Three Point Cross for Mapping

Douglas J. Burks
Department of Biology
Wilmington College of Ohio
The Three Point Cross

- The three point cross.
  - Order three genes on a chromosome unambiguously.
  - Double crossover
    - Two crossing over events
    - Least frequent event
    - Dependent on probability of each single crossover
      - $c_1 \times c_2$ is probability
Three point cross

• Perform test cross $\text{AaBbCc} \times \text{aabbcc}$.
  – 1. Test for Independent assortment.
    • If not observed, then some type of linkage.
  – 2. Determine phenotypes that determine type of crossover.
    • Two most frequent phenotypes represent parental types (linkage in $\text{AaBbCc}$ parent).
    • Two least frequent phenotype represent double crossover types.
    • Other four phenotypes represent single crossover types.
      – Organize by similar frequencies.
Some real data

- **v** = virescent  gl = glossy  va = variable sterile
- **phenotype**  
<table>
<thead>
<tr>
<th># of individuals</th>
<th>gamete</th>
</tr>
</thead>
<tbody>
<tr>
<td>normal</td>
<td>235</td>
</tr>
<tr>
<td>glossy, variable sterile</td>
<td>62</td>
</tr>
<tr>
<td>variable sterile</td>
<td>40</td>
</tr>
<tr>
<td>variable sterile virescent</td>
<td>4</td>
</tr>
<tr>
<td>glossy, variable sterile, virescent</td>
<td>270</td>
</tr>
<tr>
<td>glossy</td>
<td>7</td>
</tr>
<tr>
<td>glossy, virescent</td>
<td>48</td>
</tr>
<tr>
<td>virescent</td>
<td>60</td>
</tr>
</tbody>
</table>
## Rearrange Types

<table>
<thead>
<tr>
<th>Parental Type</th>
<th>Single crossover 1</th>
<th>Single crossover 2</th>
<th>Double crossover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>phenotype</strong></td>
<td><strong># of individuals</strong></td>
<td><strong>gamete</strong></td>
<td><strong># of individuals</strong></td>
</tr>
<tr>
<td>normal</td>
<td>235</td>
<td>+ + +</td>
<td>virescent</td>
</tr>
<tr>
<td>glossy, variable sterile, virescent</td>
<td>270</td>
<td>gl va v</td>
<td>glossy, variable sterile</td>
</tr>
<tr>
<td>virescent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>glossy, variable sterile</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Three Point Mapping

3. Determine the gene order
   - The gene that has changed linkage in double crossover must be in middle
     - display parental linkage
       - ++ +
       - gl va v
     - display double crossover and determine which gene change allele linkage (must be center gene)
       - gl ++
       - + va v
   - gl changed orientation from parental type
     - must be center gene
       - gl ++ + +
       - + va v gl va v
   - v----gl------va or va------gl --------v
• Calculate map distance
  – \( \mu = \frac{rf \cdot (sc + dc/total)}{100} \)
  – \( v \) ---- gl
    • \( v + + \) 60
    • \( + gl va \) 62
    • \( + gl + \) 7
    • \( v + va \) 4
    • 133
• \( \mu = \frac{133}{726} \times 100 = 18.3 \)
Three Point Mapping

- Calculate map distance
  - $\mu = rf \times (sc + dc/total) \times 100$
  - $gl ----- va$
    - + + va 40
    - $v gl + 48$
    - + gl + 7
    - $v + va 4$
    - 99
  - $\mu = (99/726) \times 100 = 13.6$
  - Map $gl \ldots va$
  - 13.6
Three Point Mapping

- Map vgl va
- 18.3 mu 13.6
- adjust for interference