Life Science

Genetics

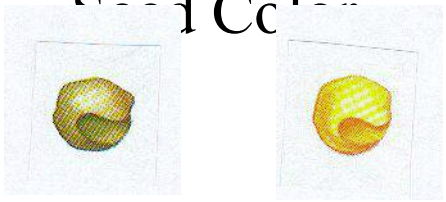
Gregor Mendel

The basic laws of heredity were first formed during the mid-1800's by an Austrian botanist monk named Gregor Mendel. Because his work laid the foundation to the study of heredity, Mendel is referred to as "The Father of Genetics."

Mendel' Pea Plants

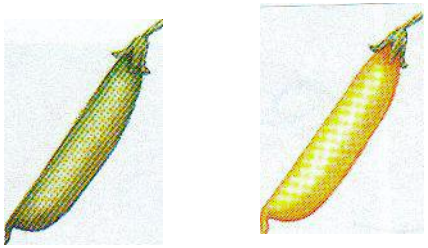
Mendel based his laws on his studies of garden pea plants. Mendel was able to observe differences in multiple traits over many generations because pea plants reproduce rapidly, and have many visible traits such as:

Seed Color



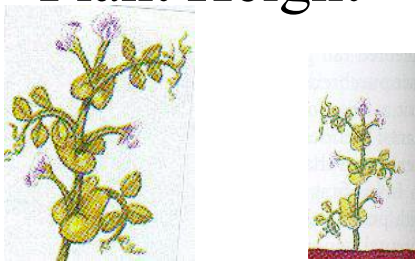
Green Yellow

Pod color



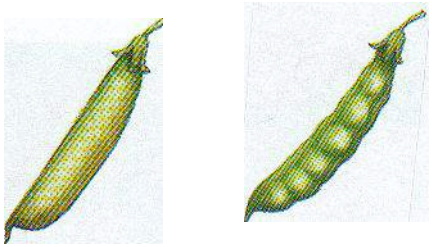
Green Yellow

Plant Height



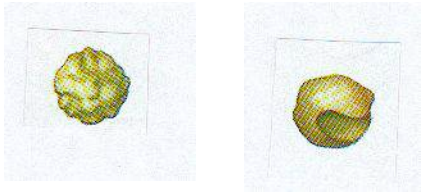
Tall Short

Pod Shape



Smooth Pinched

Seed Shape



Wrinkled Round

Mendel's Experiments

Mendel noticed that some plants always produced offspring that had a form of a trait exactly like the parent plant. He called these plants ***"purebred"*** plants. For instance, purebred short plants always produced short offspring and purebred tall plants always produced tall offspring.

X

Purebred Short Parents

Short Offspring

X

Purebred Tall Parents

Tall Offspring

Mendel's First Experiment

Mendel crossed purebred plants with opposite forms of a trait. He called these plants the ***parental generation*** **, or** ***P generation***. For instance, purebred tall plants were crossed with purebred short plants.

X

Parent Tall
P generation

Parent Short
P generation

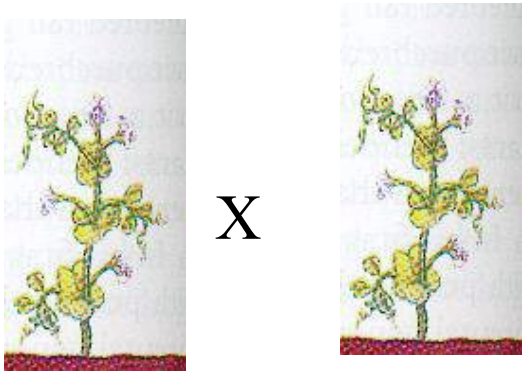
Offspring Tall
F1 generation

Mendel observed that all of the offspring grew to be tall plants. None resembled the short parent. He called this generation of offspring the ***first filial*** **, or** ***F1 generation***, (The word filial means "son" in Latin.)

