# 5.1 Understanding Inheritance

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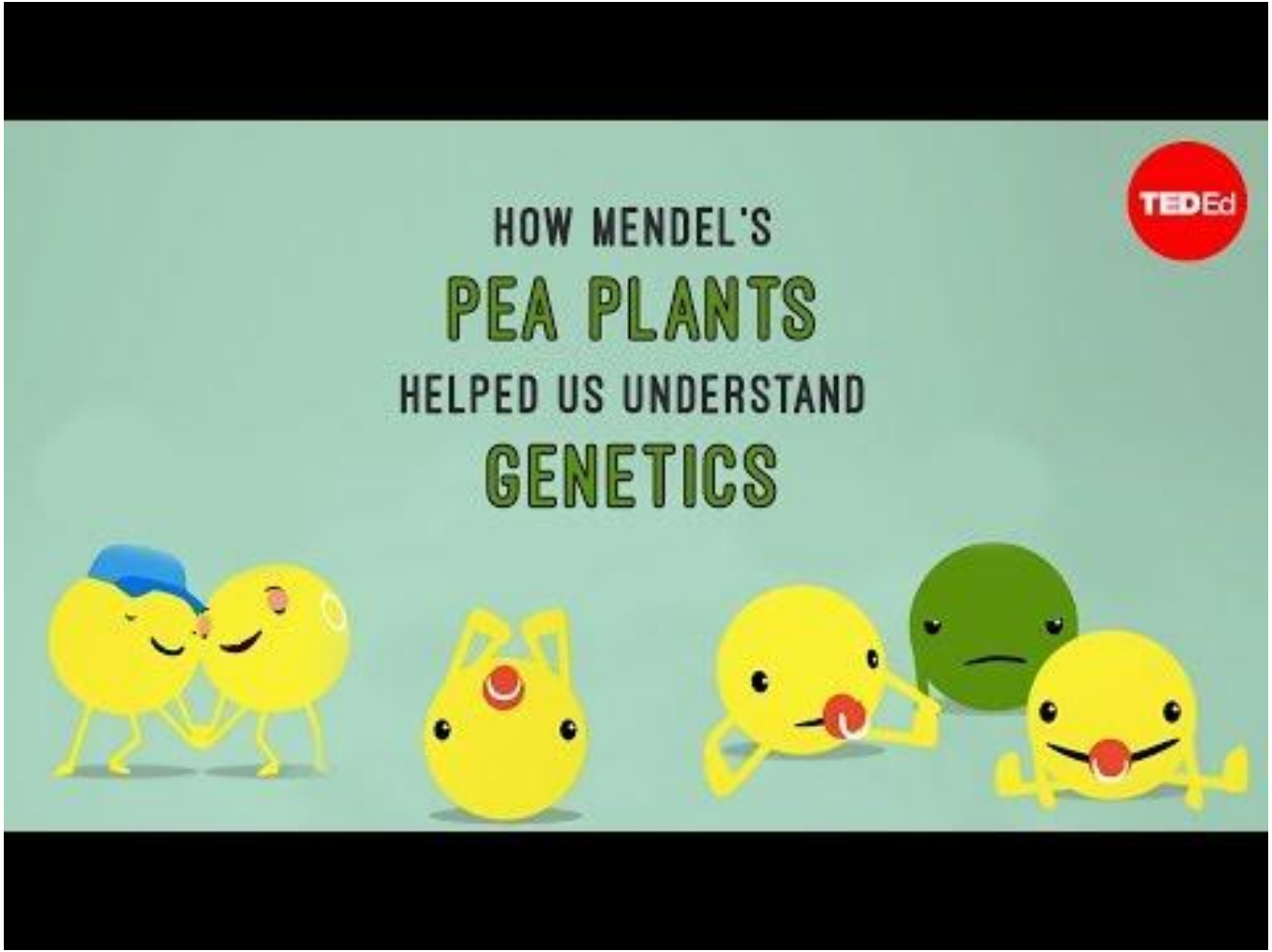
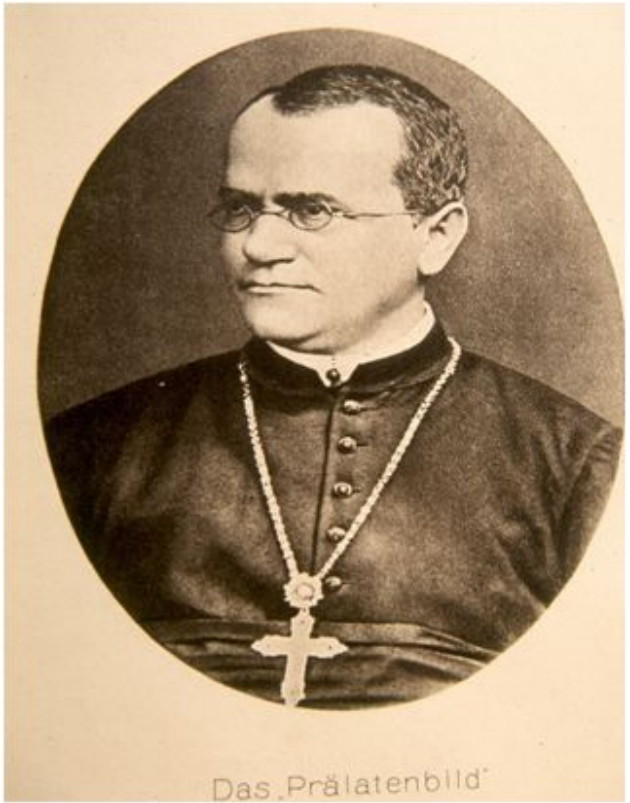

