
Mendelian
Genetics

Mendelian Genetics

- Has anyone ever told you that you have your mother's dimples or your father's nose?

- Have you ever wondered why you are a particular height, have curly hair, or maybe green eyes?

- All of these questions can be answered by understanding **heredity** - the passing of traits from one generation to the next.

Gregor Mendel

- Gregor Mendel is known as the *father of genetics*.
- He was born in **1822** in Austria.
- He became a monk and worked in the monastery **gardens**.
- He became fascinated with **pea** plants that grew there.

Gregor Mendel

Mendel's Garden

Gregor Mendel

- Mendel's experiments with peas were able to show that **genes** are discrete units that keep their separate identities when passed from **generation** to **generation**.

- One of the reasons for the success of Mendel's experiments was that they were very carefully designed and controlled.

- Mendel kept detailed notes of everything that he did and what he observed.

Mendel used peas because they were easy to grow and had many traits that were easily distinguishable (color, shape, height, etc.)

Gregor Mendel

- Mendel observed traits in his pea plants (7 to be exact).

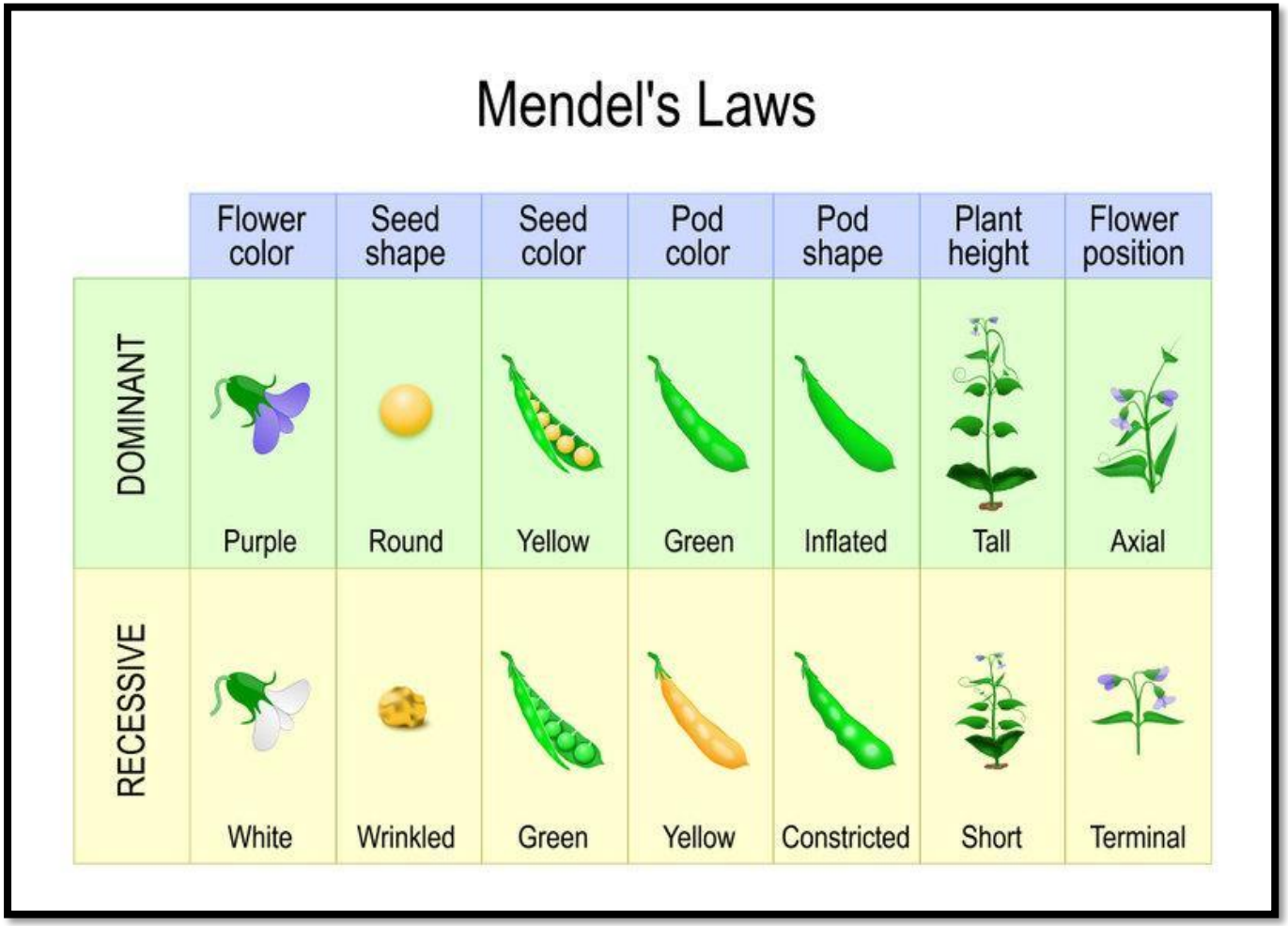
- **Traits** are distinguishing characteristics that are inherited.
  - eye color
  - leaf shape
  - tail length
  - widow's peak

- Scientists knew that traits were inheritable (passed from one generation to the next), but they didn't know HOW.