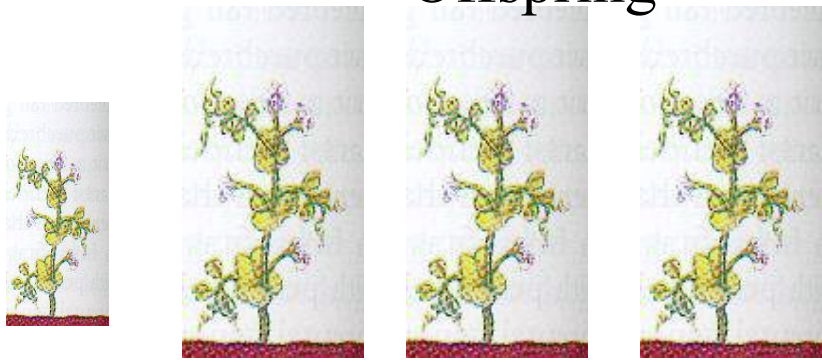
Mendel's Second Experiment

Mendel then crossed two of the offspring tall plants produced from his first experiment.

Parent Plants



Offspring



Tall
F1 generation

¾ Tall & ¼ Short
F2 generation

Mendel called this second generation of plants the second filial, F2, generation. To his surprise, Mendel observed that this generation had a mix of tall and short plants. This occurred even though none of the F1 parents were short

TERMS TO KNOW

ALLELES	**DIFFERENT FORMS OF A TRAIT THAT A GENE MAY HAVE**	T,t
HOMOZYGOUS	**AN ORGANISM WITH TWO ALLELES THAT ARE THE SAME**	TT, tt
HETEROZYGOUS	**AN ORGANISM WITH TWO DIFFERENT ALLELES FOR A TRAIT**	Tt, Gg

TERMS TO KNOW

HYBRID	**SAME AS HETEROZYGOUS**	Tt, Gg
DOMINANT	**A TRAIT THAT DOMINATES OR COVERS UP THE OTHER FORM OF THE TRAIT**	**REPRESENTED BY AN UPPERCASE LETTER** T OR G
RECESSIVE	**THE TRAIT BEING DOMINATED OR COVERED UP BY THE DOMINATE TRAIT**	**REPRESENTED BY A LOWER CASE LETTER** t or g

TERMS TO KNOW

PHENOTYPE	**THE PHYSICAL APPEARANCE OF AN ORGANISM** **(WHAT IT LOOKS LIKE)**	TALL, SHORT, GREEN, WRINKLED
GENOTYPE	**THE GENE ORDER OF AN ORGANISM** **(WHAT ITS GENES LOOK LIKE)**	TT, GG, Tt, gg Gg, tt
RATIO	**THE RELATIONSHIP IN NUMBERS BETWEEN TWO OR MORE THINGS**	3:1, 2:2, 1:2:1

DNA

D.N.A. - Deoxyribonucleic Acid

Molecule made of:

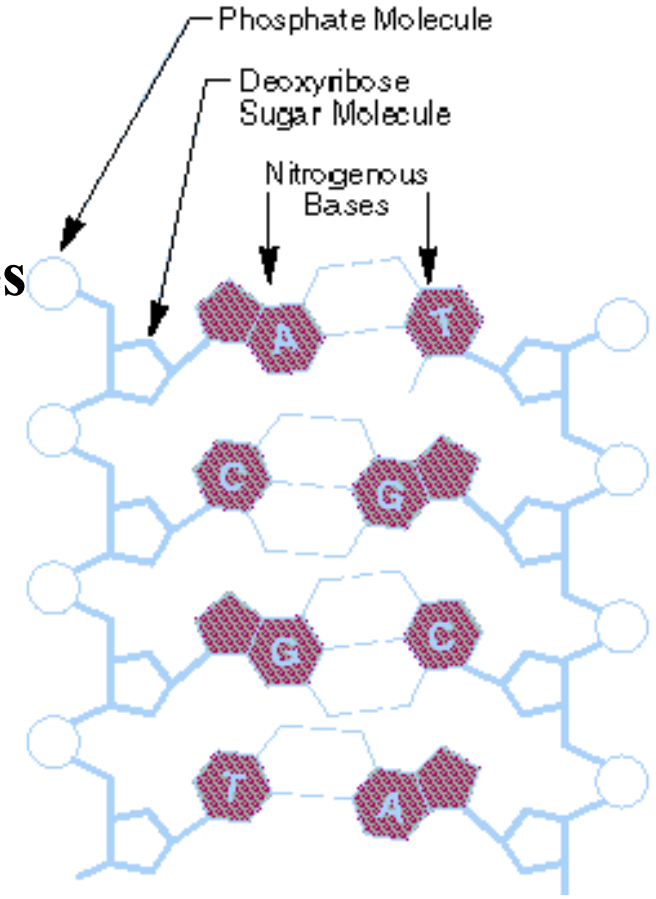
1. **Deoxy Sugar**
2. **Combination of four nitrogen bases**

