UNIT 7 GENETICS

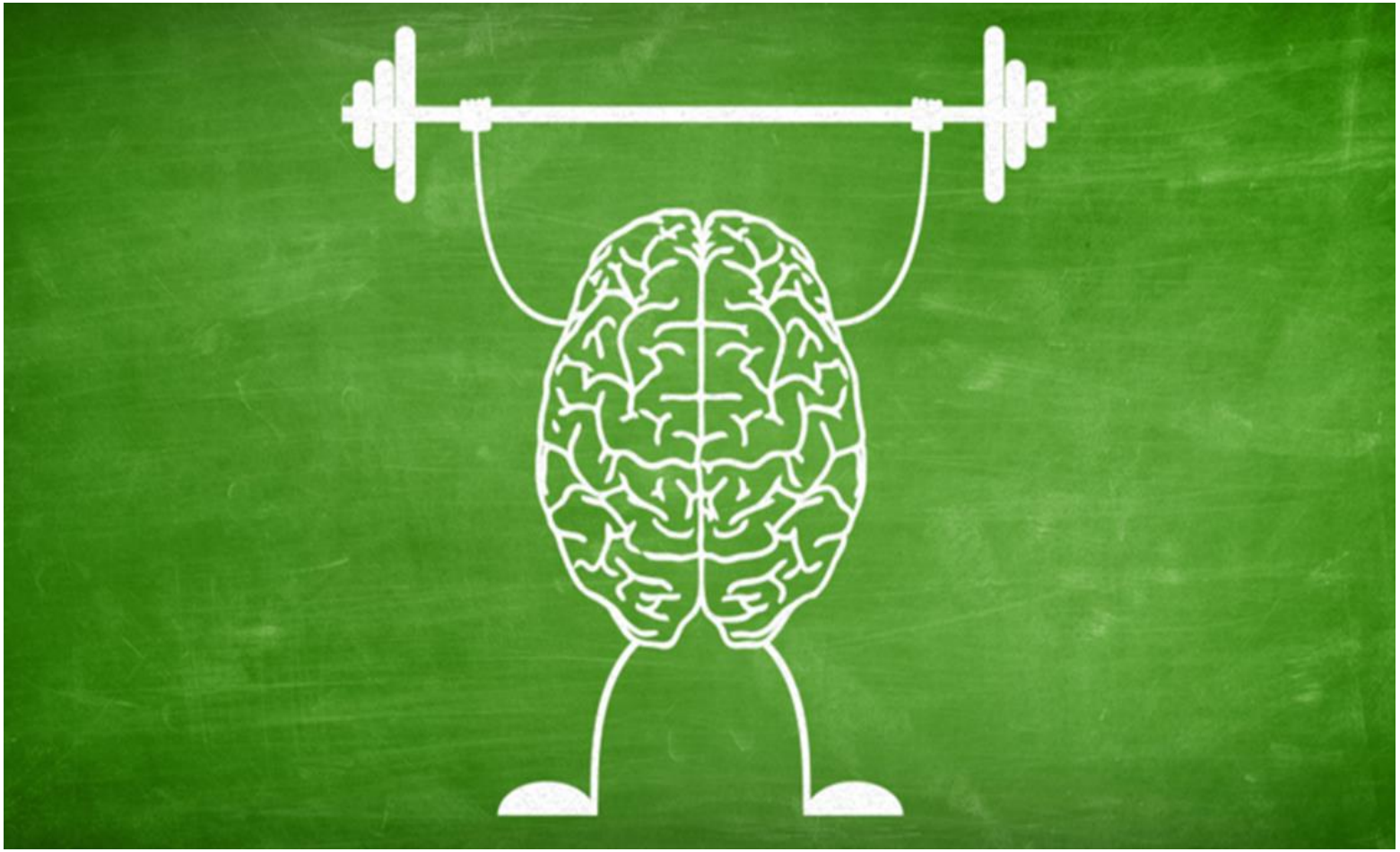
Topic 1

Genetics Introduction

Mendel's Laws

Monohybrid Cross

Finish your warm up sheet and turn it in, please



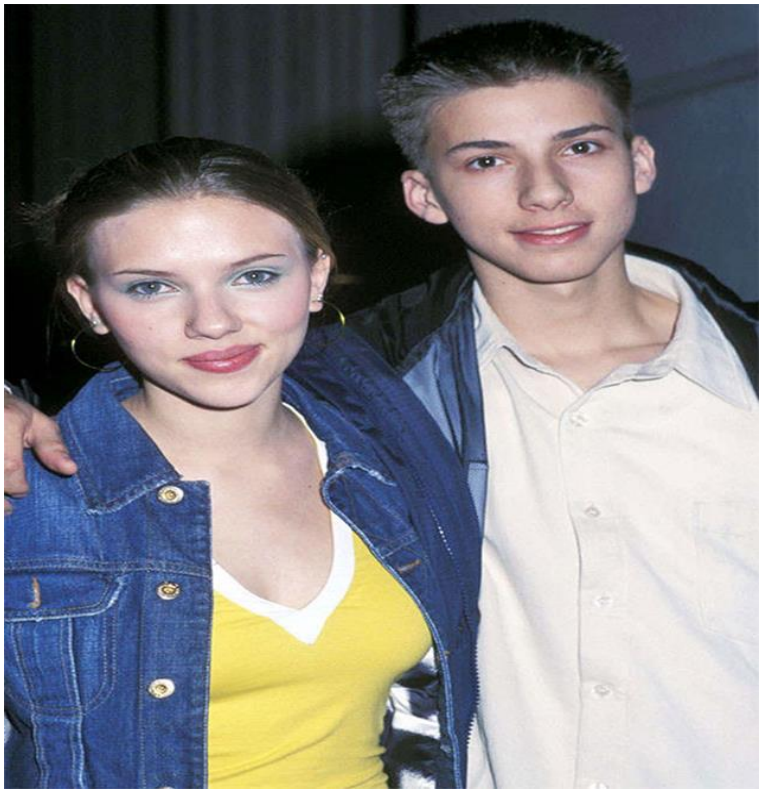
Objectives

Students will be able to:

- Explain Mendel's 3 laws of inheritance
- Differentiate between genotypes and phenotypes
- Draw and label a Punnett square to show a monohybrid cross
- Predict the outcomes of a monohybrid cross by using Punnett square

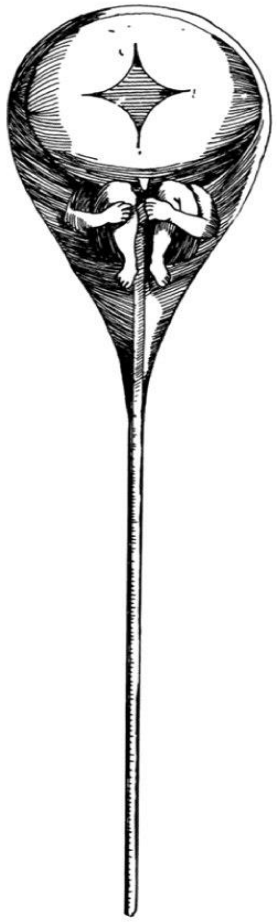
Driving Question #1

- Why siblings do not look exactly alike even though they have the same parent?



Historical Views of Inheritance

- Hippocrates (c.460-c.375 BCE)
  - Particles given off from bodies of father and mother
  - Offspring is a mixture (Blending Theory)
- Gregor Mendel (1850)
  - Discovered process of heredity



Genetics and Heredity

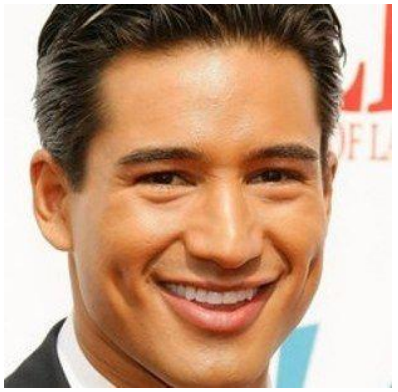
- **Genetics:** Science that study heredity
- **Heredity:** Passing on traits from parent to offspring through the genes
- **Trait:** a specific characteristic that affect the way we look and how our bodies function

- Can you give me some examples of traits????

Ear lobe attachment: unattached (free) earlobes are dominant and attached earlobes are recessive

Attached earlobe

Free earlobe



Dimples are dominant (people may exhibit a dimple on only one side of the face) and a lack of dimples recessive

Hairline Shape: a widow's peak is dominant and a straight hairline is recessive

Tongue Rolling: the ability to roll the tongue is a dominant trait and the lack of tongue rolling ability is a recessive trait

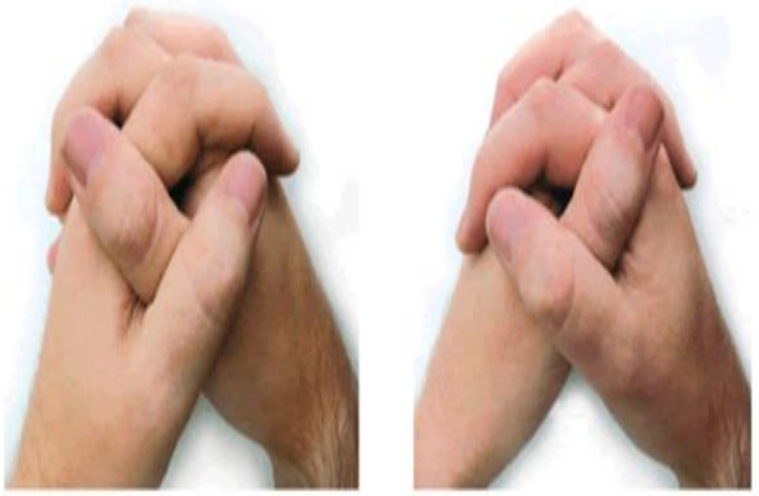
Can Roll Tongue

Can't Roll Tongue

Left

Right

Handedness: Right handedness is dominant while left is recessive



Hand Clasping: 55% of people place their left thumb on top, 45% place their right thumb on top and 1% has no preference.

Thumb Extensibility: Straight thumb is dominant and hitchhiker's thumb is recessive.

Freckles trait is dominant and the absence of freckles is recessive.

Cleft chin is a dominant trait, while smooth chin is recessive

Crossing Legs: Right over left is a dominant trait and left over right is recessive trait.