- That is…until Mendel!

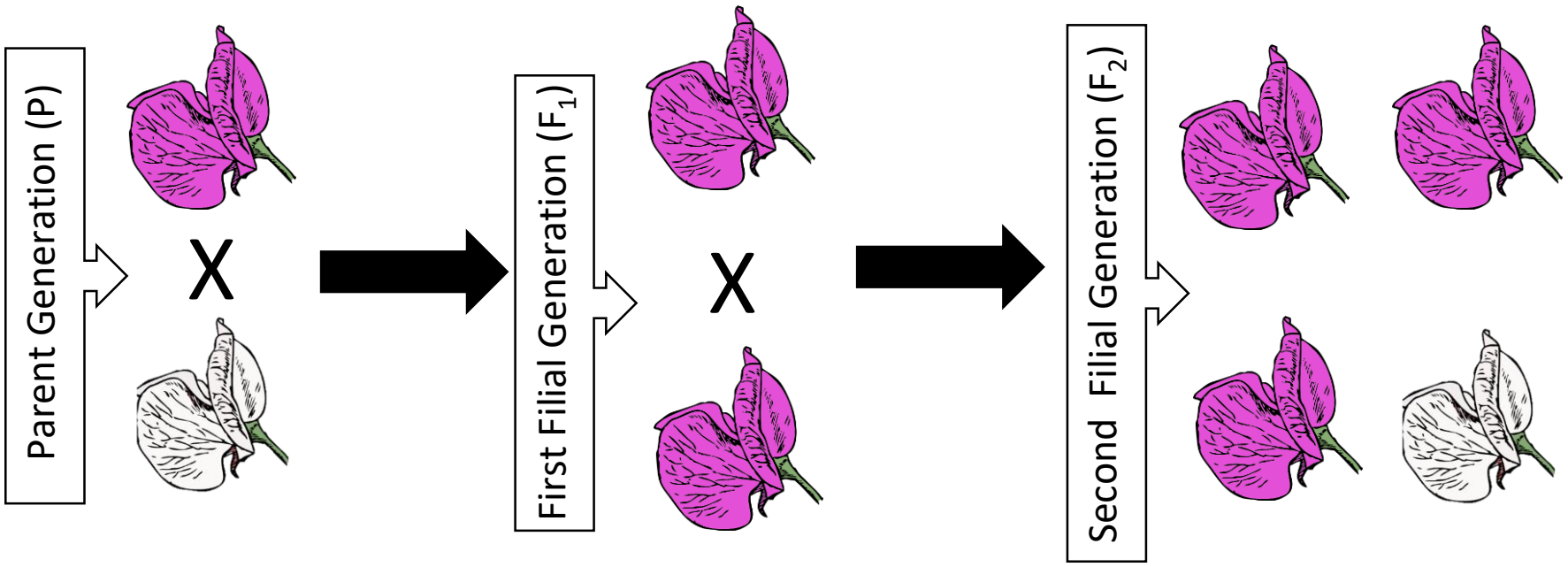
Gregor Mendel

- Mendel observed the following traits in his pea plants:



Gregor Mendel

- In genetics, we refer to the mating of two organisms as a **cross**.
- Mendel noticed that when he crossed a purebred, white-flowered pea plant with a purebred, purple-flowered pea plant, the resulting offspring looked like this:



- Traits that were hidden when parental purebred flowers were crossed reappeared in the F_2 generation.

