Mendelian Genetics

Standard B-4.6

Predict inherited traits by suing the principles of Mendelian genetics (including segregation, independent assortment, and dominance).

Key Concepts

Genetics: alleles

Law (Principle) of Dominance

Law(Principle) of Segregation

Law(Principle) of Independent Assortment

Punnett squares

What You Already Know…

In the ***7th grade***, you summarized how genetic information is passed from parents to offspring using the terms genes, chromosomes, inherited traits, genotype, phenotype, dominant traits, and recessive traits and used Punnett squares to predict inherited monohybrid traits.

It is Essential for you to Know…

- The principles of Mendelian Genetics

OBJECTIVES

- ***Predict*** inherited traits by using the principles of Mendelian Genetics.
- ***Identify*** traits as homozygous or heterozygous, dominant or recessive.
- ***Infer*** the possible genotypes and phenotypes of offspring.
- ***Illustrate*** monohybrid and dihybrid crosses.
- ***Summarize*** the Mendelian concepts of independent assortment, segregation and dominance.
- ***Compare*** the genotypes and phenotypes of offspring to their parents.

Define the Following:

1. Trait
2. Genetics
3. Purebred
4. Cross
5. Law of segregation
6. Gene
7. Allele
8. Homozygous
9. Heterozygous
10. Genome
11. Genotype
12. Phenotype
13. Dominant
14. Recessive
15. Punnett square
16. Monohybrid square
17. Testcross
18. Dihybrid cross
19. Law of independent assortment
20. Probability

Genetics

- Heredity deals with genes and genetics.
  - Genes come in many forms and determine traits.
  - This explains the diversity of life.

- Genetics is the scientific study of heredity.
  - A geneticist studies genetics.

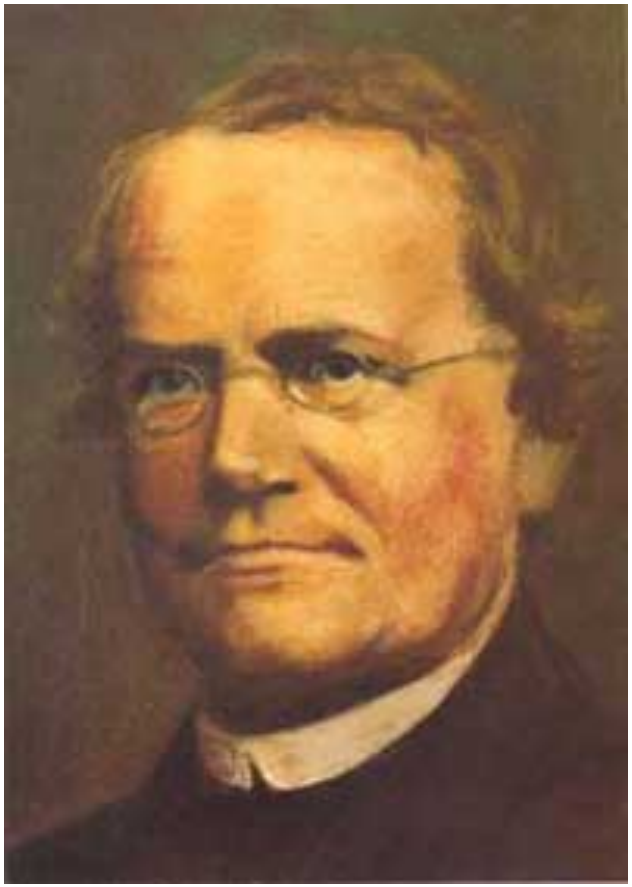
Traits are distinguishing characteristics that make each organism a little different.

We study heredity through the field of Genetics.

Gregor Mendel's Peas

The Father of Genetics is Gregor Mendel

- Austrian Monk
- Born 1822
- In charge of the monastery's garden.
- Worked with garden peas.
- Knew nothing about genetics yet correctly predicted the results of meiosis.



