Notes: Types of Inheritance
Think about it

• You have a purple flower, you know purple is the dominate allele, but you do not know the genotype of the plant.

• How could you figure out it’s genotype?
  – Assume that you do not have access to the technology to sequence the alleles
Test Cross

- Used to determine the genotype of an individual that displays a dominant trait.
  - Either PP or Pp
- Cross with homozygous recessive (pp)
- If in the offspring, there are pp individuals, then the parent had to be Pp
Types of Inheritance

- Complete Dominance
- Incomplete Dominance
- Codominance
- Sex-linked
- Polygenic
- Epistasis
Complete Dominance
(What we have been looking at so far)

• One allele is completely dominant over the other
• Only two phenotypes exist
• One phenotype is masked
• The heterozygous phenotype shows dominant trait
  – Ex: Purple flowers are dominant to white
  – PP= purple
  – Pp= purple
  – pp= white
Complete Dominance

Autosomal Recessive Genetic Disorders

*Carrier: A heterozygote for a recessive disorder/trait (ex. Cc).

- Carrier does not show symptoms but can pass recessive allele to offspring
- Affected person must inherit two recessive alleles
- Example Cystic Fibrosis, Tay-sachs, sickle-cell anemia
  - CC & Cc = unaffected
  - cc = affected
Practice Problem

A male and female are both carriers for sickle-cell anemia. What percent chance do they have of having a child with sickle-cell anemia?
Incomplete Dominance

• Neither allele is completely dominant over the other
• Three phenotypes exist
• The heterozygous phenotype is in between the two homozygous parents (2 alleles are partially expressed)
Incomplete Dominance

- Neither allele is completely dominant over the other
- Three phenotypes exist
- The heterozygous phenotype shows a blended trait
- Ex: Four o’clock Flowers can be red, pink, or white.
  - RR = red
  - Rr = pink
  - rr = white
Incomplete Dominance

• Example: Four o’clock flowers
• Cross two pink flowers
  – What percent of their offspring will have white flowers?
Incomplete Dominance

- Fish can be green (GG), blue (BB), or teal (GB) 
a mix of blue and green

Green (GG)  Teal (GB)  Blue (BB)
Codominance

- **Both** alleles are dominant and are fully expressed
- Neither phenotype is masked
- Three phenotypes exist
- The heterozygous phenotype shows **both** traits at once
Codominance

EX: In Smileys, eye shape can be starred, circular, or a circle with a star.

Write ALL the phenotypes and genotypes that exist.
Codominance

EX: In Smileys, eye shape can be starred, circular, or a circle with a star.

Write ALL the phenotypes and genotypes that exist.

- CC = circle
- SS = star
- SC = circle-star
Codominance

Ex. Cattle fur color

- Red and white fur are codominant
- When you cross a red and a white cow, a red and white spotted cow is produced (this color is known as roan)

\[
\begin{align*}
\text{red (RR)} & \times \\
\text{white (WW)} & = \\
\text{red & white (WR)} & \quad \text{(this color is called roan)}
\end{align*}
\]
Types of Inheritance

- Complete Dominance
- Incomplete Dominance
- Codominance
- Sex-linked
- Polygenic
- Epistasis
Sex-linked

• Disorder/trait found on the “X” chromosome

Hint to remember which chromosomes (seX-linked)
Sex-linked

- Disorder/trait found on the “X” chromosome
- Which gender has more instances of having an x-linked disorder?
  - Men: Males do not have second copies of the X chromosome (XY). *Unless they have a genetic disorder.*
  - Females have two X chromosomes (XX) so if one has a defect the normal chromosome masks the defect on the other
Sex-linked

• Making a sex-linked Punnett square
  – Punnett square determines sex and trait
  – First, use X and Y to show gender
  – Second, use a letter on the X chromosome to show which allele they have
  – DO NOT put a letter on the Y chromosome, the trait is not on that chromosome
Sex-linked

• EX: color blindness

Possible genotypes and phenotypes:

\(X^R X^R = \text{Female, normal vision}\)
\(X^R X^r = \text{Female, normal vision}\)
\(X^r X^r = \text{Female, color blind}\)
\(X^R Y = \text{Male, normal vision}\)
\(X^r Y = \text{Male, color blind}\)
Sex-linked

What is the probability of having color blind children if a female carrier and a male who has normal vision had children?

*Solve on notes*
Polygenic

- Many genes may interact to produce one trait
- Ex: Skin color is the result of three genes that interact to produce range of colors
**Figure 16.4**

<table>
<thead>
<tr>
<th></th>
<th>AB</th>
<th>Ab</th>
<th>aB</th>
<th>ab</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AB</strong></td>
<td>AA BB</td>
<td>AA Bb</td>
<td>Aa BB</td>
<td>Aa Bb</td>
</tr>
<tr>
<td><strong>Ab</strong></td>
<td>AA Bb</td>
<td>AA bb</td>
<td>Aa Bb</td>
<td>Aa bb</td>
</tr>
<tr>
<td><strong>aB</strong></td>
<td>Aa BB</td>
<td>Aa Bb</td>
<td>aa BB</td>
<td>aa Bb</td>
</tr>
<tr>
<td><strong>ab</strong></td>
<td>Aa Bb</td>
<td>Aa bb</td>
<td>aa Bb</td>
<td>aa bb</td>
</tr>
</tbody>
</table>

Mother: Aa Bb

Father: Aa Bb

Copyright © 2001 by Harcourt, Inc. All rights reserved.
Epistasis

- When other genes affect the phenotype of a specific gene
- Ex. Coat color in Labs

<table>
<thead>
<tr>
<th><strong>Epistatic Interactions on Coat Color</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ee</td>
</tr>
<tr>
<td>No dark pigment in fur</td>
</tr>
<tr>
<td><strong>eebb</strong></td>
</tr>
<tr>
<td>Yellow fur, brown nose, lips, eye rims</td>
</tr>
<tr>
<td><strong>eeB_</strong></td>
</tr>
<tr>
<td>Yellow fur, black nose, lips, eye rims</td>
</tr>
</tbody>
</table>

*Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.*
B= black, b=brown

E is for epistatic gene, E=no change to coat color phenotype, e=change to coat color phenotype

• B_E__ is a black Lab
• bbE__ is a brown Lab
• __ ee is a yellow Lab

• The blank spaces represent either the dominant or recessive allele, it does not matter which is inherited, the coat will be that color no matter what!
Pleiotrophy

• One gene controls many traits
• EX: Albinism
• Albinos are unable to synthesize melanin, the pigment molecule responsible for eye, skin, and hair/fur coloring
• It also results in poor vision and decreased immunity
Environmental impact on phenotype

• What about color-changing hydrangeas?
• This is not due to genetics, but by the environment
• When grown in acidic soil the flowers are blue, and in basic soil are pink