Genetics &
The Work of Mendel

TEKS

6 Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and **the principles of Mendelian Genetics**. The student is expected to:

6F **predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;**

Prerequisite Questions

1. How does DNA store information in our genes?

2. In what process do we make gametes?

3. Where does an organisms get its genes from?

Essential Question #1

- What is the role of nucleic acids in genetics?

Vocabulary

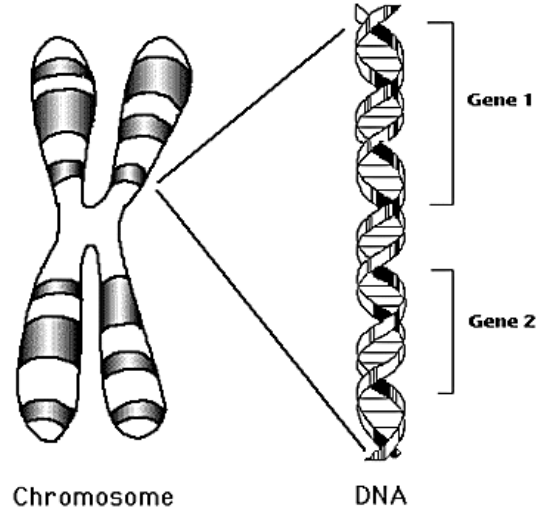
- Genetics
- Heredity
- Self pollination
- Cross pollination
- Hybrid
- Monohybrid
- Dihybrid
- Gene
- Trait
- Allele
- Dominant allele
- Recessive allele
- Homozygous
- Heterozygous
- (F1 generation)
- (F2 generation)
- Locus (preAP)
- somatic
- gamete
- Phenotype
- Genotype
- True-breeding
- Probability
- Law of Segregation
- Law of Independent Assortment

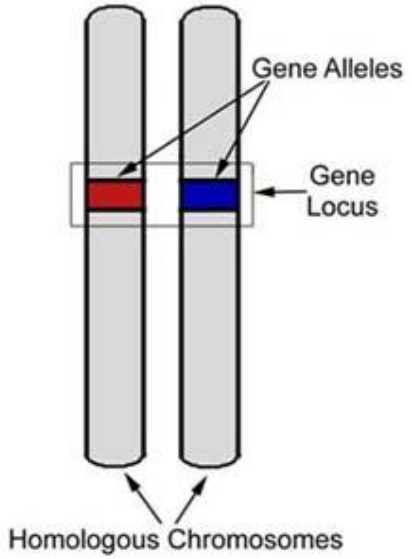
Vocabulary

Gene – portion of DNA that codes for a trait or protein

Trait – inheritable characteristic

Allele – number of alternative forms of the same **gene** or same **genetic locus** (spot)





Complete Dominance

- The following genetics slides cover the concept of Complete Dominance.

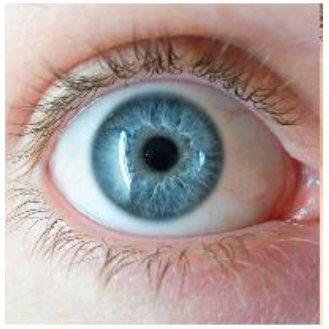
Vocabulary

Dominant allele/trait – trumps other alleles (hides them) and is written with an uppercase letter

ex. Not blue/green eyes are dominant = **B**

Recessive allele/trait – hidden if dominant allele is present and is written with a lowercase letter

ex. Blue/green eyes are recessive = **b**



Vocabulary

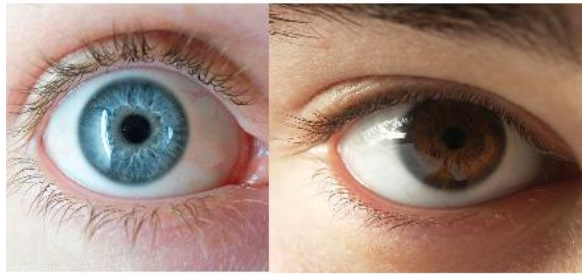
Homozygous – both forms of the allele are the **same**
(also known as **purebred, true-breeding)**

ex. Homozygous dominant eyes = **BB**

Homozygous recessive eyes = **bb**

Heterozygous – forms of the allele are **different**
(also known as **hybrid)**

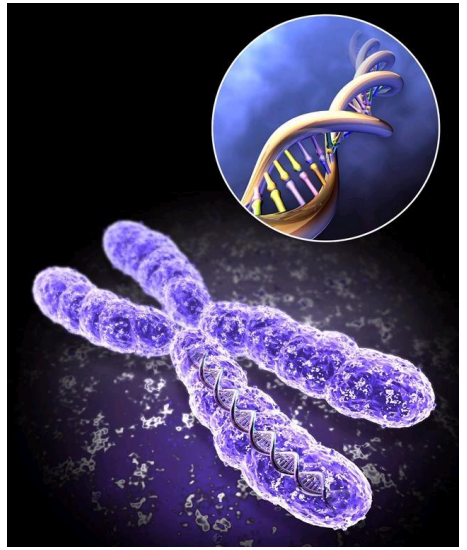
ex. Heterozygous eyes = **Bb**



What is genetics?