TEDEd
HOW MENDEL'S
PEA PLANTS
HELPED US UNDERSTAND
GENETICS

# Gregor Mendel

- Known as the “Father of Genetics”
- Austrian monk
- He explored patterns of inheritance by crossbreeding thousands of plants and carefully recording the offspring’s traits



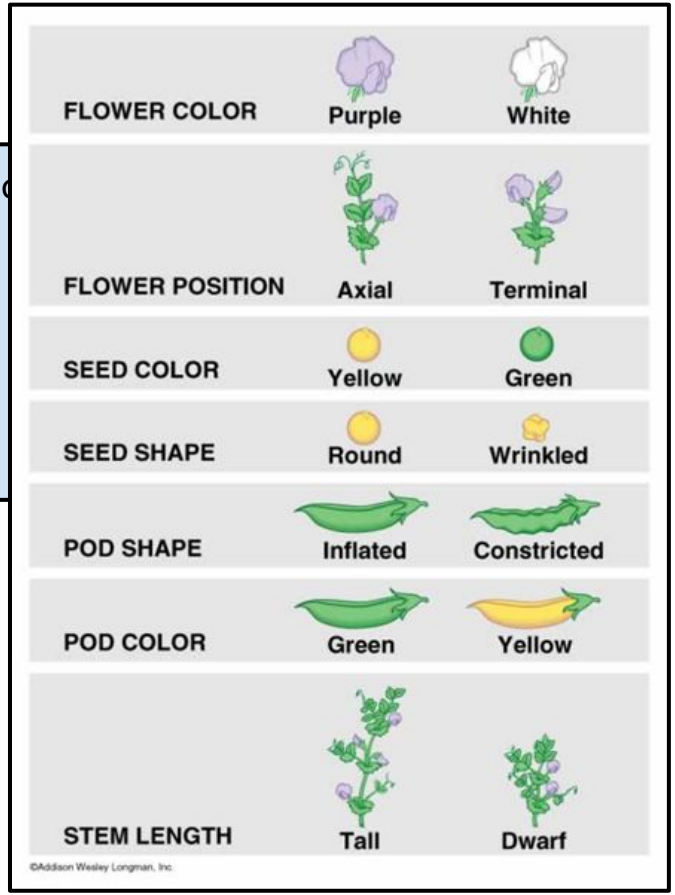

1822- 1884

# Mendel's Garden Pea Plant

Why did he choose to use peas?

- Easy to grow
- Inexpensive
- Short generation time
- Easily self-fertilized or cross fertilized*
- Only 2 variations per characteristic

Mendel performed his experiments on seven hereditary characteristics of pea plants.