Gregor Mendel's Peas

3 Key Choices

1. Control over breeding.
2. Use of purebred plants.
3. Used "either-or" traits.

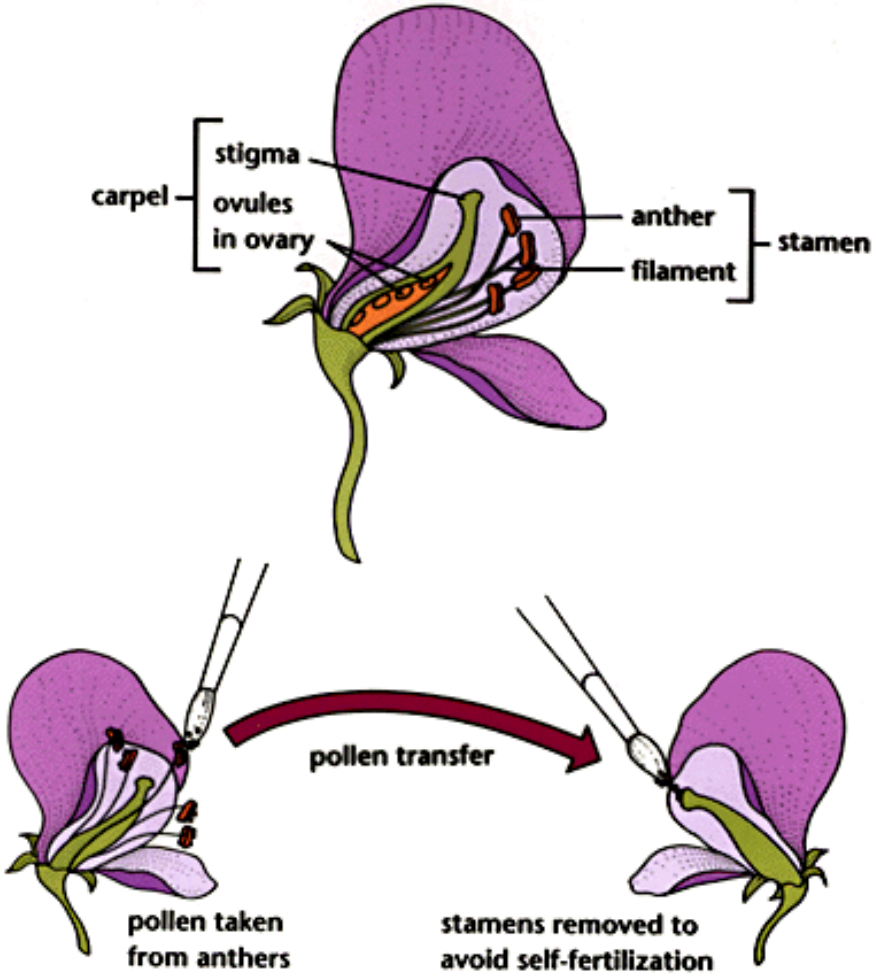
Gregor Mendel's Peas

- Pea plants reproduce quickly.
- Pea plants can either cross-pollinate (2 parents) or self-pollinate (1 parent).
- Had purebred peas, if allowed to self pollinate, then they would produce identical peas.
  - Only tall peas make tall peas
  - Only short peas make short peas
  - Only green peas make green peas
  - Only yellow peas make yellow peas

In the 1800s, Gregor Mendel discovered the rules of genetics.

Pea plants are how Mendel's genetic studies began.

Mendel Cross Pollinated



Traits Studied

Mendel studied 7 traits in his pea plants:

1) **Seed Shape** (round or wrinkled)
2) **Seed Color** (yellow or green)
3) **Seed Coat Color** (gray or white)
4) **Pod Shape** (smooth or constricted)
5) **Pod Color** (green or yellow)
6) **Flower Position** (axial or terminal)
7) **Plant Height** (tall or short)

Trait	Phenotypes	
Seed shape	 Round	 Wrinkled
Seed color	 Yellow	 Green
Pod shape	 Inflated	 Constricted
Pod color	 Green	 Yellow
Flower color	 Purple	 White
Flower and pod position	 Axial (on stem)	 Terminal (at tip)
Stem length	 Tall	 Dwarf

