Dominance and Multiple Allele Notes

"You're the mother and those are your children? — I'd like to see a DNA test."
Snapdragons

http://faculty.pnc.edu/pwilkin/incompdominance.jpg
Snapdragons

* HUH?


http://faculty.pnc.edu/pwilkin/incompdominance.jpg
* Snapdragons

HUH?


http://faculty.pnc.edu/pwilkin/incompdominance.jpg

Monday, January 28, 13
Incomplete dominance - When the alleles are blended and the offspring have a mix of their parent traits.

ex. Snap Dragons

\[ R = \text{red} \]

\[ r = \text{white} \]

Offspring can be pink!
Hair Texture
Hair Texture

Mackerel  Classic  Abyssinian
Hair Texture

Animal Fur

Mackerel  Classic  Abyssinian
Codominance

- in this case both alleles are expressed.

Heterozygous genotype
Codominance – in this case both alleles are expressed.

Heterozygous genotype

\[ \text{BB} = \text{black corn} \]
\[ \text{YY} = \text{yellow corn} \]
\[ \text{BY} = \text{black and yellow corn} \]
Codominance

Codominance - in this case both alleles are expressed.

Heterozygous genotype

BB = black corn
YY = yellow corn
BY = black and yellow corn
Roan Horse

http://search.vadlo.com/b/qrel=2&keys=Dominance+Incomplete+Dominance+Codominance+PPT
Fish
Fish
Fish

Variegated Clover

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Incomplete Dominance or Codominance?
Incomplete Dominance or Codominance?
Incomplete Dominance or Codominance?

Roan Cow
Incomplete Dominance or Codominance?
Incomplete or Codominance?
Incomplete or Codominance?
Is that it?
Is that it?

* Nope! There are also cases where there are many alleles that influence a trait!
A polygenic trait is determined by multiple genes. (poly=many, genic=genes)

Example: eye color and height
Polygenic Traits

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Example: eye color and height
Multiple Alleles

Karyotype
Remember:
- Chromosomes occur in pairs.
  (homologous pairs)
Multiple Alleles

Remember:
- Chromosomes occur in pairs.
  (homologous pairs)

- The different alleles of a gene occupy the same positions on each chromosome
So far each gene we have discussed has been made of two possible alleles.
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Ex. Y = Yellow  y = green
However, it is possible to have several different allele possibilities for one gene.
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Multiple alleles is when there are more than two allele possibilities for a gene.
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**Multiple alleles** is when there are more than two allele possibilities for a gene.

<table>
<thead>
<tr>
<th>Possible genotypes</th>
<th>Phenotype</th>
<th>$CC$, $Cc^{ch}$, $Cc^{h}$, $Cc$</th>
<th>$c^{ch}c^{ch}$</th>
<th>$c^{ch}c^{h}$, $c^{ch}c$</th>
<th>$c^{h}c^{h}$, $c^{h}c$</th>
<th>$cc$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dark gray</td>
<td>Chinchilla</td>
<td>Light gray</td>
<td>Himalayan</td>
<td>Albino</td>
<td></td>
</tr>
</tbody>
</table>
In traits with multiple alleles, each individual can carry any two of the several possible alleles.

Ex. BLOOD TYPE

The gene for blood type has 3 possible alleles. 
$I^A$, $I^B$, and $i$
Blood Type

In this case both A and B are dominant to O (recessive).

A and B are codominant (both expressed)

So... there are four human blood types
Blood Type

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<table>
<thead>
<tr>
<th>Genotype</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAIA, IAi</td>
<td>Blood type A</td>
</tr>
<tr>
<td>IBIB, IBi</td>
<td>Blood type B</td>
</tr>
<tr>
<td>IAIB</td>
<td>Blood type AB</td>
</tr>
<tr>
<td>ii</td>
<td>Blood Type O</td>
</tr>
</tbody>
</table>
Blood Type

- A antigen
  - Blood type A

- B antigen
  - Blood type B

- AB antigen
  - Blood type AB

- No antigens
  - Blood type O

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Scientists sometimes study Rhesus monkeys to learn more about the human anatomy because there are certain similarities between the two species. While studying Rhesus monkeys, a certain blood protein was discovered. This protein is also present in the blood of some people. Other people, however, do not have the protein.

The presence of the protein, or lack of it, is referred to as the Rh (for Rhesus) factor.