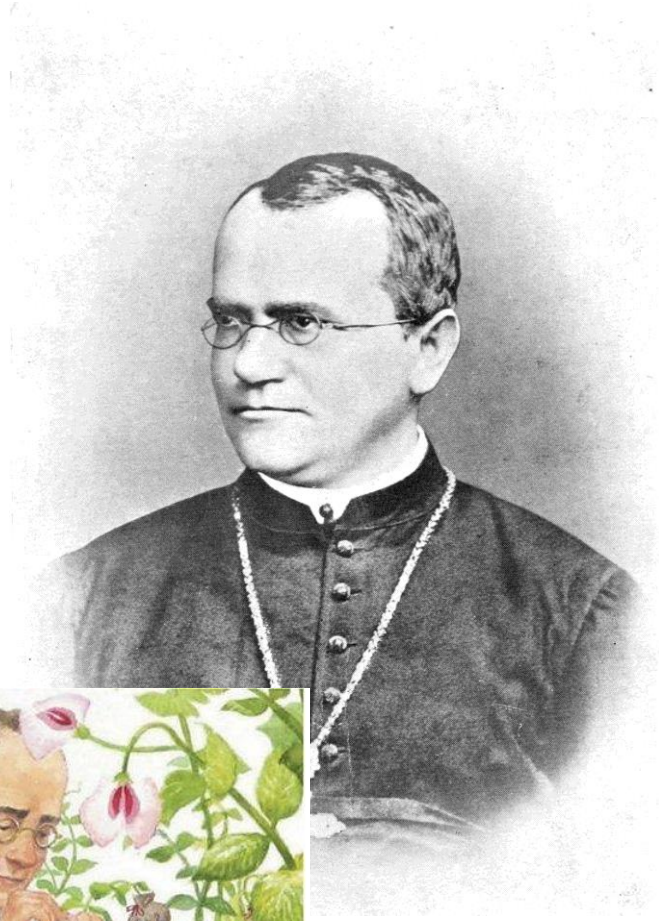
- **Genetics** studies heredity.

- **Heredity** is the passing of traits from parents to offspring.

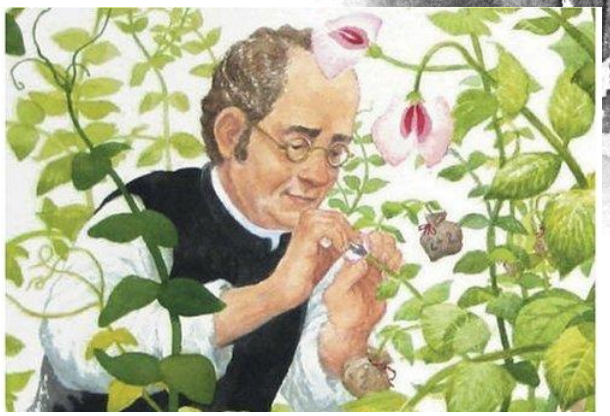


Who is Father of Genetics?

- **Gregor Mendel** – in mid-1800s, Austrian monk who was the first person to succeed in predicting how traits passed from parent to offspring

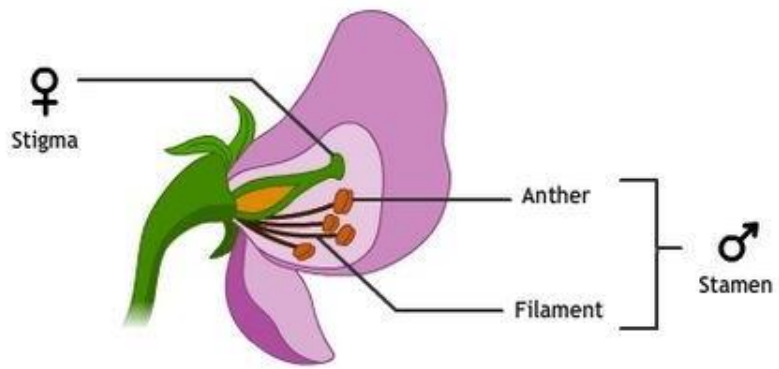


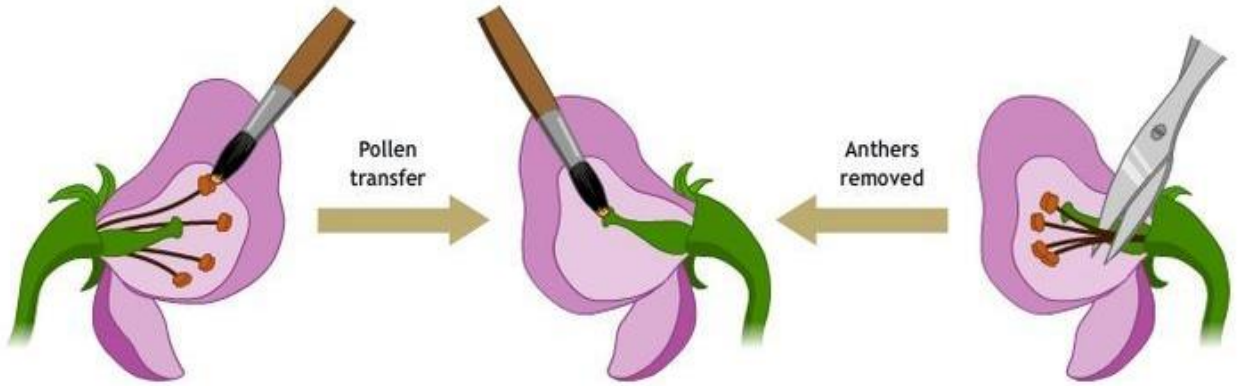
- He used garden peas in his experiments.



Mendel's Experiments

- He controlled his experiments to ensure accurate results:
  - **Self-Pollination** – pea plant would pollinate itself
  - **Cross-Pollination** – one pea plant would pollinate another



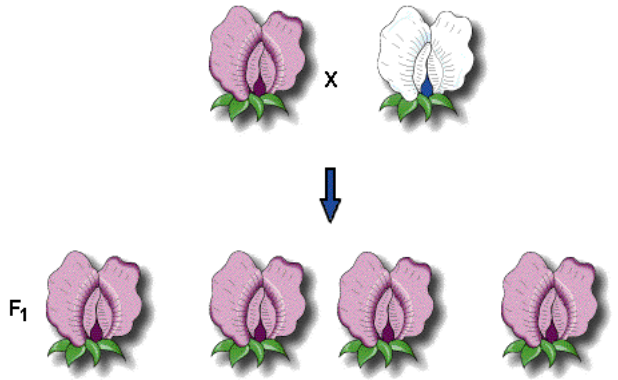


Mendel's Monohybrid Crosses

- Mendel selected a white-flower plant and a purple-flower plant.
  - He crossed them to produce new plants.