True Breeding - crossed to itself produces only itself

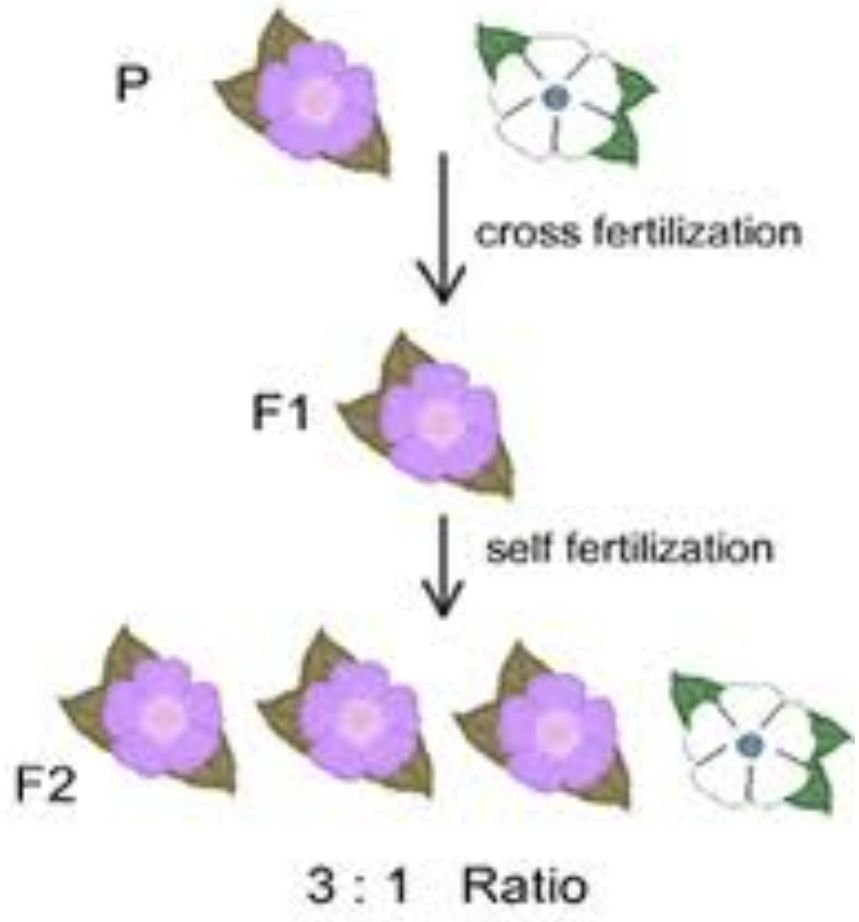
Crosses

- Mendel crossed (mated) peas with different traits to see what would the offspring would look like.
- The original pair is called the *P generation* (parental generation). Their offspring is called the *F_1 generation* (first filial generation).
- When Mendel crossed parents of different traits, their F_1 generation was considered a hybrid.

Crosses

Mendel noticed that the F_1 generation looked like only one of the parents and NOT a combination of both of them. Why?

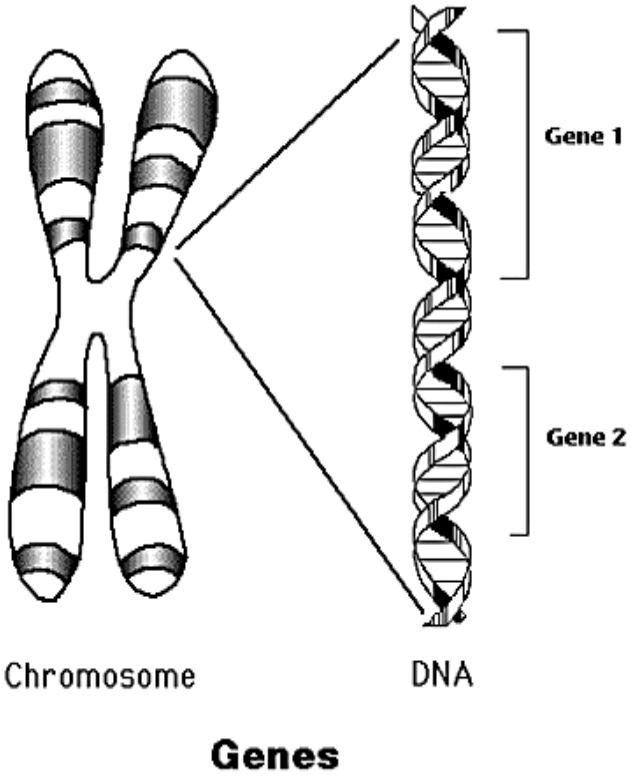
What happened in the F_2 generation? Why?



What did all this tell Mendel?

Mendel drew three conclusions about heredity through his experiments:

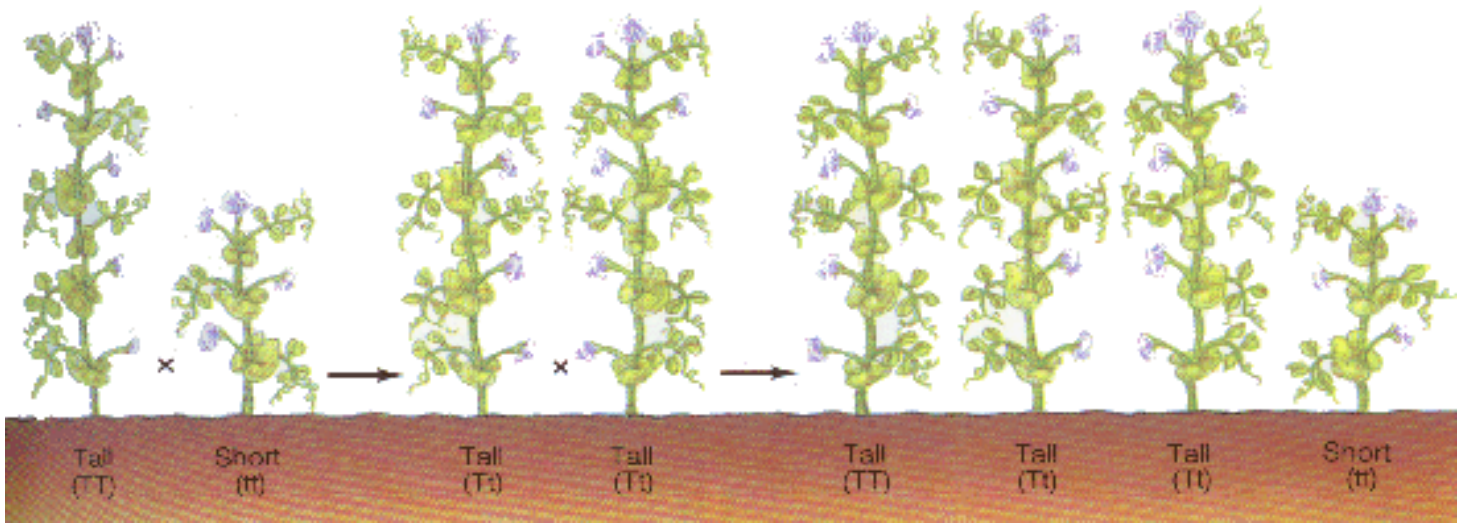
a. Traits are inherited as discrete units.
b. Organisms inherit two copies of each gene, one from each parent.
c. Organisms donate only one copy of each gene in their gametes. The two copies separate (segregate) through gamete formation.



Look at the picture to the left. Within a chromosome, DNA is found. On that DNA, there are different genes. Each chromosome has certain genes that are found only on that chromosome. Since you have two sets of chromosomes, one set of those genes came from your mother, while the other set came from your father. The combination of those genes determines what the organism looks like.

Principle of Dominance

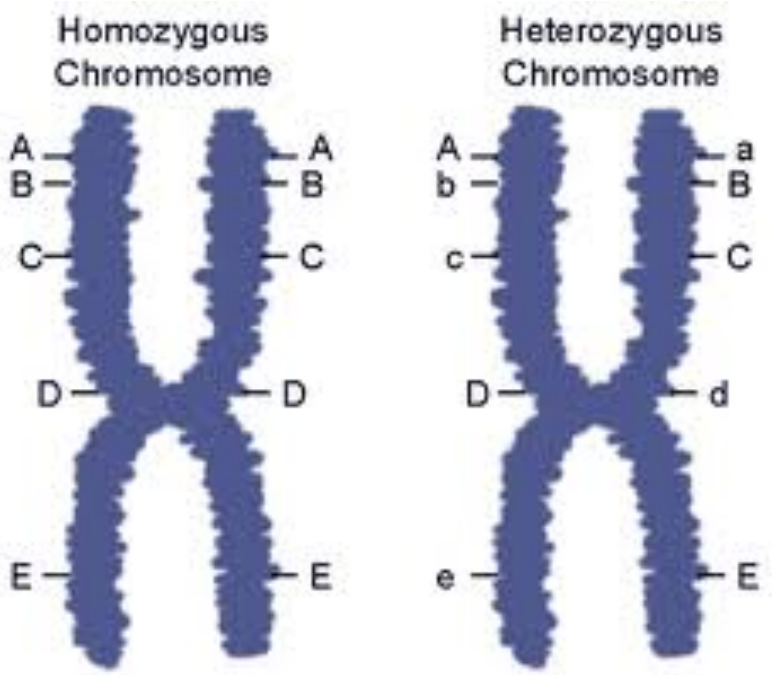
The **Law (Principle) of Dominance** states that some alleles are dominant and others are recessive.