If your blood does contain the protein, your blood is said to be Rh positive (Rh+). If your blood does not contain the protein, your blood is said to be Rh negative (Rh-).
Who can give you blood?

People with TYPE O blood are called Universal Donors, because they can give blood to any blood type.

People with TYPE AB blood are called Universal Recipients, because they can receive any blood type.

Rh +  Can receive + or -
Rh -  Can only receive -
## How common is your blood type?

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DISTRIBUTION</th>
<th>RATIOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>O +</td>
<td>1 person in 3</td>
<td>38.4%</td>
</tr>
<tr>
<td>O -</td>
<td>1 person in 15</td>
<td>7.7%</td>
</tr>
<tr>
<td>A +</td>
<td>1 person in 3</td>
<td>32.3%</td>
</tr>
<tr>
<td>A -</td>
<td>1 person in 16</td>
<td>6.5%</td>
</tr>
<tr>
<td>B +</td>
<td>1 person in 12</td>
<td>9.4%</td>
</tr>
<tr>
<td>B -</td>
<td>1 person in 67</td>
<td>1.7%</td>
</tr>
<tr>
<td>AB +</td>
<td>1 person in 29</td>
<td>3.2%</td>
</tr>
<tr>
<td>AB -</td>
<td>1 person in 167</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

Sex-Linked Traits
Sex Chromosomes

Karyotype

[Image of a karyotype diagram showing the autosomes and sex chromosomes]
Sex Chromosomes

Humans have 23 pairs of chromosomes.
Sex Chromosomes

Humans have 23 pairs of chromosomes.

1-22 are autosomes

Karyotype

U.S. National Library of Medicine

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Humans have 23 pairs of chromosomes.

1-22 are autosomes

The 23rd pair of chromosomes is related to the sex of an individual, these chromosomes are called sex chromosomes.
Are you XX or XY?

In humans the female has a pair of XX chromosomes (homogametic).
Are you XX or XY?

* In humans, the sex of an individual depends on the presence or absence of the Y chromosome.

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Female is XX

Male is XY
Are you XX or XY?

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Female is XX

Male is XY

* Y is much smaller and only contains about 25 genes (NOT MANY!)
How sex is determined:

Male gametes

X
Y

Female gametes

X
XX
XY

X
XX
XY

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How sex is determined:

50/50 Chance of becoming a male or female!
Sex-linked Traits
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* Traits carried only on the X chromosome
Sex-linked Traits

- Traits carried only on the X chromosome
- Sex-linked disorders are passed from mother to son by a defective gene on the X chromosome.
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<-Baldness
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What do you see?

(a)  

(b)
Color Blindness
Color Blindness

- is a condition in which certain colors cannot be distinguished, and is most commonly due to an inherited condition.
Color Blindness

• is a condition in which certain colors cannot be distinguished, and is most commonly due to an inherited condition.

• Problems in distinguishing 
  reds and 
  greens are the most common.
A pedigree for color-blindness

P1

Normal male  Carrier female

F1

Carrier female  Normal female  Color-blind male  Normal male
Sex-linked Punnett Square
Sex-linked Punnett Square

* X chromosome is shown with superscript. An upper case for dominant, lower case for recessive.

* Y chromosome has NO superscript
Sex-linked Punnett Square

- X chromosome is shown with superscript. An upper case for dominant, lower case for recessive.

- Y chromosome has NO superscript

1/2 of the females will be carriers
1/2 of the females will be normal
1/2 of the males will be normal
1/2 of the males will be colorblind
Practice Problem

* A man without colorblindness has children with a woman who is homozygous recessive for colorblindness

* Give the phenotype and genotype of each parent.

* Show the cross

* What can we predict about any girls they will have? What about boys?
Hemophilia is often called the disease of kings because it was carried by many members of Europe's royal family.
Queen Victoria

• Queen Victoria of England was a carrier of hemophilia and passed the disease to many of her descendants (including the Russian emperor’s family and the Spanish royal family).
Family of Queen Victoria
The history of Queen Victoria's descendants illustrates the hereditary characteristics of hemophilia. We can take a look at her family tree (pedigree).
Explanation of the inheritance of hemophilia
Explanation of the inheritance of hemophilia

- Red square = hemophilia trait
- Black square = normal

Carrier mother: XX

Normal father: XY

XX = normal daughter
XX = carrier daughter
XY = hemophiliac son
XY = normal son