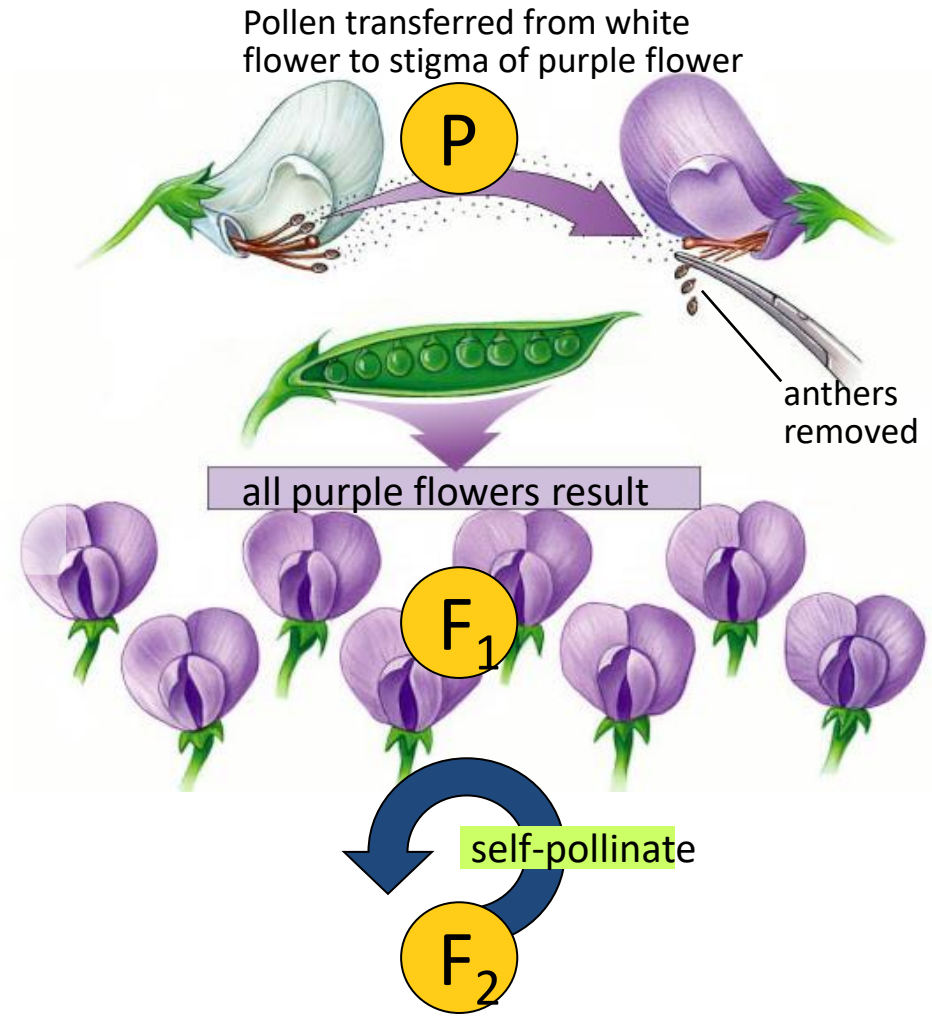
- **Hybrid** – offspring of parents that have different forms of a trait (ex. Tall and short height)