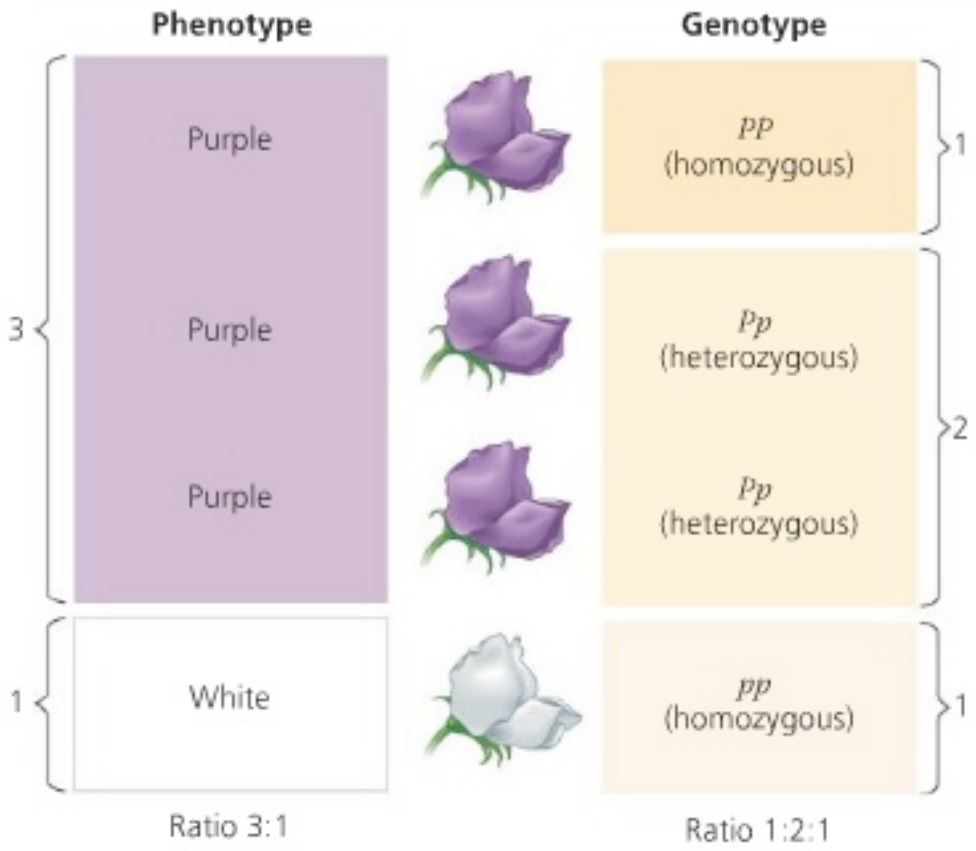
Heterozygous vs. Homozygous

Alleles that are the same are **homozygous**.

Alleles that are different are **heterozygous**.



Phenotype vs. Genotype



Genotype: The actual gene (alleles)

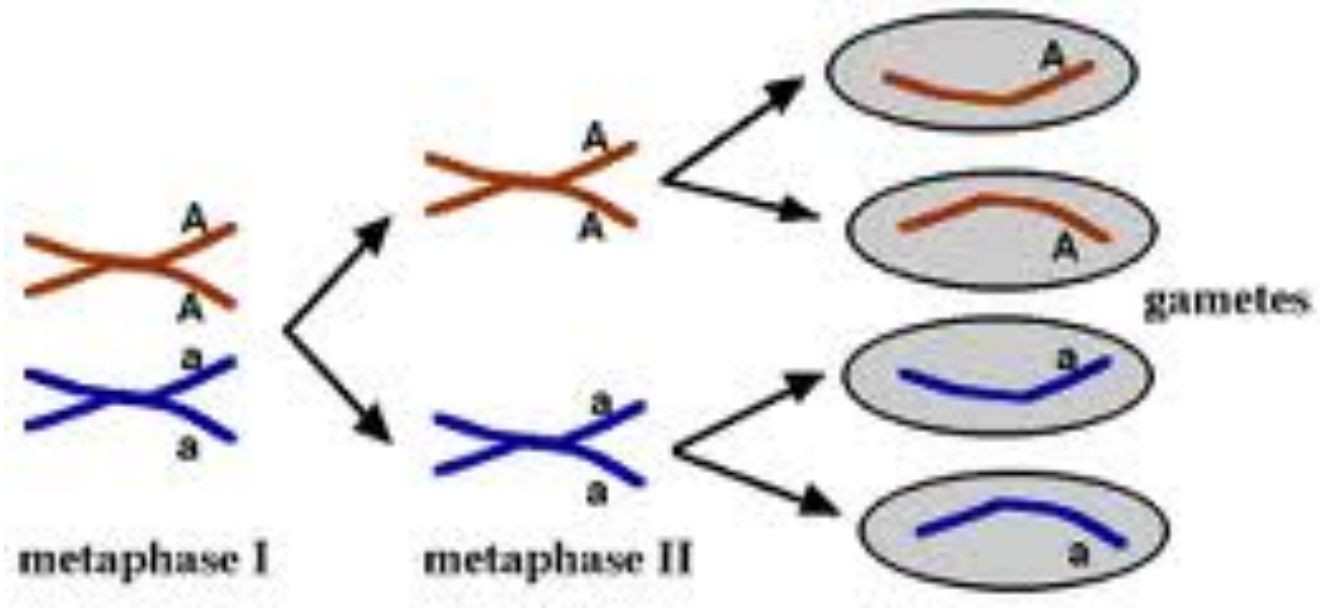
Pp

Phenotype: The physical trait expressed.

purple

Principle of Segregation

- The **Law (Principle) of Segregation** explains how alleles are separated during meiosis.



