Genetics

Mendel and Punnett Squares

What is Genetics?

- The study of heredity, how traits are passed from parent to offspring.

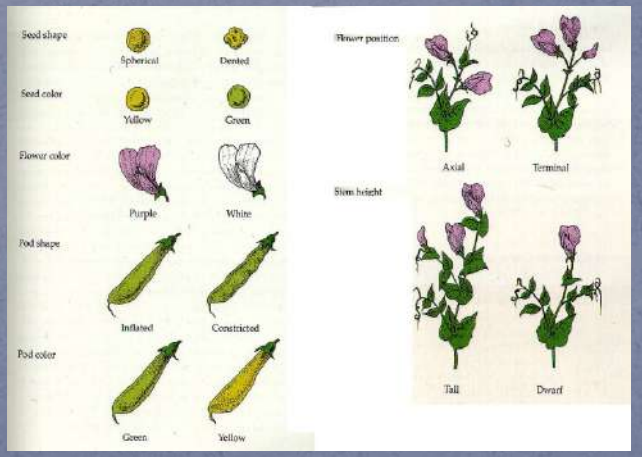
or

=

or

Gregor Mendel

- The study of genetics started with Gregor Mendel and his pea plant garden.
- He was an Austrian Monk that lived in the mid 1800s.
- He observed pea plants and how they passed their genetic information on to produce different pea plants.



Pea Plants

- Mendel's cross between tall pea plants yielded all tall pea plants. His cross between small pea plants yielded all small pea plants.


X

=



X

=


- Mendels' cross between tall pea plants and small pea plants yielded all tall pea plants


x

=

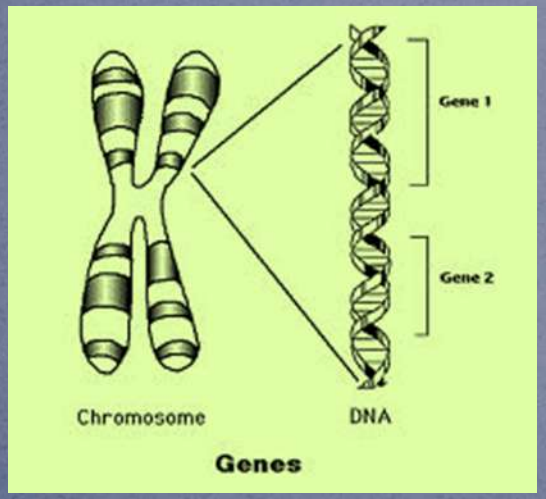

Mendel then crossed these second generation tall pea plants and ended up with 1 out 4 being small.

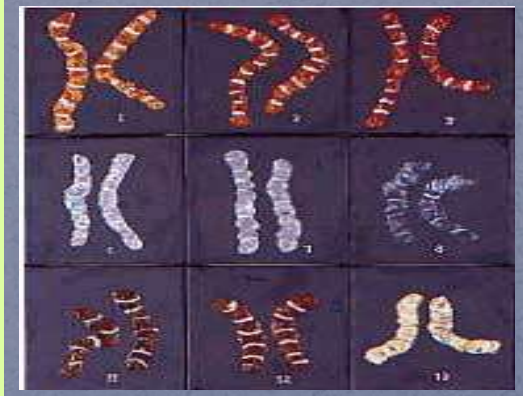
x

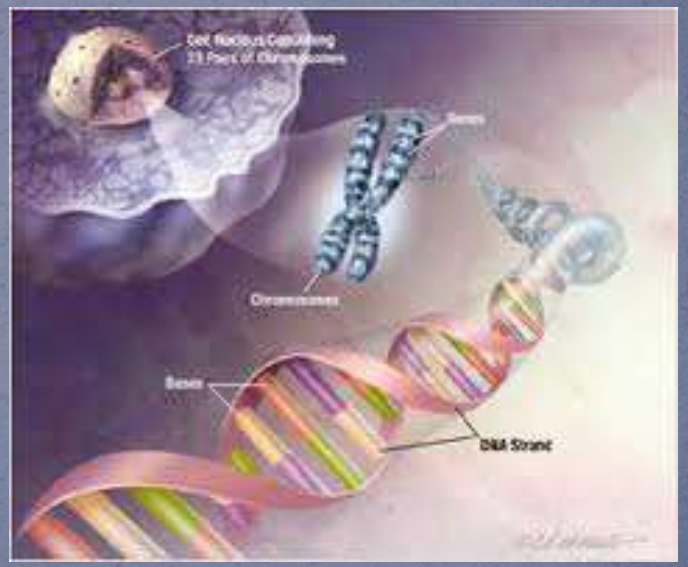
=

GENES

- Mendel's work led him to the understanding that traits such as plant height are carried in pairs of information not by single sets of information.
- Carrying the information are chromosomes.
- Chromosomes are made up of DNA and divided into sections called genes.