- **Monohybrid** – looking at "one trait" of a hybrid

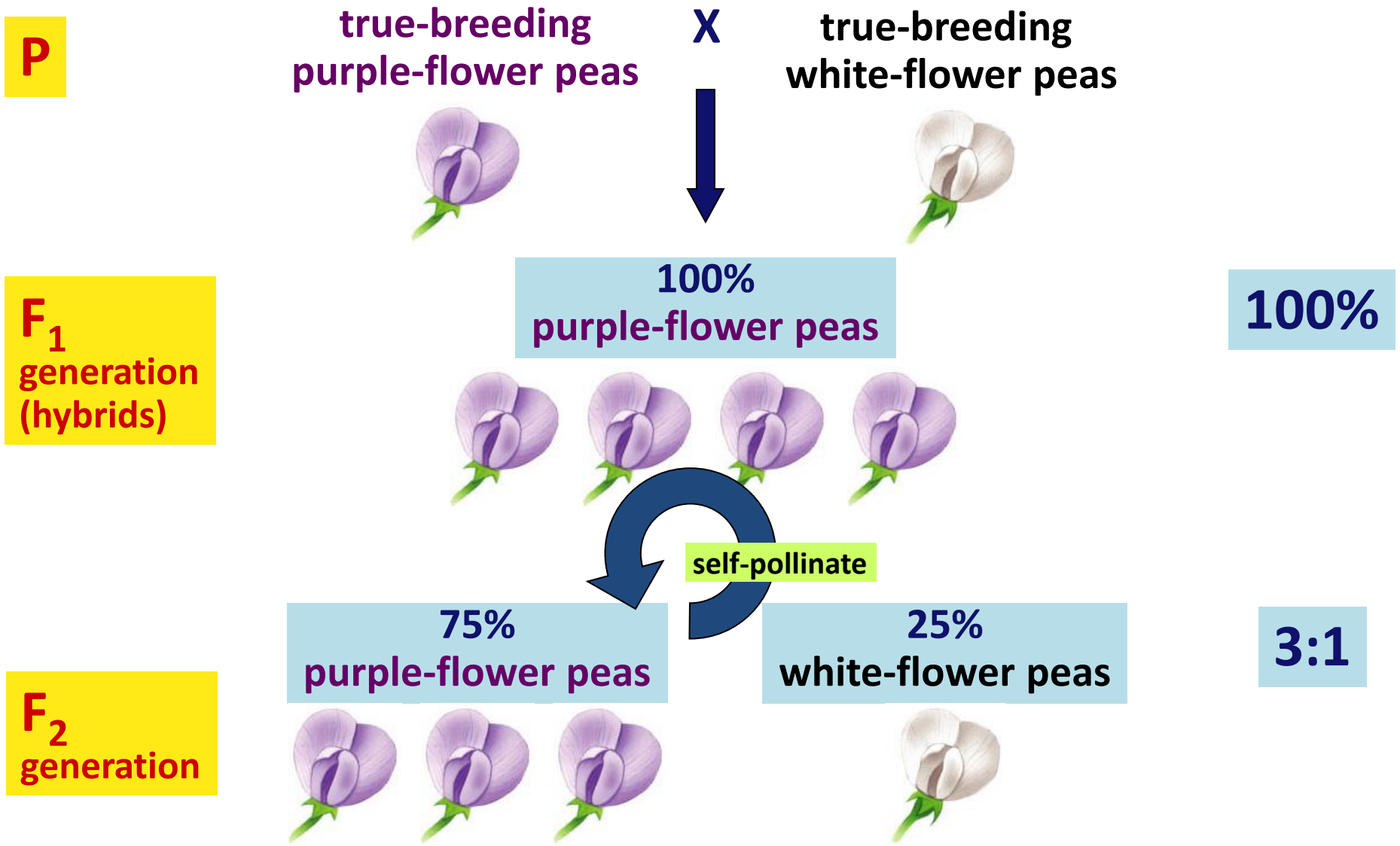


Mendel's Work (do not copy into notes, but understand)

- **Parent generation (P):**
  - White plant x Purple plant
- **First generation (F_1):**
  - Produced all purple plants
    - **F = filial**
- **Second generation (F_2):**
  - Self pollinate F_1 generation
  - Purple plant x purple plant produced 3 purple plants & 1 white plant.



Looking closer at Mendel's work (Do not copy, but understand)

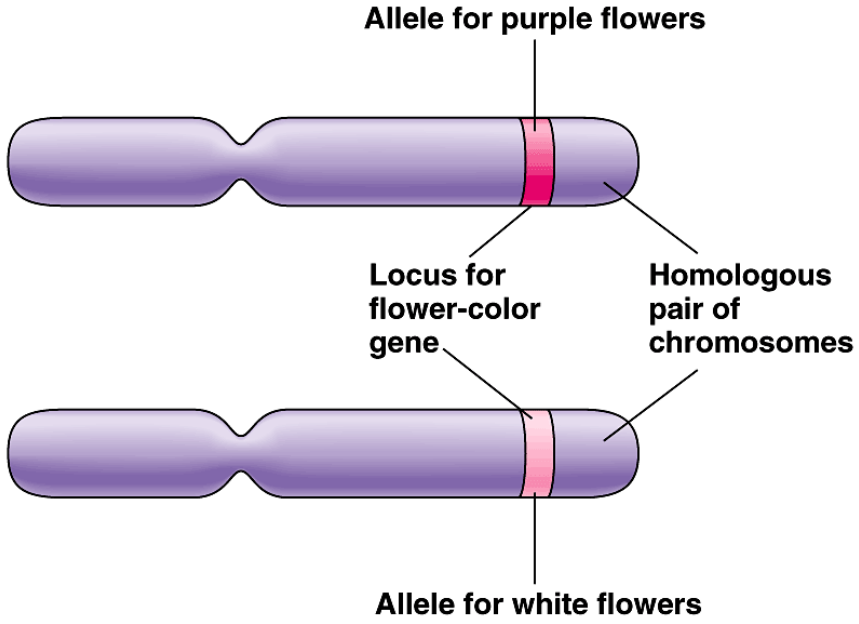


What did Mendel's findings mean? (Do not copy, but understand)

- Traits come in alternative versions:
  - Purple vs. White flower color
  - **Alleles -** a number of alternative forms of the same **gene** or same **genetic locus** (spot)
    - some difference in sequence of A, T, C, G

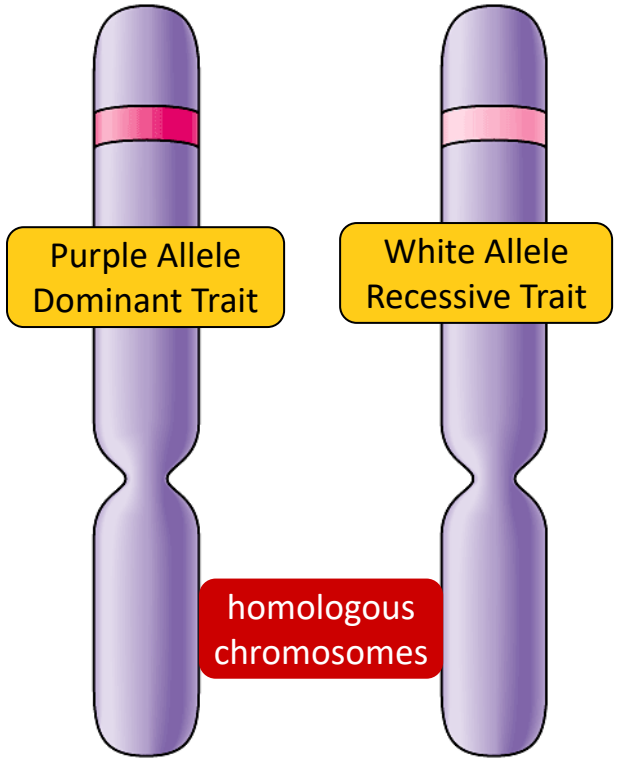
purple-flower allele & white-flower allele are two DNA variations at flower-color locus

different versions of gene at same location on homologous chromosomes



What did Mendel's findings mean? (Do not copy, but understand)

