

Zoo-352 Principles of genetics
Lecture 6

Mendelian genetics

Gregor Mendel

- ❖ He was born in 1822 in Austria.
- In 1854, Mendel began his classic experiments with the garden pea plant (*Pisum sativum*).
- ❖ He discovered the law of heredity in plants and animals.
- ❖ He died in 1884 by a kidney disorder.



Mendel's experimental design

❖ He did his experiments on the pea plants. This was achieved by two different methods:

1) **Self-fertilization**: occurs when pollen falls from the anther onto the stigma of the same flower.

2) **Cross-fertilization**: occurs when pollen of one plant is used to fertilize a different plant.

❖ He cross-fertilized the plants by opening the **keel** of a flower before the anthers matured and removed them to prevent self-fertilization (Figure 1)

❖ Mendel then collected **pollen** from the removed **anther** and placed it on the stigma of a second plant.

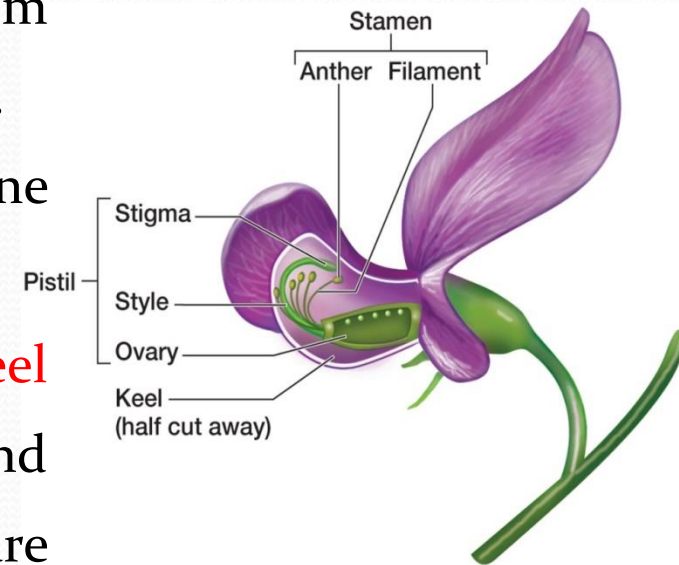
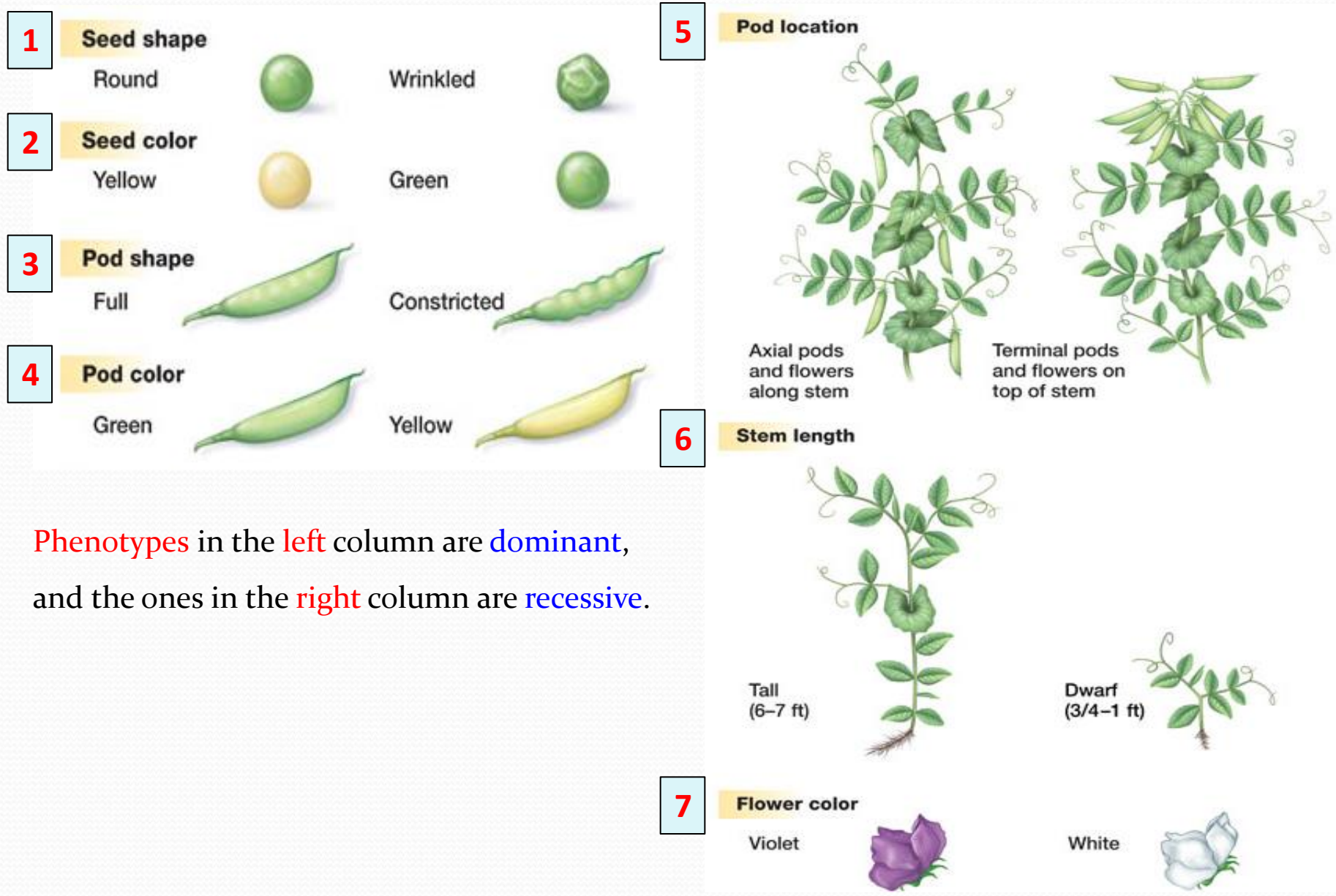