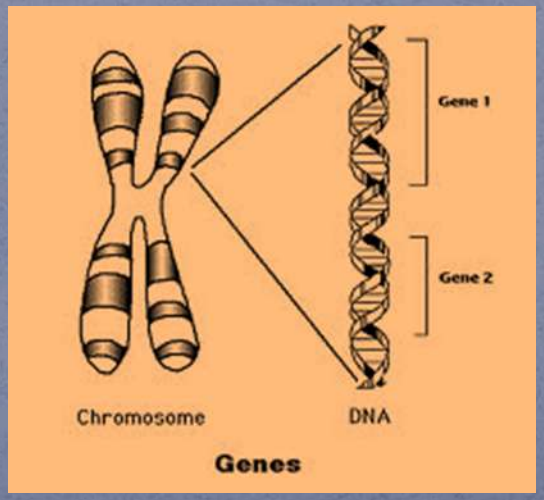




Genetics

Small sections of DNA are responsible for a "trait". These small sections are called "Genes".

- **Gene - A segment of DNA that codes for a specific trait**
- **Trait - A characteristic an organism can pass on to it's offspring through DNA**



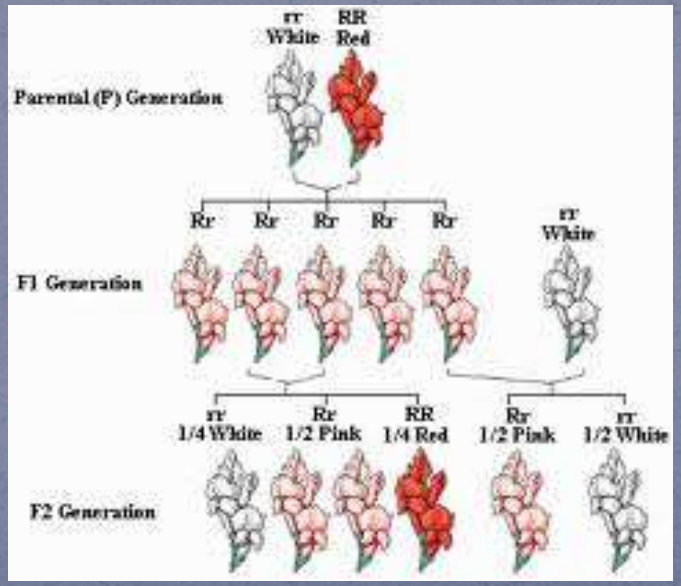
Genetics

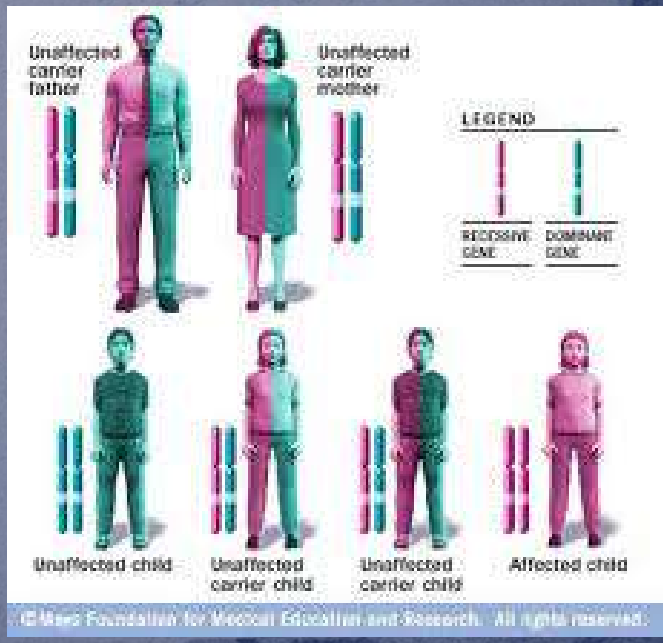
There are three basic kinds of genes:

- Dominant - A gene that is always expressed and hides others
- Recessive - A gene that is only expressed when a dominant gene isn't present
- Codominant - Genes that work together to produce a third trait

Descriptions:

- P generation
- F 1 generation
- F2 generation





Human Traits

	Dominant	Recessive
Earlobe attachment	Unattached	Attached
Tongue Rolling	Can roll the tongue	Cannot roll
Dimples	Have dimples	Do not have dimples
Handedness	Right handed	Left handed
Hand clasping	Left thumb	Right thumb
Hairline	Widow's peak	Straight hairline