Either:a. Guanine

b. Cytocine

c. Thymine

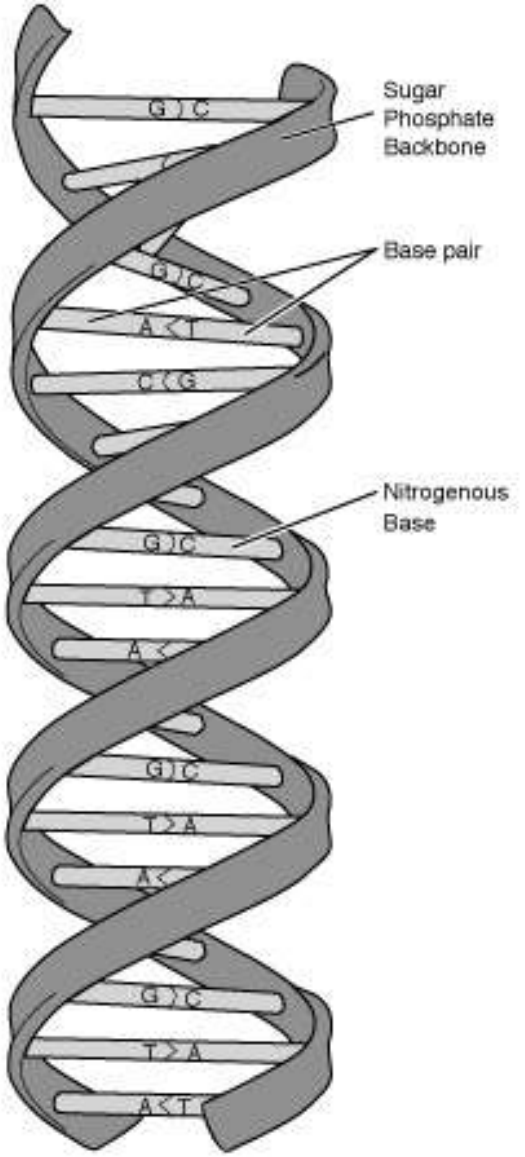
d. Adenine



The sum total of combinations that these four bases are capable of creating are greater than all the stars visible in the night time sky

