Genetics

The study of how traits are passed from parents to offspring
History of Genetics

People used to believe that offspring’s traits were a blend of their parents traits (ex. tall + short = medium)

We now know it’s not that simple...
Gregor Mendel

• In the 1840’s he studied heredity (the passing of traits from parent to offspring).
• He studied garden pea plants because they are simple and have sexual reproduction (two different kinds of sex cells or gametes)
  
  male gamete – sperm (pollen)
  female gamete – egg (ovule)

Fertilization → seed
The stamens, which produce pollen, and the pistil, which produces eggs, are surrounded by the petals and the sepals.
Pollination and Fertilization

1. Pollen lands on the stigma and begin to grow pollen tubes.

2. Sperm travel down pollen tubes and fertilize the eggs.
A mature plant produces a flower. Pollination and fertilization take place.

Each ovule within the flower's ovary contains a fertilized egg.

Petals and stamens fall away.

Each seed contains a tiny plant. If a seed sprouts, or begins to grow, it will become a new plant.

The ovary becomes the fruit, and each ovule becomes a seed. Eventually, the fruit ripens, and seeds are dispersed.
## Genetics of Pea Plants

<table>
<thead>
<tr>
<th>Traits</th>
<th>Seed Shape</th>
<th>Seed Color</th>
<th>Seed Coat Color</th>
<th>Pod Shape</th>
<th>Pod Color</th>
<th>Flower Position</th>
<th>Stem Height</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Controlled by Dominant Allele</strong></td>
<td>Round</td>
<td>Yellow</td>
<td>Gray</td>
<td>Smooth</td>
<td>Green</td>
<td>Side</td>
<td>Tall</td>
</tr>
<tr>
<td><strong>Controlled by Recessive Allele</strong></td>
<td>Wrinkled</td>
<td>Green</td>
<td>White</td>
<td>Pinched</td>
<td>Yellow</td>
<td>End</td>
<td>Short</td>
</tr>
</tbody>
</table>

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Mendel crossed two purebred Parent plants (P Generation):

\[ P_1 \text{ Tall (6ft.)} \times \text{ Short (2 ft.)} \]

All offspring were tall!

F Generation: F stands for Filial (latin for son or daughter)

\[ F_1 \quad 4 \text{ Tall} \]

\[ F_2 \quad 3 \text{ Tall} \quad 1 \text{ Short} \quad 3:1 \]

Mendel realized that traits are controlled by separate “factors” (genes)
Genes are units of heredity that determine a particular trait. Each gene has different expressions called alleles.

<table>
<thead>
<tr>
<th>gene</th>
<th>alleles</th>
</tr>
</thead>
<tbody>
<tr>
<td>height</td>
<td>tall</td>
</tr>
<tr>
<td></td>
<td>short</td>
</tr>
<tr>
<td>eye color</td>
<td>brown</td>
</tr>
<tr>
<td></td>
<td>blue</td>
</tr>
<tr>
<td></td>
<td>hazel</td>
</tr>
<tr>
<td>hair color</td>
<td>blonde</td>
</tr>
<tr>
<td></td>
<td>brown</td>
</tr>
<tr>
<td></td>
<td>black</td>
</tr>
<tr>
<td></td>
<td>red</td>
</tr>
</tbody>
</table>
Every organism gets two alleles for each trait, one from mom and one from dad.

**dominant allele** - this expression always shows up.

**recessive allele** - this expression is hidden by the dominant allele and only shows up if there is no dominant allele.

Dominant alleles are represented with a capital letter.  

*ex. tall = T*

Recessive alleles are represented with the lowercase letter of the dominant trait.  

*ex. short = t*
dominant allele – curly hair
recessive allele – straight hair

curly $\text{C}$
straight $\text{c}$

dominant allele – yellow seeds
recessive allele – green seeds

yellow $\text{Y}$
green $\text{y}$
dominant allele – purple flowers
recessive allele – white flowers

purple $P$
white $p$

dominant allele – rolling tongue
recessive allele – non-rolling tongue

rolling $R$
non-rolling $r$
homozygous – two of the **SAME** alleles
*also called purebred

ex. **TT** or **tt**

**homo**

**same**

**homonym** - two words that sound the **same** but are spelled differently like bear and bare

**homophone** - two words with the **same** spelling but different meanings like rose and rose

**homosexual** - two people of the **same** gender that are in a relationship
heterozygous – two different alleles
*also called hybrid
ex. Tt
hetero
different
heterogeneous- a mixture of different ingredients
heterosexual- two people of the different genders that are in a relationship

Heterozygous (He) or homozygous (Ho)?
*Say the WHOLE term

AA  Ho      Dd  He      Gg  He
Bb  He      EE  Ho      hh  Ho
cc  Ho      ff  Ho      li  He
There are two ways to describe the traits of an organism:

**genotype** – the combination of alleles (ex. Tt)

**phenotype** – the physical appearance (ex. Tall)

In humans, brown eyes (B) are dominant to hazel (b). If a man has brown eyes, what are the possible genotypes?

BB or Bb

If a woman has the genotype bb, what must her phenotype be?

hazel
Punnett Squares

• Reginald Crundall Punnett (1875-1967) was a believer in the theories put forward by obscure monk Johann Gregor Mendel (1822-1884), the founder of modern genetics, and wrote the first textbook on the subject. Punnett worked to confirm Mendel's theories experimentally.

• Punnett was also the inventor of the "Punnett Square", which depicts the number and variety of genetic combinations.
Remember: You have **two alleles** for each trait.

When you give your genetic info to your offspring, you give $\frac{1}{2}$ the info (one allele).

**Meiosis** is the process that creates **gametes** with half the genetic information.

A **punnett square** organizes the possible combinations of gametes that can occur during fertilization.
Steps for solving a Punnett Square Problem

Step 1. Key to alleles

Step 2. Parental Cross

Step 3. Punnett Square

Step 4. Results
   genotype, phenotype, ratio, percent

Step 5. Go back and answer the original questions.
In mice, the dominant allele for eye color is black and the recessive allele is red. If two heterozygous parents are crossed, what will be all the possible genotypes and phenotypes of the offspring?

**Step 1. Key to alleles**

- Black  B
- red  b

**Step 2. Parental Cross**

\[ P_1 \quad Bb \times Bb \]
Step 1. Key to alleles
- Black  B
- red    b

Step 2. Parental Cross
\[ P_1 \text{ Bb} \times \text{ Bb} \]

Step 3. Punnett Square

The standard format is Capital first so flip it!

Step 4. Results (genotype, phenotype, ratio, percent)
- BB, black, 1: 4, 25%
- Bb, black, 2: 4, 50%
- bb, red, 1: 4, 25%

Step 5. Answer the original question
In this case the original question is already answered so, DONE 😊
In goats, a recessive gene causes the goats to “faint” when they are startled. A farmer breeds two goats (that have never fainted) and their first offspring faints two days after it’s birth. What must the parent’s genotypes have been? Show the cross to prove it.

http://www.youtube.com/watch?v=we9_CdNPuJg