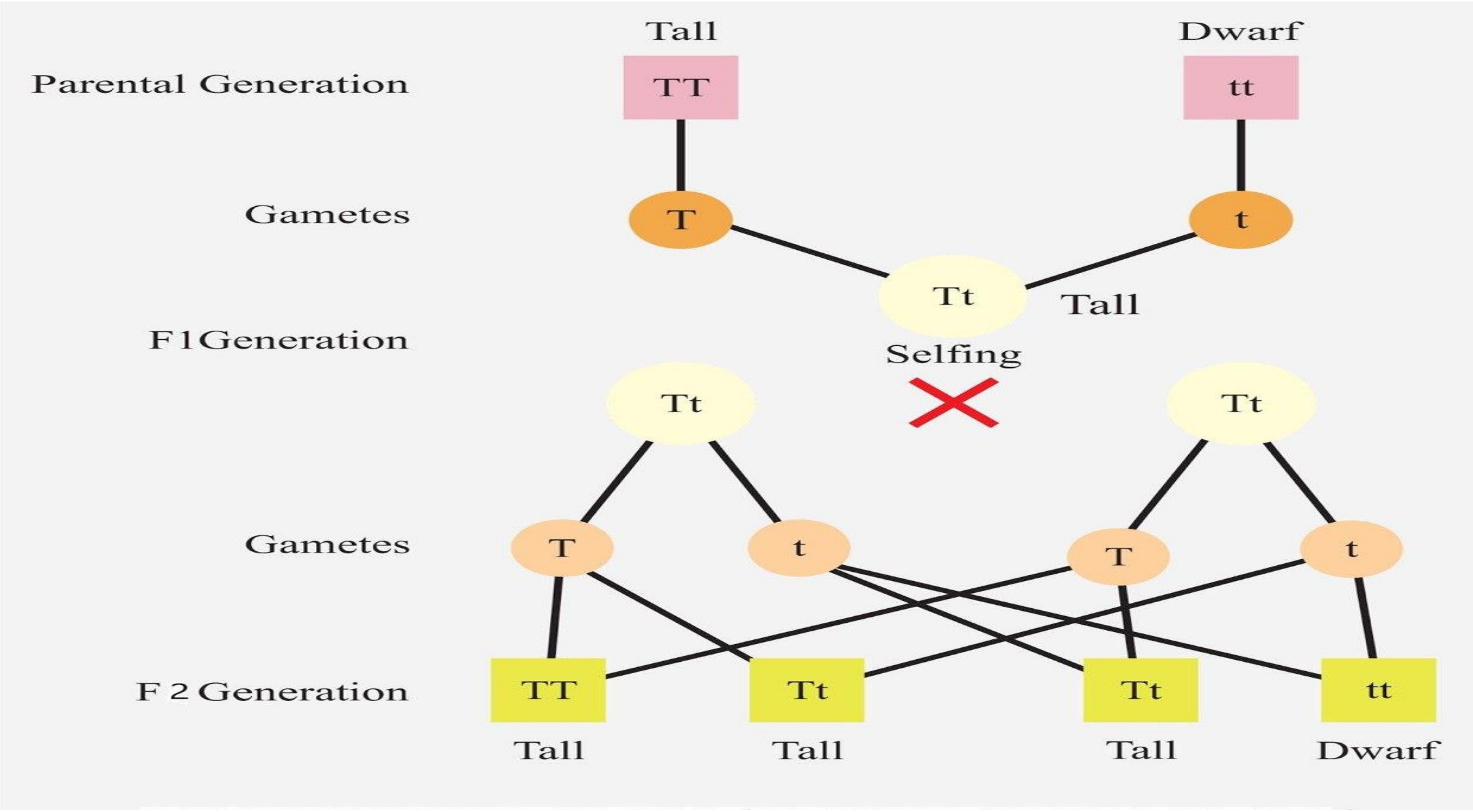
11. Heterozygote: refers to having inherited different versions (alleles) of a genomic marker from each biological parent.