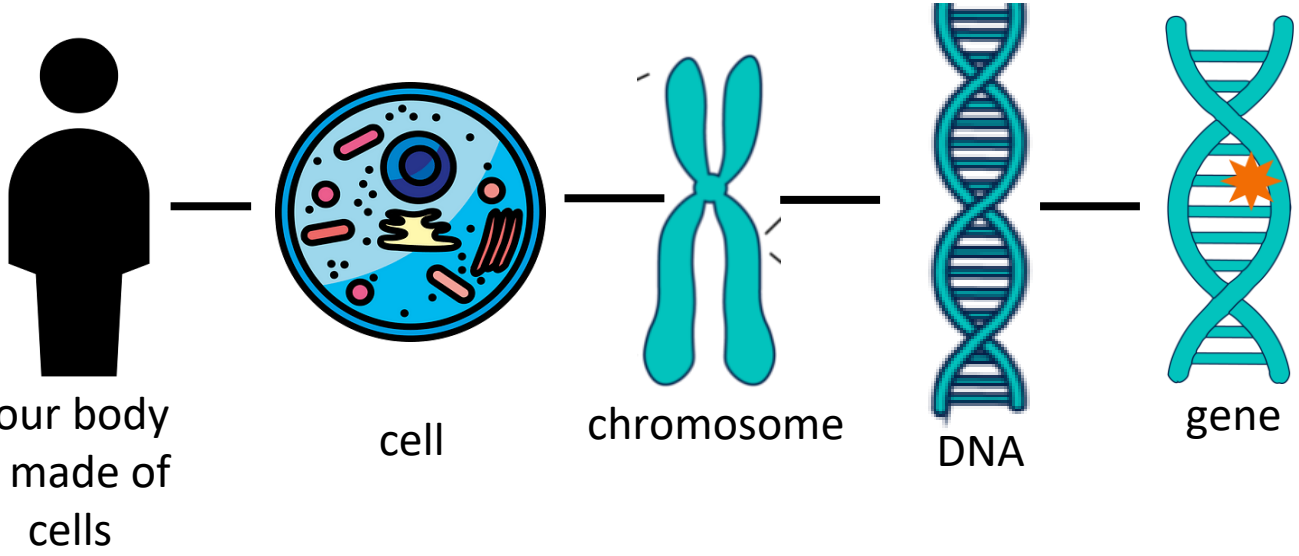
Gregor Mendel

- This was one example of the many patterns that Mendel discovered during his experiments.

- From these observations, Mendel drew three important conclusions which are known as Mendel's laws:
  - Law of Segregation
  - Law of Independent Assortment
  - Law of Dominance

Law of Segregation

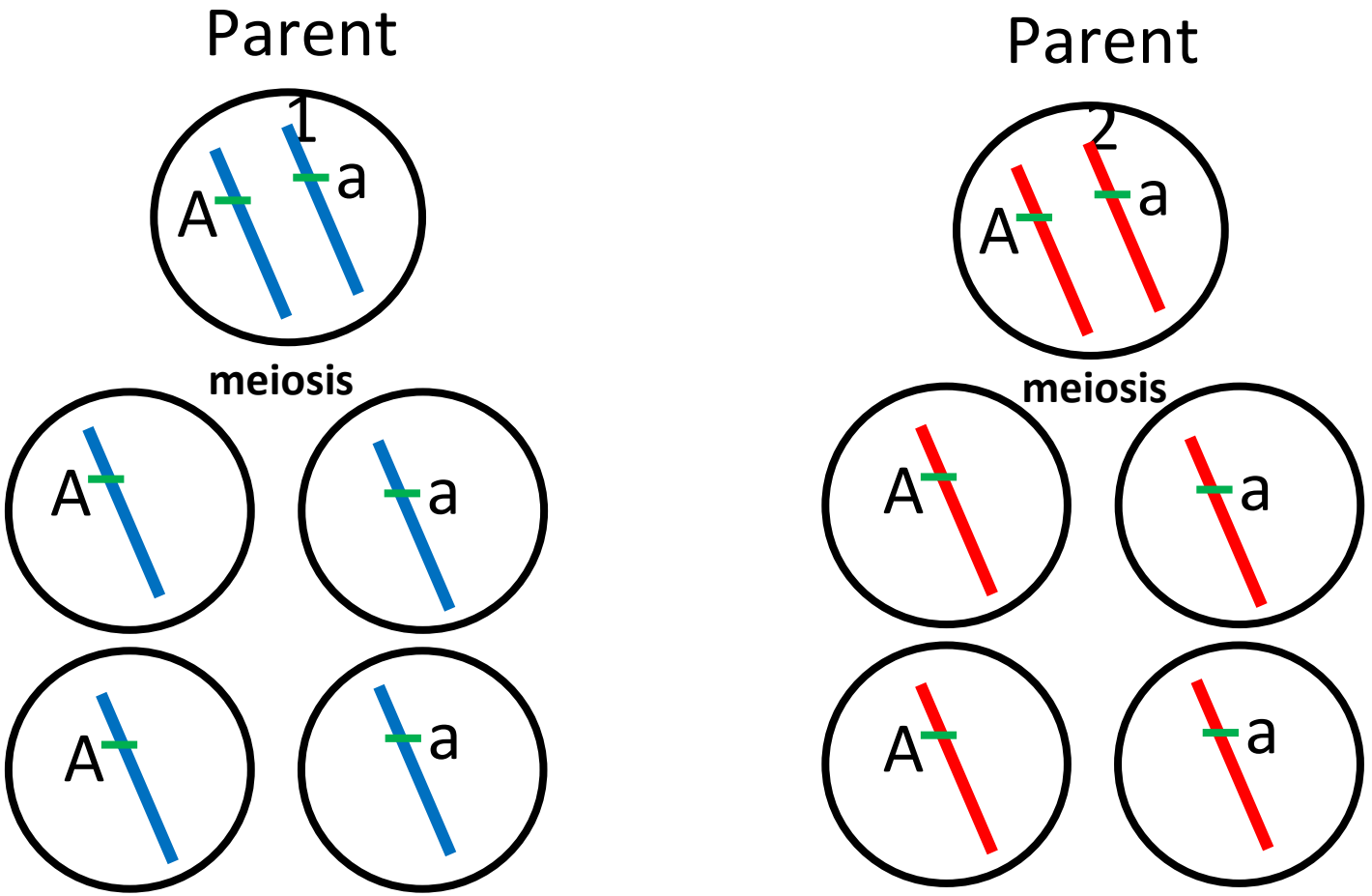
- Organisms inherit **two** copies of each gene, one from each parent.