Always a Dominant?

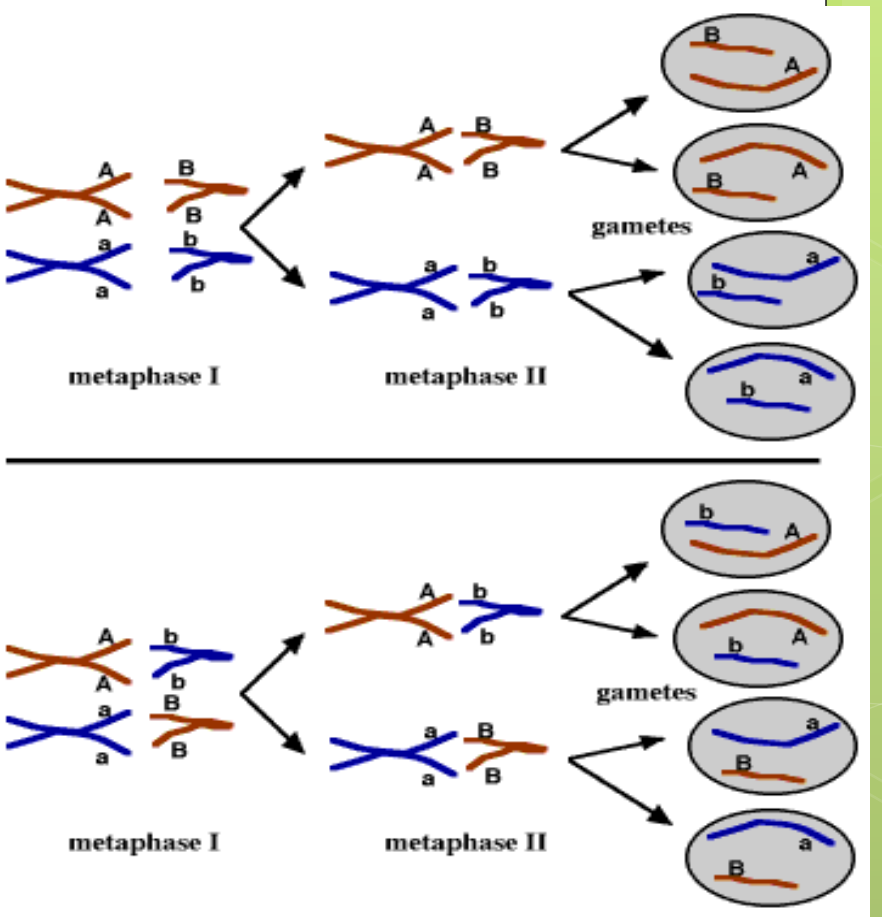
Are there always only two forms of a gene?

We will discuss exceptions to the Principle of Dominance in the next section.

Principle of Independent Assortment

The **Law (Principle) of Independent Assortment** states that the segregation of alleles of one trait does NOT affect the segregation of the alleles of another trait.

Holds true unless genes are linked.