Trait Inventory Activity

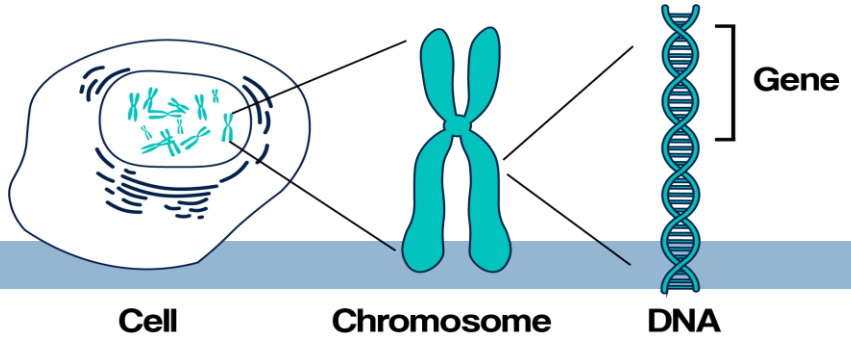
- Put check mark beside the trait form that you have
- Answer the 3 questions

Trait	Form 1 (dominant)	# of students (dominant)	Form 2 (recessive)	# of students (recessive)
Ear lobe	Free		attached	
Dimples	Presence (1 or 2 sides)		absence	
Handedness	Right		left	
Tongue rolling	presence		absence	
Hairline	widow peak		Straight	
Chin	Cleft		No cleft	
Thumb	Straight		hitchhiker	
Freckles	Presence		absence	
Hand Clasping	Left on top		Right on top	
Leg Crossing	Right on top		Left on top	

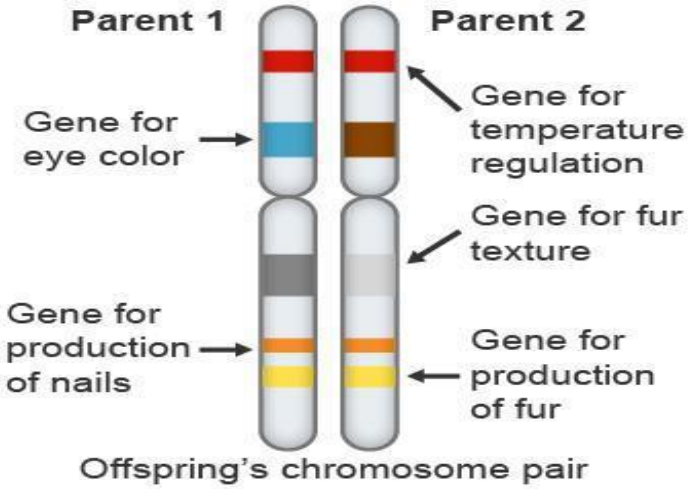
We will revisit this activity later on

Genetic Vocabulary

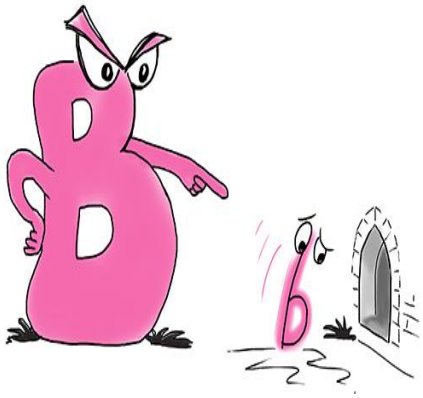
Gene & Allele



- **Genes:**
  - Sequence of DNA nucleotides that controls the traits
  - Located on specific places on **homologous chromosomes** called locus
  - Come in pairs and offspring inherit one copy of each gene from each parent
- **Alleles**: Alternative or different forms of genes
  - Gene: eye color
  - Alleles: brown & blue
- **What is homologous chromosomes?**



Dominant & Recessive



Dominant trait

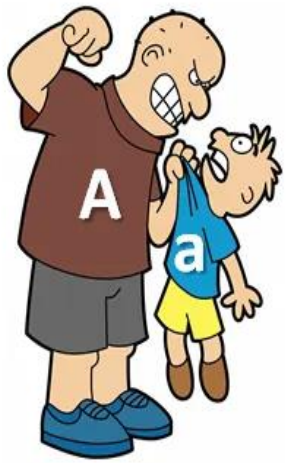
- Trait that is always shown (expressed)
- Represented by CAPITAL LETTER for example **A** or **B**
- Expressed when both alleles are dominant (BB)
- Or when one allele is dominant (Bb)

Recessive trait

- Trait that is covered (masked) when dominant allele is present (Bb)
- Represented by lower case letter for example **a** or **b**
- Expressed only when both alleles are recessive (aa) or (bb)

A = dominant

a = recessive



Quick check

Let's say that:

- B = dominant allele for blue color
- b = recessive allele for white color

- What is the color of the following alleles combinations?
- BB =
- Bb =
- bb =

Review

- Body cells (like skin cell)
- 46 chromosomes organized as 23 pairs
- Diploid (2n)
- Replicate by mitosis

- Sex-cells (egg & sperm)
- 23 chromosomes
- Haploid (1n)
- Produces by meiosis

Review

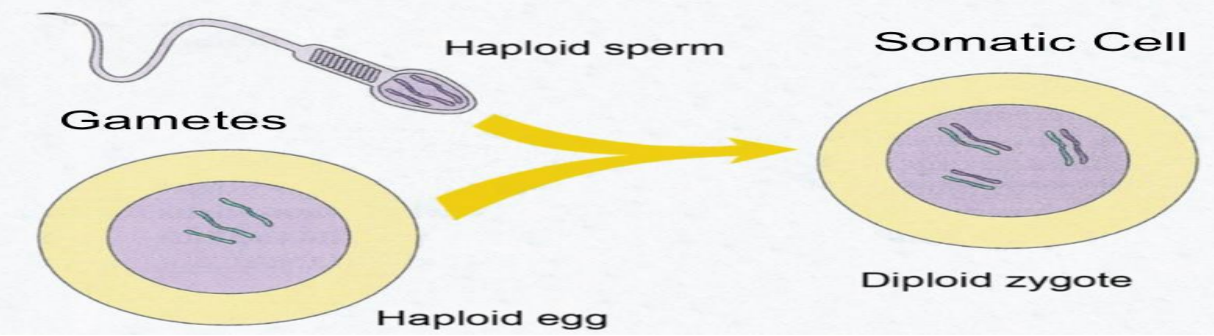
Somatic Cells

- Body cells (like skin cell)
- 46 chromosomes organized as 23 pairs
- Diploid (2n)
- Replicate by mitosis

Gametes

- Sex-cells (egg & sperm)
- 23 chromosomes
- Haploid (1n)
- Produces by meiosis

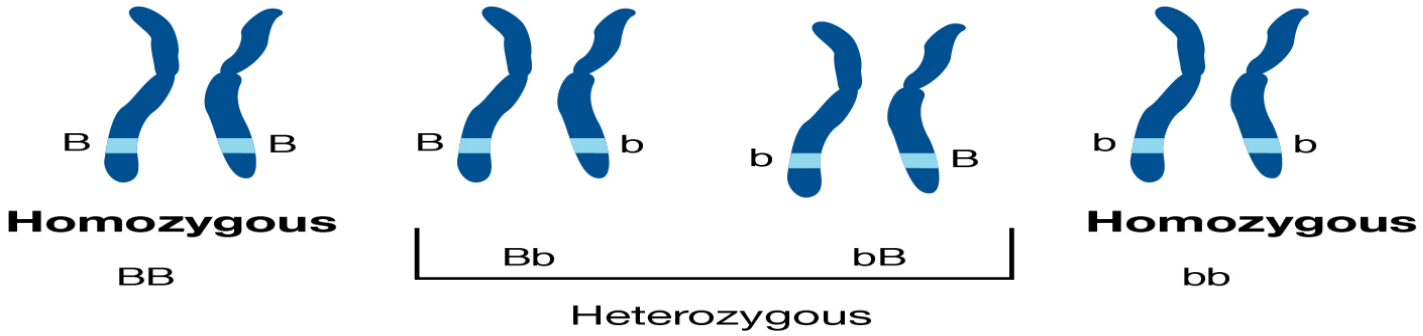
What is fertilization?



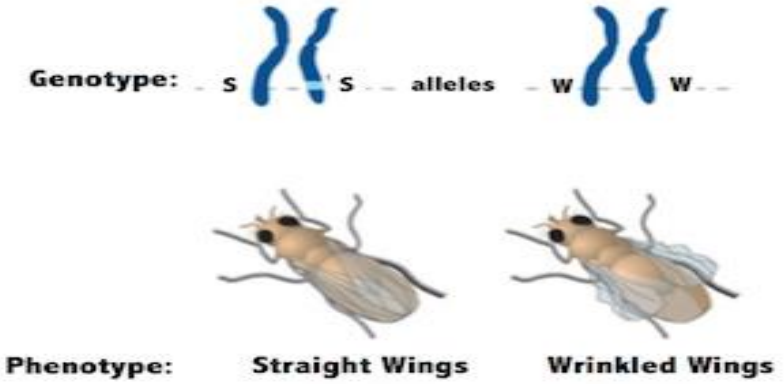
Homozygous & Heterozygous

- **Homozygous**:
  - When the two alleles are identical for example AA or bb
  - Also called purebred

- **Heterozygous**:
  - When the two alleles are different for example Aa or Bb
  - Also called hybrid



Phenotype & Genotype



- **Phenotype:** the observable physical or biochemical characteristics of the organism (purple or white flower)
- **Genotype:** the genetic makeup of the organism (alleles like pp or Pp)
- Each trait requires 2 alleles
  - Dominant trait will show up if genotype is homozygous dominant (AA) or heterozygous (Aa)
  - Recessive trait can be ONLY show up when the genotype is homozygous recessive (aa)

Description	Phenotype	Genotype
Homozygous dominant (purebred)	Tall	TT
Heterozygous (hybrid)	Tall	Tt
Homozygous recessive (purebred)	Short	tt

Revisit The Trait Activity

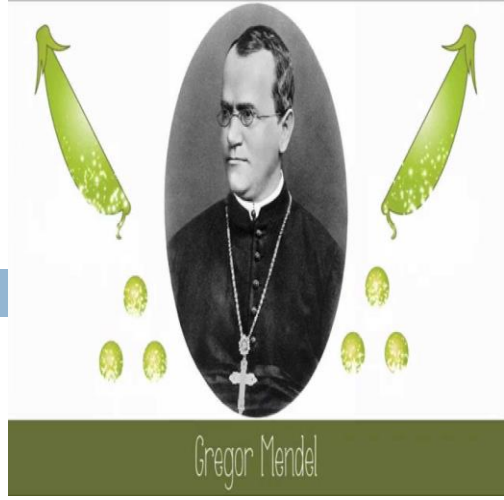
Go back to your trait activity worksheet and modify your answers

