11–3 Exploring Mendelian Genetics

Independent Assortment

To determine if the segregation of one pair of alleles affects the segregation of another pair of alleles, Mendel performed a two-factor cross.

The Two-Factor Cross: F1

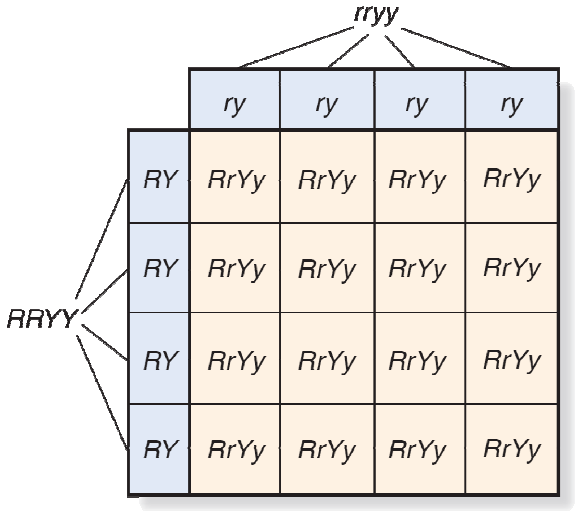
Mendel crossed true-breeding plants that produced round yellow peas (genotype *RRYY*) with true-breeding plants that produced wrinkled green peas (genotype *rryy*).

What are the possible gametes each parent can make?

RRYY can only give the R (round) allele for seed shape and the Y (yellow) allele for seed color – making only RY gametes

rryy can only give the r (wrinkled) allele for seed shape and the y (green) allele for seed color – making only make ry gametes

The alleles for round (*R*) and yellow (*Y*) are dominant over the alleles for wrinkled (*r*) and green (*y*).



All of the F1 offspring produced round yellow peas (*RrYy*).

The Two-Factor Cross: F2

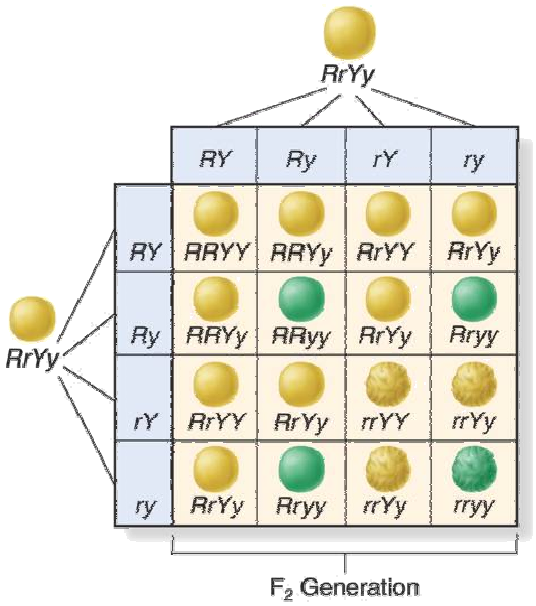
Mendel crossed the heterozygous F1 plants (*RrYy)* with each other to determine if the alleles would segregate from each other in the F2 generation.

$$RrYy \times RrYy$$

What possible gametes can each of these F1 plants (*RrYy)* make?

FOIL the genotype. RrYy
First = RY
Outer = Ry
Inner = rY
Last = ry

Put the four possible gametes across the top and down the sides of a Punnett Square.



In Mendel's experiment, the F2 generation produced the following:

- 9/16 seeds that were round and yellow
- 3/16 seeds that were wrinkled and green
- 3/16 seeds that were round and green
- 1/16 seeds that were wrinkled and yellow

The Punnett square predicts a 9 : 3 : 3 :1 phenotypic ratio in the F2 generation.

The alleles for seed shape segregated independently of those for seed color. This principle is known as **independent assortment**.
Genes that segregate independently do not influence each other's inheritance.
Mendel's experimental results were very close to the 9 : 3 : 3 : 1 ratio predicted by the Punnett square.
Mendel had discovered the principle of independent assortment.
The principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes.
Independent assortment helps account for the many genetic variations observed in plants, animals, and other organisms.