- **Genes** are pieces of DNA that provide instructions to make a certain protein.
- Genes determine your **traits** (features or characteristics that are passed on to you - or inherited - from your parents).

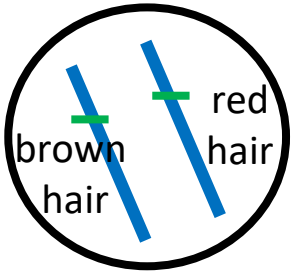
Law of Segregation

- Organisms donate only one copy of each gene in their gametes.



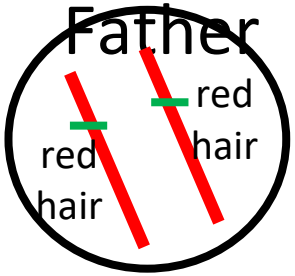
Law of Segregation

Emma's Mother

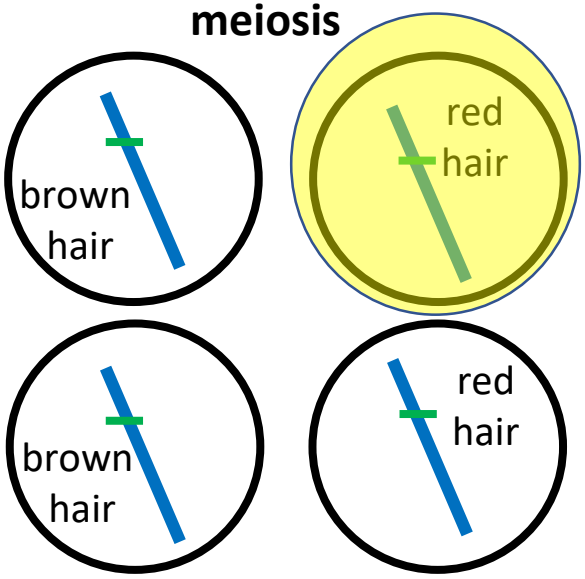


Emma

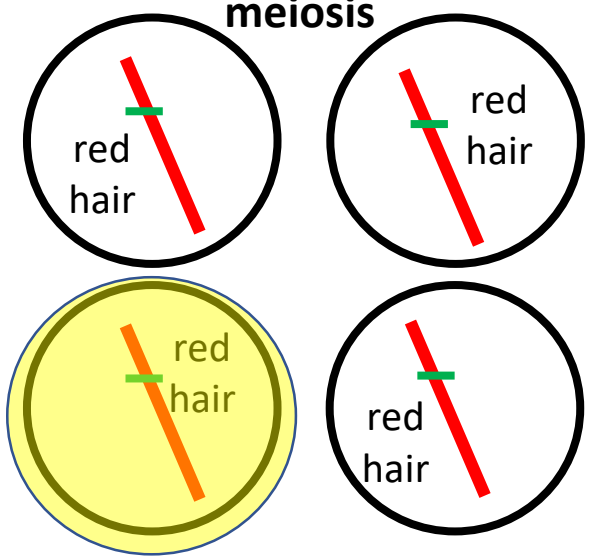
Emma's Father



meiosis

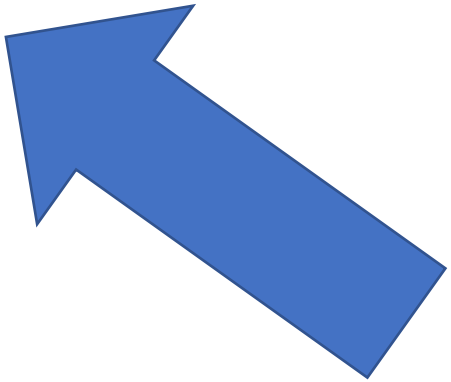


meiosis



Mendel's Laws

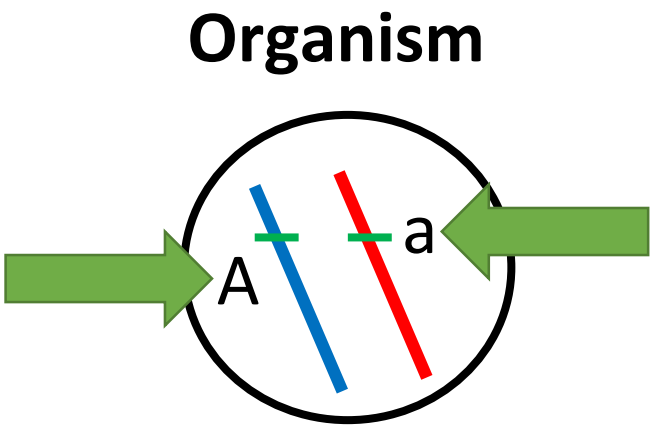
- Law of Segregation
- Law of Independent Assortment
- Law of Dominance



Before we discuss Mendel's other laws, we need to understand some important principles of heredity.

Traits, Genes and Alleles

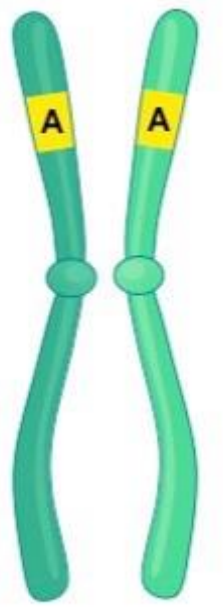
- There can be different versions of genes called **alleles.**
- You receive one from each parent.
- represented by letters (ex: Y for yellow color or y for green color in peas)



