

# Mendel and the gene

*The theory of inheritance*

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Subject : **Engineering Biology (BT101)**

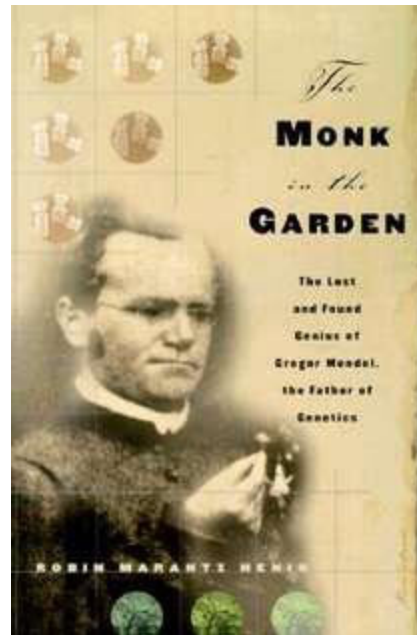
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# The monk in the garden: Gregor Mendel

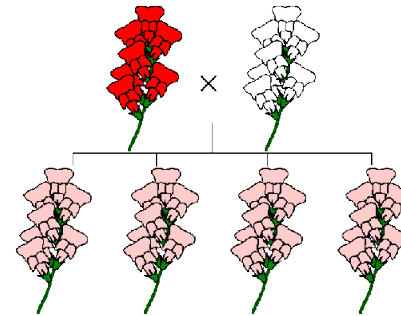
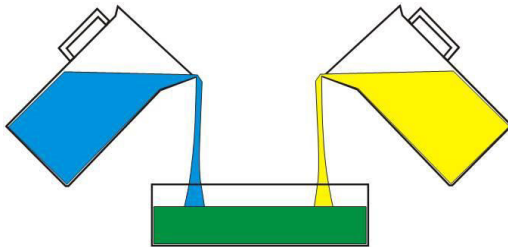


**Johann Gregor Mendel (1822–1884)**, is called the “father of genetics,” was a monk, teacher, and scientist. He persevered through difficult circumstances to make the most important discoveries in biology that is *theory of inheritance*.



# What Questions Was Mendel Trying to Answer?

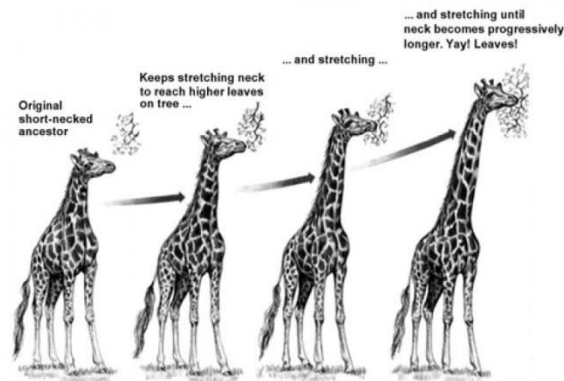
**Blending inheritance:** proposed that the traits observed in a mother and father blend together to form traits in their offspring. As a result, an offspring's traits are intermediate between traits of the mother and father.



**“It is a blending of genetic information”**

# What Questions Was Mendel Trying to Answer?

**Inheritance of acquired:** characters proposed that traits present in parents are modified through use and then passed on to their offspring in the modified form.



*Is this true ??*



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# Concept of Phenotype

Mendel experimented on varieties of peas that differed in seven **traits**: seed shape, seed color, pod shape, pod color, flower color, flower and pod position, and stem length. These are called phenotype



Seed shape

Biologists refer to the observable traits of an individual, such as the shape of a pea seed or the eye color of a person, as its **phenotype** (literally, “show-type”).

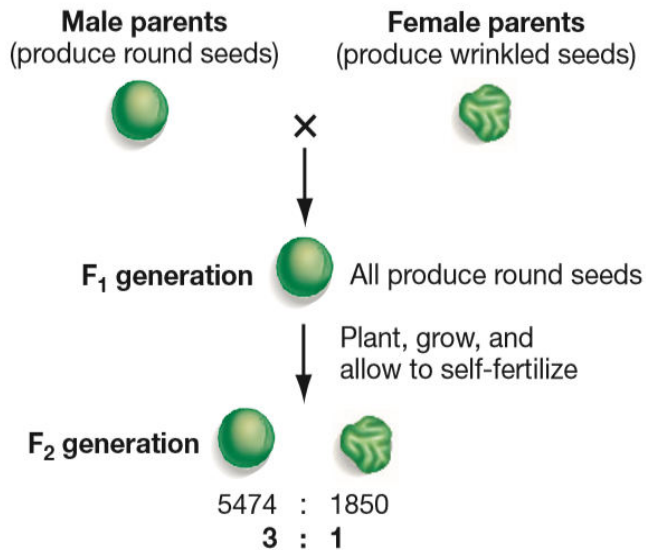


(A **trait** is any characteristic of an individual, ranging from outward appearance like height to molecular characteristics such as the primary structure of a particular membrane protein)