Dominant Gene	Recessive Gene
Cleft Chin 	No Cleft 
Widow's Peak 	No Widow's Peak 
Dimples 	No Dimples 
Brown/Black Hair 	Blonde Hair 
Freckles 	No Freckles 
Brown Eyes 	Gray/Blue Eyes 
Free Earlobe 	Attached Earlobe 

Vocabulary Practice

Work with a partner for 2 minutes to finish the vocabulary practice in your notes

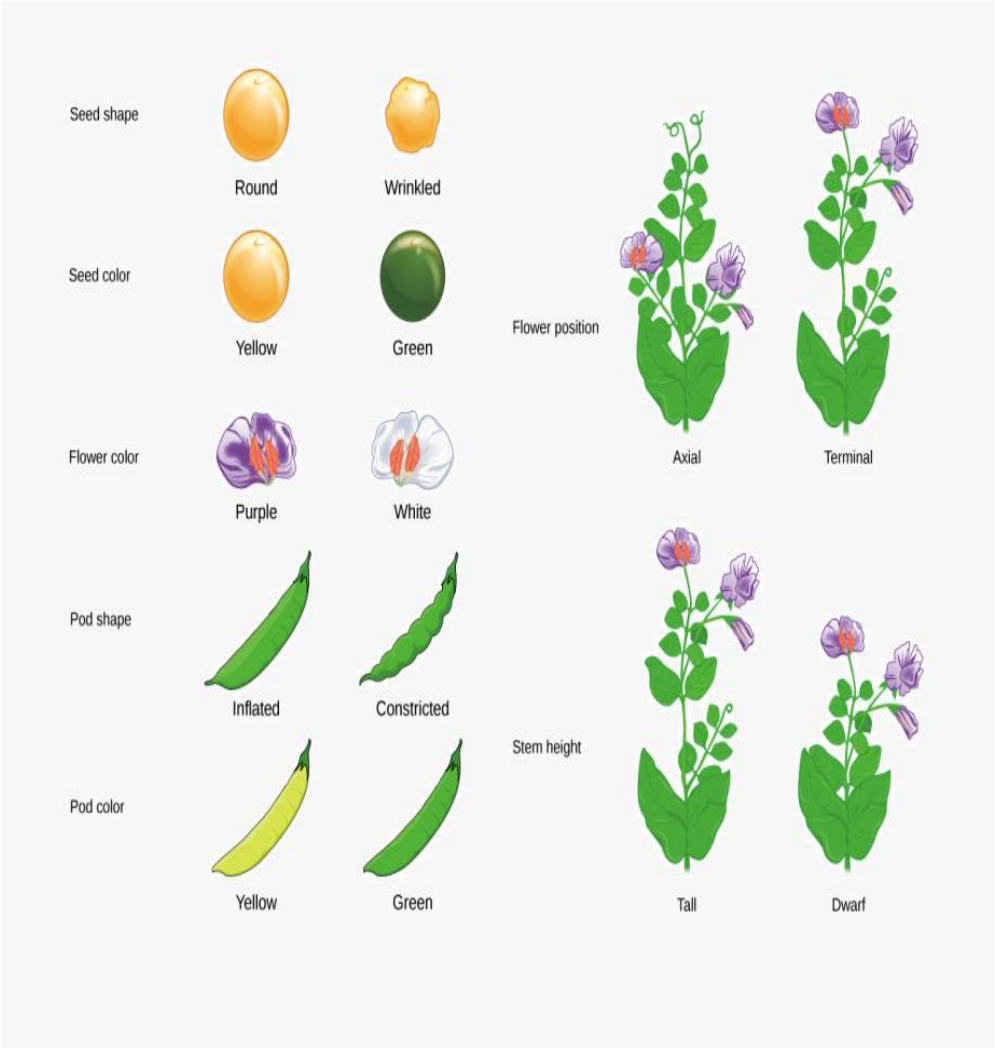
Who was Gregor Mendel?



- Called the "Father of Genetics"
- Austrian monk who worked in the monastery garden.
- His early work is the basis for much of our current understanding of genetics
- He used mathematical concept to analyze his data
- Mendel's data revealed patterns of inheritance

Why Mendel chose pea plants to do his experiments?

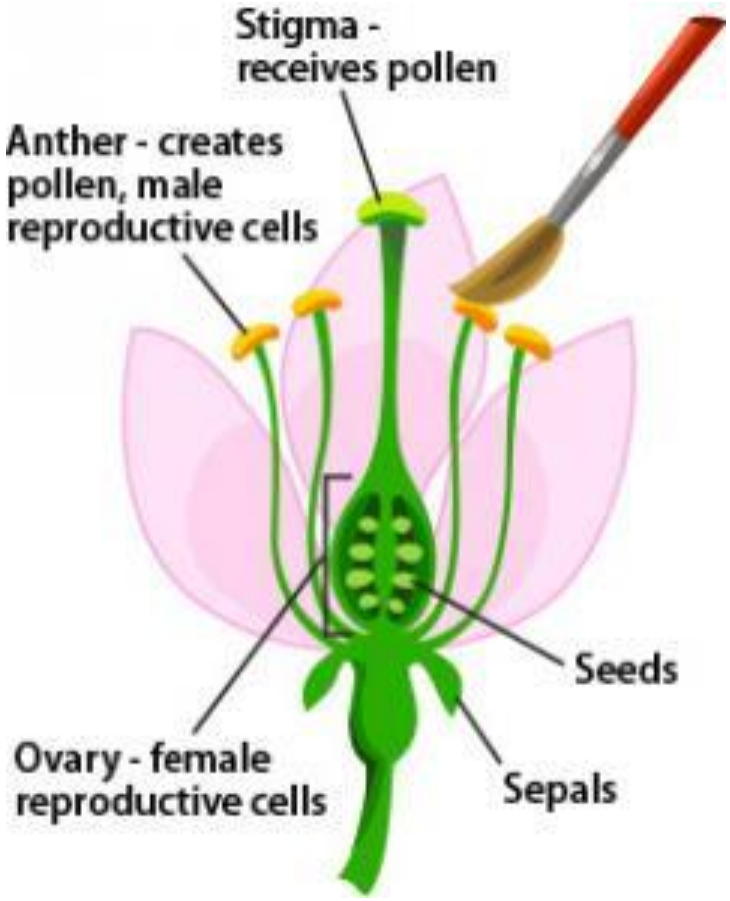
- Grow fast and produce large number of offspring in a small area
- Come in different features that can be easily distinguished
- Sexually reproduce
- Fertilization and pollination process can be controlled



Reproduction in Flowering Plants

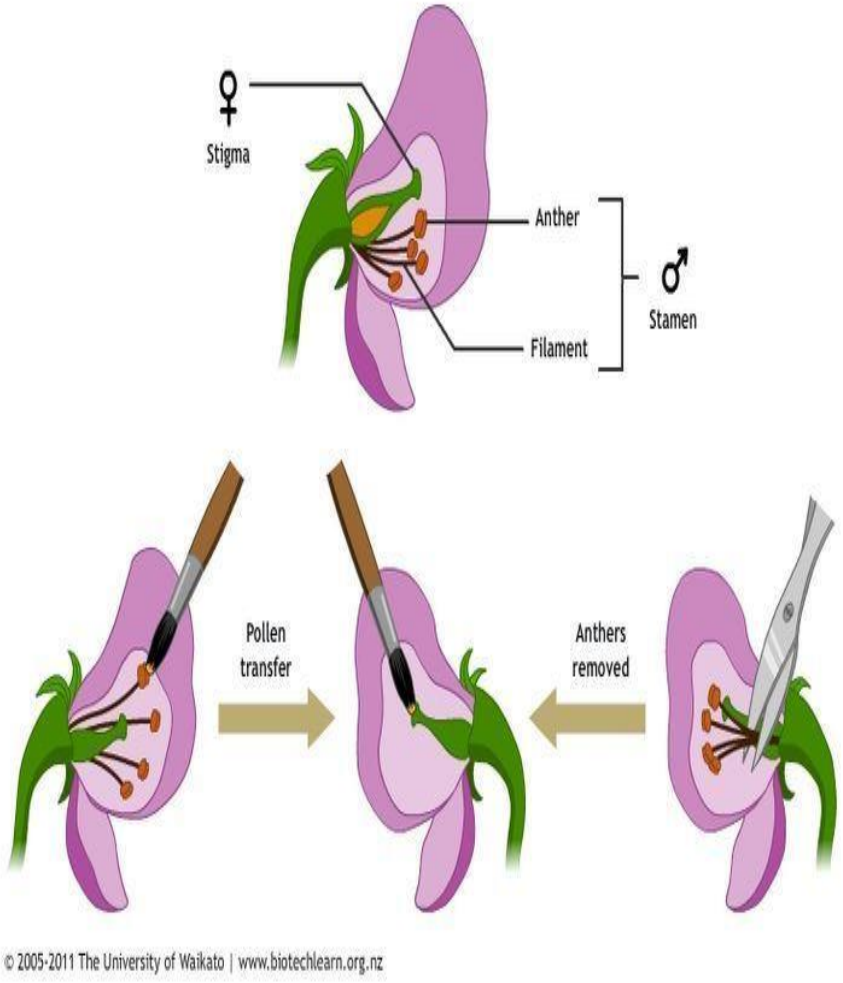
- Pea flower has both male and female reproductive structures

- Pollen carries sperm to the eggs for fertilization
  - **Self-pollination** can occur in the same flower
  - **Cross-pollination** can occur between different flowers



Mendel's Experimental Method

- Mendel controlled the pollination and the fertilization processes
  - He snipped the stamens to prevent self-pollination
  - Covered each flower with a cloth bag to prevent random cross-pollination
  - Mendel hand-pollinated flowers using a paintbrush



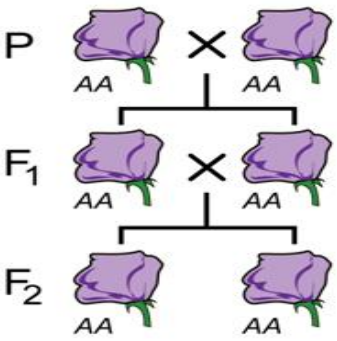
Mendel's Experimental Methods Cont.

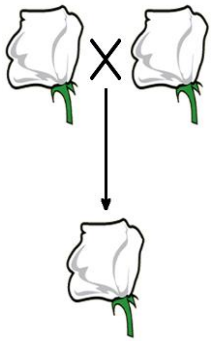
•Mendel noticed that some plants always produced offspring that had a trait exactly like the parent plant, he called these plants *"purebred"* plants.