DNA

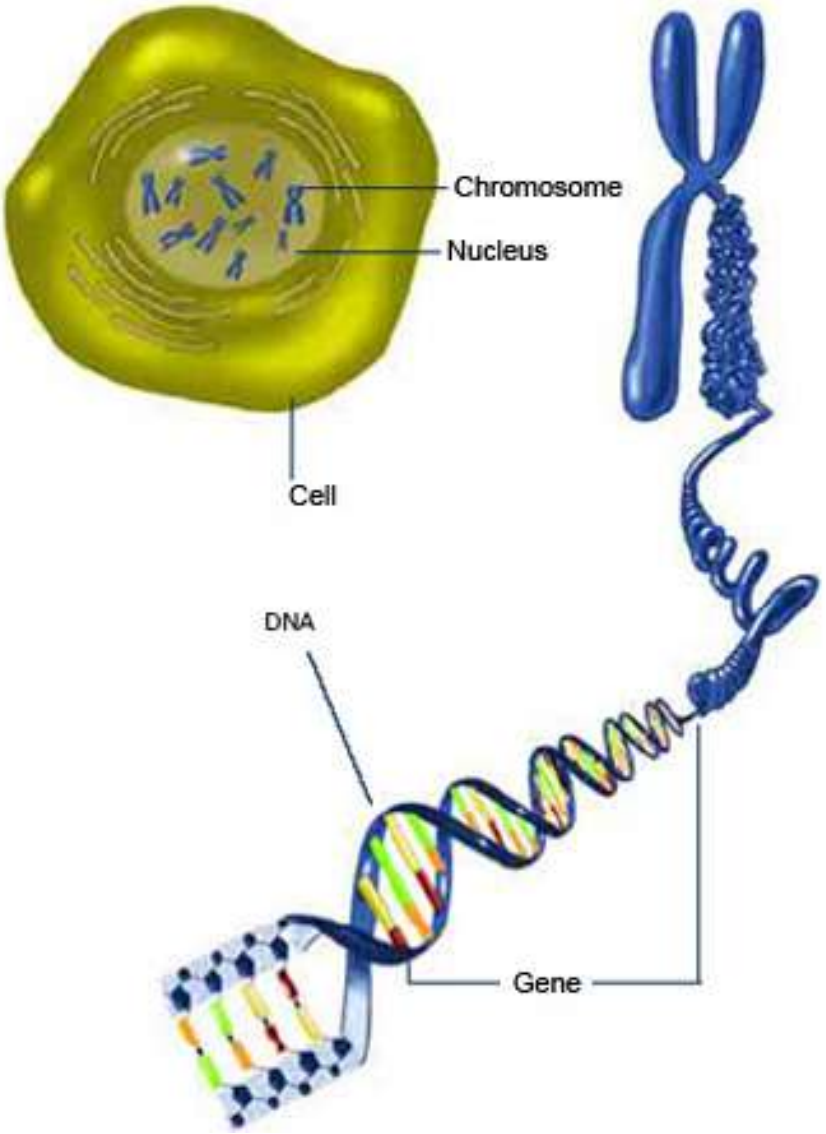
- **Nitrogen bases pair up**
  - **Cytosine & Guanine**
  - **Thymine & Adenine**
- **Pairing creates a ladder shape**
- **Angle of bonds creates a twist**



Ladder and Twist produces the famous "Double Helix"

DNA

- DNA resides in cells, inside the nucleus
- Each strand forms a chromosome



DNA

DNA is found in all living cells

- It controls all functions a cell
- It stores all the genetic information for an entire organism
  - Single cell like an amoeba
  - Multi cell like a human