Traits, Genes and Alleles

- The alleles that an organism receives from its parents can be the same (**homozygous**).

- Or… the two alleles might be different (**heterozygous**).



Homozygous
Alleles are same

Heterozygous
Alleles are different

Traits, Genes and Alleles

- A **genotype** refers to an organism's combination of alleles.
  - ex. BB, Bb, bb

- The physical characteristics, or traits, of an individual organism make up its **phenotype**.
  - ex. blue eyes, smooth peas, tall plant, brown fur

Dominant and Recessive Alleles

- As Mendel learned, one allele might be dominant over another.

- A **dominant** allele is the allele that is expressed when two different alleles or two dominant alleles are present.

Dominant alleles are represented with uppercase letters.
ex. AA, Aa

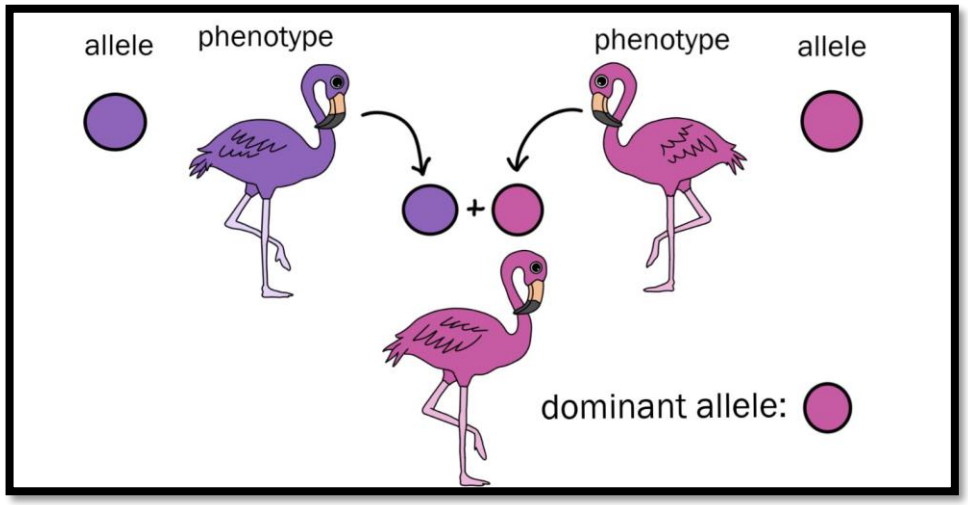


Image source: By Gabi Slizewska

Dominant and Recessive Alleles

- A **recessive** allele is the allele that is only expressed when two copies are present.
  - ex. aa