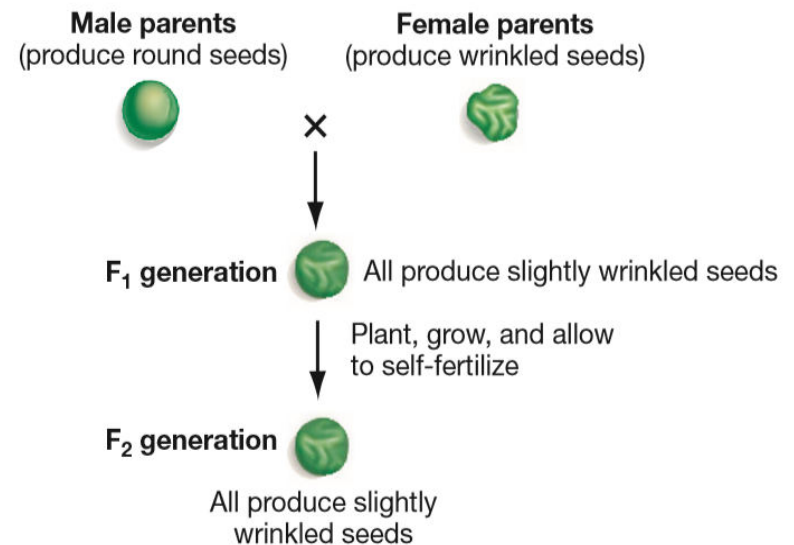
# The garden pea served as the first model organism in genetics

## Mendel's Experiments with a Single Trait

(a) Results of Mendel's single-trait (monohybrid) cross



(b) Prediction of blending-inheritance hypothesis



**Figure 14.2 Mendel Performed a Monohybrid Cross.** The results of Mendel's crosses involving a single trait (a) contrasted strongly with the predictions of the blending-inheritance hypothesis (b).

Mendel called **wrinkled shape a recessive** and **round shape a dominant** trait relative to wrinkled shape. because the round-seed phenotype appeared to dominate over the wrinkled-seed determinant when both were present in the hybrid F<sub>1</sub>.

# Reciprocal cross

Whether genetic determinant comes from male or female? **NO**

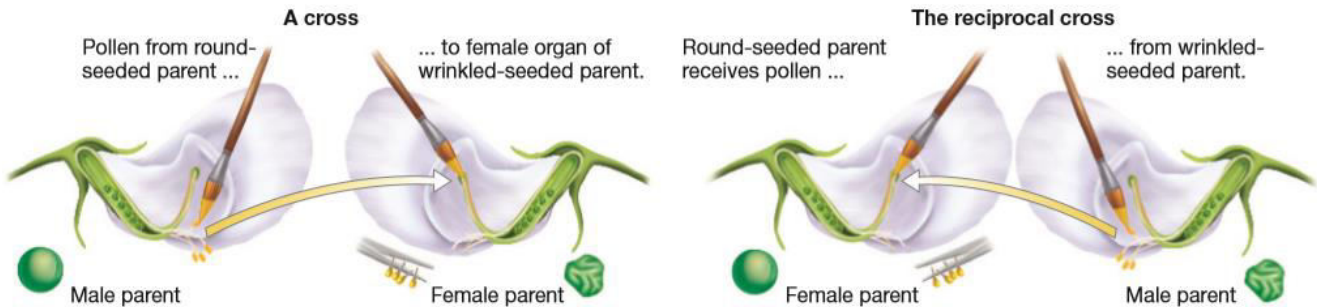
**RESEARCH**

**QUESTION:** Is the inheritance of seed shape in peas affected by whether the genetic determinant comes from a male or female gamete?

**HYPOTHESIS:** The type of gamete *does* affect the inheritance of seed shape.

**NULL HYPOTHESIS:** The type of gamete does *not* affect the inheritance of seed shape.

**EXPERIMENTAL SETUP:**



**A cross**

Pollen from round-seeded parent ...

... to female organ of wrinkled-seeded parent.

Male parent

Female parent

**The reciprocal cross**

Round-seeded parent receives pollen ...

... from wrinkled-seeded parent.