1) Rule of Segregation:

Mendel's first principle, the **rule of segregation.** The rule of segregation can be summarized as follows: A gamete receives only one allele from the pair of alleles an organism possesses; fertilization (the union of two gametes) reestablishes the double number.

Mendel used capital letters to denote alleles that control dominant traits and lowercase letters for alleles that control recessive traits. Following this notation, *T* refers to the allele controlling tallness and *t* refers to the allele controlling shortness(Dwarf stature).

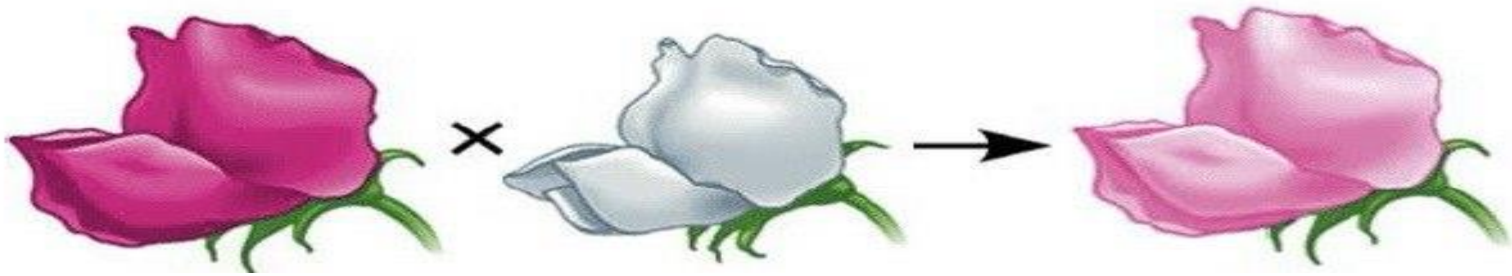
The **genotype** of an organism is the gene combination it possesses, the genotype of the parental tall plant is *TT;* that of the F1 tall plant is *Tt.* **Phenotype** refers to the observable attributes of an organism. Plants with either of the two genotypes *TT* or *Tt* are phenotypically tall. Genotypes come in two general classes: **homozygotes,** in which both alleles are the same, as in *TT* or *tt,* and **heterozygotes,** in which the two alleles are different, as in *Tt.*


Tall
Dwarf
Parental Generation
TT
tt
Gametes
T
t
Tt
Tall
F1Generation
Selfing
Tt
Tt
Gametes
T
t
T
t
F 2 Generation
TT
Tt
Tt
tt
Tall
Tall
Tall
Dwarf