Genetics

Dominant and Recessive Genes

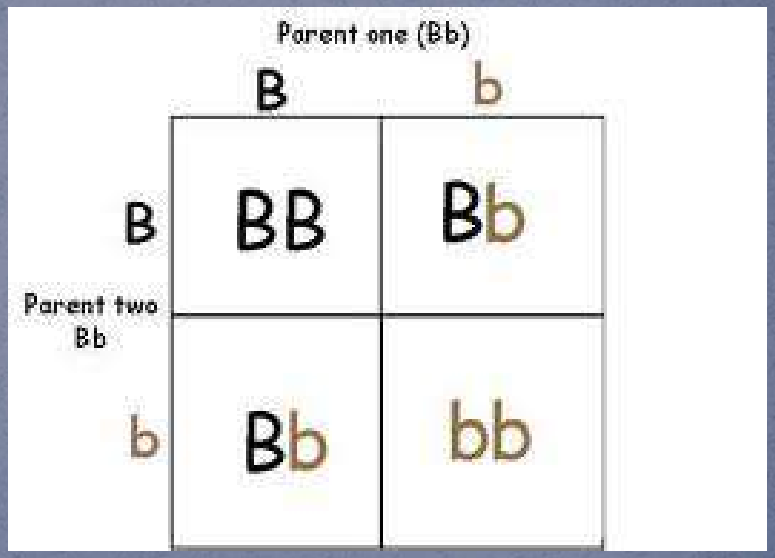
- A dominant gene will always mask a recessive gene.
- A "widows peak" is dominant, not having a widows peak is recessive.
- If one parent contributes a for a widows peak, and the parent doesn't, the off- will have a widows peak.

Widows Peak

Genetics

<u>Punnett Square</u> - A tool we use for predicting the traits of an offspring

- ***Letters are used as symbols to designate genes***
- ***Capital letters are used for dominant genes***
- ***Lower case letters are used for recessive genes***
- ***Genes always exist in pairs***



Genetics

A Widows Peak, dominant, would be symbolized with a capital "W", while no widows peak, recessive, would be symbolized with a lower case "w".

F… …No Widows Peak - w

Mo… …las a Widows Peak - W

Genetics

All organisms have two copies of each gene, one contributed by the father, the other contributed by the mother.

Homozygous - Two copies of the same gene

ie. BB

Heterozygous - Two different genes

ie. Bb

Genetics

For the widows peak:

WW **- has a widows peak Homozygous dominant**

Ww **- has a widows peak Heterozygous**

ww **- no widows peak Homozygous recessive**

Genotype: the set of alleles (the letters: Ww)

Phenotype: the physical appearance (widows peak or no widows peak)

Genetics

Since Herman has no widows peak, he must be "ww", since Lilly has a widows peak she could be either "WW" or "Ww"

De *ww* **: Homozygous recessive**

Eit **: Heterozygous**

: Homozygous dominant

Genetics

We can use a "Punnet Square" to determine what pairs of genes Lilly has

Assume Lilly is heterozygous
Ww

Assume Herman is homoozygous recessive
ww

	W	w
w	Ww	ww
w	Ww	ww

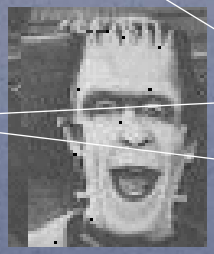
- *A Punnet Square begins with a box 2 x 2*
- *One gene is called an "allele"*
- *One parents pair is split into alleles on top, the other along the side*
- *Each allele is crossed with the other allele to predict the traits of the offspring*

Genetics

Notice that when Lilly is crossed with Herman, we would predict that half the offspring would be "Ww", the other half would be "ww"

Half "Ww", Heterozygous, and will have a widows peak

Half "ww", Homozygous, and will not have a widows peak



	W	*w*
w	*Ww*	*ww*
w	*Ww*	*ww*

Genetics

Another possibility is that Lilly might be "WW", homozygous dominant.

Assume Lilly is homozygous dominant

WW

Assume Herman is homoozygous

ww

	W	W
w	Ww	Ww
w	Ww	Ww

Notice that all the offspring are heterozygous and will have a widows peak

Genetics

So which is true? Is Lilly homozygous dominant (WW) or is she heterozygous (Ww)?