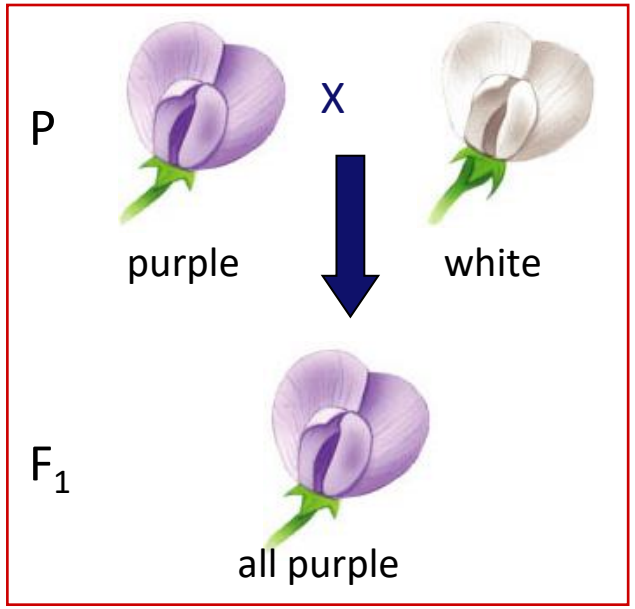
- Some traits mask others:
  - purple & white flower colors are separate traits that do not blend
    - purple x white ≠ light purple
    - purple masked white
  - **Dominant allele = purple flower color**
  - **Recessive allele = white flower color**



Genotype vs. Phenotype

- Difference between how an organism "looks" & its genetics:
  1. **Phenotype** - description of organism's trait
     - Phenotype = Physical (genes that are expressed)
  2. **Genotype** - description of organism's genetic makeup
     - Genotype = Genetics

Explain Mendel's results using
…dominant & recessive
…phenotype & genotype

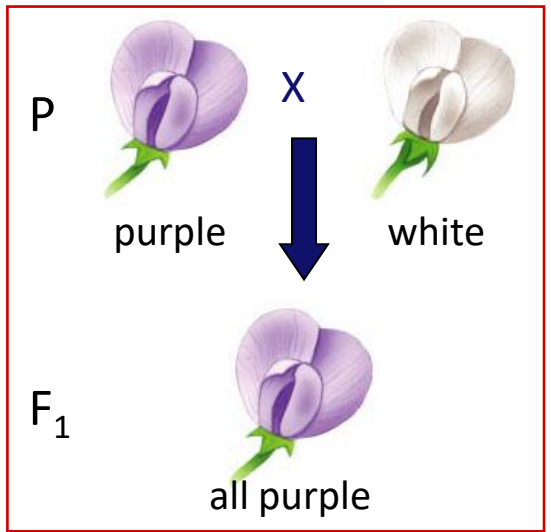


Making Crosses

- Can represent alleles as letters:

  ***when choosing letters, pick letter where uppercase looks different then lowercase*

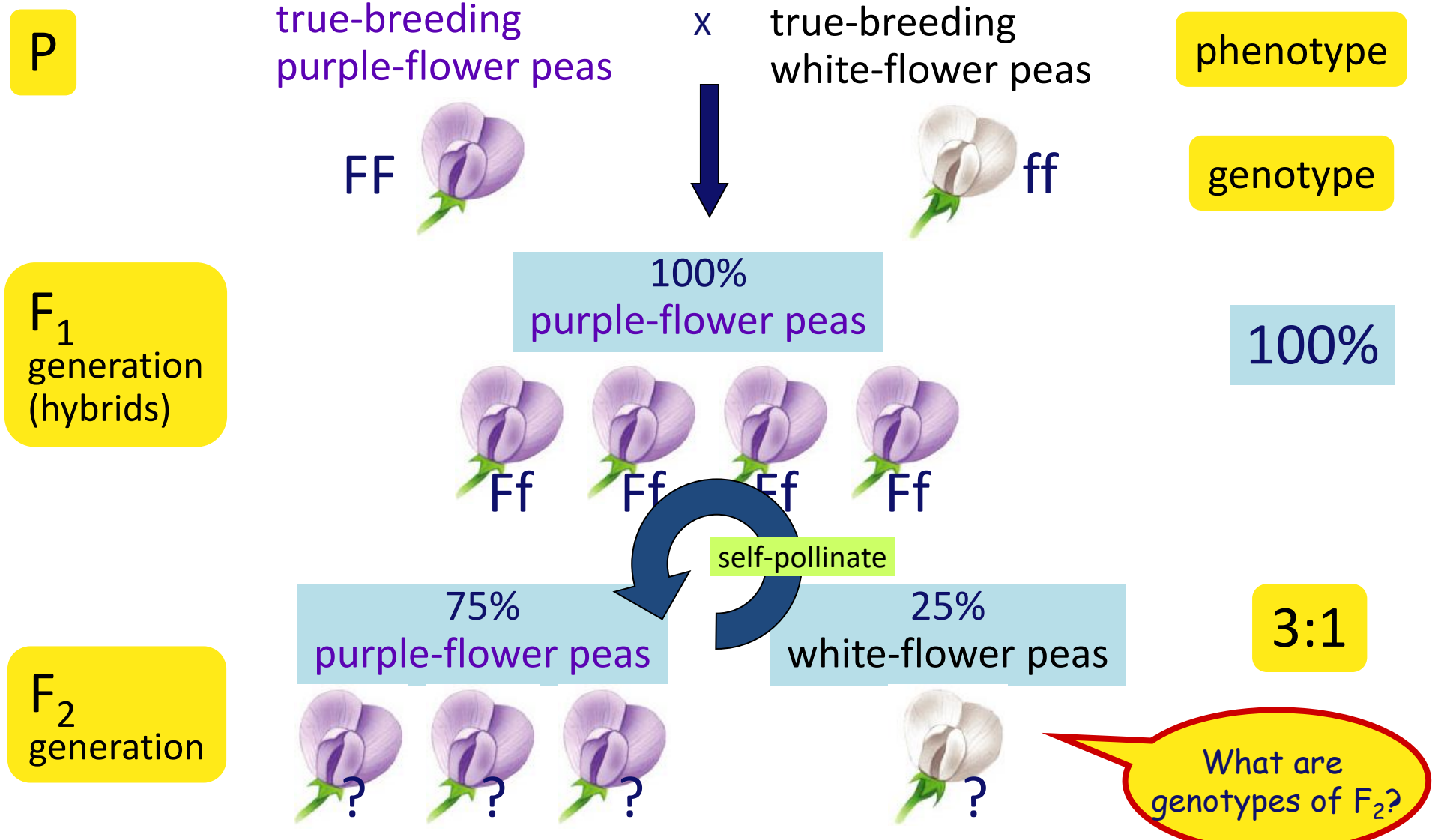
  - flower color alleles → F or f
  - true-breeding purple-flower peas → FF
  - true-breeding white-flower peas → ff



