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CARLA HÄFNER

MIEKE SCHEIER

The Code of Life

All about genes, DNA, genetic engineering and why you are the way you are

FLYING EYE BOOKS

CONTENTS

DID YOU KNOW...

that in the beginning, you were no more than one tiny cell, invisible to the naked eye? Then that cell began to divide. One cell became two, two became four, four became eight ... And in the end, a complete organism was formed: you! But how did that first tiny cell know that it was supposed to become a human being? Why not a mouse or an elephant or some other, completely different creature? And if it was to become a human being, then why not one of the billions of other people on this planet? Why YOU specifically?

For a long time, scientists had no answers to these questions. But then they discovered that so-called genes exist and that it is these genes which define the characteristics of an organism. And inside the cells, they found an extraordinary substance in which all information on these genes is stored: DNA. Imagine it as a sort of blueprint for building an organism, a plan which shows what an organism is made up of, what it will look like and what functions and features it will have. But what are genes? And what is DNA? How can DNA be small enough to fit into a single cell yet contain the details of an entire organism? How can it pass the parents' genetic information on to their children? And what happens when human beings start to change these blueprints? When they start to rewrite them? This book tells the exciting story of the discovery of DNA and explains how this discovery changed our world and us as human beings.

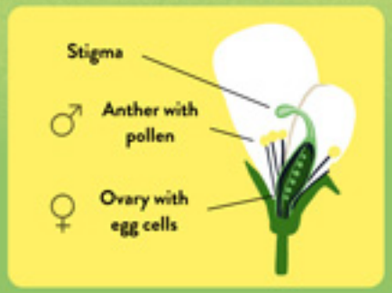
THE BIRTH OF GENETICS

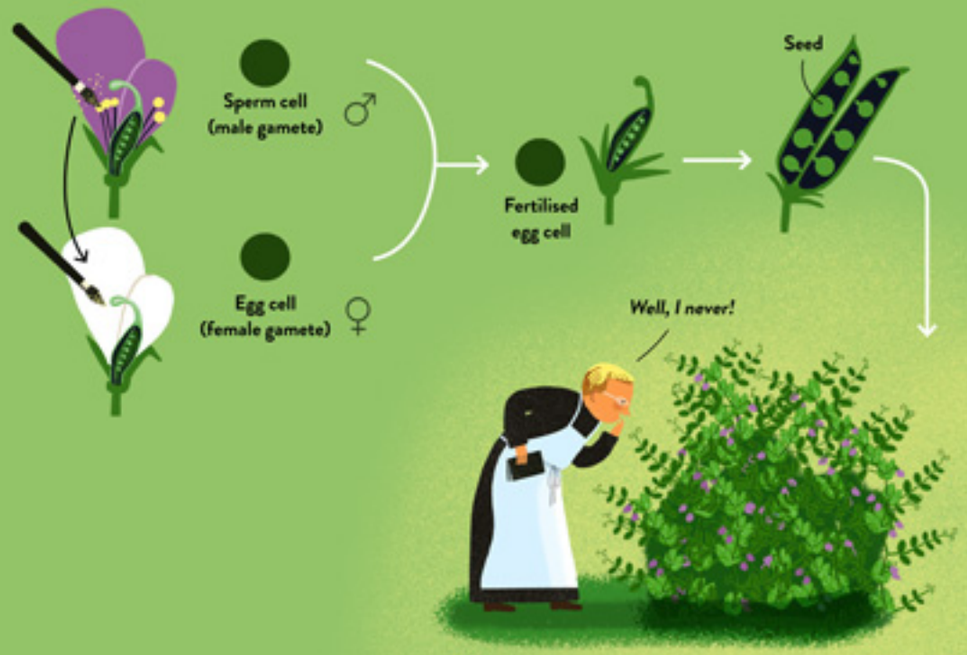
Our story begins in 1856, in an abbey in Brünn, Austria. One of the monks who lived there was called Gregor Mendel. Mendel was anything but a typical monk: he loved mathematics, physics and botany. As a child, he dreamed of becoming a scientist, but his parents were poor farmers and could not afford to send him to university. They expected him to take over the family farm. Entering a monastery was the best way out for Mendel. And he was lucky, because in Brünn the monks did more than just pray – they also carried out a lot of research. The abbey even sent Mendel to university for two years in Vienna. He returned to Brünn with a vast amount of knowledge about the laws of nature, mathematics, plants and animals. And he brought something else back with him: the idea for a highly complex research project!