Figure 1: Anatomy of a garden pea plant flower

Why did Mendel use pea plants in his experiments?

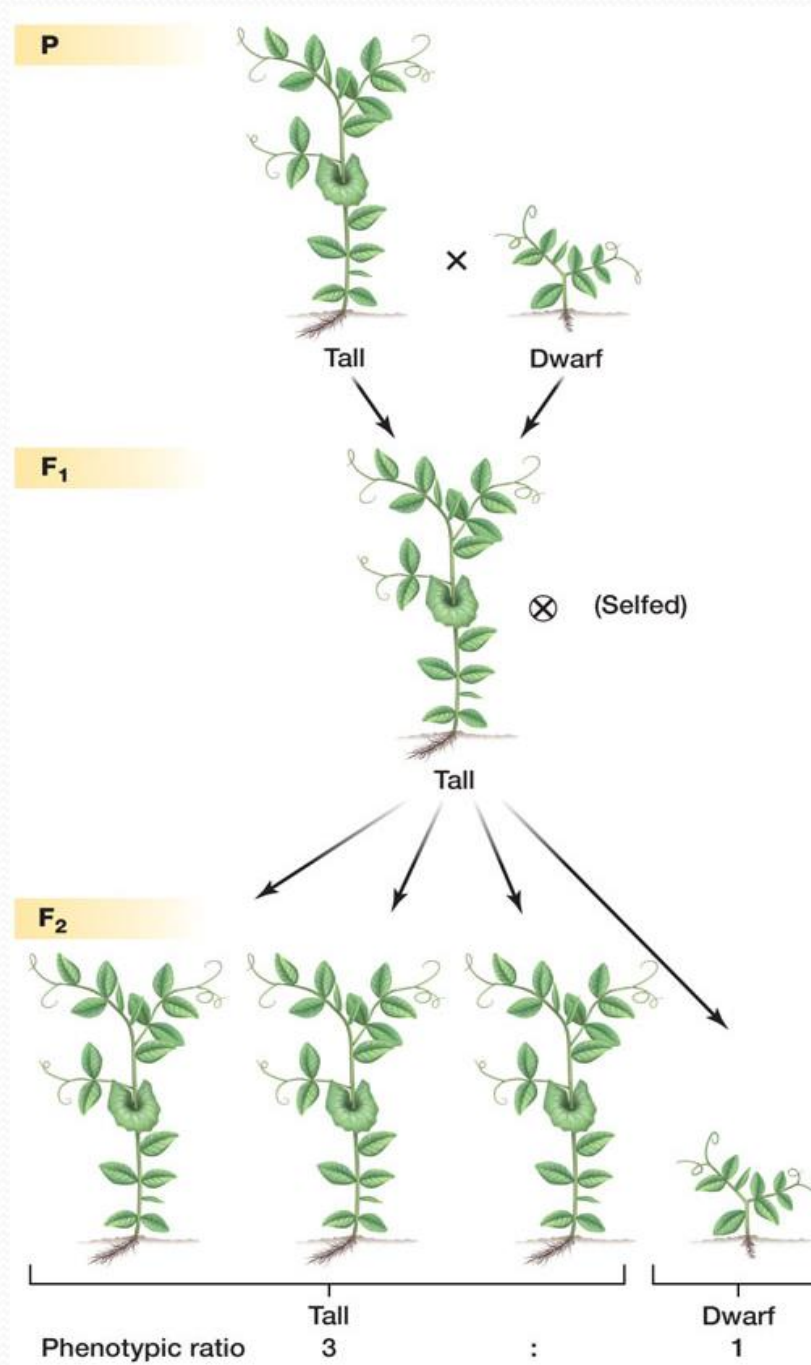
- 1) Peas exhibit a variety of contrasting traits (**seven traits**; Figure 2).
 - 2) The shape of the pea flower protected it from foreign pollen.
 - 3) You can cross or self-pollination them by yourself.
 - 4) Pea plants are inexpensive, easy to maintain and they grow quickly.
 - 5) Short life cycle so you can make more generations.
 - 6) Easy to see and recognize their different traits.
- ❖ Before Mendel started his actual experiments, he grew the plants for **two years**. During this time, he identified plants that were **homogeneous** or pure-breeding for each of the particular characteristics he wanted to study.
 - ❖ Let us look at one of Mendel's crosses, where he crossed **tall** and **dwarf** (short) plants (Figure 3):