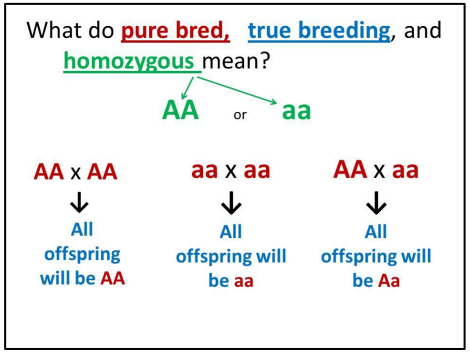


# Terminology...

**Cross-fertilized:** different plants provide male and female gametes (different DNA)

**Self-fertilized:** same plant provides both male and female gametes (same DNA)

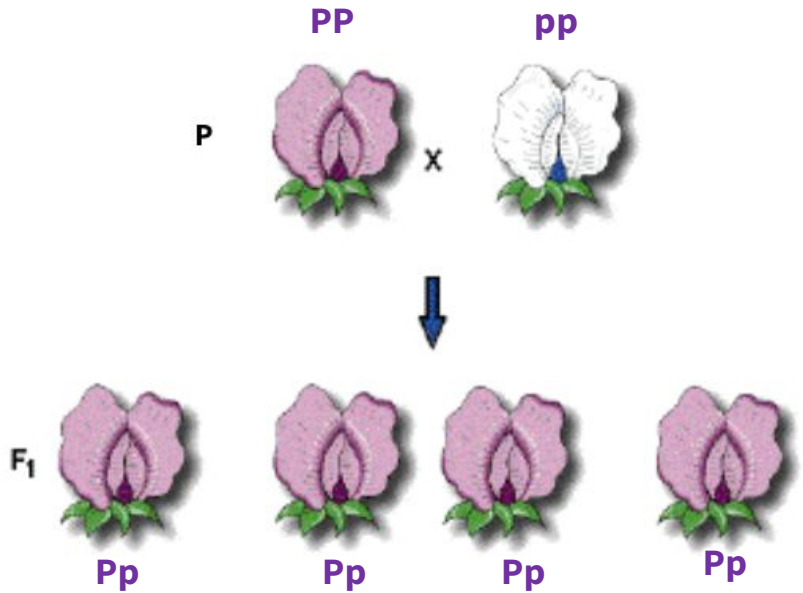
**True Breeding:** organisms that exhibit the same traits, generation after generation



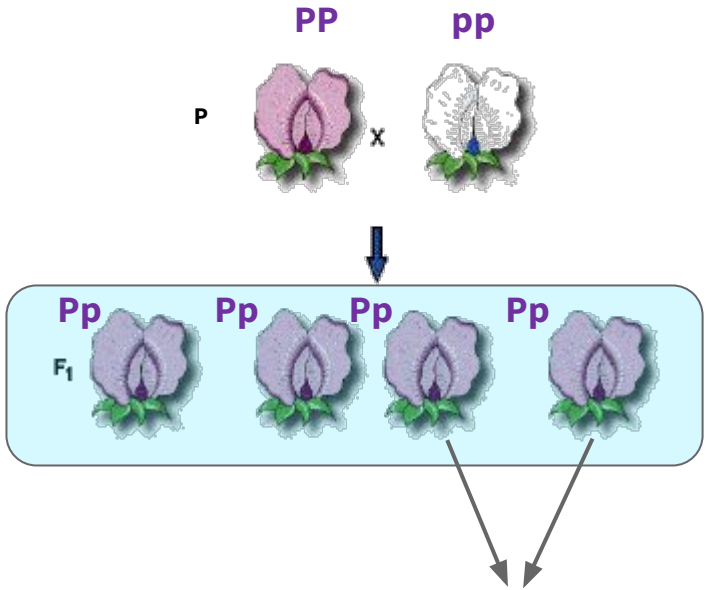
# The Results of Mendel's True-Breeding Crosses

- Mendel cross fertilized true-breeding plants, which differed in only one characteristic. These were the **parent**, or **P generation** plants.

- Offspring of the **P generation** were called the **first filial generation** (**$F_1$ generation**)



# The Results of Mendel's True-Breeding Crosses

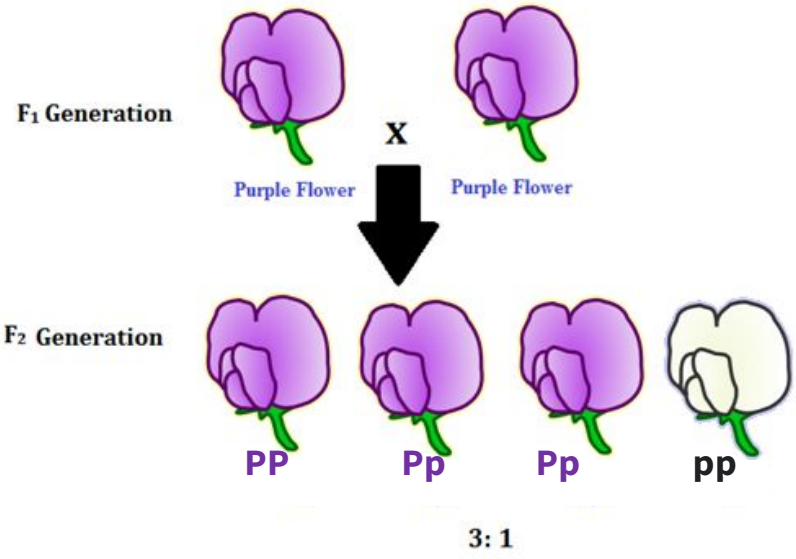



**Only one form of the trait (purple) was expressed in the offspring produced ($F_1$ generation)**

What would happen if the flowers in the F1 generation self-fertilized?
*Mendel tested this out…*