Soon afterwards, he began to grow pea plants of different varieties in the abbey's greenhouse: plants with violet and with white blossoms, with wrinkled and smooth-skinned peas, with yellow and with green peapods, long and short stems and lots more. For years, he spent hours and hours every day in his greenhouse because he knew he was on his way to solving a great mystery.

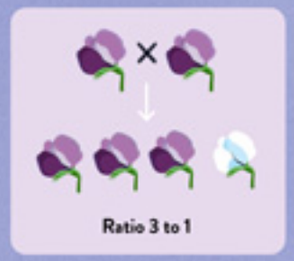
Like many others in his day, Mendel longed to unlock the secrets of heredity. It was already clear that children looked like their parents and grandparents. And it was also known that plants and animals passed traits on to following generations. Farmers, for instance, used this knowledge to select the best animals for breeding. But back then, no-one could explain why this was so.

Mendel chose the pea plant for his studies as he could select plants which varied obviously in their appearance. For every trait he studied, he always had plants of two different varieties. For example, he would cross a plant with violet flowers with one with white flowers by collecting pollen from a violet blossom and brushing it onto the stigma of a white blossom. Pollen contains the male gametes (sperm cells), and these were now transferred from the stigma to the female gametes (egg cells) of the other variety to fertilise them. The new pea plants eventually grew from the fertilised egg cells. So, what do you think happened when Mendel crossed violet-flowered pea plants with white-flowered pea plants? All the new plants had violet flowers. Not a single white flower was to be seen! What had happened?

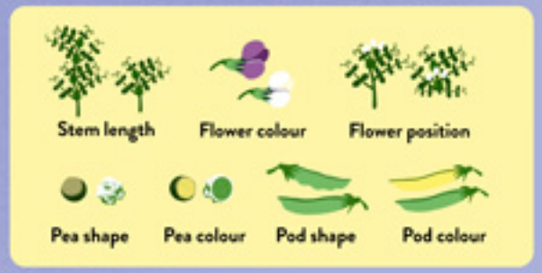


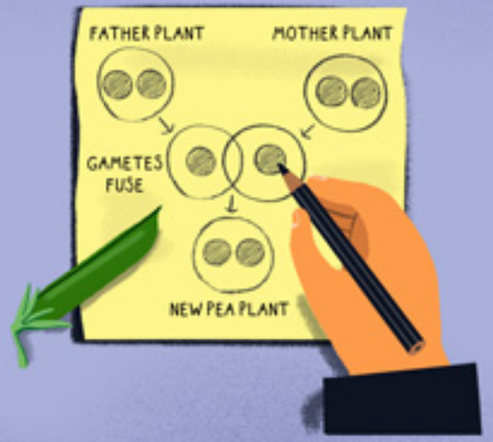


In order to find out, Mendel then crossed these newly grown plants with each other. The result was quite astonishing. The white flowers suddenly reappeared. This meant that the trait had not been lost but had somehow remained hidden. He repeated his experiment several thousand times, and it was increasingly clear that there was a recurring ratio: roughly three in four plants (that is, 75%) had violet flowers and one in four plants (that is, 25%) had white ones. A ratio of 3 to 1!



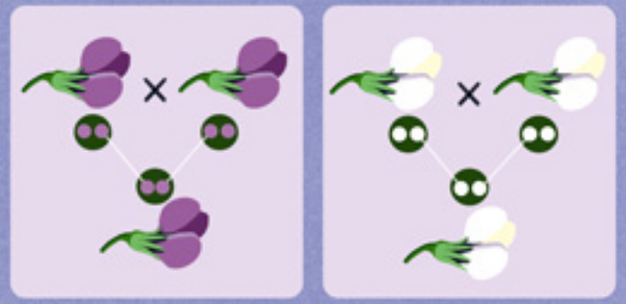
Mendel examined a total of seven different traits in his pea plants, and again and again he saw the same results: in the second generation, the pea plants all looked identical, like one of the parent plants, and in the following generation, both variants appeared – always in a ratio of 3 to 1.



