Genetics-Mendelian Inheritance-Mendel's Experiments SLFAB2

MENDEL AND HIS WORKS

Interests in heredity, or the transmission of traits from parents to offspring have long been a subject of curiosity and debate since the olden times. Scientists have been drawn to puzzling questions like, “What are the molecules in the body that will tell that a person will have black or brown hair, curly or straight?” In the collective studies of various scientists, it was found out that these molecules should contain the message that a cell will become an epidermal cell, or a muscle cell or a gamete. The molecule is to be a keeper of data containing all the information needed for living organisms to properly function.

People back then explained the transmission of traits. The first known explanation for the inheritance of traits was provided by Greek physician Hippocrates (), author of the Physician’s Oath (ca. 400 BCE). He said that all parts of the body produce seeds representing the part of the body which, upon conception, are gathered and passed on to the offspring. Meanwhile in the 1800s, the most favored explanation for inheritance was the “blending” hypothesis. It says that parents have equal genetic contributions to their offspring and that their genetic material blends or mixes together upon transmission to the next generation. biologist Gregor Mendel (1822-1884) proposed a different idea based on his breeding works on pea plants. He proposed the *particulate theory of inheritance* – the idea that the determinants of hereditary traits are transmitted intact from one generation to the next. The determinants of such traits can be likened to marbles, they are complete when they are passed on to their offspring. There is also no blending but only mixing of distinct and different marbles in resulting progeny. So who is this proponent Gregor Mendel? Take a look.

Figure 2.1 Gregor Mendel

Gregor Johann Mendel was born in a village in Czech Republic. As a young man, he was exposed to breeding because he was born to a family of farmers. His mother and father worked with animals and plants. Agricultural training became part of the basic education where Mendel grew. He became interested to work on artificially pollinating crop plants to control their breeding and to tend fruit trees. In 1843, Mendel entered an Augustinian monastery in Brno where he was ordained to become a priest and eventually taught there. At the age of 21, the monastery sent him to the University of Vienna where he pursued a college degree in Physics and Chemistry. One of his professors at the university, Christian Doppler, inspired him and encouraged him to experiment on the learnings of science and the use of mathematics to explain natural phenomena. Franz Unger, a botanist at university, also influenced and stirred Mendel’s interests in the causes of variation in plant organisms. The impacts of these two professors in Mendel’s life would later be shown in his famous work on garden peas. After two years at the university, he went back to the monastery to teach and there he began his classical experiment on garden peas. He painstakingly worked on his breeding experiments for seven years (1856-1863). Later, he published a paper entitled *"Experiments in Plant Hybridization"* where he recorded all his observations and the results from his experiment.

The ideas that Mendel brought forth were rejected during his time. Several years after Mendel's experiment, there have been several independent experiments that rediscovered Mendel's work. Three biologists namely Hugo de Vries of Holland, Carl Correns of Germany, and Erich von Tschermak of Austria conducted separate experiments which consistently support the significance of what Mendel did and its impact to the world of science.

Mendel's works and its rediscovery paved the way for the birth of a new branch of science now known as *genetics*, or the study of heredity and variation. *Heredity* refers to how traits are passed on from parents to offspring, and *variation* would mean the differences observed in organisms.

Mendel's Experiments and Some Genetic Terms

Mendel chose the garden pea (*Pisum sativum*) as his experimental organism. He may have chosen this plant since it was available in many varieties and probably because it was **self-pollinating** or a **self-fertilizing** plant. It means that the sperm nuclei in pollen produced by the anthers in a flower are able to fertilize egg cells housed in the carpel of the same flower. The flower structure of pea plant (**Figure 1.2A**) allows self-pollination in the plant.

What Mendel did in his experiment was to mate pea plants through *cross fertilization*. In order to do this, he removed the anther containing the pollen of a flower and allowed the pollen of other plants with different traits to fertilize the flower of that plant (**Figure 1.2B**). The progeny or offspring produced through cross fertilization is called a *hybrid*. This method allowed him to test the effects of crossing pea plants of different parental types. Before proceeding with his crosses, he ensured that the parental types he worked on were of **pure breeding** or **from true breeding lines**. These plant lines exhibited traits that are the same from one generation to the next or over many generations of self-pollination. For example, if a plant has a purple flower and it is a tall plant, and such plant is capable to self-fertilize, then the seed produced by the plant will produce a purple flowered plant which is tall. After many rounds of self-fertilization, the plant will produce progenies which are purple-flowered and tall.