FF x ff

	F	F
f	Ff	Ff
f	Ff	Ff

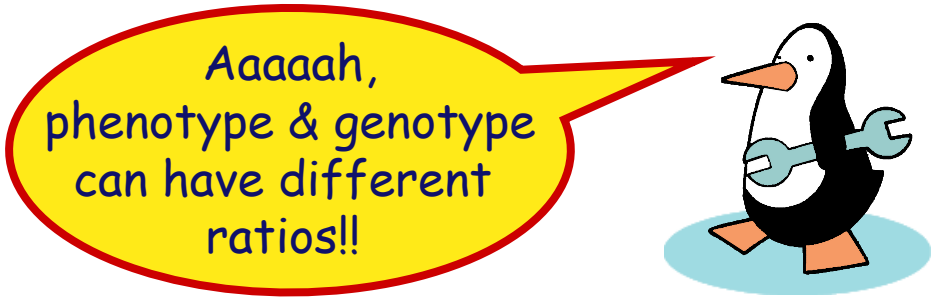
Looking closer at Mendel's work



Punnett Squares

F_1 generation (hybrids)

Ff x Ff



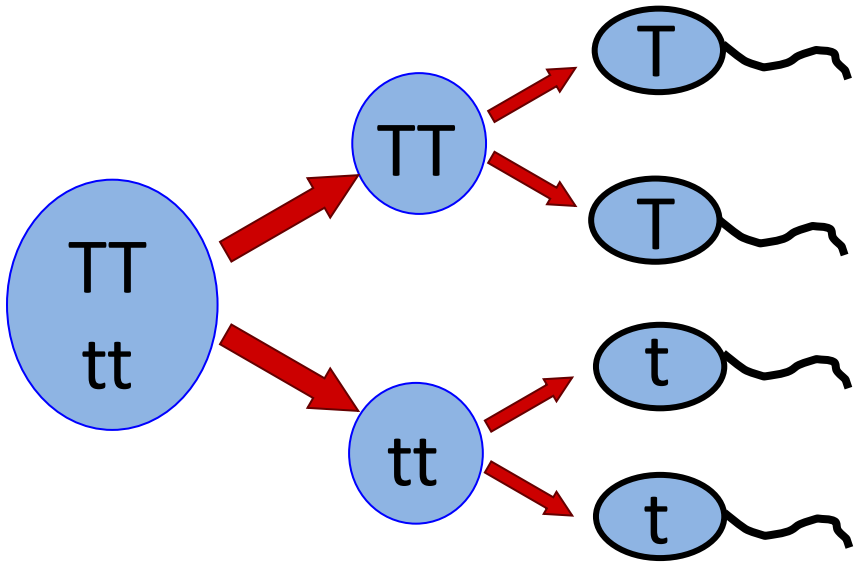
male / sperm

female / eggs	F	f
F	FF	Ff
f	Ff	ff

Genotype	Phenotype
FF = 25%	Purple = 75%
Ff = 50%	White = 25%
ff = 25%	3:1 ratio
1:2:1 ratio	

Mendel's Laws of Heredity

- **Law of Segregation:**
  - Alleles for SAME trait separate into different gametes during meiosis.
  - Ex. Height



- **Law of Independent Assortment:**
  - Alleles for DIFFERENT traits separate independently of each other during meiosis.
  - Ex. **Blonde hair** does not mean you have **blue eyes**. Traits inherited independently.

Essential Question #2

- How can you predict the outcomes of monohybrid and dihybrid crosses?

Monohybrid Crosses Practice

- Every genetics problem you work must include:
  1. Key
  2. Cross (Parent x Parent)
  3. Punnett Square
  4. Results (Genotype & Phenotype)

Monohybrid Crosses Practice

1. In pea plants red flower color (R) is dominant over white (r). Cross a red pure-bred with a white pure-bred.

Key

R = red

r = white

Cross: RR x rr

	R	R
r	Rr	Rr
r	Rr	Rr

Genotype	**Phenotype**
Rr = 100%	Red = 100%

1 Ratio

Monohybrid Crosses Practice

2. In pea plants red flower color (R) is dominant over white (r). Cross a hybrid red with a white pure-bred.

Key

R = red

r = white

Cross: Rr x rr

	R	r
r	Rr	rr
r	Rr	rr

Genotype	**Phenotype**
Rr = 50%	Red = 50%
rr = 50%	White = 50%
1:1 Ratio	1:1 Ratio

Monohybrid Crosses Practice

3. In human, dimples (D) is dominant over no dimples (d). Cross a hybrid woman with a man who does not have dimples. Give phenotypic and genotypic results of F_1 generation. What are the chances the couple will have a child with no dimples?