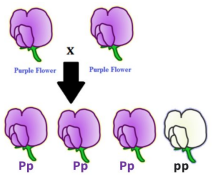
# The Results of Crossing $F_1$ Individuals

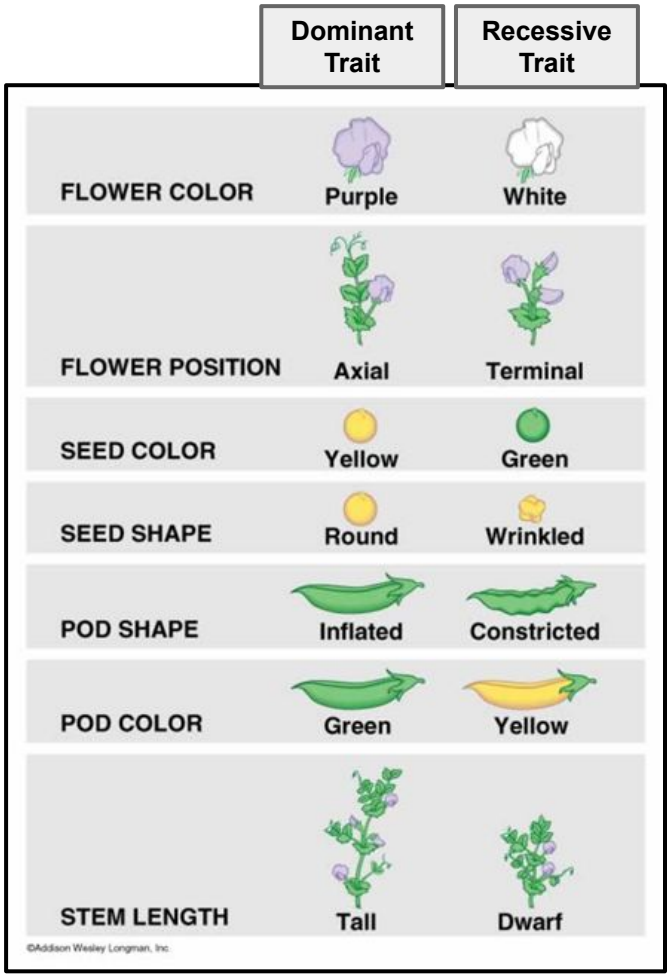
- *He observed something surprising!*
- The **white flower trait** (that was hidden in the $F_1$ generation) reappeared in the $F_2$ generation!




**Notice that the colours (phenotypes) of the offspring appear in a 3:1 ratio.**

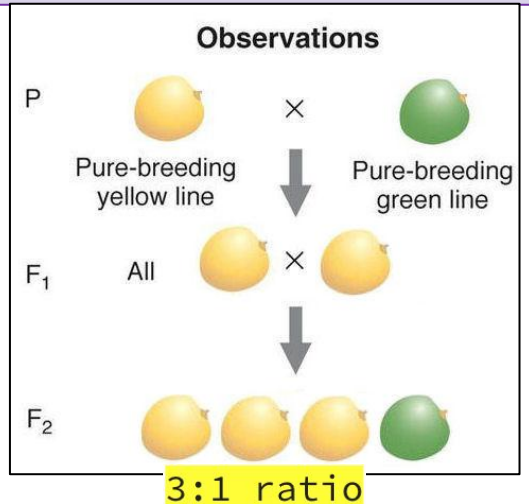
- Mendel hypothesized that the trait appearing in the $F_1$ generation was **dominant**
- **Dominant allele:** the allele, that if present, is **always** expressed.
  - Therefore, allele for **purple flower** colour is **dominant (P)**
  - Allele for white flower colour is recessive (p)
- The **recessive trait** began to show up in the $F_2$ generation in a 3:1 ratio



**When crossing purebreds for different traits, he made similar observations…**

- **F1 offspring would always show the dominant form of the trait**
- **Ratio of phenotypes in F2 offspring was always 3:1**
  **(3 dominant: 1 recessive phenotypes)**