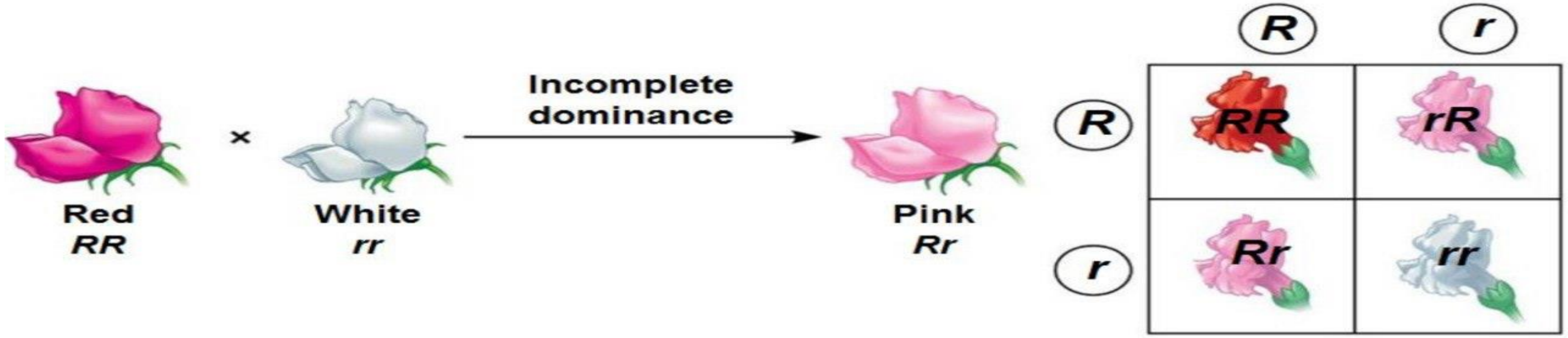
DOMINANCE IS NOT UNIVERSAL

If dominance were universal, the heterozygote would always have the same phenotype as the dominant homozygote, and we would always see the 3:1 ratio when heterozygotes are crossed. If, however, the heterozygote were distinctly different from both homozygotes, we would see a 1:2:1 ratio of phenotypes when heterozygotes are crossed. In **partial dominance** (or **incomplete dominance),** the phenotype of the heterozygote falls between those of the two homozygotes.

An example occurs in flower petal color in some plants by cross a plant that has red flower petals with another that has white flower petals; the offspring will have pink flower petals. If these pink-flowered F1 plants are crossed, the F2 plants appear in a ratio of 1:2:1, having red, pink, or white flower petals, respectively.



- For some characters, the appearance of F_1 hybrids falls between the phenotypes of the two parental varieties. This is called **incomplete dominance**.



The pink-flowered plants are heterozygotes that have a petal color intermediate between the red and white colors of the homozygotes. In this case, one allele (*R*1) specifies red pigment color, and another allele specifies white color (*R*2). Flowers in heterozygotes (*R*1*R*2) have about half the red pigment and white pigment.

The other category in which the heterozygote is not related to Mendel's Law occurs when the heterozygous phenotype is not on a scale somewhere between the two homozygotes, but actually expresses both phenotypes simultaneously or called **codominance.**

For example, people with blood type AB are heterozygotes who express both the *A* and *B* alleles for blood type).

MULTIPLE ALLELES

A given gene can have more than two alleles. The classic example of multiple human alleles is in the ABO blood group. There are four blood-type phenotypes produced by three alleles.

Blood Type Corresponding to Antigens on Red Blood Cells	Antibodies in Serum	Genotype	Reaction of Red Cells to Anti-A Antibodies	Reaction of Red Cells to Anti-B Antibodies
O	Anti-A and anti-B	ii	–	–
A	Anti-B	I^AI^A or I^Ai	+	–
B	Anti-A	I^BI^B or I^Bi	–	+
AB	None	I^AI^B	+	+

The I^A and I^B alleles are responsible for the production of the A and B antigens found on the surface of the erythrocytes (red blood cells).

