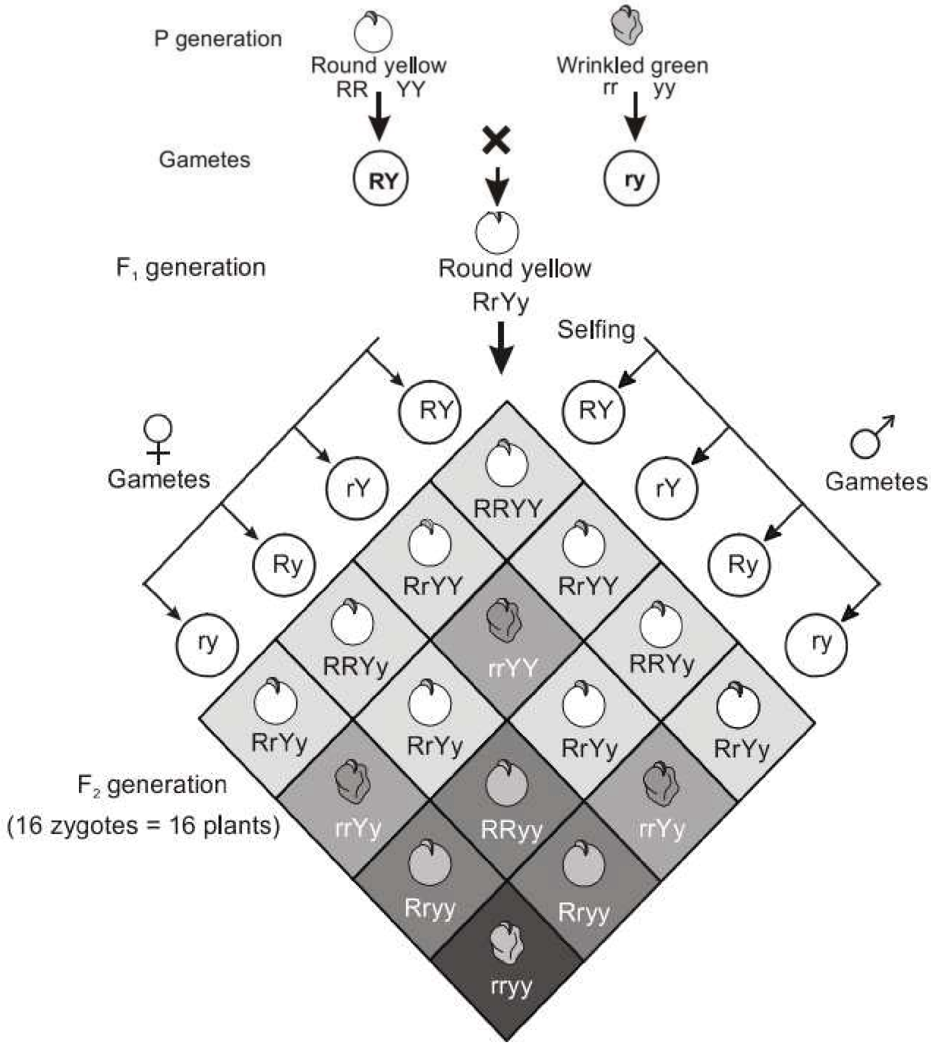
INHERITANCE OF TWO GENES

Mendel didn't stop at studying just one thing in pea plants. He went a step further by mixing pea plants that were different in two ways, which he called a dihybrid cross. This was his way of double-checking what he learned from his earlier experiments with just one thing.

In one of these mixings, he paired up a pure pea plant with round and yellow seeds (RRYY) with another pure pea plant that had wrinkled and green seeds (rryy). Keep in mind that in pea plants, yellow color is more powerful than green, and the round shape of the seed is stronger than the wrinkled shape. This method helped Mendel figure out how two sets of things were passed down at the same time.