3:1 ratio

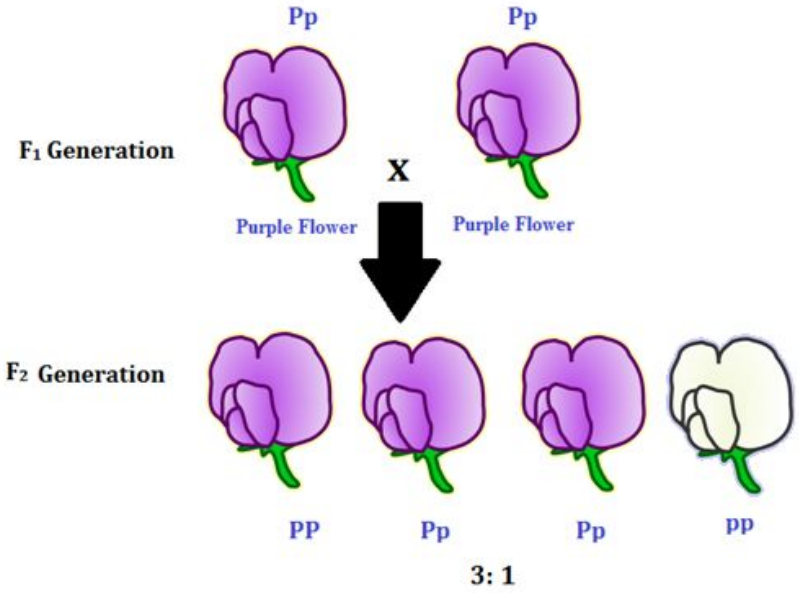
Which form of the trait is dominant?

**Table 14.1 The Results of Mendel's $F_1$ Crosses for Seven Characters in Pea Plants** [ true breeding: itself = itself ]

| Character | Dominant Trait | × | Recessive Trait | $F_2$ Generation Dominant:Recessive | Ratio |
|---|---|---|---|---|---|
| Flower color | Purple | × | White | 705:224 | 3.15:1 |
| Flower position | Axial | × | Terminal | 651:207 | 3.14:1 |
| Seed color | Yellow | × | Green | 6022:2001 | 3.01:1 |
| Seed shape | Round | × | Wrinkled | 5474:1850 | 2.96:1 |
| Pod shape | Inflated | × | Constricted | 882:299 | 2.95:1 |
| Pod color | Green | × | Yellow | 428:152 | 2.82:1 |
| Stem length | Tall | × | Dwarf | 787:277 | 2.84:1 |

# Representing Alleles

- Alleles are represented using upper-case and lower-case letters
- **Dominant allele: upper-case letter** (usually associated with the trait)
- **Recessive allele: lower-case** (same letter as dominant allele)



# Genotype and Phenotype

**Genotype:** the combination of alleles for any given trait

*Example:* ***PP, Pp, pp***

**Phenotype:** an individual's outward appearance with respect to a specific characteristic.

*Example: purple flowers, white flowers*

*Genotype cannot always be determined by observing phenotype…*

- If you saw a purple flower you could not know for sure what its genotype is (either FF or Ff)... you could perform a testcross to figure it out though(slide 20)

# How Traits are Determined

The form of trait that is expressed depends on which allele was inherited from each parent

- If one or two **dominant** allele(s) is present, the dominant form of the trait will be expressed; dominant alleles hide recessive alleles.

- For a **recessive** trait to be expressed, **two** recessive alleles **must** be present.

