Incomplete Dominance, Co-Dominance, and Sex-Linked Traits

It is a little more complicated than Mendel thought....

Remember:

- An allele is: a possible form of a gene.
- Normally, there are 2 alleles for a given gene (Dominant and Recessive.)
- Sometimes though, there are multiple alleles which allow 3, 4, 5 or more forms of a gene, but...
  - Though there are more forms of the gene, organisms still get just one from mom and one from dad...unless there is a mutation of course!
  - Populations can have more forms of the allele though.
  - Most known about is 100 alleles for a single trait.

Incomplete Dominance:

- Blending of the homozygous phenotypes.
- Where the heterozygote shows an intermediate phenotype between the two homozygotes.
- Both alleles of the gene produce products which combine to give a new trait.
- Neither allele is more dominant than the other.
- Generally symbolized with the capital letter of the darker color and the same symbol prime for the other color (if colors.)

Incomplete Dominance Example

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R'</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td>Red</td>
<td>RR'</td>
</tr>
<tr>
<td>RR'</td>
<td>White</td>
<td>RR</td>
</tr>
<tr>
<td>RR</td>
<td>RR</td>
<td></td>
</tr>
</tbody>
</table>

All the offspring are Pink (RR')

Incomplete Dominance:

- The alleles for curly hair and straight hair are examples of alleles for a trait that are incompletely dominant.
  - Individuals with curly hair are homozygous for curly hair alleles.
  - Individuals with straight hair are homozygous for straight hair alleles.
  - Individuals who are heterozygous, with one of each allele have wavy hair.
**Co-Dominant:**

- Where 2 types of alleles that are equally dominant.
- When an individual is heterozygous for such traits, both alleles for one trait in an individual are expressed equally.
- Phenotype of the heterozygote has both traits simultaneously.

**Co-Dominance Horse Example**

Co-Dominance Horse Example

```
B W W
B W W
```

WW = White
BB = Chestnut
BW = Palomino

All the offspring are Palomino (BW).

The offspring are 2 Palomino (BW) And 2 White (WW).

**Sex-Linked Traits:**

- Traits controlled by genes located on the sex chromosomes.
  - i.e: Humans: 22 Homologous pairs of matching chromosomes (autosomes) and 1 pair of sex chromosomes (match if female only.)
  - There are genes found on (generally) the X chromosome that are not found on the Y chromosome.
  - Inheritance of phenotypic traits determined by these genes is therefore linked to the sex of the individual.
  - The Y chromosome is most important in determining the sex of an organism.
  - XX = Female; XY = Male

**Sex-Linked Traits:**

- Thomas Hunt Morgan was the first to discover sex-linkage in 1907.
  - Born: September 25, 1866
  - Died: December 4, 1945
  - American
  - He was working with Drosophila (Fruit Flies)
  - Notices eye color gene is on the X chromosome while performing test crosses in several generations.
Sex-Linked Traits

- When writing genotypes:
  - Put the trait gene as a superscript to the sex chromosome.
  - ie: \( X^R X^r \), \( X:Y \)

Sex-Linked Trait Example In Humans

- The X chromosome carries genes that are not associated with sex determination.
- One example is a gene that codes for a blood clotting protein. (The Y chromosome does not carry this gene.)
- Improper blood clotting is known as hemophilia.

Sex-Linked Hemophilia Example In Humans

- There are 3 types of possible chromosomal states:
  - \( X^H \) (X chromosome with normal blood clotting)
  - \( X^h \) (X chromosome with a mutant blood clotting gene)
  - \( Y^o \) (Y chromosome with no blood clotting gene)

Sex-Linked Hemophilia Example In Humans

- There are 5 types of possible genotypes:
  - \( X^H X^h \) (female with normal blood clotting)
  - \( X^h X^h \) (female with normal blood clotting but is a carrier of the trait)
  - \( X^H Y^o \) (female with hemophilia - rare condition)
  - \( X^H Y^o \) (normal male)
  - \( X^h Y^o \) (hemophiliac male)

Sex-Linked Hemophilia Example

- \( X^H X^H \) \( X^h X^h \) \( X^H Y^o \) \( X^h Y^o \)

The offspring are: 1 Normal Female, 1 carrier Female, 1 Normal Male, 1 Hemophiliac Male

Multiple Alleles:

- When more than 2 alleles control a trait.
- Ie: 4 alleles for coat color in rabbits
  - \( C = \) dark grey
  - \( C^{Hh} = \) light grey (Chinchilla); dominant to \( c \) and \( c^h \)
  - \( c = \) white
  - \( c^{Hh} = \) white with black points (Himalayan); dominant to \( c \).
The offspring are: all chinchillas