Recessive alleles are represented with lowercase letters.
ex. Aa, aa

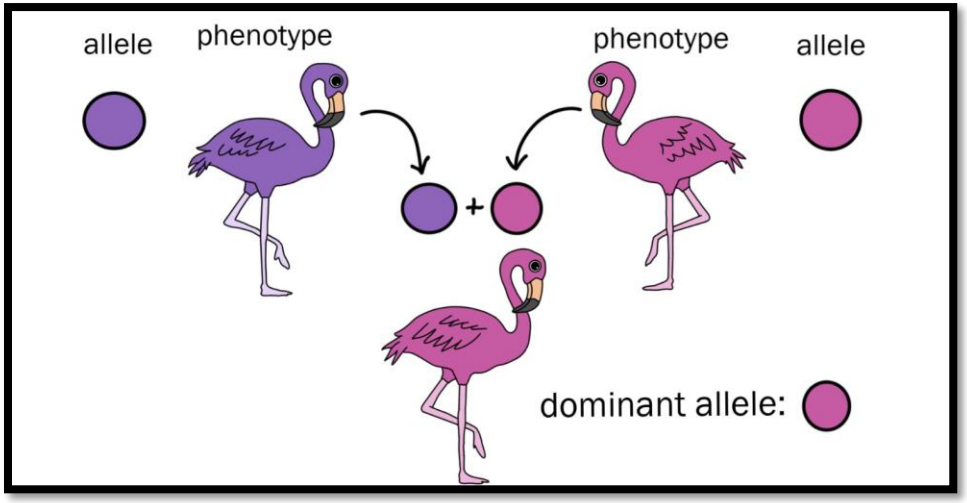


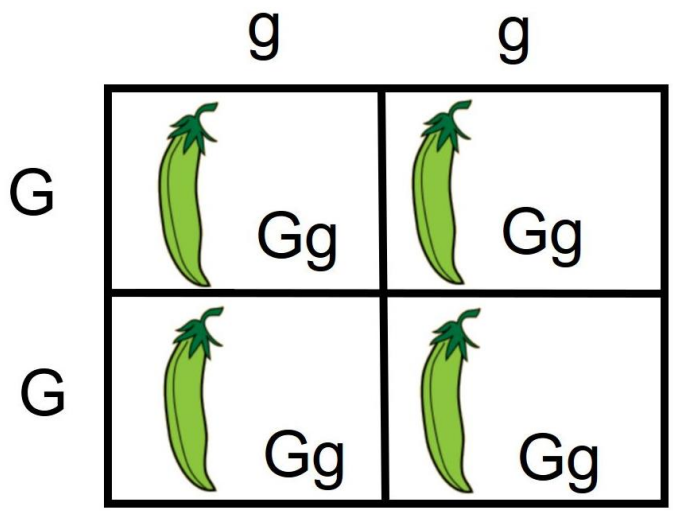
Image source: By Gabi Slizewska

Dominant and Recessive Alleles

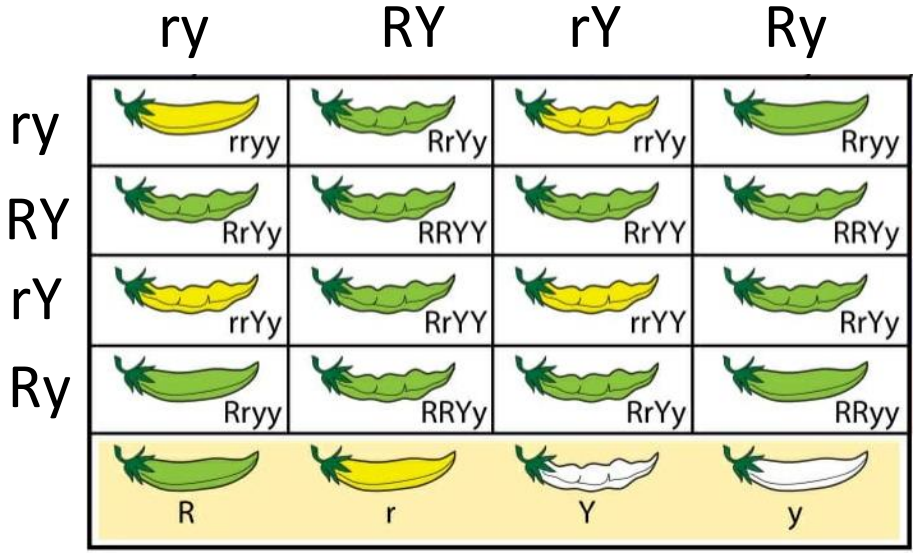
- an organism's genotype might be:
  - homozygous dominant (TT)
  - heterozygous (Tt)
  - homozygous recessive (tt)

Punnett Square

- A Punnett square is used to show possible **offspring** of a genetic cross.
  - monohybrid- crosses one trait (4 boxes)
  - dihybrid- crosses two traits (16 boxes)