# Allele Combinations

**Homozygous:**

an organism that has two of the **same** alleles for a gene

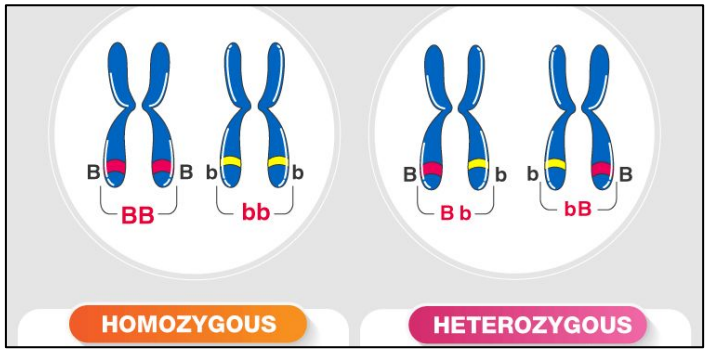
**BB** = homozygous dominant

**bb** = homozygous recessive

**Heterozygous:**

an organism that has two **different** alleles of a gene

**Bb**= heterozygous

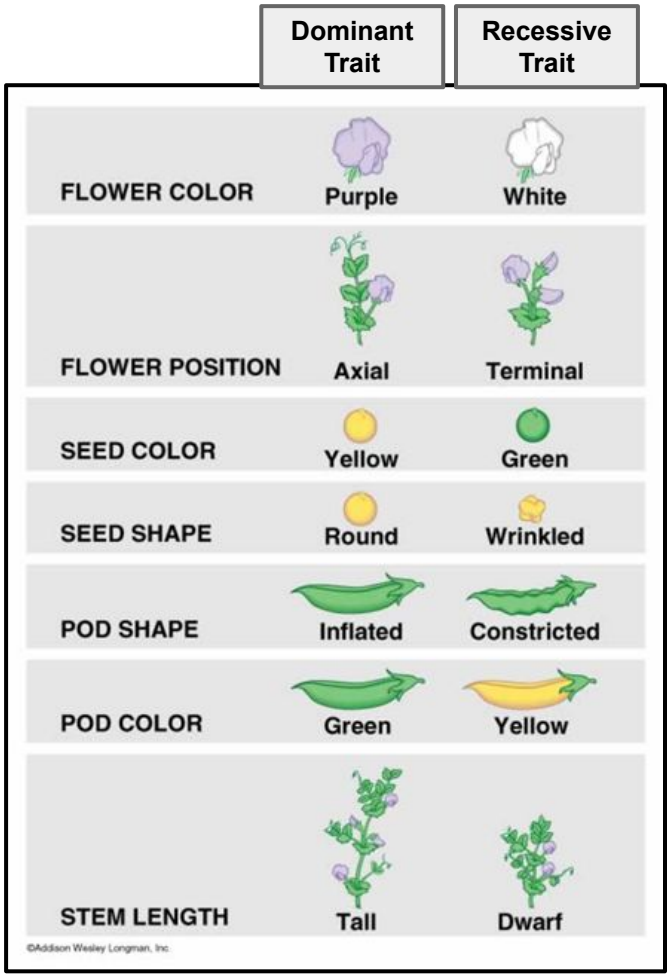


1. **How would you represent…**
   **a.** the dominant allele for seed shape

   **b.** The recessive allele for seed shape

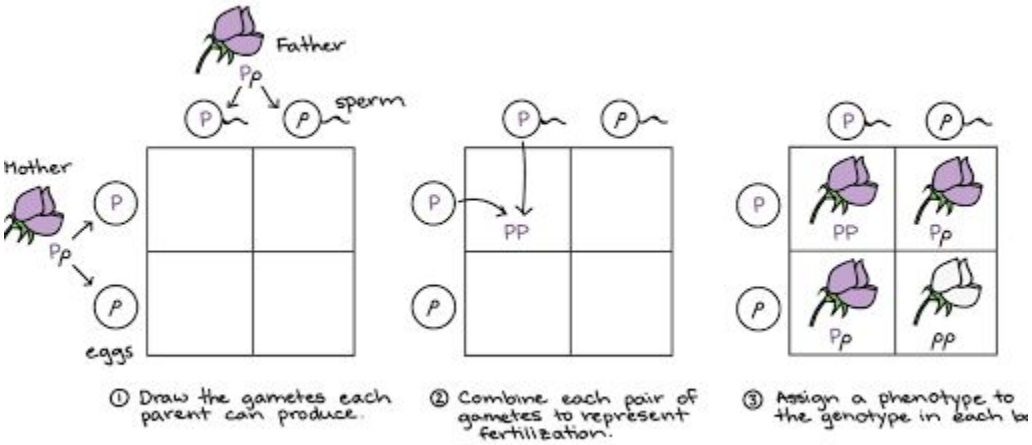
**2. What is the genotype of a plant that is homozygous dominant for plant height (stem length):**

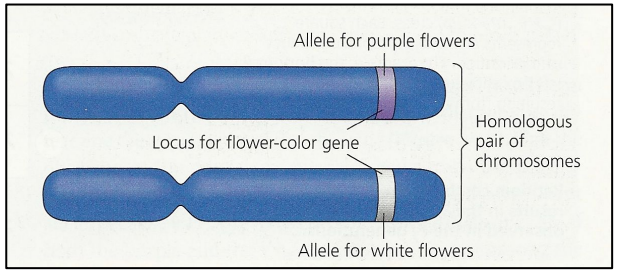
**3. Genotype of a plant that is heterozygous for plant height:**



# Punnett Squares - Monohybrid Cross

- A monohybrid cross is **a cross between two organisms with different variations at <u>one</u> genetic locus of interest.**
- The **Punnett square** is a square diagram that is used to predict the genotypes of a particular cross or breeding experiment.