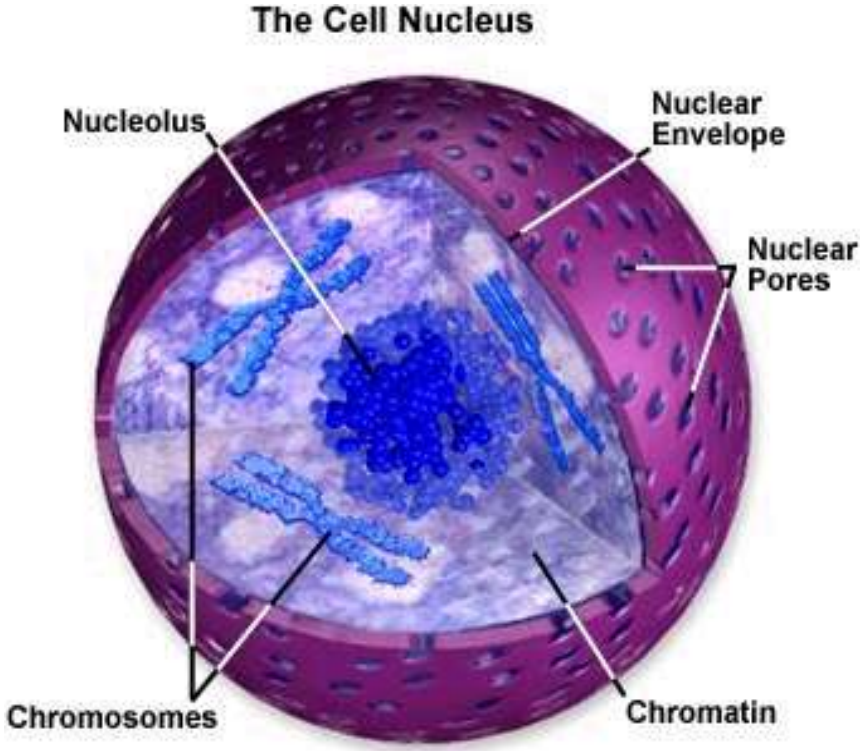


Figure 1

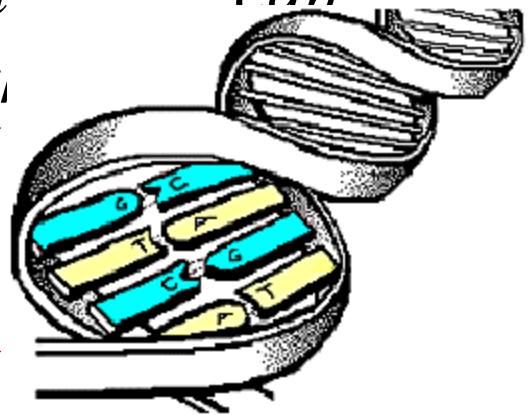
Genetics

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*

DNA

Gene



Genetics

Hair color is a perfect example of a trait

Prince Charming is blond

Snow White has dark hair

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

Genetics

- **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 gene for a widows peak, and the other parent doesn’t, the off- spring will have a widows peak.

Genetics

Punnet Square - 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".

her - No Widows Peak - w

ther - Has 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

Heterozygous - Two different genes

Genetics

For the widows peak:

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

***Ww* - has a widows peak Heterozygous**

***ww* - no widows peak Homozygous recessive**

Genetics

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

ely *ww* **Homozygous**

cessive

Ww **Heterozygous**

WW **Homozygous**

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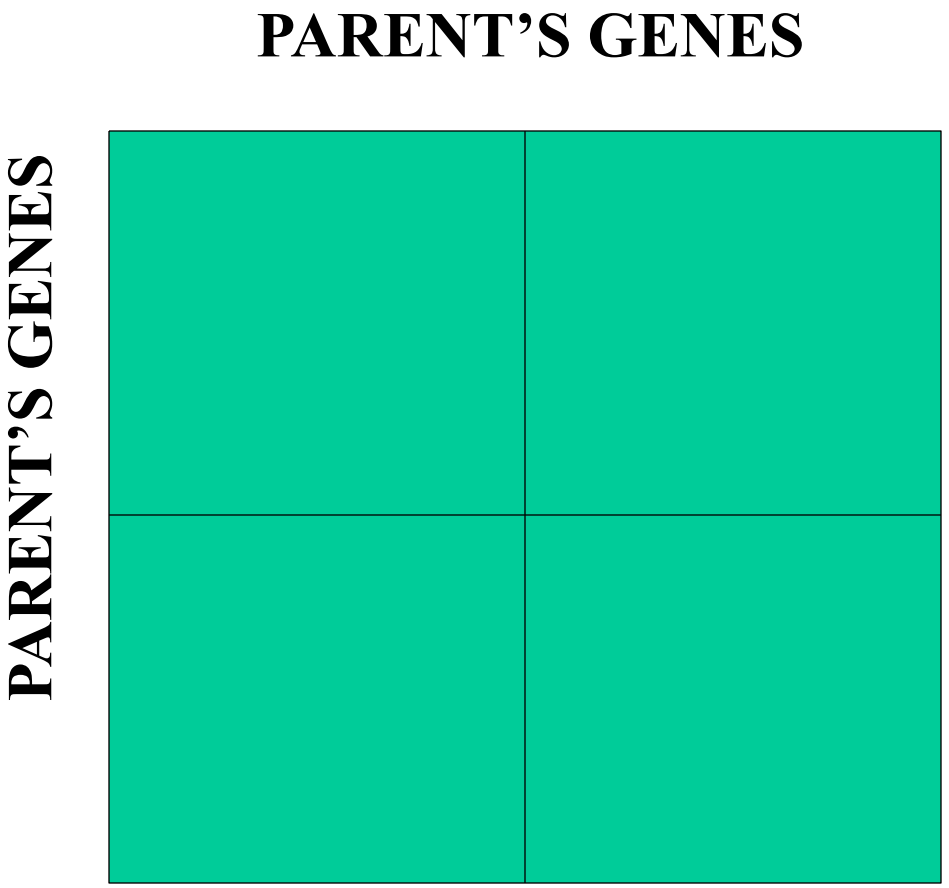
TOOLS TO KNOW