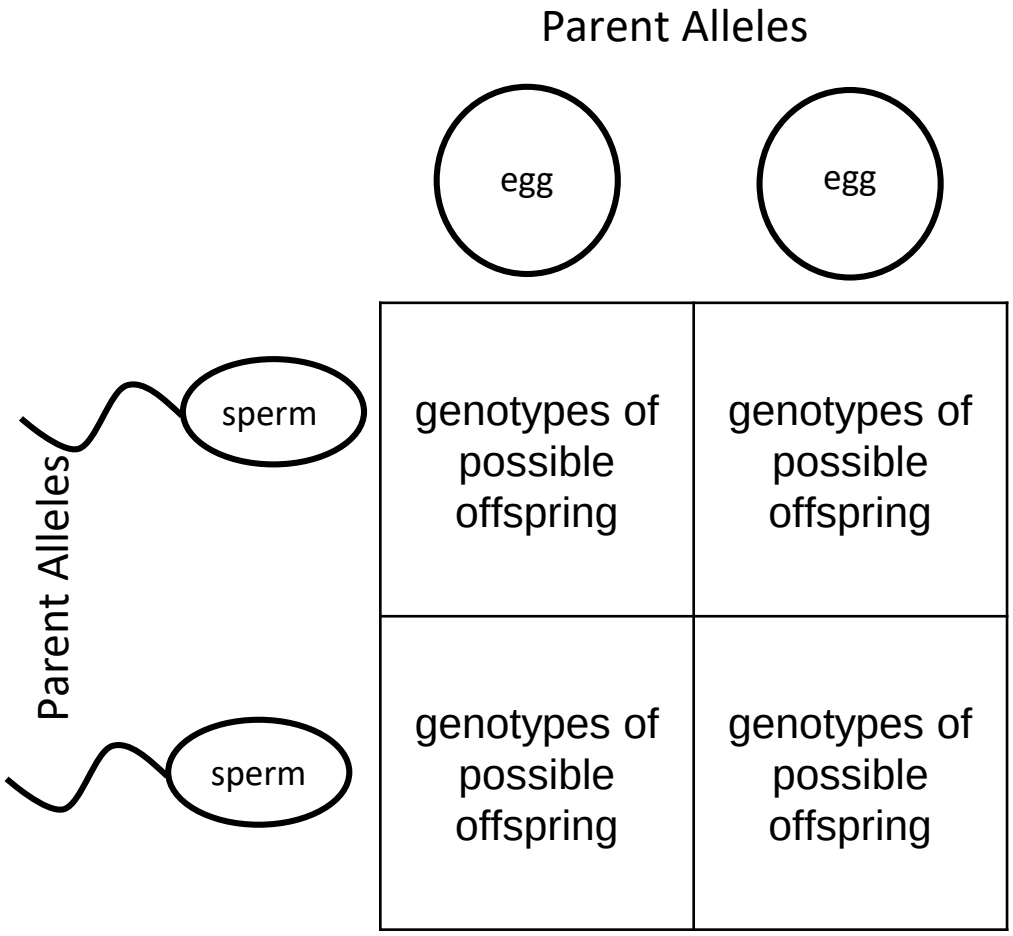


monohybrid cross



dihybrid cross

Punnett Square



	t	t
T	Tt	Tt
t	tt	tt

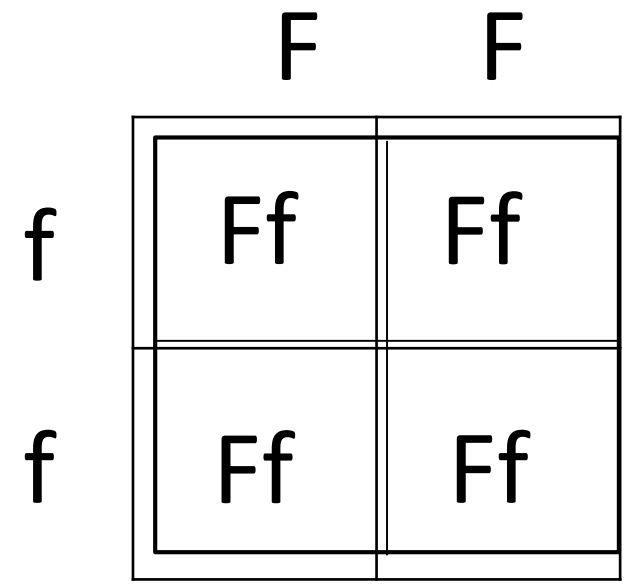
Punnett Square

HOMOZYGOUS-HOMOZYGOUS

Suppose you cross a pea plant that is homozygous dominant for purple flowers with a pea plant that is homozygous recessive for white flowers.