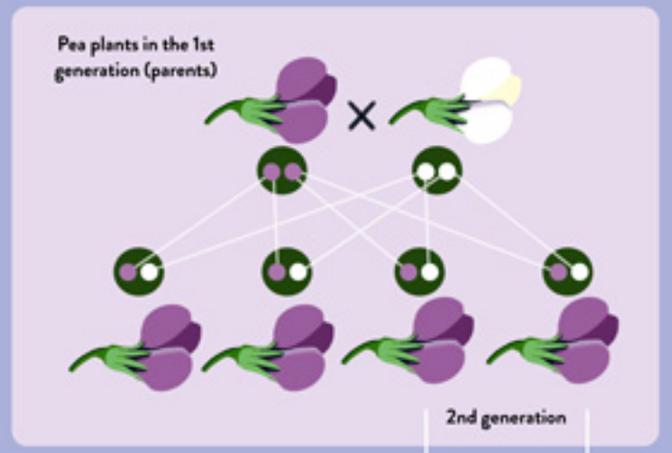


Mendel thought deeply about this. Obviously, something in the gametes contained information on the traits and passed it on to the next generation when the plants were crossed. Tiny particles of some kind. He named them **elements**.

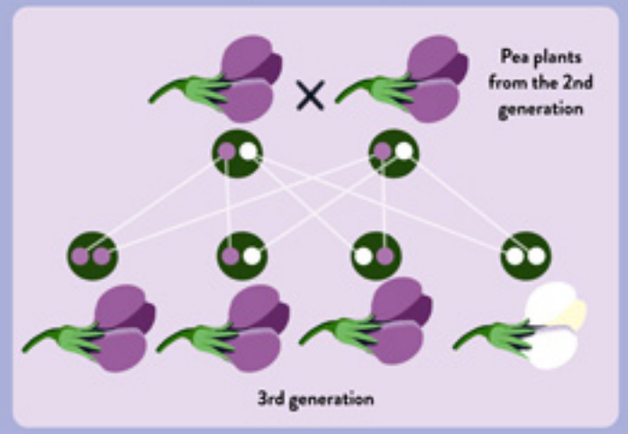
And Mendel realised something else. Since he had achieved the same result for all traits, the numbers had to follow a uniform rule! Then he found a possible explanation for the recurring ratio: there had to be two of these elements for each trait. A pair! But the parents only passed on one element to their offspring, and it was pure coincidence which of the two was handed down. In other words, the young pea plants inherited one element from the father plant and one from the mother, and therefore had two elements, like their parents.



But the elements existed in two variants: in the case of flower colour, for example, 'violet' and 'white'. If a plant receives two elements of the same kind from its parents, the situation is clear: two violet elements will produce violet blossoms, two white elements will result in white blossoms.



Things are a little more complicated if a plant has received elements of two different kinds. In this case, one element or variant prevents the other becoming visible in the next generation. When it comes to flower colour, for example, the violet variant prevents the white one from appearing. Mendel called the stronger variant **dominant** and the weaker variant, which does not become visible, **recessive**.



Later, Mendel also crossed pea plants which varied in two or three traits. Based on the mathematical ratios, he was able to show that the different traits were inherited independently of each other. In the case of flower colour, for example, it makes no difference whether the plant has a short or a long stem and whether the peas are wrinkly or smooth. The expression of one trait has no influence on the expression of the other traits.

Mendel published his findings, but no-one paid much attention to his work. The results of his experiments were not rediscovered until 40 years later, long after Mendel's death, and only then did people realise the great significance of his observations. Although Mendel had no idea what the so-called elements were made of or where exactly they were located, he was the first to discover that they existed. And it was these elements which determined what the pea plants looked like and which were passed down from the parent plants to their offspring according to fixed rules. Later, Mendel's elements were renamed **genes**. Mendel really had discovered the fundamental principles of genetics. And this was not some unusual phenomenon that only happened in pea plants: genes are the carriers of genetic information for all other organisms, too. They contain information on the characteristics of the organism. And the laws of heredity explain how these genes are passed on from one generation to the next - and it's the same for humans as it is for pea plants.

You, too, inherited genes from your parents – one half from your father and the other half from your mother. These genes define what you look like and make you the person you are. So, now you know why children often look like their parents or grandparents, and why siblings are alike: it's all because of the genes! What Mendel found out about heredity marked the birth of a new science – genetics. This is why today Mendel is sometimes called the **father of genetics**!

The elements Mendel discovered (later renamed genes) are responsible for passing on traits from one generation to the next. There are two copies of each gene, one inherited from the father and the other from the mother. Mendel's laws of inheritance describe how the genes are passed on.

The gene copy which suppresses the effect of the other copy is called **dominant**.

The gene copy which is suppressed is called **recessive**.