Female parent

Male parent

**PREDICTION OF "SEX MATTERS" HYPOTHESIS:** Offspring phenotypes will be different in the two crosses.

**PREDICTION OF NULL HYPOTHESIS:** Offspring phenotypes will be identical in the two crosses.

**RESULTS:**



First cross: All progeny have round seeds.

Results are identical

Reciprocal cross: All progeny have round seeds.















**CONCLUSION:** It makes no difference whether the genetic determinant for seed shape comes from the male gamete or from the female gamete.

**Figure 14.3 Mendel Also Performed a Reciprocal Cross.**

SOURCE: Mendel, G. 1866. Versuche über Pflanzen-hybriden. Verhandlungen des naturforschenden Vereines in Brünn 4: 3-47. English translation available from ESP: Electronic Scholarly Publishing ([www.esp.org](http://www.esp.org)).

# Observation from Mendel's experiment

**Table 14.2** The F<sub>2</sub> Produced from Mendel's Monohybrid Crosses

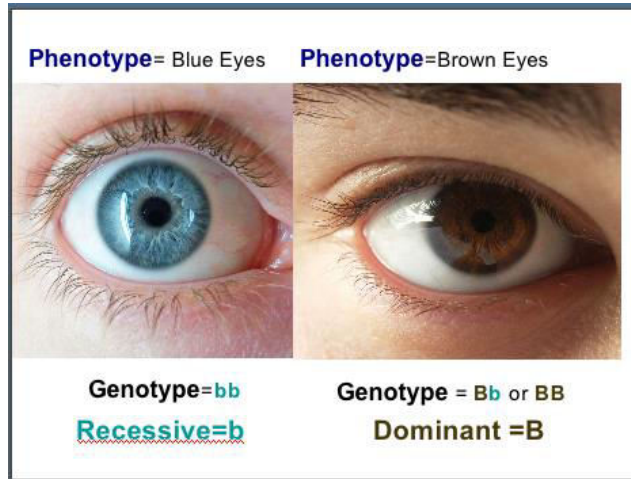
Trait	Dominant Phenotype	Recessive Phenotype	Ratio
Seed shape	5474 round 	1850 wrinkled 	2.96 : 1
Seed color	6022 yellow 	2001 green 	3.01 : 1
Pod shape	882 inflated 	299 constricted 	2.95 : 1
Pod color	428 green 	152 yellow 	2.82 : 1
Flower color	705 purple 	224 white 	3.15 : 1
Flower and pod position	651 axial 	207 terminal 	3.14 : 1
Stem length	787 tall 	266 dwarf 	2.96 : 1

1. The F<sub>1</sub> progeny showed only the dominant trait and did not exhibit an intermediate phenotype.
2. Reciprocal crosses produced the same results.
3. The ratio of dominant to recessive phenotypes in F<sub>2</sub>-generation individuals was about 3 to 1.



# Phenotype and Genotype

**Observable traits (Phenotype) of an individual depends on Genotype.**



## Genes, Alleles, and Genotypes:

**Gene** to indicate the hereditary determinant for a trait

**Alleles:** Mendel also proposed that each individual can have two versions of any gene. Today different versions of the same gene are called alleles.

**Genotype:** The combination of alleles found in an individual is called the genotype

# Conclusion from Mendel's experiment:

## Particulate inheritance

1. Hereditary determinants for traits do not blend together or become modified through use.
2. Hereditary determinants maintain their integrity from generation to generation.

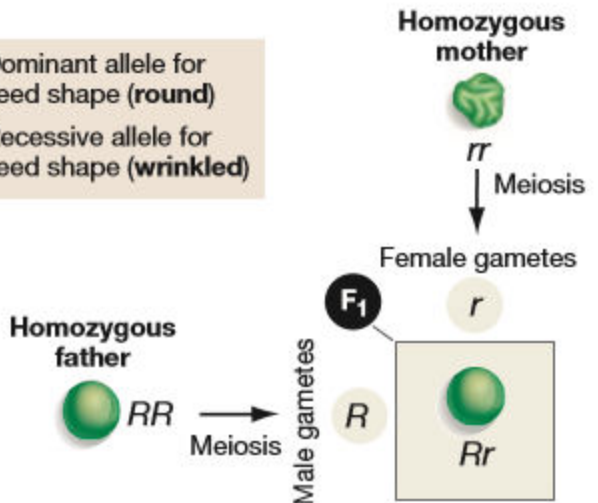
**Mendel's postulate** that there are two copies of each gene, which opened the possibility that when **F1** hybrids are crossed, some of the **F2** offspring may inherit two copies of the recessive allele, one from each of the hybrid parents. These F2 offspring with only the recessive allele would be expected to show the recessive phenotype that was hidden in the F1 hybrids.