What percent of the offspring will have purple flowers? **100%**

White flowers? **0%**



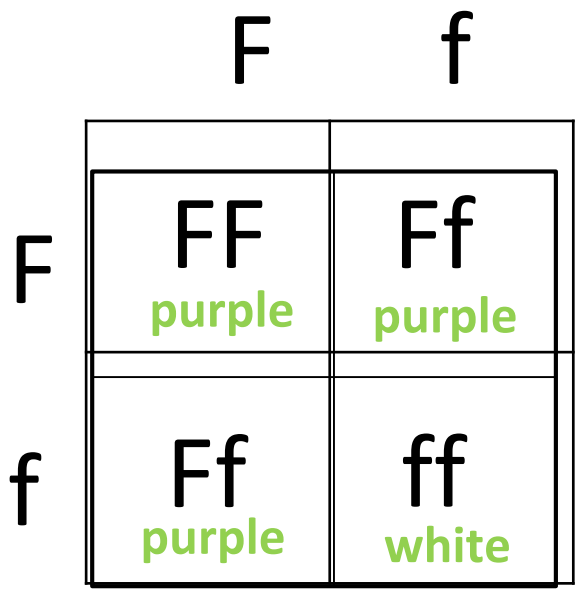
Punnett Square

HETEROZYGOUS-HETEROZYGOUS

Suppose you cross two purple-flowered pea plants that are both heterozygous (Ff).
(*Note*: Purple-flowered plants are dominant to white-flowered plants.)

What percentage of the offspring will have white flowers? **25%**

What is the phenotypic ratio?
3:1 (purple : white)
What is the genotypic ratio? **1:2:1**



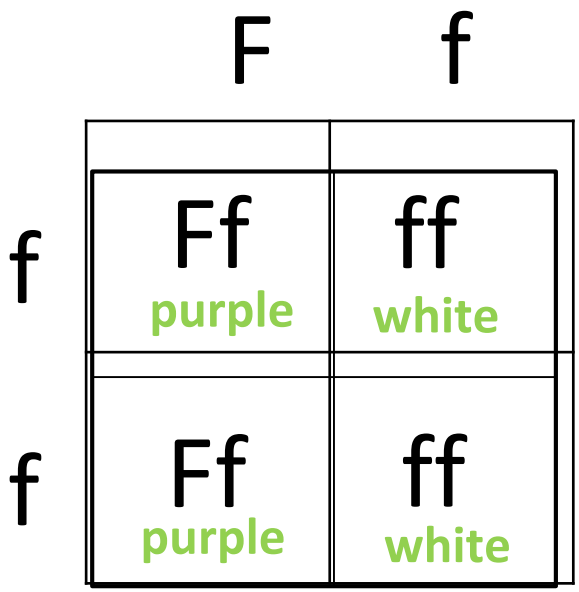
Punnett Square

HETEROZYGOUS-HOMOZYGOUS

Suppose you cross a pea plant that is heterozygous for purple flowers (Ff) with a pea plant that is homozygous recessive for white flowers (ff).

What percentage of the offspring will have white flowers? **50%**

What is the phenotypic ratio? **1:1**



Practice

Describe each of the following as a genotype (g) or phenotype (p):

1. red hair p
2. Hh g
3. yy (homozygous recessive) g
4. wrinkled peas p
5. freckles p

Practice

Describe each of the following as homozygous dominant, homozygous recessive, or heterozygous:

1. yy homozygous recessive
2. Hh heterozygou
3. MM homozygous dominant
4. Xx heterozygou
5. gg homozygous recessive

Practice

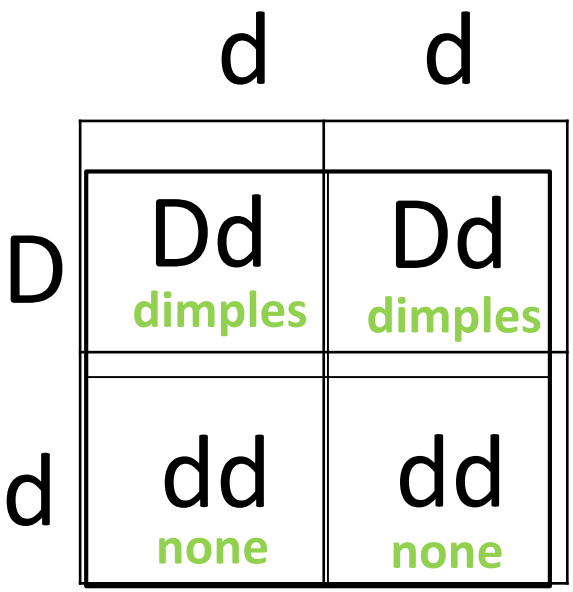
In humans, dimples (D) are dominant to no dimples (d). Cross a female with no dimples with a man who is heterozygous for dimples.

What is the phenotypic ratio of their offspring?

1:1 (dimples: no dimples)

What percent of the offspring will have dimples?

50%



Practice

In humans, freckles are dominant to no freckles. Cross two parents that are both heterozygous.

What is the phenotypic ratio of their offspring?

3:1 (freckles: no freckles)

What percent of the offspring will have freckles?

75%