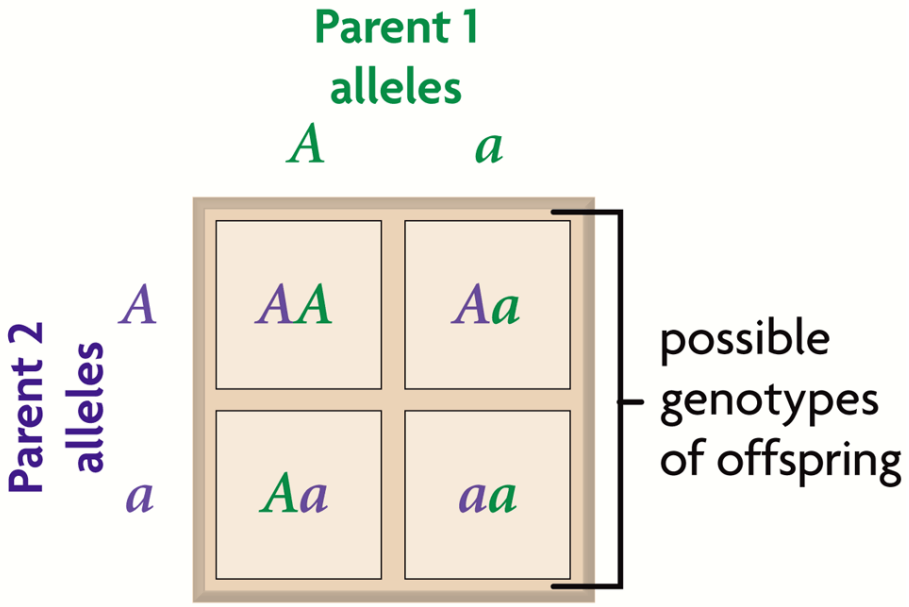


Punnett Squares

- The Punnett square is a grid system for predicting all possible genotypes resulting from a cross.
  - The axes represent the possible gametes of each parent.
  - The boxes show the possible genotypes of the offspring.

- The Punnett square yields the ratio of possible genotypes and phenotypes.

The **Punnett square** is a grid system for predicting possible genotypes of offspring.



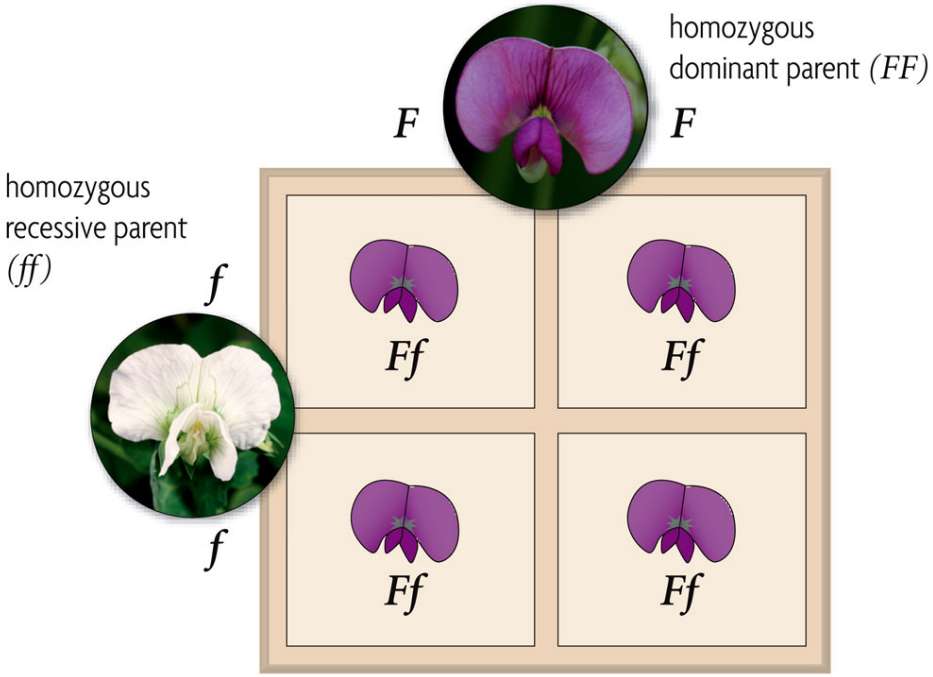
Punnett Squares

- Two types of crosses:
  - monohybrid cross
    - One type of characteristic is crossed
    - Example: TT x tt
    - 4 square Punnett Square
  - dihybrid cross
    - Two characteristics are crossed
    - Example: TTRr x ttRR
    - 16 square Punnett Square