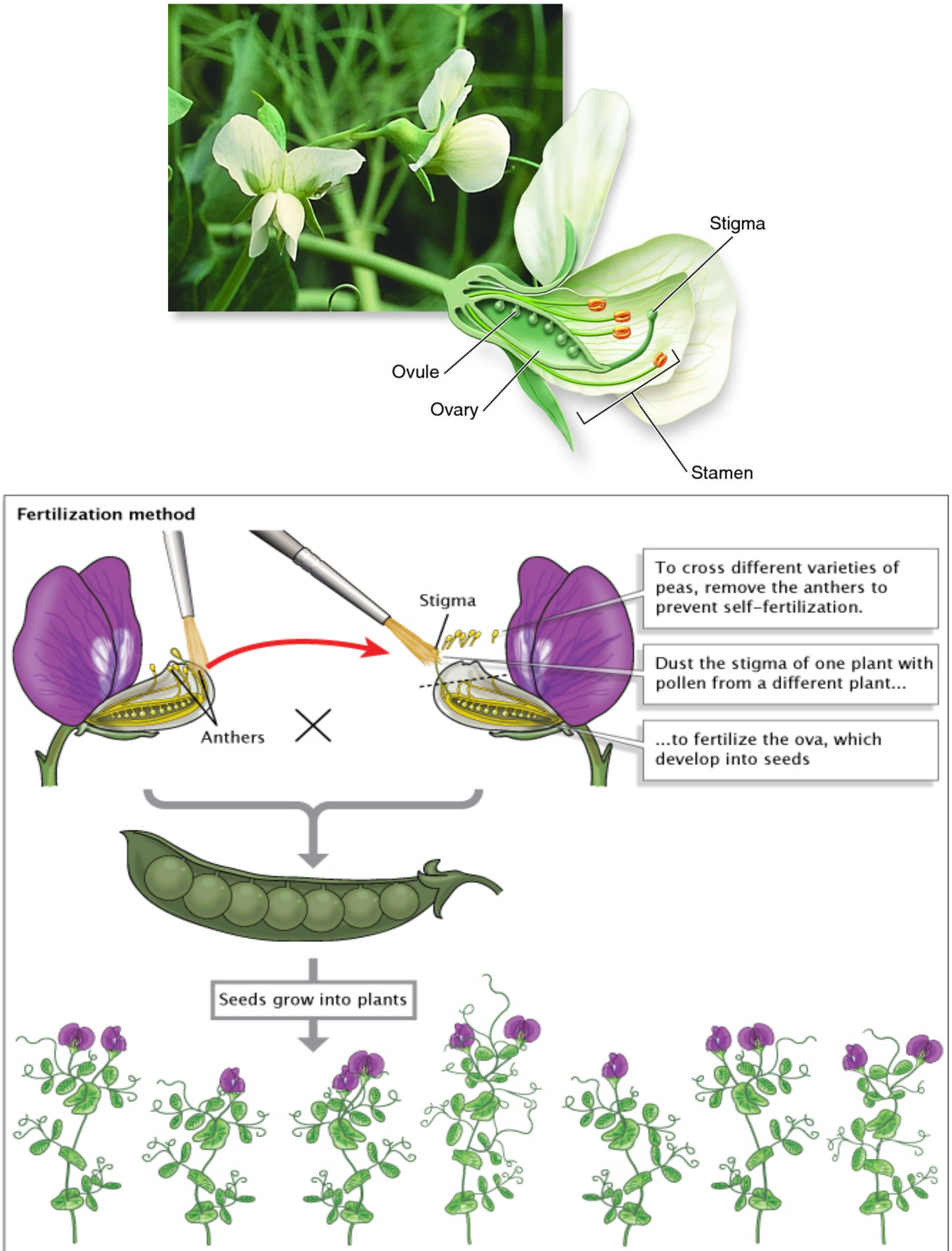

Figure 1 A) Structure of a flower of a pea plant designed for self-pollination (McGraw-Hill Companies, Inc©); **B)** Procedure for cross-pollination in pea plants.
(Adapted from Pierce, Benjamin. Genetics: A Conceptual Approach, 2nd ed.)