# The Principle of Segregation

To account for the characteristic 3 : 1 ratio of phenotypes in F<sub>2</sub> individuals, Mendel reasoned that the two members of each gene pair must segregate—that is, separate—into different gamete cells during the formation of eggs and sperm. As a result, each gamete contains one allele of each gene. This idea is called the principle of segregation.

(a) A cross between two homozygotes

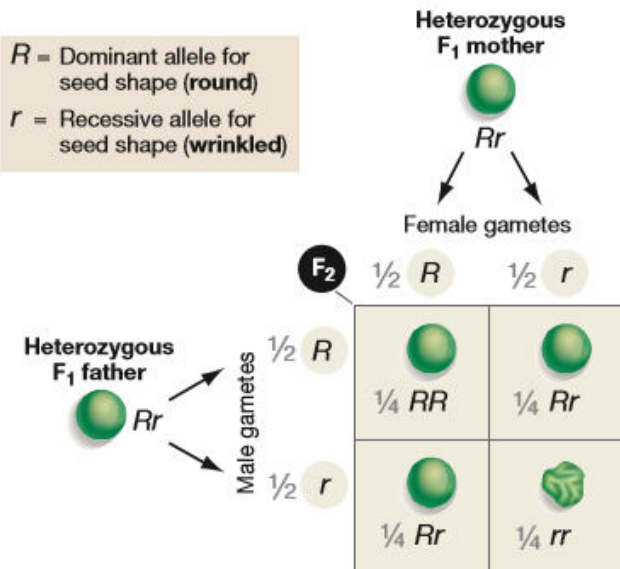
$R$  = Dominant allele for seed shape (round)  
 $r$  = Recessive allele for seed shape (wrinkled)



Offspring genotypes: All  $Rr$  (heterozygous)  
 Offspring phenotypes: All round seeds

(b) A cross between two heterozygotes

$R$  = Dominant allele for seed shape (round)  
 $r$  = Recessive allele for seed shape (wrinkled)



Offspring genotypes:  $\frac{1}{4} RR$  :  $\frac{1}{2} Rr$  :  $\frac{1}{4} rr$   
 Offspring phenotypes:  $\frac{3}{4}$  round :  $\frac{1}{4}$  wrinkled

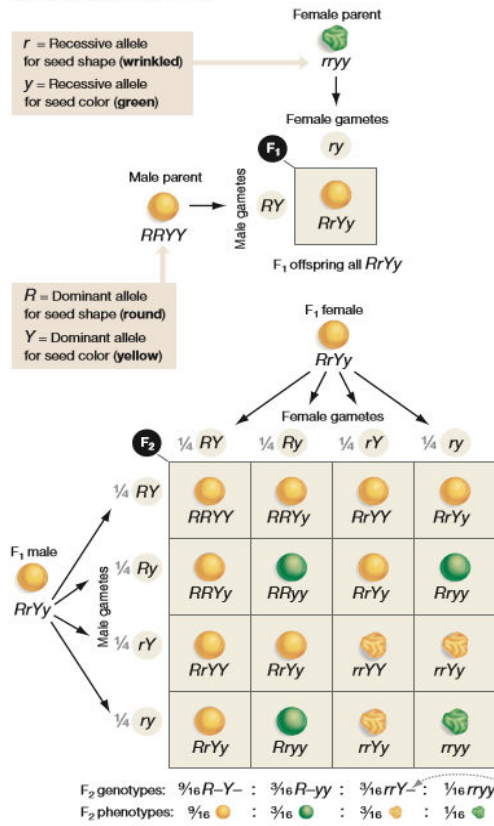
**Figure 14.4** Mendel Analyzed the Offspring of a Monohybrid Cross. See Making Models 14.1 for tips on how Punnett squares are constructed.

# Mendel's Experiments with Two Traits

## The Dihybrid Cross

A mating between two individuals who are heterozygous for two traits is called a **Dihybrid CROSS**

(a) Hypothesis of independent assortment:  
Alleles of different genes don't stay together when gametes form.



Allele for seed shape and the allele for seed color originally present in each parent and separate from each other and be transmitted independently. This is known as **independent assortment**

(c) Mendel's results

<b>F<sub>2</sub> phenotypes</b>					556 total
<b>Number</b>	315	108	101	32	
<b>Fraction of offspring</b>	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{16}$	

Data are consistent with the predictions of independent assortment.

# If not Independent Assortment

**(b) Hypothesis of dependent assortment:**  
Alleles of different genes stay together when gametes form.

