OUTLINE 13

Extensions to Mendel’s Rules

A. Partial dominance
   1. incomplete dominance
   2. Co-dominance

B. More than 2 possible alleles at a locus
   1. Human ABO blood groups

C. Polygenic Inheritance
   1. Human skin color
   2. Human eye color

D. Sex-linked Inheritance
RULES OF PROBABILITY

1. When all outcomes equally likely, the probability that a particular outcome will occur is

\[
\frac{\text{#ways to obtain that outcome}}{\text{total # possible outcomes}}
\]

2. The product rule = the "AND" rule

For 2 independent events, the probability of observing 2 particular outcomes (outcome 1 AND outcome 2) is the PRODUCT of their independent probabilities.

3. The addition rule = the "OR" rule
The probability of observing either one OR another outcome is equal to the SUM of their independent probabilities.
Fig. 14.7  A Dihybrid Cross

(a) Hypothesis: dependent assortment
(b) Hypothesis: independent assortment
Application of Mendel’s Rules assumes:

1. One allele completely dominates the other

2. All genes have 2 allelic forms

3. All traits are monogenic (affected by only one locus)

4. All chromosomes occur in homologous pairs

5. All genes assort independently

6. An allele is completely expressed when either dominant or homozygous

7. Each trait is controlled by a different set of factors
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Fig. 14.9

Incomplete Dominance
Co-dominance

CC (blue) x C’C’ (yellow)

CC’ (green)
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Drosophila melanogaster
“wild type” Red eyes

White eyes

eosin eyes
## Multiple alleles

<table>
<thead>
<tr>
<th>(a) Phenotype (blood group)</th>
<th>(b) Genotypes (see p.258)</th>
<th>(c) Antibodies present in blood serum</th>
<th>(d) Results from adding red blood cells from groups below to serum from groups at left</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$I^A I^A$ or $I^A i$</td>
<td>Anti-B</td>
<td>A:B:AB:O</td>
</tr>
<tr>
<td>B</td>
<td>$I^B I^B$ or $I^B i$</td>
<td>Anti-A</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>$I^A I^B$</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>$ii$</td>
<td>Anti-A Anti-B</td>
<td></td>
</tr>
</tbody>
</table>
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Height is a continuous trait

Figure 3.—A modern version of Figure 2, from Connecticut State University in 1996. The means and standard deviations in inches are as follows: males, 70.1 ± 3.0; females, 64.8 ± 2.7; combined, 67.6 ± 4.0. Photo from LINDA STRAUSBAUGH.

Crow, 1997 Genetics 147:1
Fig 14.12  Polygenic inheritance of skin tone

3 loci: each has two possible alleles: A,a B,b C,c, each capital allele adds one unit of darkness each lower case allele adds nothing

Parents with intermediate tone

Offspring can have tone darker or lighter than either parent
Fig 14.12

Number of ‘darker’ alleles

Fraction of population

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Hypothetical mechanism for determination of eye color in Humans

Gene for melanin production B (produce) dominant to b (none)
2 Modifier loci affect amount of pigment deposited
CC’ and DD’ each non prime allele contributes one unit of deposition

<table>
<thead>
<tr>
<th>G’type at B</th>
<th>Modifier loci</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>B_</td>
<td>CCDD</td>
<td>Dk brown (+4)</td>
</tr>
<tr>
<td>B_</td>
<td>CCDD’</td>
<td>Med. Brown (+3)</td>
</tr>
<tr>
<td>B_</td>
<td>CC’DD’</td>
<td>Lt Brown (+2)</td>
</tr>
<tr>
<td>B_</td>
<td>CC’D’D’</td>
<td>Hazel (+1)</td>
</tr>
<tr>
<td>BB</td>
<td>C’C’D’D’</td>
<td>Green</td>
</tr>
<tr>
<td>Bb</td>
<td>C’C’D’D’</td>
<td>Greenish blue</td>
</tr>
<tr>
<td>bb</td>
<td>any g’type</td>
<td>Blue</td>
</tr>
</tbody>
</table>
Hypothetical mechanism for determination of eye color in Humans

A possible cross:

\[
P: \quad \text{bbCCDD} \quad \text{X} \quad \text{BbC’C’D’D”} \\
\text{(Blue)} \quad \text{(Gr-blue)}
\]

\[
\begin{aligned}
\text{Gametes} & \quad \text{bCD} \\
\text{F1} & \quad \text{BbCC’DD”} \\
\text{(Lt. Brown)}
\end{aligned}
\quad \begin{aligned}
& \quad \text{BC’D’, bC’D’} \\
\text{F1} & \quad \text{bbCC’DD’} \\
\text{(Blue)}
\end{aligned}
\]