Mendel started his experiment by producing pure breeding parents first via *selfing*. After that, he did cross pollination between two pure breeding peas with different traits to produce hybrid offsprings. Then, he carefully allowed the hybrids to self-pollinate or sib mate to produce their second generation offsprings. Peas are easy to grow and breed. So, he made sure that he used homozygous plants and made crosses from them to make sure that his lines were bred-true. In **Figure 1.3**, Mendel's experimental design on how he went about with his experiments is summarized. Mendel chose to tract only those characters that occurred in two distinct, alternative forms. A character is defined as a heritable feature that varies among individuals. Mendel investigated the inheritance of seven characters in pea, summed up in **Figure 1.4**. The characters he worked on were seed color (yellow or green), seed shape (round or wrinkled), seed coat color (gray or white), pod color (yellow or green), pod shape (inflated or constricted), flower position (axial or terminal), and stem length (tall or short).

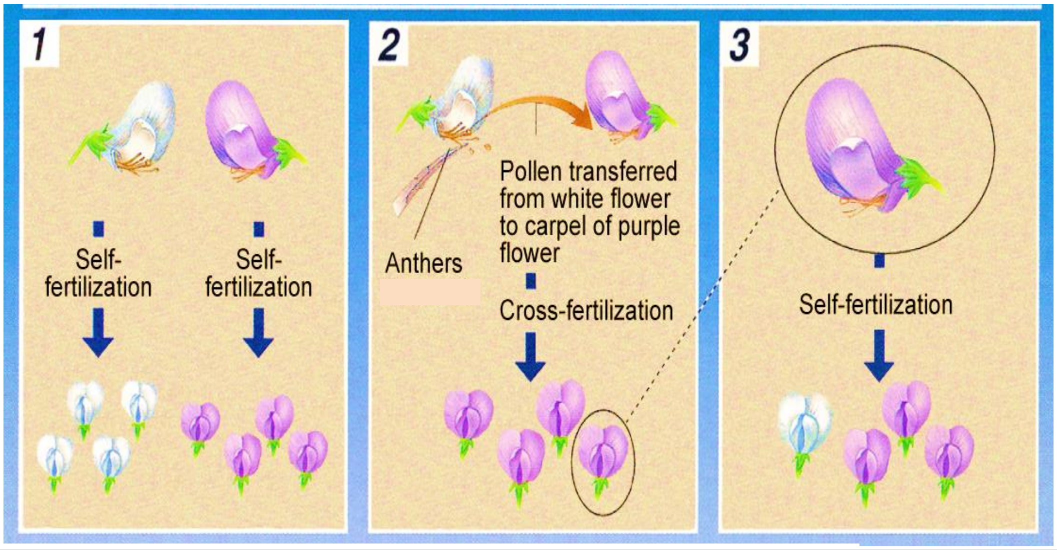

Figure 5.1 Seven contrasting characters in peas examined by Mendel.
(Adapted from Pierce, Benjamin. Genetics: A Conceptual Approach, 2nd ed.)

Before you proceed and take a look at Mendel's crosses, the terms that are commonly used in genetics will be defined first. A *gene* is a hereditary unit or factor that determines a characteristic. An example would be a gene responsible for seed shape. *Alleles* are alternative forms of a gene. In Mendel's appearance of the organism. A phenotype for the seed color for example, can either be a yellow or a green.

During Mendel's time, knowledge of what chromosomes are, the carrier of genes, are not yet known. The results of his experiment and later, the advent of microscopy and the discovery of chromosomes led to the founding of the *Chromosome Theory of Inheritance* by Walter Sutton and Theodor Boveri. According to this theory, inherited traits are controlled by genes residing on chromosomes faithfully transmitted through gametes, maintaining genetic continuity from generation to generation.