Phenotypes in the left column are dominant, and the ones in the right column are recessive.

Figure 2: Seven characteristics that Mendel observed in peas

Figure 3: First two offspring generations (F₁, and F₂) from the cross between a tall and dwarf plant



Offspring generations from the cross between a tall and dwarf plant

- ❖ Offspring of this cross are referred to as the **first generation or F₁**.
- ❖ Mendel also referred to these F₁ individuals as **hybrids** because the offspring were a mixture from parents with different traits.
- ❖ We will refer to these offspring as **monohybrids** because they are hybrid for only one characteristic.
- ❖ Because all the F₁ plants were tall, Mendel referred to **tallness** as the **dominant** trait and **shortness** as the **recessive**.
- ❖ Mendel wondered what happened to the short traits in the F₁ generation. Therefore, **self-fertilization** was done to produce the second generation or F₂.

- ❖ Among the F₂ offspring, Mendel observed 787 tall and 277 short plants for a ratio of 2.84:1. Mendel recognized the dominant to recessive trait ratio in the F₂ generation is 3:1 in a monohybrid cross.
- ❖ Mendel proposed that an organism carries two forms of a genetic unit, which we now call the alleles of a gene.
- ❖ The term gene would first be used in 1909 by Johannsen, 43 years after Mendel published his results.
- ❖ Each trait was controlled by a gene and alleles represent different forms of a gene.
- ❖ The allele for tall stem (D) is dominant compared to the allele for short stem (d) (Figure 4).

