Mendel's conclusion from the monohybrid crosses

Mendel drew several important conclusions from the results of his monohybrid crosses.

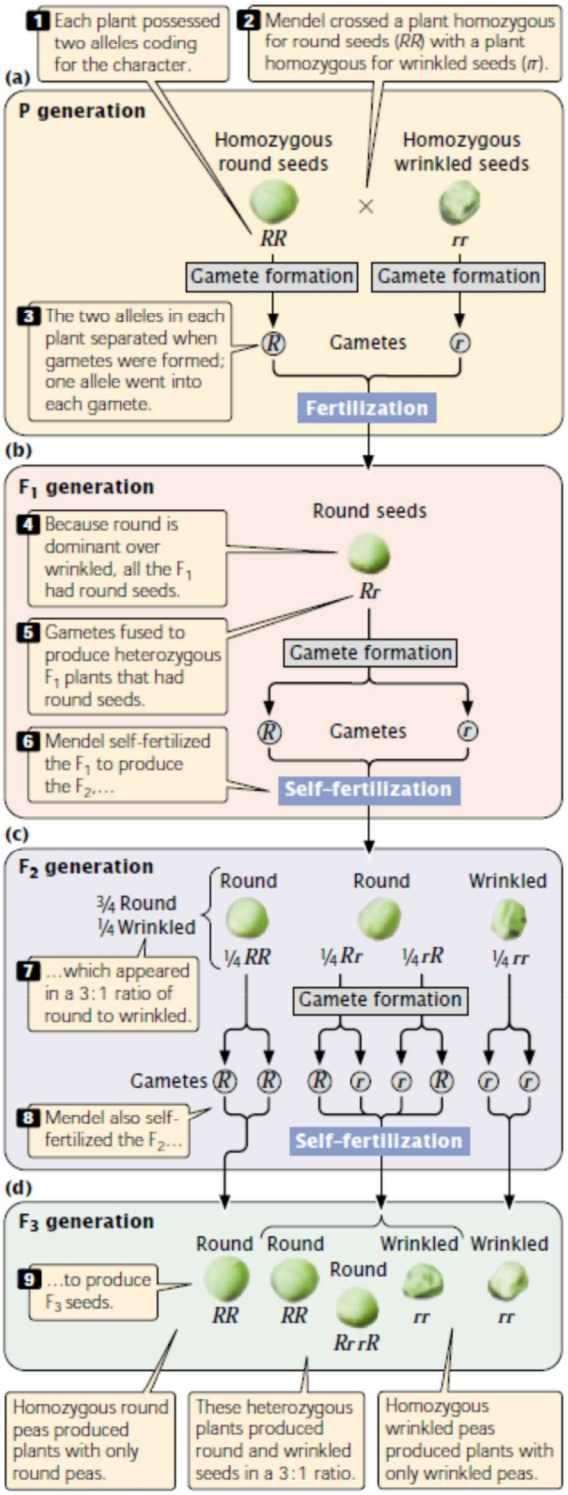
1. First, though the F_1 plants show the phenotype of only one parent, they must inherit genetic factors from both parents because they transmit both phenotypes to the F_2 generation. The presence of both round and wrinkled seeds in the F_2 could be explained only if the F_1 plants possessed both round and wrinkled genetic factors that they had inherited from the P generation. He concluded that each plant must therefore possess **two genetic factors** coding for a character.

The genetic factors that Mendel discovered (alleles) are, by convention, designated with letters; the allele for round seeds is usually represented by *R*, and the allele for wrinkled seeds by *r*. The plants in the P generation of Mendel's cross possessed two identical alleles:

RR in the round-seeded parent and *rr* in the wrinkled-seeded parent **(figure a)**.

2. Second conclusion: that the two alleles in each plant separate when gametes are formed, and one allele goes into each gamete. When two gametes (one from each parent) fuse to produce a zygote, the allele from the male parent unites with the allele from the female parent to produce the genotype of the offspring. Thus, F_1 plants inherited an *R* allele from the round-seeded plant and an *r* allele from the wrinkled-seeded plant **(figure b)**.

3. Third conclusion: Only the trait encoded by round allele (*R*) was *observed* in the F_1—all the F_1 progeny had round seeds. Those traits that appeared unchanged in the F_1 heterozygous offspring Mendel called **dominant,** and those traits that disappeared in the F_1



heterozygous offspring he called **recessive.** When dominant and recessive alleles are present together, the recessive allele is masked, or suppressed. The concept of dominance was a third important conclusion that Mendel derived from his monohybrid crosses.

4. Fourth conclusion: That the two alleles of an individual plant separate with equal probability into the gametes. When plants of the F_1 (with genotype *Rr*) produced gametes, half of the gametes received the *R* allele for round seeds and half received the *r* allele for wrinkled seeds.

The gametes then paired randomly to produce the following genotypes in equal proportions among the F2: *RR, Rr, rR, rr* **(figure c).** Because round (*R*) is dominant over wrinkled (*r*), there were three round progeny in the F_2 (*RR, Rr, rR*) for every one wrinkled progeny (*rr*) in the F_2. This 3:1 ratio of round to wrinkled progeny that Mendel observed in the F_2 could occur only if the two alleles of a genotype separated into the gametes with equal probability.

Mendel conclusions from his monohybrid crosses have been further developed and formalized into the principle of segregation and the concept of dominance.

Principle of segregation (**Mendel's first law**) states that each individual diploid organism possesses two alleles for any particular characteristic. These two alleles segregate (separate) when gametes

are formed, and one allele goes into each gamete. Furthermore, the two alleles segregate into gametes in equal proportions.

Concept of dominance states that, when two different alleles are present in a genotype, only the trait of the dominant allele is observed in the phenotype.

Mendel confirmed these principles by allowing his F_2 plants to self-fertilize and produce an F_3 generation. He found that the F_2 plants grown from the wrinkled seeds— those displaying the recessive trait (*rr*)—produced an F_3 in which all plants produced wrinkled seeds. Because his wrinkled-seeded plants were homozygous for wrinkled alleles (*rr*) they could pass on only wrinkled alleles to their progeny **(figure d)**.

The F_2 plants grown from round seeds—the dominant trait—fell into two types. On self-fertilization, about $^2/_3$of the F2 plants produced both round and wrinkled seeds in the F3 generation. These F2 plants were heterozygous (*Rr*); so they produced $^1/_4$*RR* (round), $^1/_2$*Rr* (round), and $^1/_4$*rr* (wrinkled) seeds, giving a 3:1 ratio of round to wrinkled in the F_3. About $^1/_3$of the F_2 plants were of the second type; they produced only the dominant round-seeded trait in the F_3. These F2 plants were homozygous for the round allele (*RR*) and thus could produce only round offspring in the F_3 generation. Mendel planted the seeds obtained in the F_3 and carried these plants through three

more rounds of self-fertilization. In each generation, of the round-seeded plants produced $^{2}/_{3}$ round and wrinkled offspring, whereas $^{1}/_{3}$ produced only round offspring. These results are entirely consistent with the principle of segregation.