

“Experiments in Plant Hybridization” (1866), by Johann Gregor Mendel

During the mid-nineteenth century, Johann Gregor Mendel experimented with pea plants to develop a theory of inheritance. In 1843, while a monk in the Augustian St Thomas’s Abbey in Brünn, Austria, now Brno, Czech Republic, Mendel examined the physical appearance of the abbey’s pea plants (*Pisum sativum*) and noted inconsistencies between what he saw and what the blending theory of inheritance, a primary model of inheritance at the time, predicted. With his experiments, which he recored in “Versuche über Pflanzenhybriden” (“Experiments in Plant Hybridization”) in 1865, Mendel discredited the blending theory of inheritance, and from them he proposed laws for inheritance patterns. Despite the fact that Mendel’s work did not define all aspects of inheritance, his ideas and laws contributed to later concepts of traits, specifically that offspring inherit traits from their parents via genes, that an offspring has at least two genetic factors for any given qualitative trait, and that the offspring inherits the genetic factors in equal proportion from both parents.

In 1856 Mendel noticed that plants in the same species had different physical appearances, including colors, heights, and seed shapes. At the time, many biologists held that all offspring were a mixture of parental traits that could never be separated back into the original parental traits. Consequently, all traits would eventually blend together and result in a homogenous amalgamation of the parental characters. This idea of a blended inheritance conflicted with what Mendel noted in many of the abbey’s plants. Mendel investigated these phenomena by experimentally mating pea plants and observing the results.

Mendel encountered a number of benefits in using the pea plant for his experiments on heredity. Specifically, the *Pisum sativum* plant reproduces and matures quickly, has easily observable physical traits, and can be easily artificially fertilized. As Mendel sought to trace the heredity of physical characteristic’s through generations, he needed to fertilize plants from one generation with others from the same generation. With controlled fertilization, Mendel bred generations of pea plants with the confidence that there was little or no contamination from plants of other generations. Mendel managed mating by removing the reproductive organ of a flower (piston) from one plant and pollinating another plant of his choice. He repeated his tests with thousands of plants in a relatively short time.

Mendel used pea plants that, within a lineage, displayed only one physical characteristic, like a specific pod color or a specific seed shape, for many generations. He then crossed those plants with those from a different lineage that had displayed a different physical characteristic for many generations. He chose to cross pea plants with seven different characteristics: plant height (tall vs. short), seed color (green vs. yellow), seed shape (smooth vs. wrinkled), seed-coat color (gray vs. white), pod shape (full vs. constricted), pod color (green vs. yellow), and flower distribution (along stem vs. at the end of the stem). Mendel examined the first offspring generation, noted physical appearances and then crossed plants within the first generation to produce a second generation of offspring. By examining each characteristic throughout the generations of offspring, Mendel concluded that individuals in successive generations displayed the original characteristics of their parents.

Mendel noticed that only one of the characteristics for each category was displayed per offspring. For example, pea plants exhibited either green or yellow seeds, but not both colors within the same plant or seed colors that blended yellow and green. In the first generation of hybrids the trait that resulted always mirrored one of the parents. These results discredited the theory of blending

between parental traits, as the offspring of a tall pea plant and a short pea plant yielded not a medium pea plant, but only tall pea plants.

From 1856 to 1863, Mendel continued his experiments and noted that the trait of the parent that was missing in an organism from the first generation reappeared in organisms of the second generation. Furthermore, the ratio of these traits within the second generation occurred in roughly a 3:1 proportion, such that out of every four offspring, approximately three possessed the physical trait of one parent and one displayed the physical trait of the other parent. The trait that appeared most often Mendel called the dominant trait, and the other he called recessive. Through his experiments, Mendel determined the dominant traits in pea plants to be: tall plant height, yellow seed color, smooth seed shape, gray seed-coat color, full pod shape, green pod color, and flower distribution along the stem.

Mendel re-tested his experiment from 1856 to 1863 on almost 30,000 plants to verify his results. He proposed that factors (later called genes) determine the appearance of a characteristic and that for each physical character, a factor has two contributing forms (later called alleles). Furthermore, an organism inherits one form from its mother and one form from its father. If, within a factor, the forms are different, for example, a green seed color form via the mother and a yellow seed color form via the father, then one is dominant and determines the physical appearance of a trait in an offspring, while the other is recessive, and doesn't influence the physical character. Mendel formulated a theory of particulate inheritance around this theory that recessive traits, although not always physically expressed in the offspring of one generation, can reappear in the offspring of subsequent generations. Mendel postulated two laws to explain the results he had obtained.

The law of segregation states that during sex cell formation, each sex cell will receive one factor out of a pair of factors. The law of independent assortment, claims that when each of these sex cells receives a factor, the members of each pair separate into sex cells independently of one another.

Few people noticed Mendel's experiments for most of the nineteenth century, even after publication of "Versuche über Pflanzenhybriden" in the journal *Verhandlungen des naturforschenden Vereins Brünn* (Proceedings of the Natural History Society of Brünn) in 1866. Mendel's article remained untranslated from German. However, Mendel posthumously received credit for his work. In 1899 at the Royal Horticultural Society's International Conference on Hybridization and Plant Breeding in London, Great Britain, William Bateson revived the papers and findings of Mendel through his own experiments on heredity in the UK.

Furthermore, in 1900, three botanists in Europe, Hugo de Vries, Carl Correns, and Erich von Tschermak-Seysenegg, each performed their own experiments and independently arrived at the same conclusions as Mendel, without knowing Mendel's work. Repetitions of Mendel's experiments showed that not all traits exhibited a classic dominance and recessive character. Hybrids, or mixes, appeared and showed that a blending of traits can occur in some cases.

Sources

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