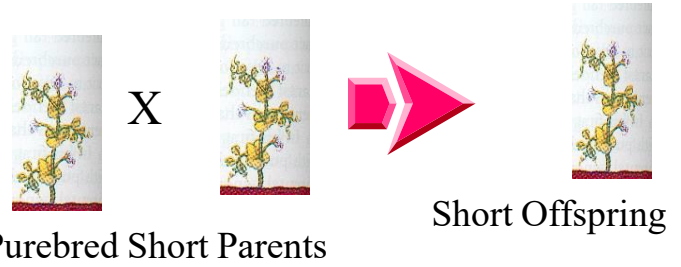
•Mendel produced pure strains by allowing the plants to self-pollinate for several generations

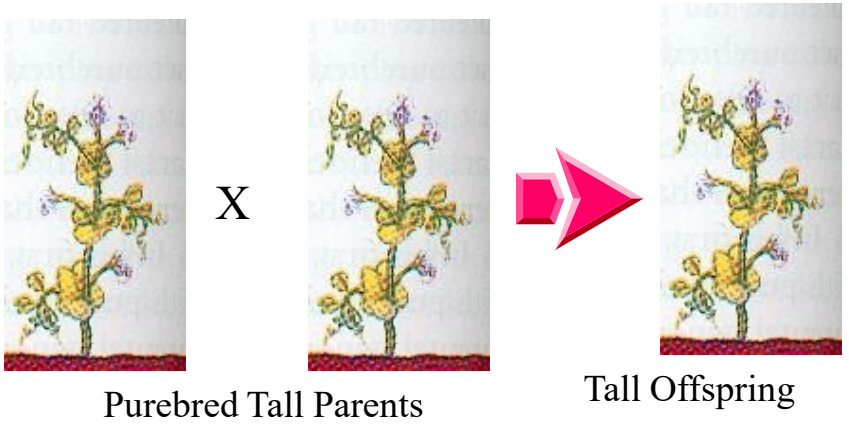
•**True breeding** produces offspring that carry the same phenotype and genotype as the parents who are homozygous for certain traits

•**Purebred** offspring resulting from a true breeding









THINK LIKE A SCIENTIST

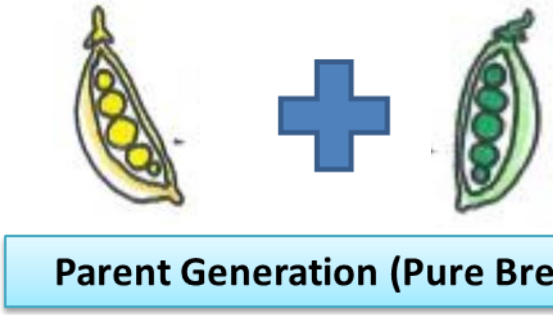
- Your job today is to be a scientist!
- You will see the data of Mendel's experiment and you will try to figure out the rules for passing on traits
- Work with your classmates who sit next to you (group of 3-4)
- You will be given 3 evidence, one evidence at a time
- With each evidence you will record your observations, any question about the evidence, and if you have any explanation for what happened.
- Let's do this!

Evidence Analysis

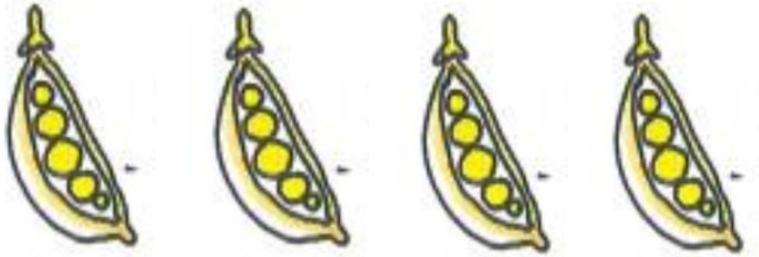
	Record your observations	Do you have any question?	Can you explain what happened?
Evidence 1			
Evidence 2			
Evidence 3			

Evidence # 1

Phenotype

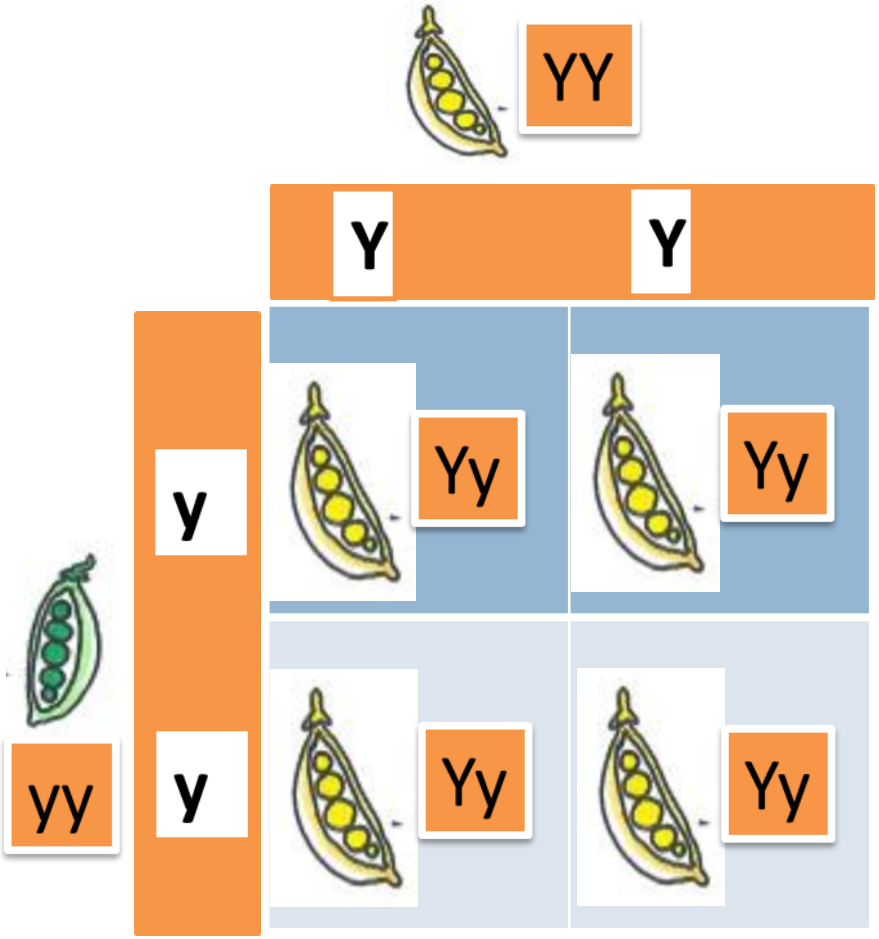


Parent Generation (Pure Breed)



F1 Generation

Genotype

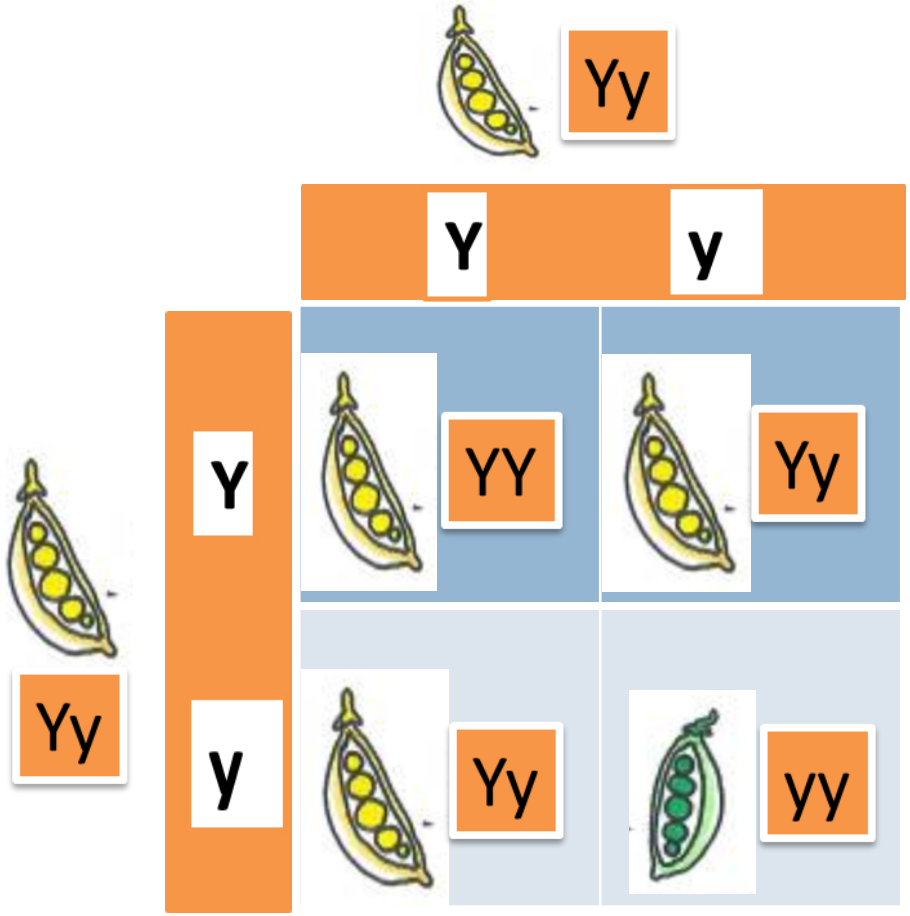


- Crossing parent generation- purebred (out side the box)
- F1 generation inside the box