A PUNNET SQUARE IS A TOOL USED TO PREDICT THE POSSIBLE GENOTYPES FOR THE OFFSPRING OF TWO KNOWN PARENTS.



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*

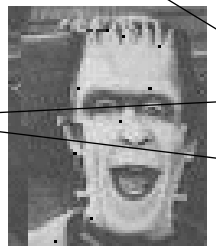
- *A Punnet Square begins with a box 2 x 2*
- *One gene is called an "allele"*
- *One parents pair is split into alleles on top, the other along the side*
- *Each allele is crossed with the other allele to predict the traits of the offspring*

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

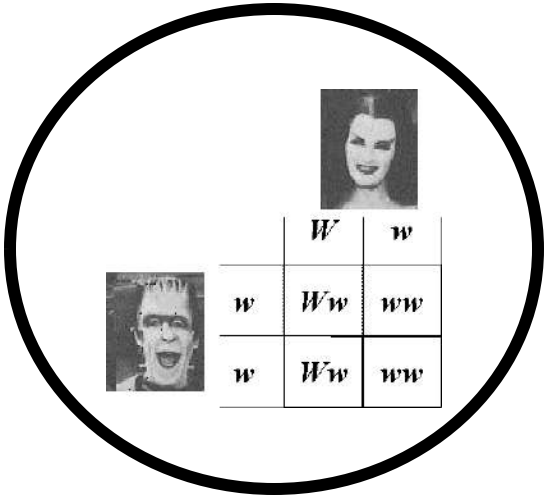
	W	*w*
w	*Ww*	*ww*
w	*Ww*	*ww*

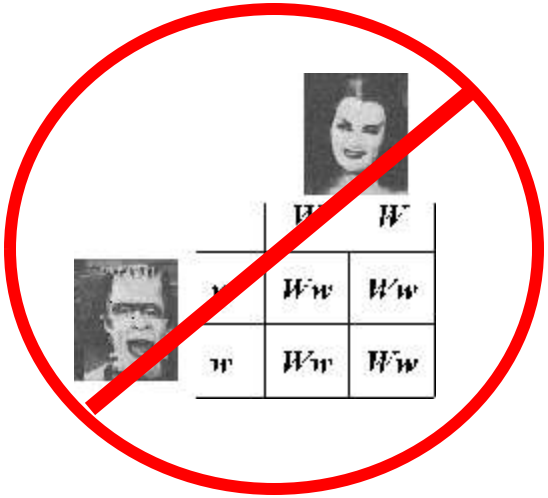
If Lilly were homozygous, all of their children will have a widows peak

	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.