Phenotypic ratio : round yellow : round green : wrinkled yellow : wrinkled green

$\frac{9}{16}$ $\frac{3}{16}$ $\frac{3}{16}$ $\frac{1}{16}$

1 RRYY (pure round, pure yellow)	2 RRYy (pure round, hybrid yellow)	1 RRyy (pure round, green)
2 RrYY (hybrid round, pure yellow)	4 RrYy (hybrid round, hybrid yellow)	2 Rryy (hybrid round, green)
1 rrYY (wrinkled, pure yellow)	2 rrYy (wrinkled, hybrid yellow)	1 rryy (wrinkled, green)

i.e., Genotypic ratio: 1:2:1:2:4:2:1:2:1 (9 types of genotypes)

Fig.: Results of a dihybrid cross where the two parents differed in two pairs of contrasting traits: seed colour and seed shape

Such phenotypic ratio (9 : 3 : 3 : 1) in F_2 generation was observed for several pairs of traits that Mendel studied. Mendel found that plants of the F_1 generation have all yellow and round seeds because yellow and round traits are respectively dominant over green and wrinkled traits. These results were identical to those that he got when he made separate monohybrid crosses between yellow and green seeded plants and between round and wrinkled seeded plants. When Mendel self hybridised the F_1 plants he found that 3/4th of F_2 plants had yellow seeds and had green. It means, yellow and green colour segregate in a 3 : 1 ratio; just like in a monohybrid cross. Similarly 3/4 th of F_2 plants had round seeded and 1/4th had wrinkled seeded condition i.e., segregation of round and wrinkled shape traits in 3 : 1 ; just like in a monohybrid cross.

Seed colour

$$\left.\begin{array}{l}\text{Yellow } (9 + 3 = 12) \\ \text{Green } (3 + 1 = 4)\end{array}\right] = 3 : 1$$

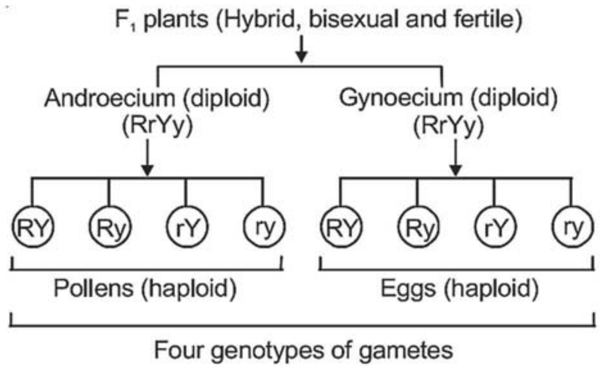
Seed shape

$$\left.\begin{array}{l}\text{Round}(9 + 3 = 12) \\ \text{Wrinkled}(3 + 1 = 4)\end{array}\right] = 3 : 1$$

Law of Independent Assortment

Mendel's Law of Independent Assortment, formulated based on the outcomes of dihybrid crosses, states that when two pairs of traits are combined in a hybrid, the separation of one pair of traits is not influenced by the other pair. This means that the inheritance of traits happens independently.

To comprehend how these traits segregate independently during the formation of eggs and pollen in a diploid plant (F_1, for example, with the genotype RrYy), we can use a Punnett square. Let's consider the segregation of the factors R and r. Half of the gametes will carry R, and the other half will carry r. Each of these gametes will also carry either the factor Y or y. Importantly, the segregation of R and r is unrelated to the segregation of Y and y.



Therefore, 50% of the gametes with r will have Y, and the other 50% will have y. Similarly, 50% of the gametes with R will have Y, and the remaining 50% will have y. This results in four types of gametes (pollen and eggs): RY, Ry, rY, and ry, each occurring with a frequency of 25% or 1/4th of the total gametes produced.

By organizing these four types on a Punnett square, we can easily deduce the combinations of zygotes that give rise to the F_2 generation. This confirms that the segregation of one pair of factors occurs independently of the other pair, ensuring that gametes carry all possible combinations of factors in equal frequency.