Evidence # 2

Phenotype

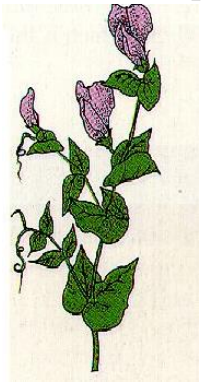
Genotype



- Crossing F1 generation (out side the box)
- F2 generation inside the box

Evidence # 3

Parent 1



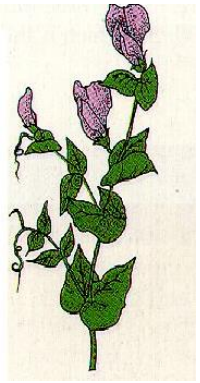
Tall & Green

X

Parent 2

Short & Yellow

Offspring



tall & yellow

tall & green

short & green

short & yellow

Group Discussion

Each group will share 2 rules for how genetics work based on their observation

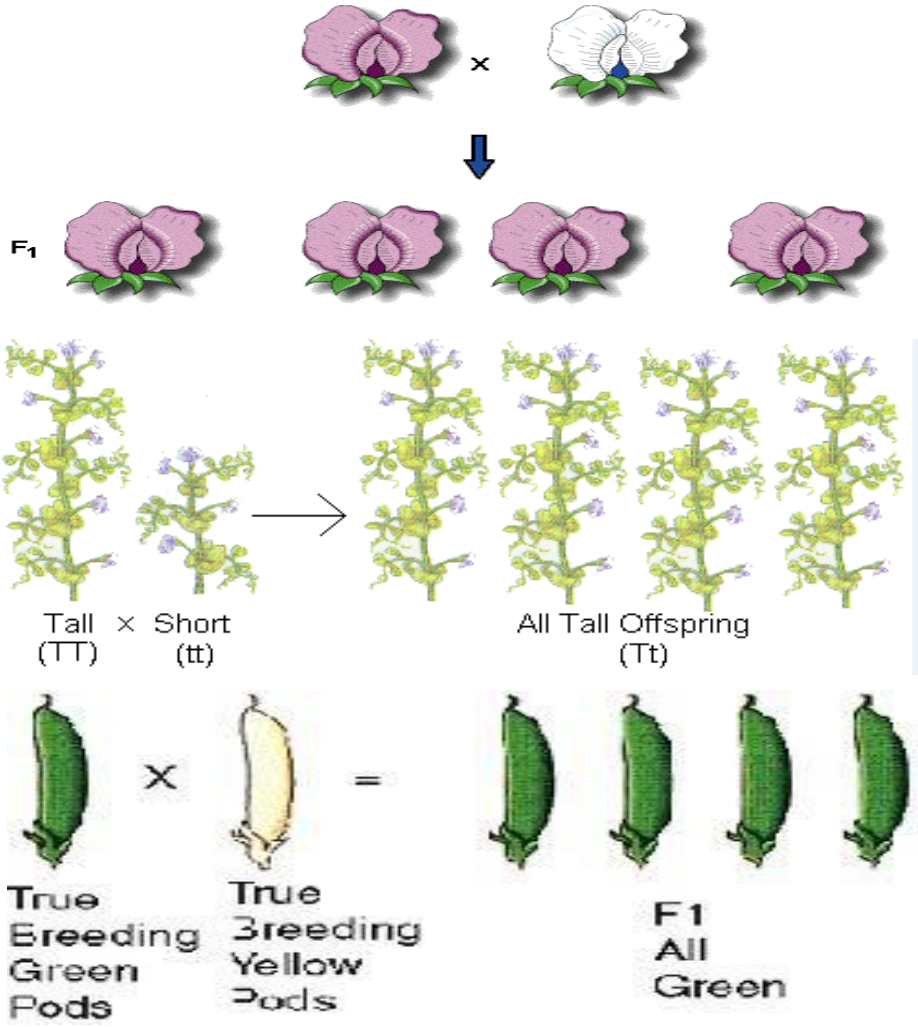
Mendel's Experiment &Laws of Heredity

Mendel's laws

1. Law of dominance
2. Law of segregation
3. Law of independent assortment

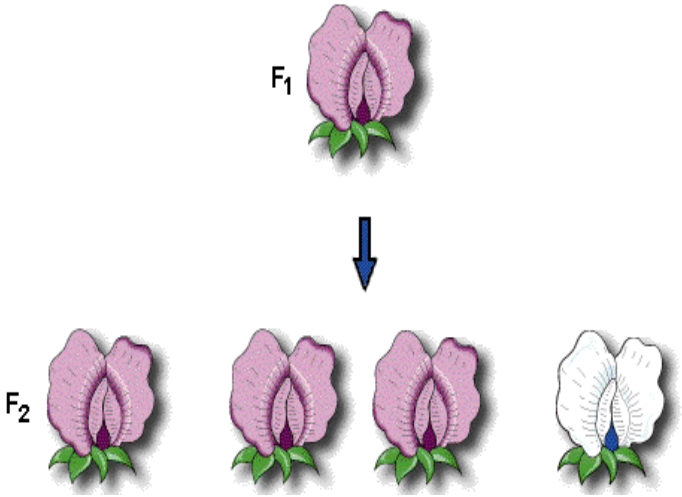
Mendel's One Factor Cross Experiments: F1 Generation

- **Monohybrid cross:** crossing parent differing in only one trait (example flower color)
- Mendel cross-fertilized two purebred pea plants with opposite traits like purple and white flowers. He called them the parental generation (P generation)
- He got the first filial (F1) generation

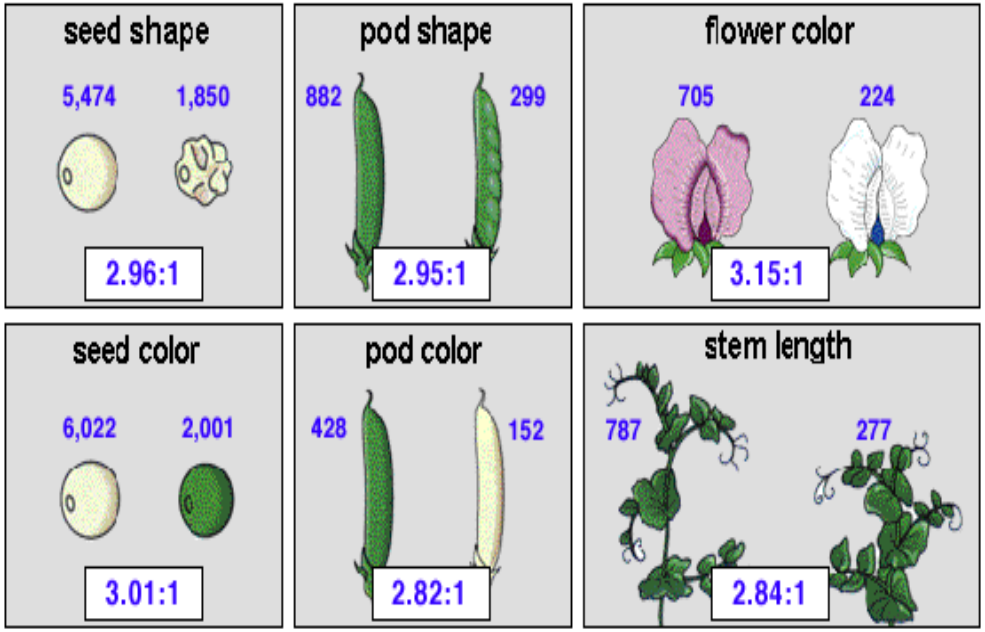


Mendel's One Factor Cross Experiments: F2 Generation

- Mendel let F1 generation <u>self-fertilize</u>
- Got F2 generation
- Mendel did this experiment with all the different traits

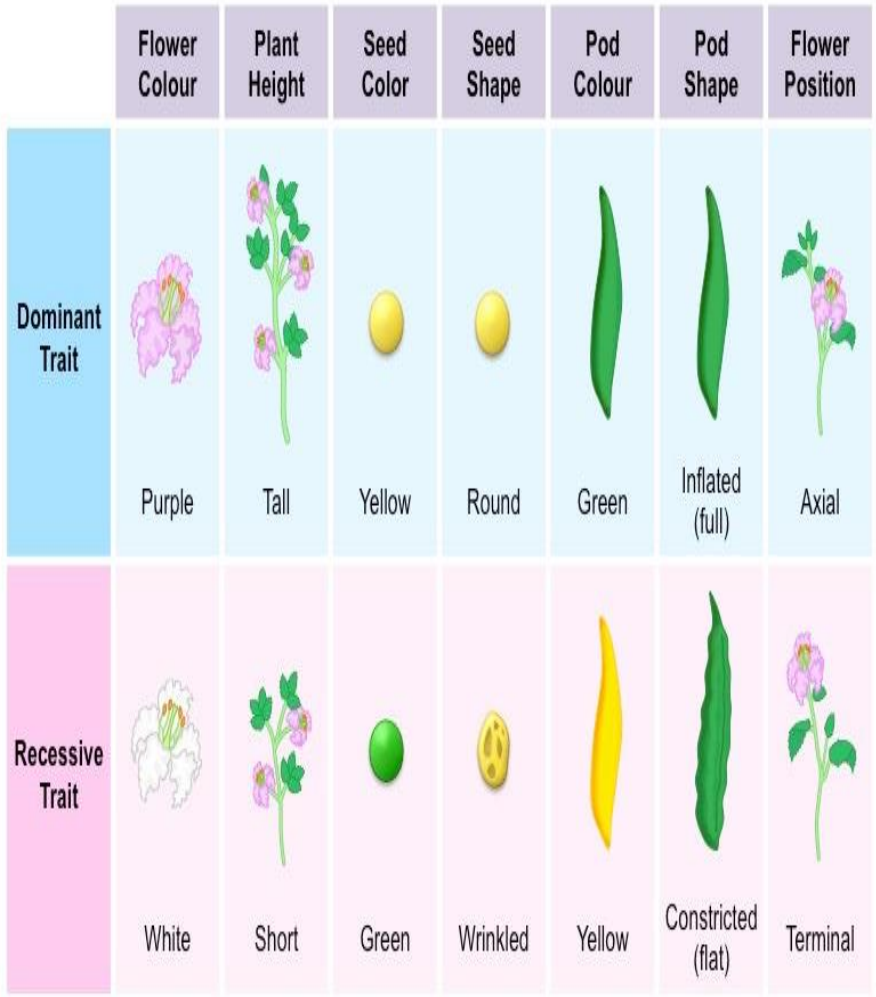


- He noticed the trait that disappeared in F1 reappeared in F2 (example white flower)
- He always saw a ~**3:1 ratio** in the F2 generation