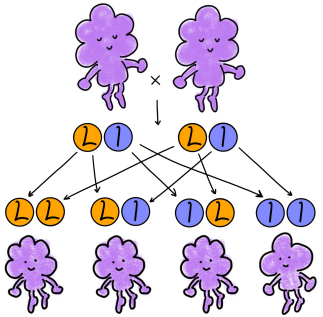



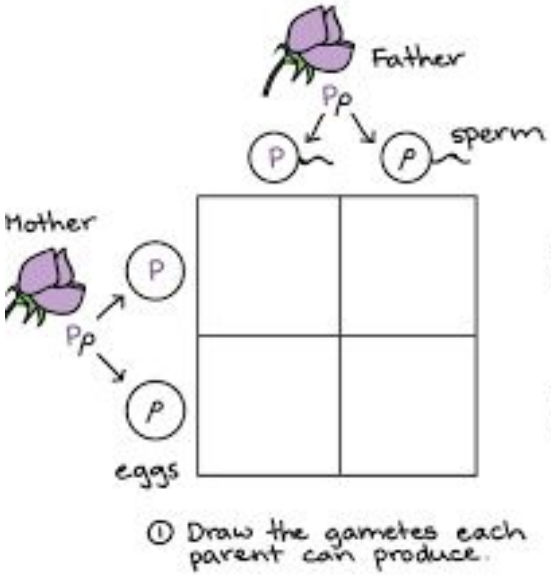

Heterozygous offspring

# Law of Segregation

**Law of Segregation - a pair of factors (alleles) are segregated, or separated, during the formation of gametes (meiosis)**

- Organisms donate only one copy of each gene to their gametes because genes separate during gamete formation
- Therefore, when gametes fuse to form a zygote, the zygote gets one allele from the mother and one from the father





# Practice - Monohybrid Cross

In guinea pigs, **short hair is dominant** over long hair. If a **heterozygous short haired** guinea pig is crossed with a **long haired** guinea pig, what are the possible genotypes and phenotypes of their offspring and the percent chance of each?

| | | |
|---|---|---|
| | | |
| | | |
| | | |

**Possible Genotype(s):** _____ _____

# Practice - Monohybrid Cross

In guinea pigs, **short hair is dominant** over long hair. If a **heterozygous short haired** guinea pig is crossed with a **long haired** guinea pig, what are the possible genotypes and phenotypes of their offspring and the percent chance of each?

| | S | S |
|---|---|---|
| S | Ss | Ss |
| s | ss | ss |

50% Short Hair

50% Long Hair

**Genotype of parent:** ___Ss____ ___ss___

# Test Cross

To determine genotype of an individual with a **dominant phenotype** in a cross.
*(E.g. is the individual's genotype BB or Bb?)*

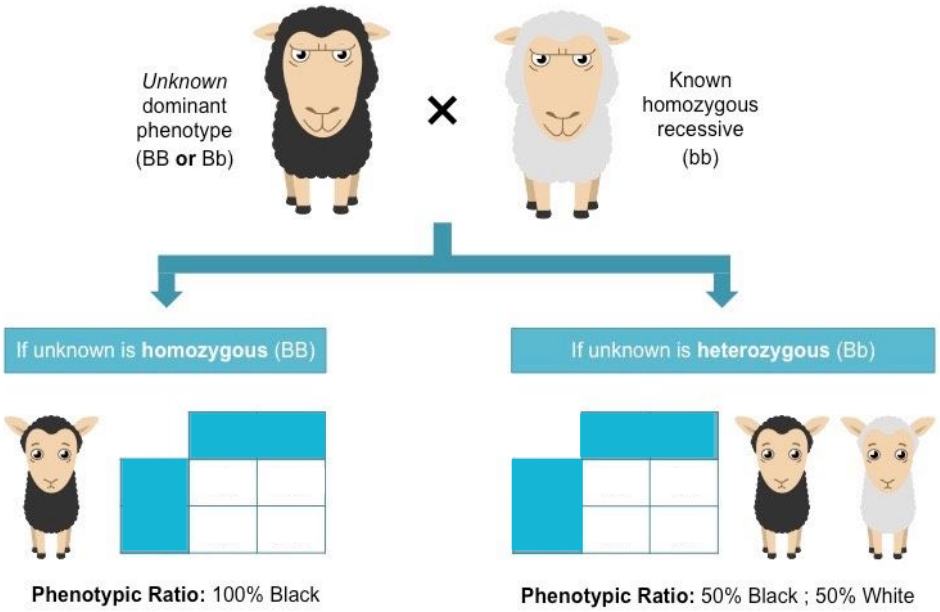
A testcross is used to determine the genotype of an individual expressing a **dominant trait.**

➔ Determines if an individual is homozygous dominant (BB) **OR** heterozygous dominant (e.g Bb)

How it works?