Key

D = dimples

d = no dimples

Cross: Dd x dd

	D	d
d	Dd	dd
d	Dd	dd

Genotype	**Phenotype**
Dd = 50%	Dimples = 50%
dd = 50%	No dimples = 50%
1:1 Ratio	1:1 Ratio

50% chance of child with no dimples

4. Curly hair (H) is dominant over straight hair (h). Cross a purebred curly haired woman with a true-breeding straight haired man. Give phenotypic and genotypic results of **F_1 generation**. Then, cross F_1 offspring to show phenotypic and genotypic results of **F_2 generation**.

Key

H = curly

h = straight

Cross: HH x hh

	H	H
h	Hh	Hh
h	Hh	Hh

F_1

Genotype	Phenotype
Hh = 100%	Curly = 100%

Key

H = curly

h = straight

Cross: Hh x Hh

	H	h
H	HH	Hh
h	Hh	hh

F_2

Genotype	Phenotype
HH = 25%	Curly = 75%
Hh = 50%	Straight = 25%
hh = 25%	3:1 Ratio
1:2:1 Ratio	

Dihybrid Crosses

Dihybrid Cross

- Is the crossing of two traits.

- Instead of looking at probability of inheriting 1 trait, we are now going to analyze inheriting 2 traits at the same time.

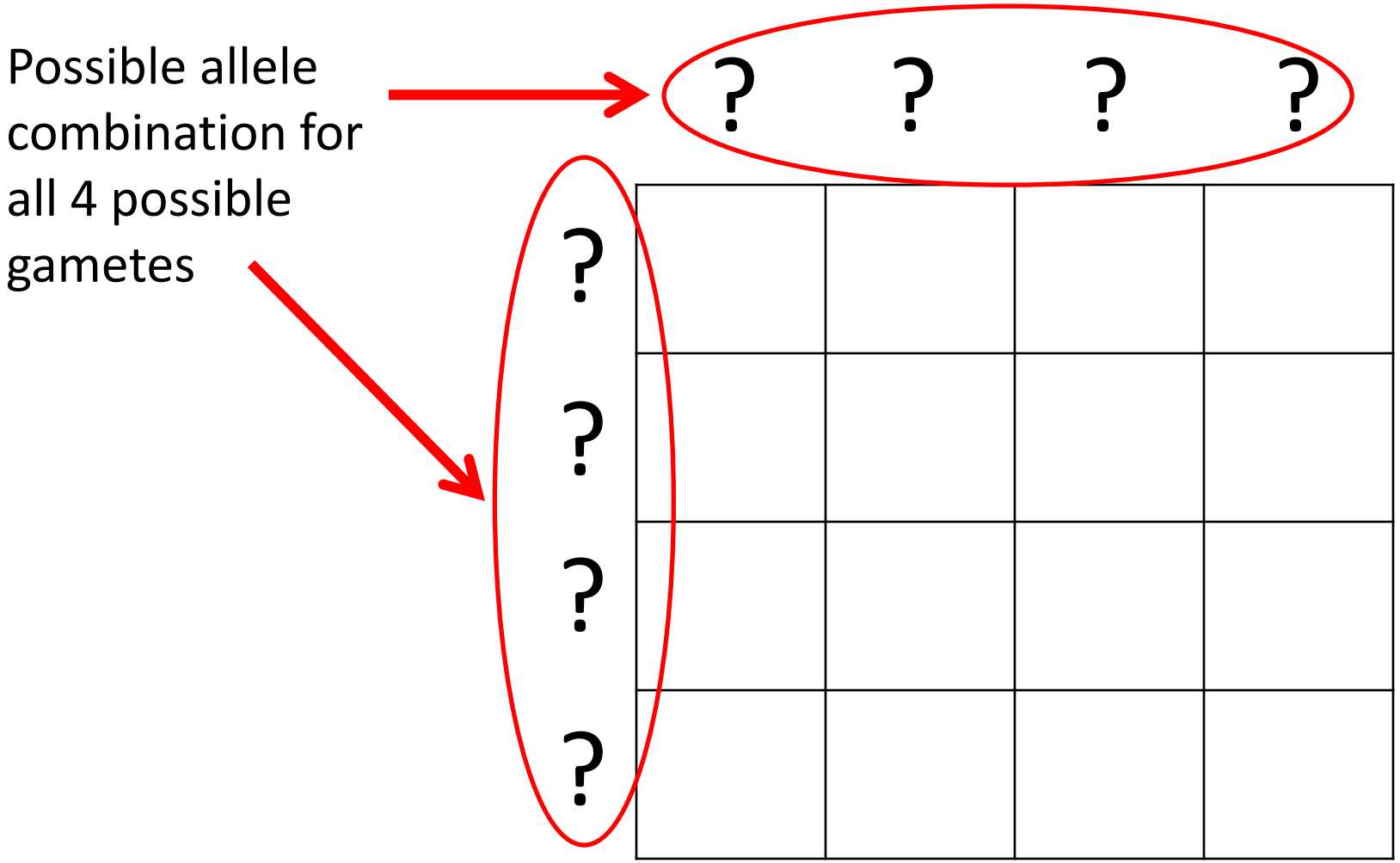
Setting up the Parent Alleles

- Remember: every trait in a dihybrid cross has 2 alleles (one from each parent)

- When setting up a dihybrid cross make sure each possible gamete has 2 alleles (one for each trait.)