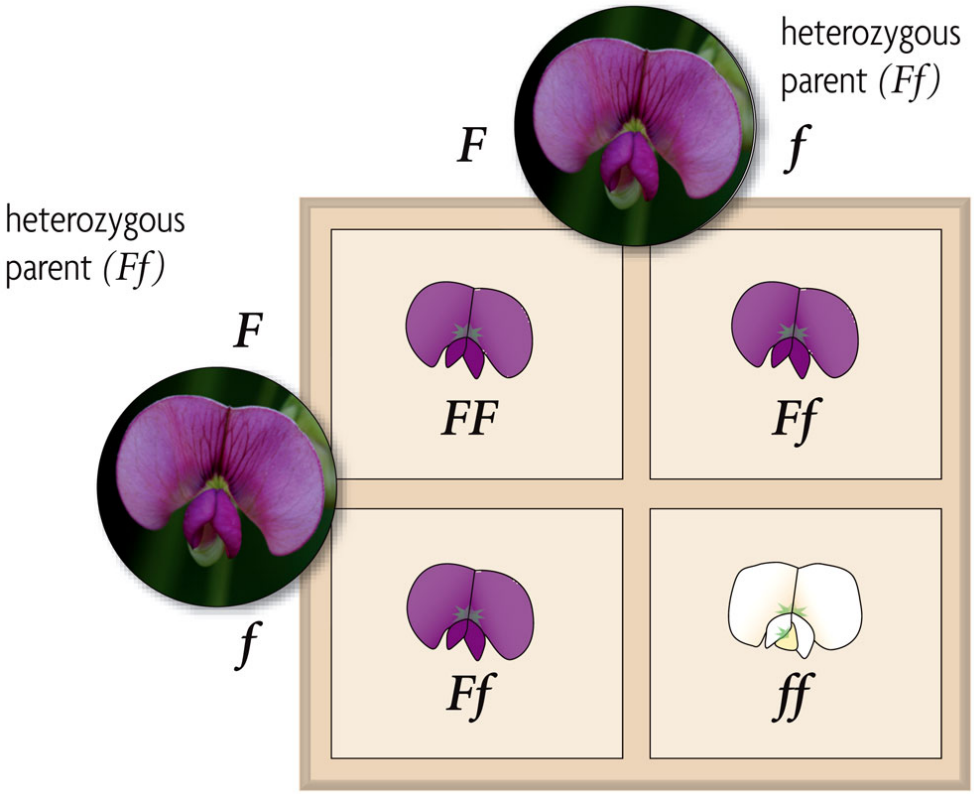
Let's Practice!

Monohybrid Cross

- Monohybrid crosses examine the inheritance of only one specific trait.
  - homozygous dominant-homozygous recessive: all heterozygous, all dominant

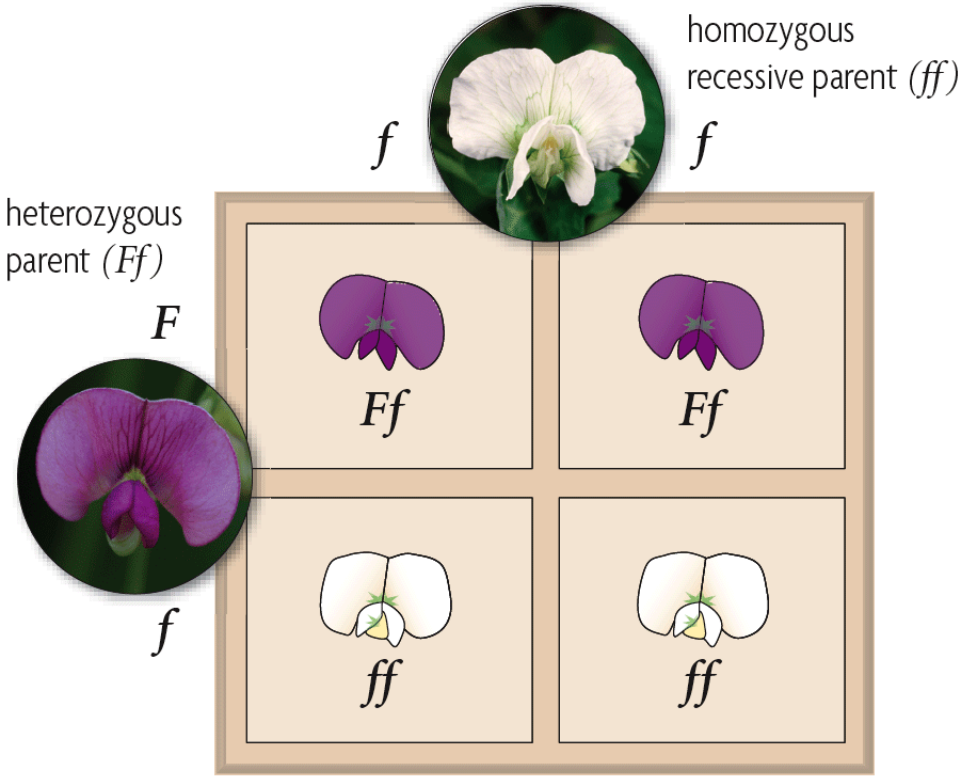


- heterozygous-heterozygous—1:2:1 homozygous dominant: heterozygous:homozygous recessive; 3:1 dominant:recessive



- heterozygous-homozygous recessive—1:1 heterozygous:homozygous recessive; 1:1 dominant:recessive

- A testcross is a cross between an organism with an unknown genotype and an organism with the recessive phenotype.



Dihybrid Cross

Mendel's dihybrid crosses with heterozygous plants yielded a 9:3:3:1 phenotypic ratio.

- Mendel's dihybrid crosses led to his second law, the law of independent assortment.
- The law of independent assortment states that allele pairs separate independently of each other during meiosis.