Mendel’s Laws of Heredity
Why we look the way we look...
What is heredity?

- The passing on of characteristics (traits) from parents to offspring

- **Genetics** is the study of heredity
More than 150 years ago, an Austrian monk named Gregor Mendel observed that pea plants in his garden had different forms of certain characteristics. Mendel studied the characteristics of pea plants, such as seed color and flower color.
Mendel used peas...

- They reproduce sexually

- They have two distinct, male and female, sex cells called gametes

- Their traits are easy to isolate
Mendel crossed them

- **Fertilization** - the uniting of **male** and **female** gametes
- **Cross** - combining gametes from parents with different traits

Mendel’s actual numbers: 787 tall : 277 short (2.84:1).
What Did Mendel Find?

- He discovered different laws and rules that explain factors affecting heredity.
Rule of Unit Factors

- Each organism has two alleles for each trait
  - Alleles - different forms of the same gene

- Genes - located on chromosomes, they control how an organism develops
Rule of Dominance

- The trait that is observed in the offspring is the dominant trait (uppercase)

- The trait that disappears in the offspring is the recessive trait (lowercase)

<table>
<thead>
<tr>
<th>$B$ = Brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b$ = Blue</td>
</tr>
</tbody>
</table>

(includes green, hazel, grey)
Law of Segregation

- The two alleles for a trait must **separate** when gametes are formed.
- A parent **randomly** passes only one allele for each trait to each offspring.

*Alleles separate during gamete formation.*
Law of Independent Assortment

- The genes for different traits are inherited independently of each other.
Questions...

- How many alleles are there for each trait?
- Two alleles control each trait.
- What is an allele?
- Different forms of the same gene.
Questions...

● How many alleles does a parent pass on to each offspring for each trait?

● A parent passes only ONE allele for each trait to offspring.
Phenotype & Genotype

- Phenotype - the way an organism looks - red hair or brown hair

- Genotype - the gene combination of an organism - AA or Aa or aa
Heterozygous & Homozygous

• **Heterozygous** - if the two alleles for a trait are different (Aa) **recessive** AKA **hybrid**

• **Homozygous** - if the two alleles for a trait are the same (AA or aa) AKA **pure or pure bred**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>Homozygous Dominant</td>
</tr>
<tr>
<td>Bb</td>
<td>Heterozygous</td>
</tr>
<tr>
<td>bb</td>
<td>Homozygous Recessive</td>
</tr>
</tbody>
</table>

B= Purple Allele ; b= White Allele
Questions...

● What do we call the trait that is observed?
  ● Dominant

● What case (upper or lower) is it written in?
  ● UPPER
Questions...

- What about the one that disappears?
- recessive
- What case is it written in?
- lower case letters
Questions...

• What is the phenotype?
• The way a living thing looks.

• What is the genotype?
• The combination of alleles or genes in the cell.
• AA, Aa or aa
Questions...

- What is homozygous?
  - When the alleles / genes are the same. AA or aa

- What is heterozygous?
  - When the pair of alleles are not the same. Aa
Punnett Square

• Developed by Reginald Punnett.
Punnett Squares:

A Model used to show the possible ways genes can combine during fertilization.
Probability

- The likelihood of a particular event occurring. Chance

- Can be expressed as a fraction or a percent.

- Example: coin flip.
Punnett Squares

Help you to predict the probability of getting genetic outcomes.
• Letters are used to represent the dominant and recessive alleles for a trait.
Punnett Squares

• The **genotype** (genetic makeup) can be used to predict the **phenotype** (physical appearance) of the offspring.
Punnett Squares

• **Genotype**: the kind of alleles in a pair of genes.

• **Phenotype**: how an organism appears (looks)
Punnett Squares

A capital letter (T) is used for dominant alleles. $T = \text{tall}$
Punnett Squares

A lowercase letter (**t**) is used for recessive alleles.

\[ t = \text{short} \]
Punnett Squares

If you wanted to know the type of offspring that a cross between two parents would produce, use a Punnett square.

**Tt x Tt (the parents)**

TT, Tt genotypes for tall

**tt** genotype for short
<table>
<thead>
<tr>
<th>Parent</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>25% on 1:4</td>
<td>1/4</td>
</tr>
<tr>
<td>1/4</td>
<td>1/4</td>
</tr>
</tbody>
</table>
Punnett Squares

The letters representing the alleles from one parent are placed along the top of the square.
Punnett Squares

The letters representing the two alleles from the second Parent are places along the side of the square.
Punnett Squares

T t x T t

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>off-</td>
<td>Spring</td>
</tr>
<tr>
<td>t</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Punnett Squares

Squares are filled by writing the letter at the top beside the letter on the side.

\[
\begin{array}{c|c|c}
\text{T} & \text{t} & \\
\hline
\text{T} & \text{T} & \text{T} \\
\text{t} & \text{t} & \text{t} \\
\text{T} & \text{t} & \text{t} \\
\end{array}
\]
Punnett Squares

Squares are filled by writing the letter at the top beside the letter on the side.
Punnett Squares

The letters in each of the squares represents the Genotypes of the offspring that the parents could produce.

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>TT</td>
<td>Tt</td>
</tr>
<tr>
<td>t</td>
<td>Tt</td>
<td>t t</td>
</tr>
<tr>
<td><strong>Genotype</strong></td>
<td><strong>Phenotype</strong></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>The genetic makeup</td>
<td>Physical appearance of the organism</td>
<td></td>
</tr>
<tr>
<td>Symbolized with letters</td>
<td>What you would see in a photograph!</td>
<td></td>
</tr>
<tr>
<td>Tt or TT</td>
<td>Expression of the trait</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short, tall, yellow, smooth, etc.</td>
<td></td>
</tr>
</tbody>
</table>
Punnett Squares

Genotype

<table>
<thead>
<tr>
<th>TT</th>
<th>Tt</th>
<th>Tt</th>
<th>tt</th>
</tr>
</thead>
</table>

Phenotype

tall   tall   tall   short
Genotypes

- Bb = heterozygous
- BB = homozygous dominant
- bb = homozygous recessive

What is the dominant phenotype?
What is the recessive phenotype?

Complete the Punnett square. List the offspring's genotypes and genotypes in a “T” chart.
<table>
<thead>
<tr>
<th>Father's Genes</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
</tr>
</tbody>
</table>

What is the percent chance on these parents producing a homozygous dominant offspring?