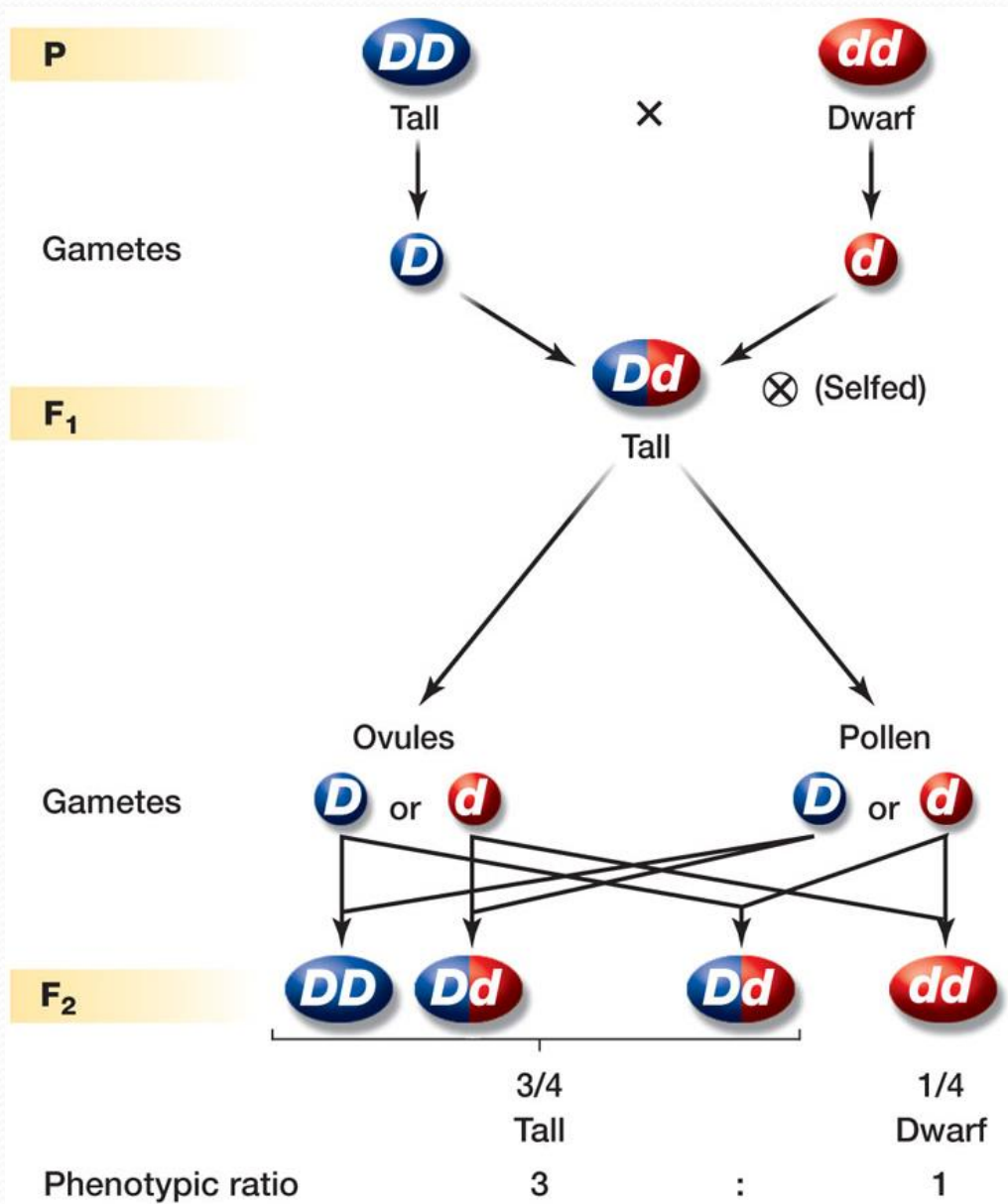


Figure 4: Assigning genotypes to the cross in Figure 3

Definitions of basic terms in Mendelian genetics

- ❖ A **dominant** trait is exhibited in the monohybrid individuals in the F₁ generation. Indicated by a **capital letter**.
- ❖ A **recessive** traits is absent in the monohybrid F₁ offspring, but reappears in the F₂ generation. Indicated by a **lowercase letter**.
- ❖ **Genotype**: A description of the genetic makeup in an organism. Genotype may be either:
 1. **Homozygous**: An organism that carries two copies of identical alleles of a gene in homologous chromosomes for a character (for example, a **DD, dd** individual)
 2. **Heterozygous**: An organism that carries two different alleles for a character (for example, a **Dd** individual).

- ❖ **Phenotype:** A description of an organism's traits (feature).
- ❖ One or two copies of the dominant allele produce the **dominant phenotype**, whereas two copies of the recessive allele produce the **recessive phenotype**.
- ❖ **Locus:** The physical location of the alleles of a gene on its chromosome.
- ❖ **Alleles:** All the different forms of the same gene.
- ❖ **Genotypic ratio:** The expected numbers of different **genotypes** produced by a particular cross.
- ❖ **Phenotypic ratio:** The expected numbers of different **phenotypes** produced by a particular cross.
- ❖ **Monohybrid Cross:** A cross between two individuals in the same species in which **one** genetic trait is documented.
- ❖ **Dihybrid Cross:** A cross between two individuals in the same species in which **two** genetic traits are documented.