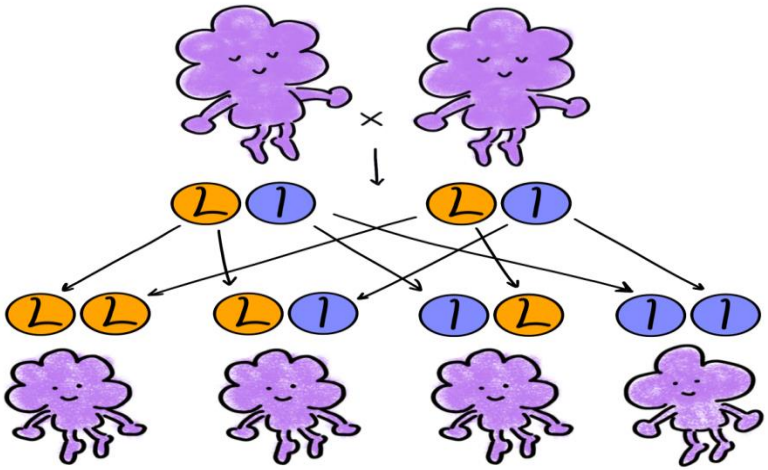
#1 Law of Dominance

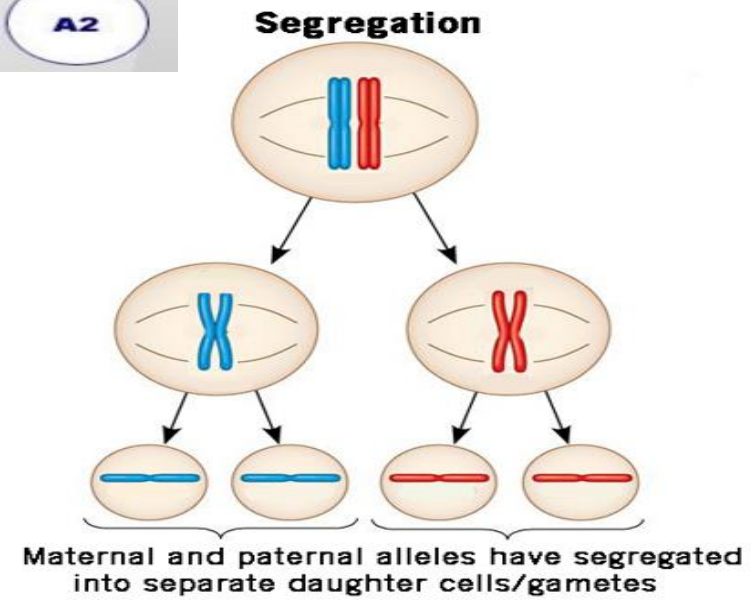
- Mendel realized that heritable factors (genes) control each trait
- Each heritable factor has two sets (alleles)
- Alleles can be either dominant or recessive
  - Mendel concluded that one allele in a pair may mask, or hide, the other allele.
  - Alleles that mask or hide other alleles are **dominant**
  - Alleles that are masked or covered up, whenever the dominant allele is present are **recessive**



#2 Law of Segregation

- In meiosis the two alleles for a trait segregate (separate). Each egg or sperm receives a copy of one of the two alleles
- There is a 50% chance that a copy of that allele will end up in the gamete.

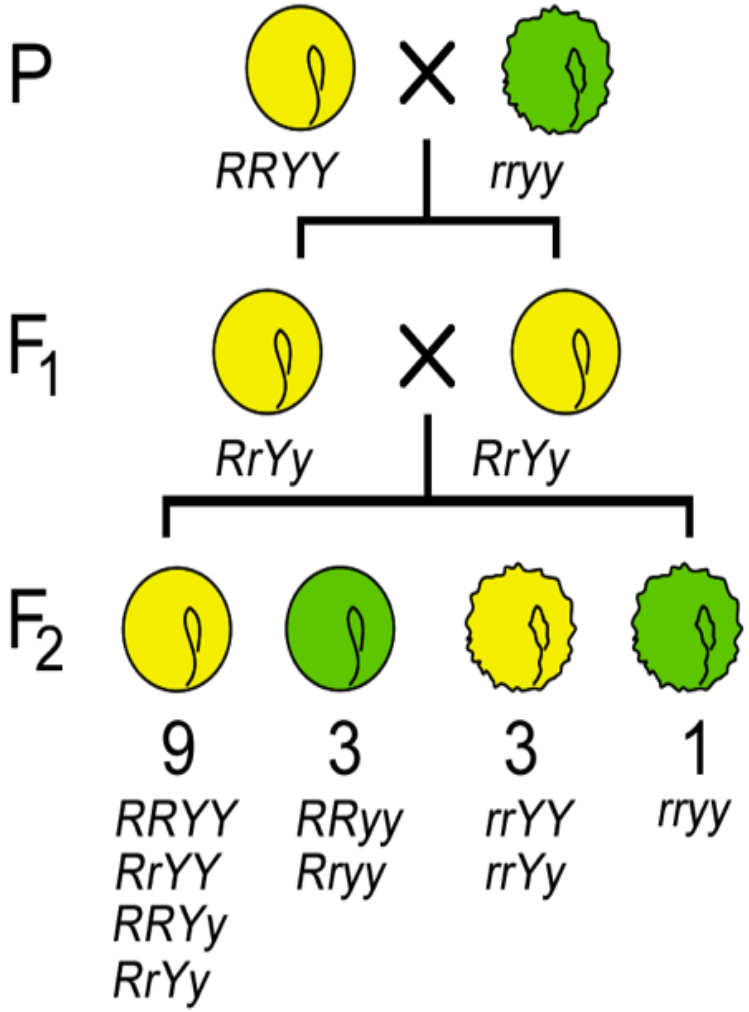




Mendel's Two Factors Cross Experiments

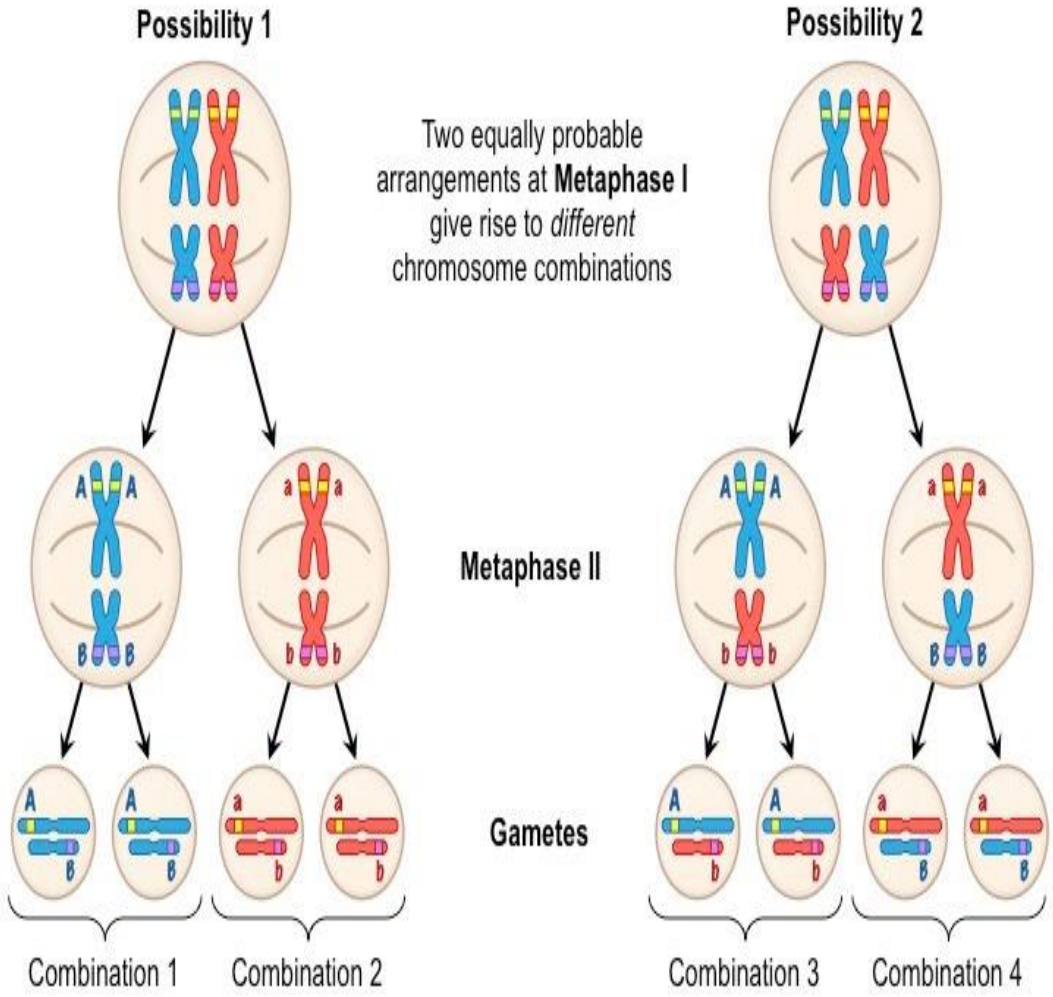
- Mendel repeated the experiment but this time with **two** different traits
- Parental generation were purebred for 2 different traits
- F1
  - All show the same phenotype
- F2
  - Appearance of **4** different phenotypes with the ratio of:

  9:3:3:1



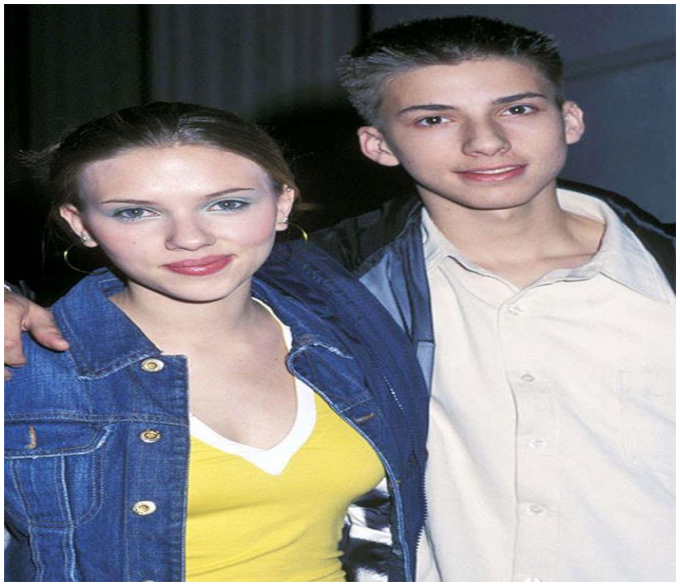
#3 Law of Independent Assortment

- Mendel noticed that traits (like flower color, height) are inherited independently - not together as a one unit
- Mendel concluded that random distribution of alleles occur during gamete formation
- Each pair of alleles (for different traits) on separate chromosomes sort independently during meiosis



Answer The Driving Question

Why siblings do not look exactly alike even though they have the same parent?