Dominant individual (with unknown genotype) is **crossed with a homozygous recessive** individual(bb).

# Test Cross

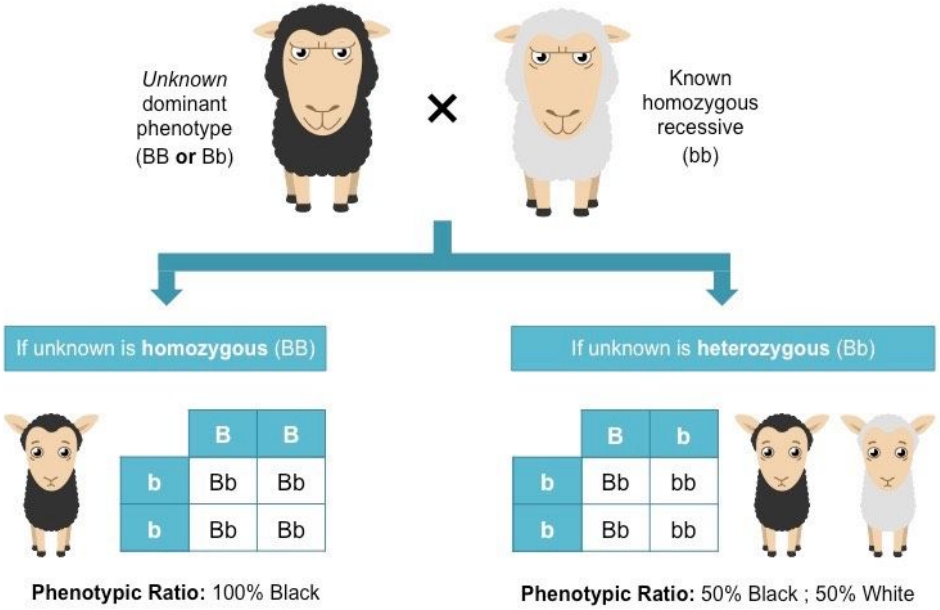



The results reveal the genotype of the parent:

- **If all offspring are dominant in phenotype** → the unknown parent genotype is probably homozygous (BB)
- **If the offspring display both dominant and recessive phenotypes** → the unknown parent is heterozygous (Bb)

# Test Cross

The results reveal the genotype of the parent.




The results reveal the genotype of the parent:

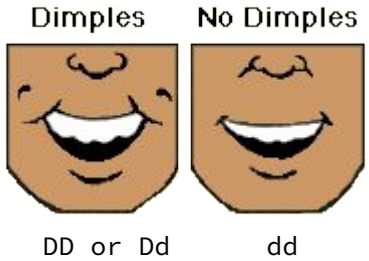
- **If all offspring are dominant in phenotype** → the unknown parent genotype is probably heterozygous
- **If the offspring display both dominant and recessive phenotypes** → the unknown parent is heterozygous

# Practice - Test Cross

Use a testcross to find the genotype of the parent (DD or Dd).

**The trait for dimples:**

Dimples (D)
No dimples (d)




| | D | ? |
|---|---|---|
| d | Dd | dd |
| d | Dd | dd |

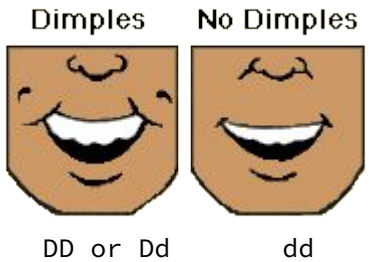
- 50% of the offspring have dimples
- 50 % have no dimples.

# Practice - Test Cross

Use a testcross to find the genotype of the missing parent (DD or Dd).

**The trait for dimples:**

Dimples (D)
No dimples (d)




| | D | d |
|---|---|---|
| d | Dd | dd |
| d | Dd | dd |

**Parent his heterozygous dominant Dd.**

# Homework:
# P.193
## #2, 5 (use chart), 6-10