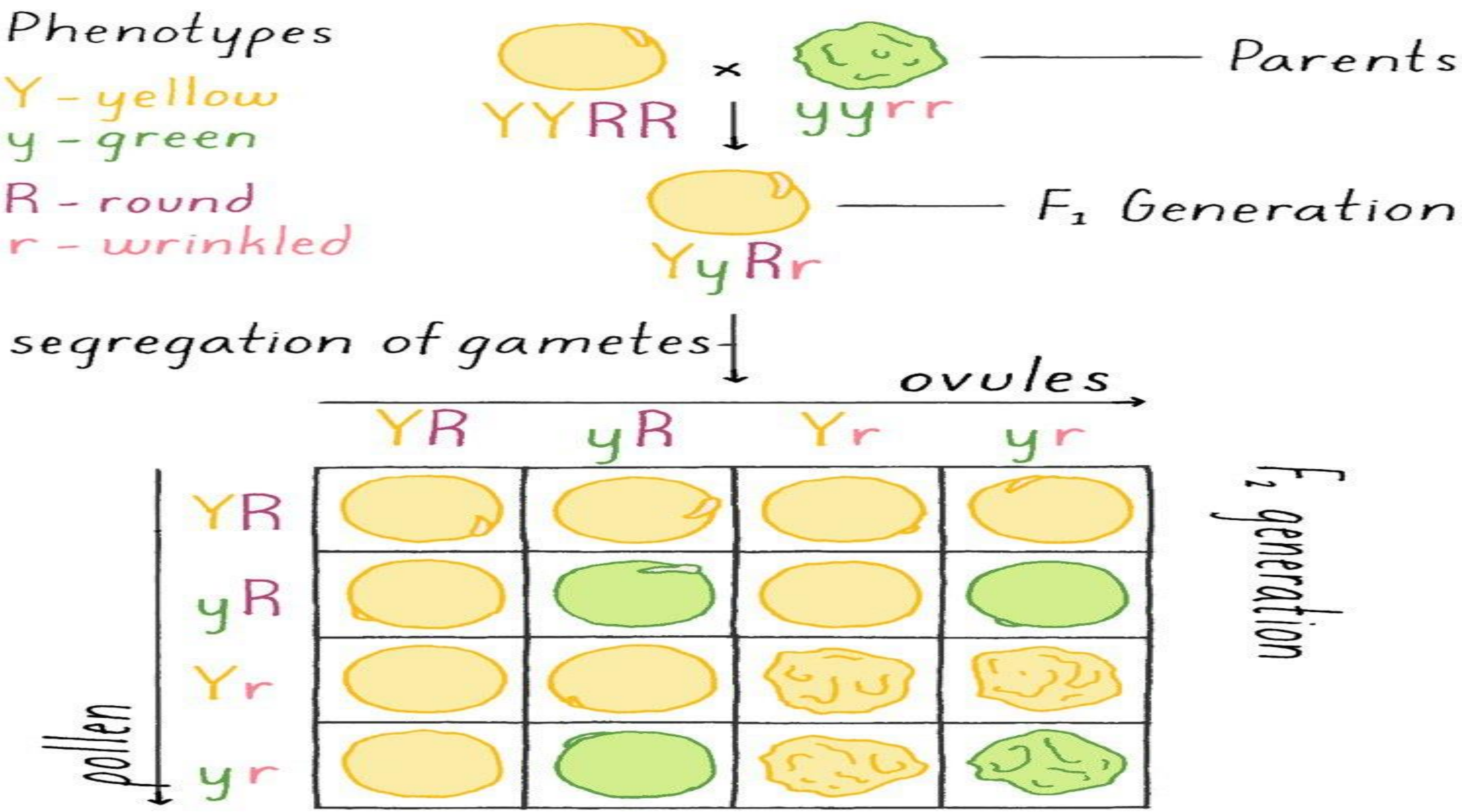
The ABO system is unusual because antibodies can be present (e.g., anti-B antibodies can exist in a type A person) without prior exposure to the antigen.

Thus, people with a particular ABO antigen on their red cells will have in their serum the antibody against the other antigen: type A persons have A antigen on their red cells and anti-B antibody in their serum; type B persons have B antigen on their red cells and anti-A antibody in their serum; type O persons do not have either antigen but have both antibodies in their serum; and type AB persons have both A and B antigens and form neither anti-A or anti-B antibodies in their serum. Since both *I*A and *I*B are dominant to the *i* allele, this system not only showsmultiple allelism, it also demonstrates both codominance and simple dominance.

1) Rule of Independent Assortment:

The Law of Independent Assortment, also known as "Inheritance Law", states that separate genes for separate traits are passed independently of one another from parents to offspring. More precisely, the law states that alleles for one gene can segregate independently of alleles for other genes. While Mendel's experiments with mixing one trait always resulted in a 3:1 ratio between dominant and recessive phenotypes, his experiments with mixing two traits (dihybrid cross) showed 9:3:3:1 ratios. Mendel concluded that different traits are inherited independently of each other, so that there is no relation, for example: the dominant phenotypic class, with round, yellow seeds, represents four genotypes: *RRYY, RRYy, RrYY,* and *RrYy.*

B. THE RESULTS OF THE CROSS



Thanks for Peas,
If were didn’t know about
it , we wouldn’t know
anything about genetics