E. Violation of independent assortment

1. Bateson and Punnet
2. Linkage
3. Crossing over
4. Chromosome mapping
5. Effects of linkage and crossing over on genotypic and phenotypic ratios
William Bateson and R.C. Punnett

\( P = \) purple dominant to \( p = \) white

\( L = \) long dominant to \( l = \) round

\[ P P L L \times p p l l \]

\( F_1 \) all purple / long

<table>
<thead>
<tr>
<th>F2 Phenotype</th>
<th>Number</th>
<th>Number expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple / long</td>
<td>284</td>
<td>215</td>
</tr>
<tr>
<td>Purple / round</td>
<td>21</td>
<td>71 Parental</td>
</tr>
<tr>
<td>White / long</td>
<td>21</td>
<td>71</td>
</tr>
<tr>
<td>White / round</td>
<td>55</td>
<td>24</td>
</tr>
</tbody>
</table>

Tendency toward non-independent segregation - Partial gametic coupling
Test cross F1 to double recessive:

<table>
<thead>
<tr>
<th>Parents</th>
<th>PpLl</th>
<th>X</th>
<th>ppll</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gametes</td>
<td>PL</td>
<td>pl</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pl</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pL</td>
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</tr>
<tr>
<td></td>
<td>pl</td>
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</tr>
</tbody>
</table>

Expect 1:1:1:1 ratio of phenotypes

Bateson and Punnett observed 7:1:1:7
Test cross to determine if genes are linked in coupling or repulsion

\[
\begin{align*}
\text{PL}//\text{pl} & \times \text{pl}//\text{pl} & \text{Pl}//\text{pL} & \times \text{pl}//\text{pl} \\
\text{Gametes} & 1/2 \text{ PL} & \text{all pl} & 1/2 \text{ Pl} & \text{all pl} \\
 & 1/2 \text{ pl} & & 1/2 \text{ pL} \\
\text{F1} & 1/2 \text{ PL}//\text{pl} (\text{purple, long}) & 1/2 (\text{purple, round}) \\
 & 1/2 \text{ pl}//\text{pl} (\text{white, round}) & 1/2 (\text{white, long}) \\
\end{align*}
\]

With independent assortment: PpLl x ppll expect 1:1:1:1
CROSSING OVER

Pairing of Homologous Chromosomes

Chiasma Formation

Chromosome Breakage & Rejoining

Recombinant Chromosomes
P: PL//PL X pl//pl

F1: (PL//pl)

= centrosome
Effects of crossing over on number of possible gamete types

With x-over:

No x-over:

pL L L l l

With x-over:

No x-over:

pL L L l l

pL L L l l

pL L L l l

pL L L l l

pL L L l l