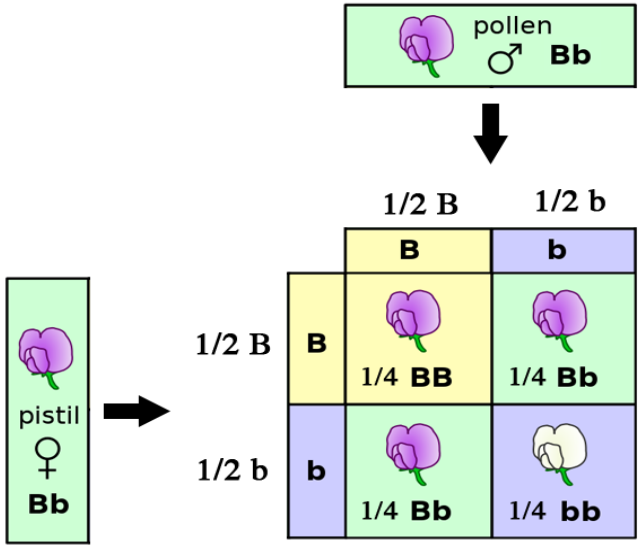
Driving Question #2

- Can we predict how often do traits passed down and show up?

Analyzing Inheritance

A. Probability

- Likelihood that event may occur
- Due to the law of segregation, if you know the genotype of the parents, you can predict the likelihood of a trait occurring in the offspring.
- Probability can be written 3 ways:
  - Fraction 1/2
  - Ratio 1:2
  - Percent 50%

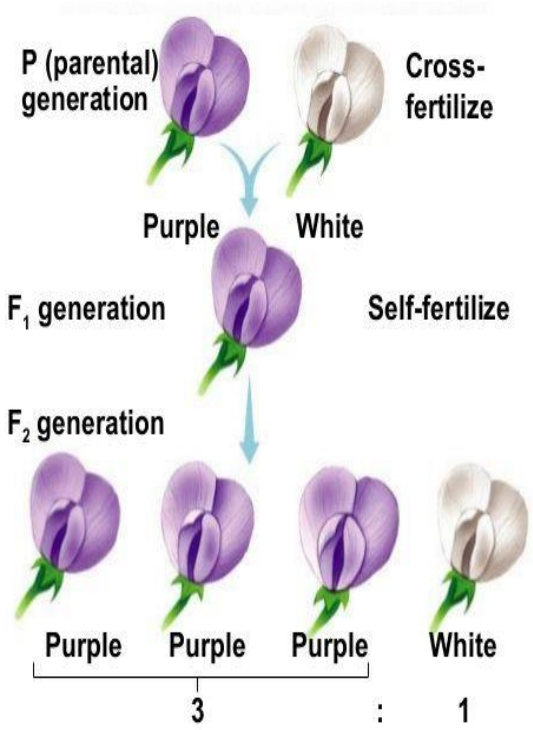


Probability

Monohybrid-Cross

F2 generation shows:

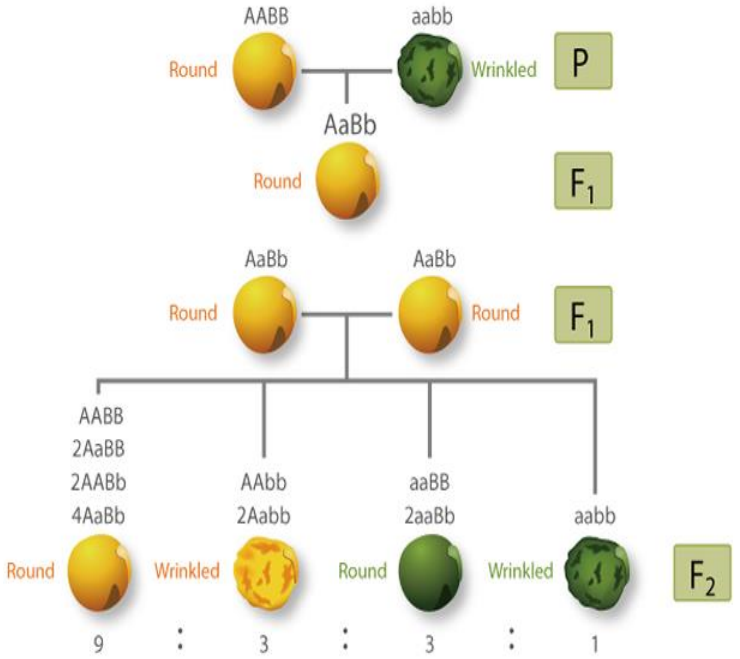
3:1 (purple to white)



Dihybrid-Cross

F2 generation shows:

9:3:3:1 (round yellow, wrinkle yellow, round green, wrinkle green)



Analyzing Inheritance Cont.

B. Punnett Square

A mathematical **model** that shows the probability of certain genetic combinations and traits in offspring

Example #1:

Cross heterozygous round father with wrinkled mother

R= round (dominant)

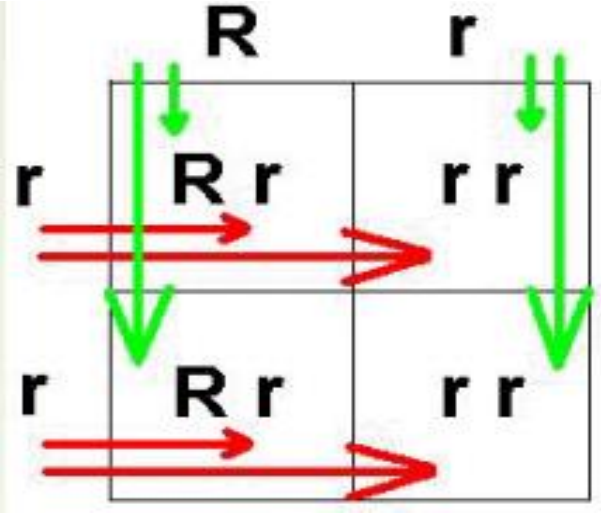
r= wrinkled (recessive)

-Father genotype is **Rr**

-Mother genotype is **rr**

Remember:

- Dominant can be homozygous (RR) or heterozygous (Rr)
- Recessive can be only homozygous (rr)



Offspring genotype

- ½ heterozygous dominant Rr
- ½ homozygous recessive rr

Offspring phenotype

- 1:1 (round to wrinkled)

Monohybrid-Cross Punnett Square

Example #2

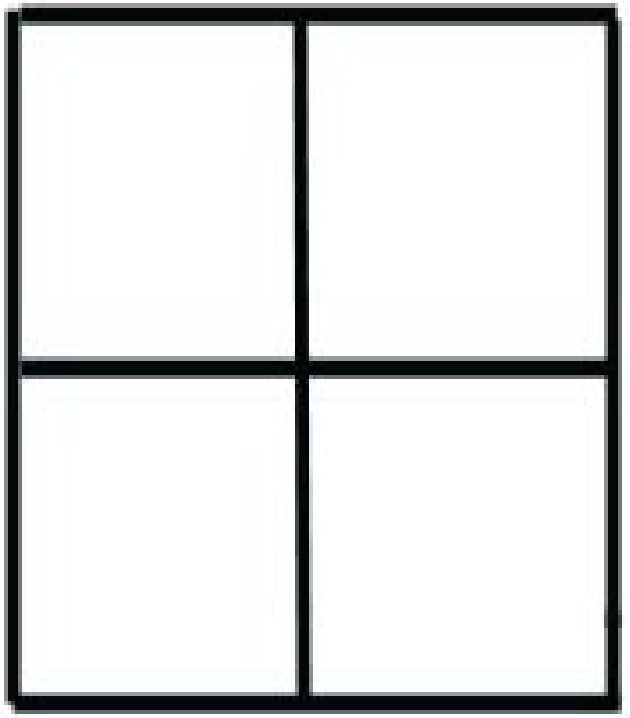
Cross two round heterozygous parents

R= round (dominant)

r= wrinkled (recessive)

-Father genotype is Rr

-Mother genotype is Rr



Offspring genotype:

- Homozygous dominant
- Heterozygous dominant
- homozygous recessive

Offspring phenotype

Practice on the White Board

- Practice solving the cases on your white board
- Use ONLY one marker
- Cover the marker when you are done
- Clean the white board when you are done
- Make sure to record the correct answers on your notes

Monohybrid Practice

Use the following information to solve the cases that you will see:

- Black Labrador is dominant trait **B**

- Chocolate Labrador is recessive **b**

Case #1

- Cross **homozygous black** Labrador with **chocolate** Labrador
- The genotype of the black Labrador is _____
- The genotype of the chocolate Labrador is _____
- What is the predicted offspring genotype(s)?

- What is the predicted offspring phenotype(s)?

Case #1 Answer

	b	b
B	Bb	Bb
B	Bb	Bb

Offspring genotype:

- 100% heterozygous

Offspring phenotype

- 100% black Labrador

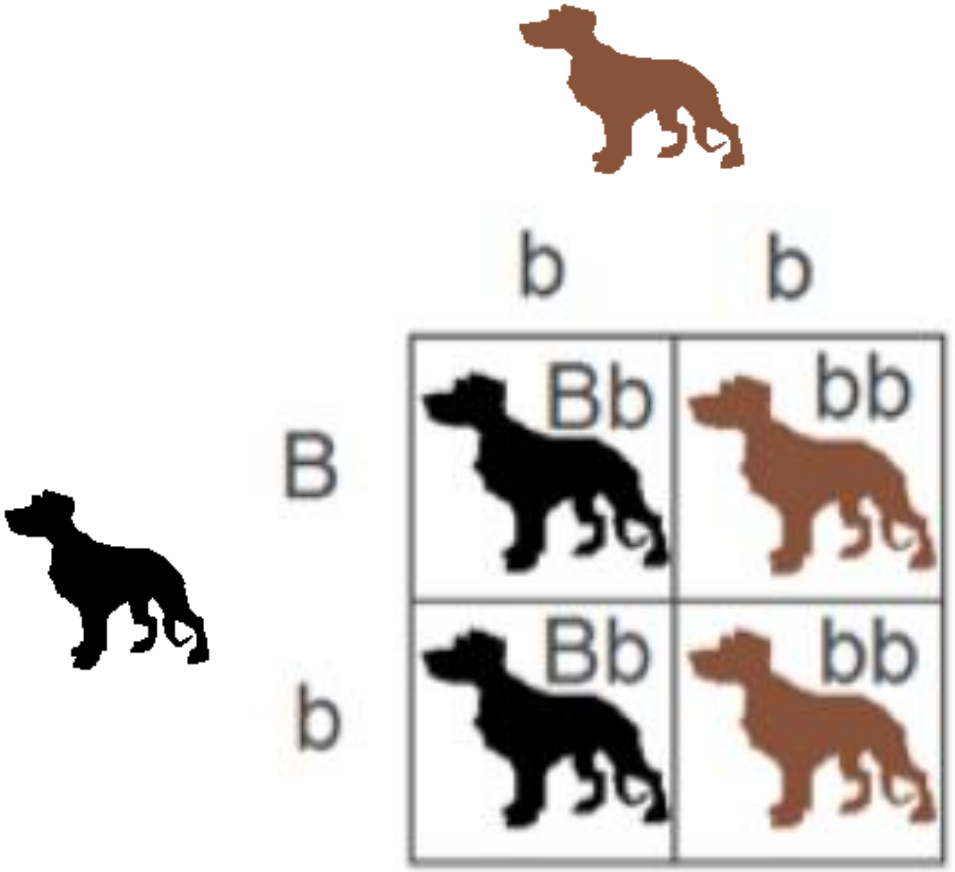
Case #2

- Cross **heterozygous black** Labrador with **chocolate** Labrador
- The genotype of the black Labrador is _____
- The genotype of the chocolate Labrador is _____

- What is the predicted offspring genotype(s)?