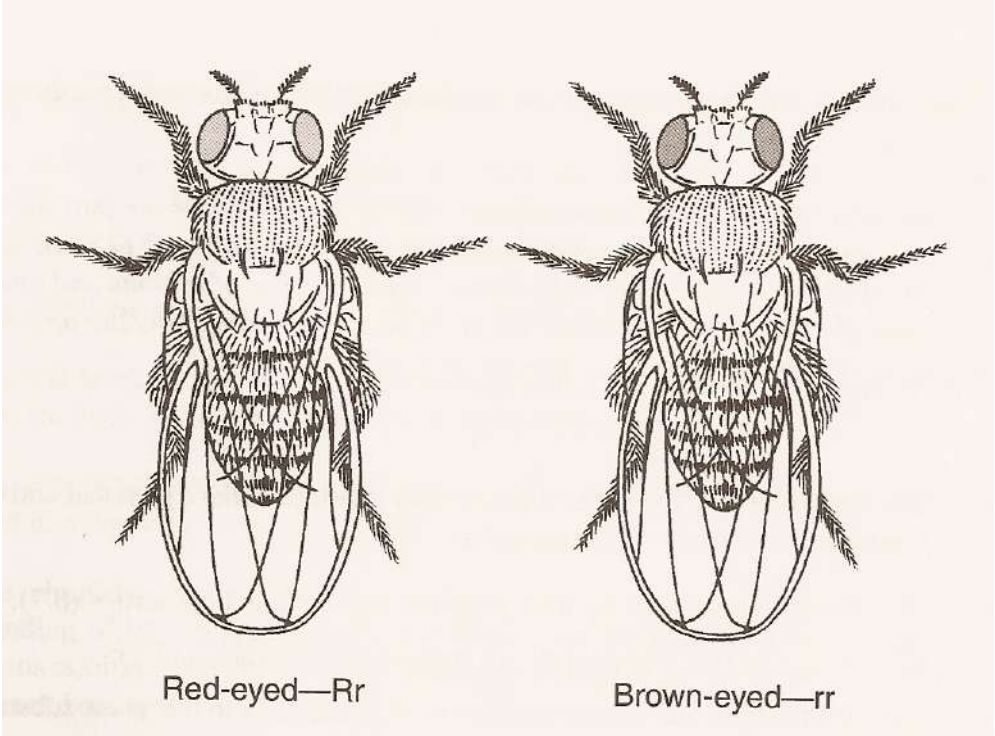




Practice Problems

TAKS FORMATTED ITEMS

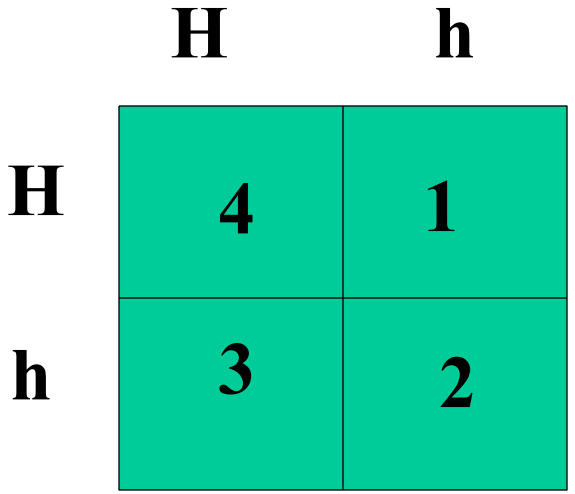
1. IN *DROSOPHILA MELANOGASTER* (FRUIT FLIES), RED EYE COLOR (R) IS DOMINANT OVER BROWN EYE COLOR (r). IF THE FLIES IN THE PICTURE WERE CROSSED, WHAT PERCENT OF THEIR OFFSPRING WOULD BE EXPECTED TO HAVE BROWN EYES?



TAKS FORMATTED ITEMS

2. WHICH OF THE FOLLOWING HAS THE hh GENOTYPE?

A. 1 & 3
B. 2
C. 4
D. NONE



3. WHICH OF THE FOLLOWING IS A TRUE STATEMENT?

A. INDIVIDUAL 4 IS RECESSIVE
B. INDIVIDUALS 1 & 3 ARE HETEROZYGOUS
C. INDIVIDUAL 2 IS DOMINANT
D. ALL INDIVIDUALS ARE FEMALE

4. IF B IS THE ALLELE FOR BLACK FUR AND b IS THE ALLELE FOR WHITE FUR, WHAT PERCENT WOULD BE BLACK?

A. 25%
B. 50%
C. 100%
D. 75%

	B	b
B	**BB**	**Bb**
b	**Bb**	**bb**

5. WHAT FRACTION IS HOMOZYGOUS DOMINANT IN THE ABOVE CROSS?

A. 1/2
B. 1/4
C. 1/3
D. 3/4

TAKS FORMATTED ITEMS

6. IN THIS CROSS, WHAT IS THE RATIO OF BB TO Bb?

A. 3 : 1
B. 4 : 1
C. 2 : 2
D. 0 : 4