	W	w
w	Ww	ww
w	Ww	ww

	W	W
w	Ww	Ww
w	Ww	Ww

Genetics

If Lilly were heterozygous, then 1/2 of their offspring should have a widows peak, 1/2 shouldn't

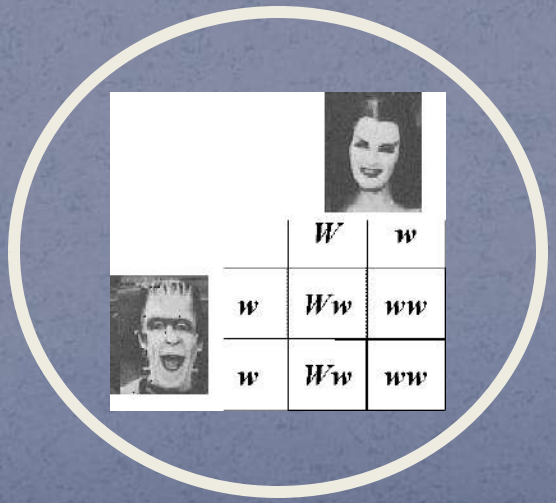
	W	w
w	Ww	ww
w	Ww	ww

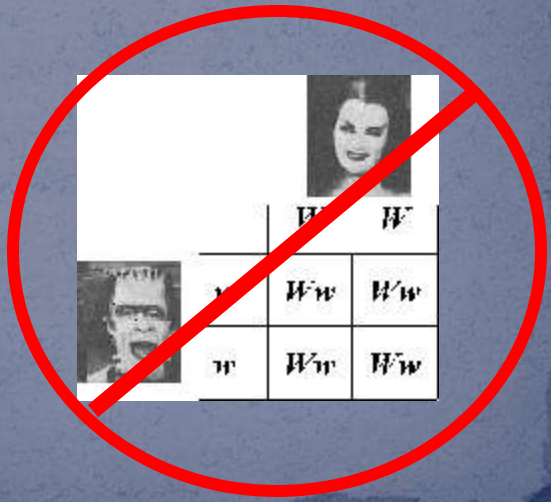
If Lilly were homozygous, all of their children will have a widows peak

	W	W
w	Ww	Ww
w	Ww	Ww

Genetics

Recall that Herman and Lilly had another offspring, Marylin. She had no widows peak, therefore, Lilly must be heterozygous.



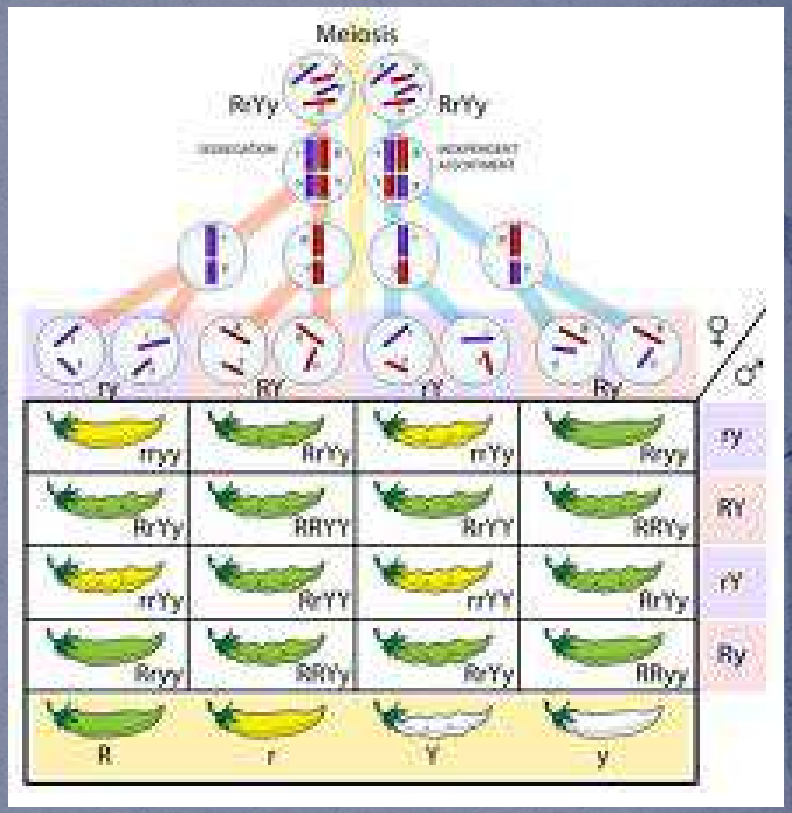


Got it?

- Let's do some Punnett Squares!

Mendels 1st Law of Genetics: Law of Segregation

- Two alleles for each trait must separate when gametes are formed
- Therefore a parent only passes on 1 allele for each trait to each offspring
- Example:
  - A parent may have a recessive and a dominate allele for a trait. But only one of these will be passed on to the offspring



Mendels 2nd Law of Genetics: Law of Independent Assortment

- Genes for different traits are inherited independently of each other
  - Example:
    - Color
    - Shape
    - Height
    - Will not affect the inheritance of each other