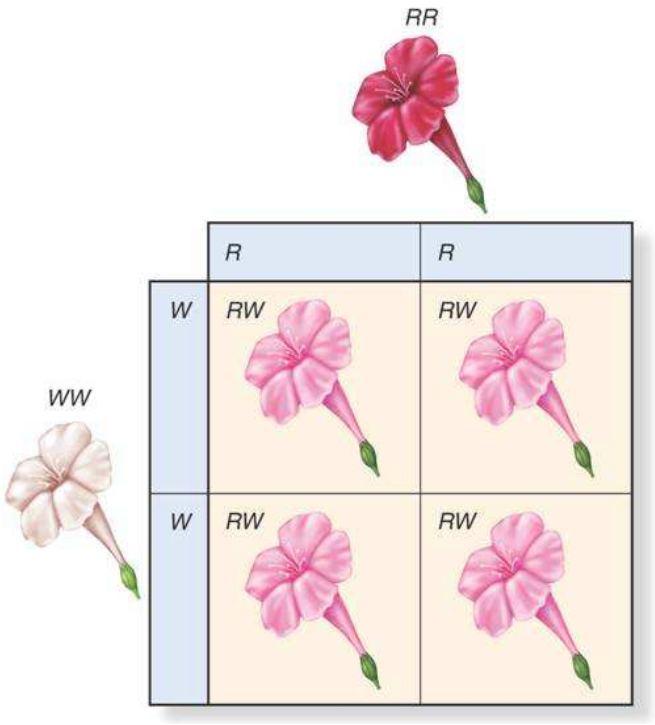
A Summary of Mendel's Principles

- Genes are passed from parents to their offspring.
- If two or more forms (alleles) of the gene for a single trait exist, some forms of the gene may be dominant and others may be recessive.
- In most sexually reproducing organisms, each adult has two copies of each gene. These genes are segregated from each other when gametes are formed.
- The alleles for different genes usually segregate independently of one another.

What inheritance patterns exist aside from simple dominance?

Some alleles are neither dominant nor recessive, and many traits are controlled by multiple alleles or multiple genes.

Incomplete Dominance
When one allele is not completely dominant over another it is called **incomplete dominance**.
In incomplete dominance, the heterozygous phenotype is between the two homozygous phenotypes.
There are **three different phenotypes**.
A cross between **red** (*RR*) and **white** (*WW*) four o'clock plants produces **pink**-colored flowers (*RW*).



Codominance
In **codominance**, both alleles contribute to the phenotype.
In certain varieties of chicken, the allele for **black** (BB) feathers is codominant with the allele for **white** (WW) feathers.
Heterozygous (BW) chickens are speckled with **both black and white feathers**. The black and white colors do not blend to form a new color, but **appear separately**.

Multiple Alleles
Genes that are controlled by more than two alleles are said to have **multiple alleles**.
An individual can't have more than two alleles. However, more than two possible alleles can exist in a population.

A rabbit's coat color is determined by a single gene that has at least four different alleles.

Multiple alleles in humans can be found in Blood Types
The three alleles are:
A allele B allele O allele
Blood types are determined by what two alleles one has.
Type A = AA or AO
Type B Blood = BB or BO
Type AB Blood = AB
Type O blood = OO

Polygenic Traits
Traits controlled by two or more genes are said to be **polygenic traits.**

Skin color, eye color and hair color in humans are polygenic traits that are controlled by more than two different genes.

Applying Mendel's Principles

Thomas Hunt Morgan used fruit flies to advance the study of genetics.

Morgan and others tested Mendel's principles and learned that they applied to other organisms as well as plants.

Mendel's principles can be used to study inheritance of human traits and to calculate the probability of certain traits appearing in the next generation.

Genetics and the Environment

Characteristics of any organism are determined by the interaction between genes and the environment.