- What is the predicted offspring phenotype(s)?

Case #2 answer



Offspring genotype:

- ½ heterozygous
- ½ homozygous recessive

Offspring phenotype

- 1:1 black to chocolate Labrador

One more time!

- Cross two heterozygous black Labrador
- Draw you punnett square
- Record the genotype of both black Labrador
- What is the predicted offspring genotype(s)?
- What is the predicted offspring phenotype(s)?

	B	b
B	BB	Bb
b	Bb	bb

Offspring genotype:

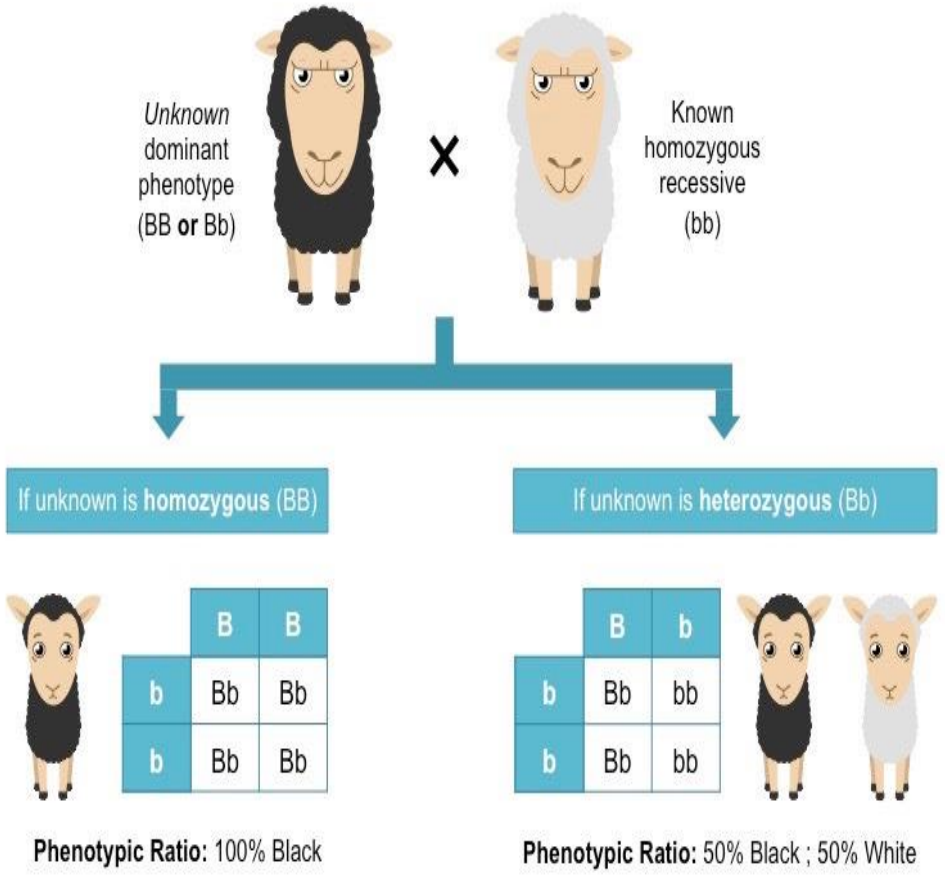
- ¼ homozygous dominant
- ½ heterozygous
- ¼ homozygous recessive

Offspring phenotype

- 3:1 black to chocolate Labrador

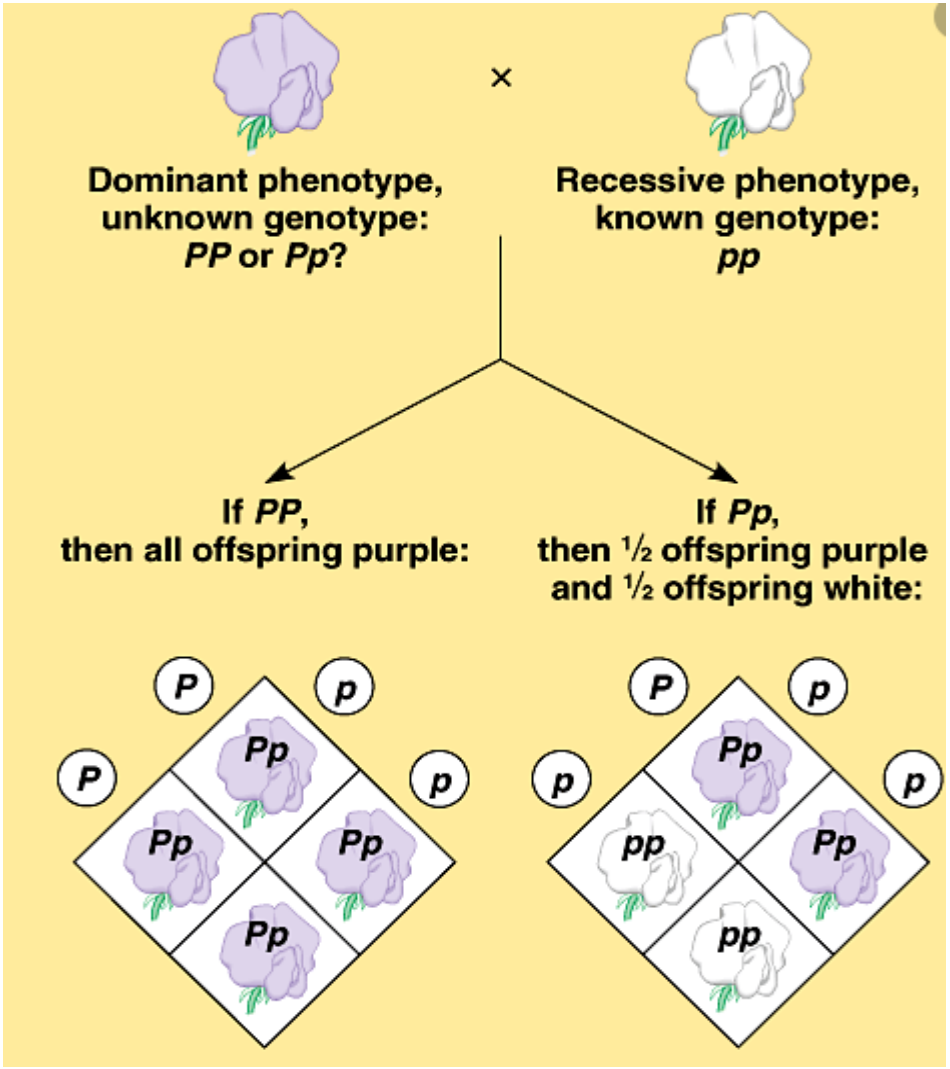
Test Cross

- Process to determine an unknown genotype of individual who expresses a dominant phenotype
  - Why it is done?
    - To find out the unknown genotype (homozygous or heterozygous)of an organism with a dominant phenotype
  - How it is done?
    - By crossing the unknown organism with a homozygous recessive one
  - How a conclusion is drawn?
    - By looking at the offspring



Test Cross Cont.

- We need to find out the genotype of a purple pea flower
- There are two genotype possibilities:
  - Homozygous PP
  - or heterozygous Pp
- Cross each possible genotype with a recessive white pea flower
- Look at the phenotype of the offspring
- If 100% of offspring show dominant phenotype (purple in this case), we can conclude that the parent genotype is homozygous dominant PP
- If 50% of offspring show dominant phenotype and the other 50% show recessive phenotype, you can conclude that the unknown parent genotype is heterozygous Pp

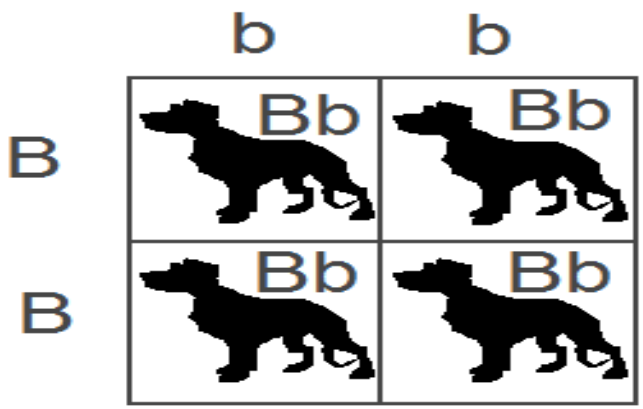


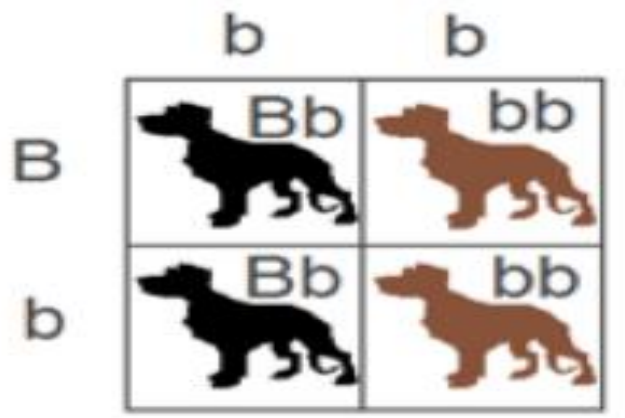
Quick Practice

- You bought a black Labrador dog, but you don't know if it is purebred (homozygous dominant) or hybrid (heterozygous). Hypothetically, what can you do to know for sure the genotype of your dog?
- Remember:
- Black Labrador is dominant (B)
- chocolate Labrador is recessive (b)
- Solve this problem on the white board

The Solution

- The two possible genotypes for the black Labrador are homozygous BB or heterozygous Bb
- Cross each possible genotype with chocolate Labrador (rr)
- If offspring phenotype is 100% Black, your dog is homozygous dominant BB
- If the offspring phenotype is 1:1 black to chocolate, your dog is heterozygous





Answer The Driving Question #2

- Can we predict how often do traits passed down and show up? How?