Setting up the Alleles

Possible allele combination for all 4 possible gametes



FOIL

- Once you know the parents Genotype, you can set up the alleles for the dihybrid punnett cross.
  - Ex: AaBb

- Using the foil method looks like this…

F – First

O – Outside

I – Inside

L – Last

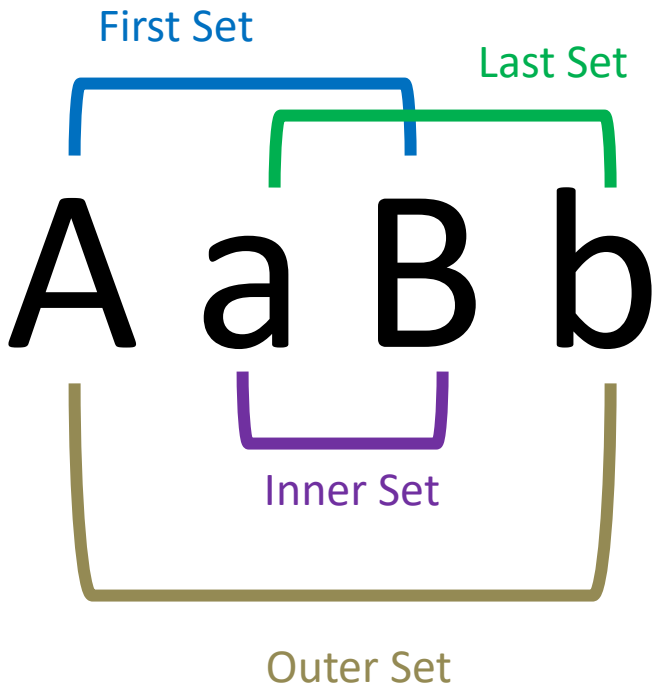
Foil Method

First – A B

Outside – A b

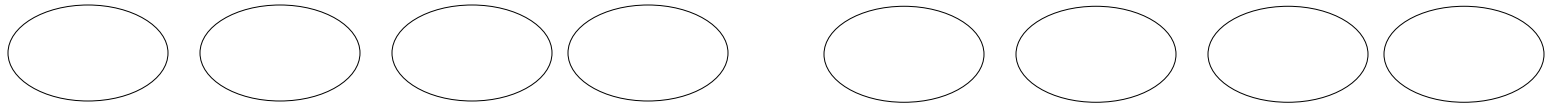
Inside – a B

Last – a b

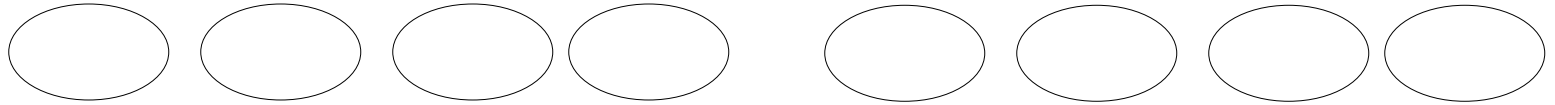


FOIL the gametes for the dihybrid cross

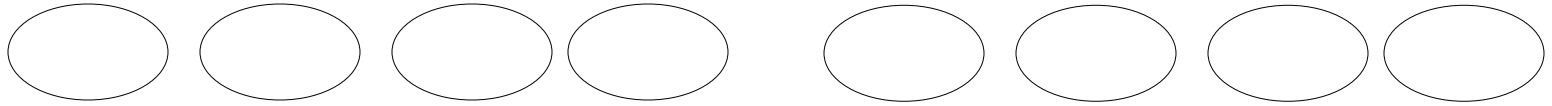
1. AABb x AaBb



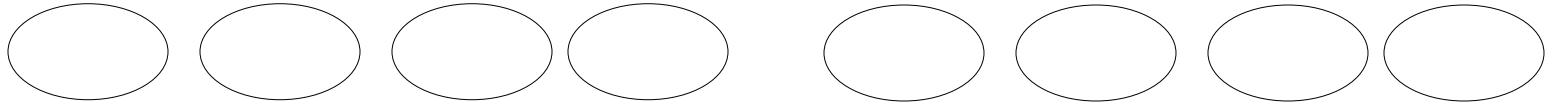
2. TtRr x TTRR



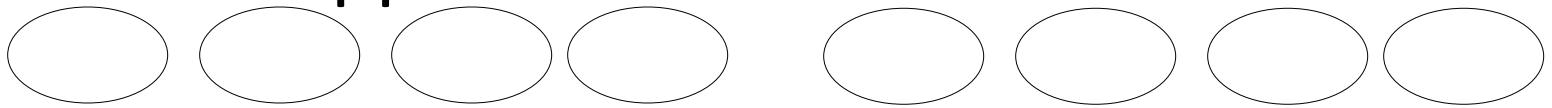
3. AaBb x AaBb



4. DDEE x ddee



5. QQRr x qqRr



1. In werewolves, sharp fangs are dominant (F) and round fangs are recessive (f). Long hair is dominant (H) and short hair is recessive (h). Cross a heterozygous sharp fanged, hybrid long haired werewolf with a hybrid sharp fanged, heterozygous long haired werewolf. Give the genotypic and phenotypic percentage and ratios of the F_1 offspring.

Key

F = sharp fangs
f = round fangs
H = long hair
h = short hair

FfHh x FfHh

	FH	Fh	fH	fh
FH	FFHH	FFHh	FfHH	FfHh
Fh	FFHh	FFhh	FfHh	Ffhh
fH	FfHH	FfHh	ffHH	ffHh
fh	FfHh	Ffhh	ffHh	ffhh

Key

F = sharp fangs
f = round fangs
H = long hair
h = short hair

FfHh x FfHh

	FH	Fh	fH	fh
FH	FFHH	FFHh	FfHH	FfHh
Fh	FFHh	FFhh	FfHh	Ffhh
fH	FfHH	FfHh	ffHH	ffHh
fh	FfHh	Ffhh	ffHh	ffhh

Genotype

FFHH = 1/16
FFHh = 2/16
FfHH = 2/16
FfHh = 4/16
FFhh = 1/16
Ffhh = 2/16
ffHH = 1/16
ffHh = 2/16
ffhh = 1/16

Phenotype

Sharp fangs, long hair	=	9
Sharp fangs, short hair	=	3
Round fangs, long hair	=	3
Round fangs, short hair	=	1

Neat video of Mendel's Contribution to Genetics

https://www.youtube.com/watch?v=Mehz7tCxjSE