Monohybrid Cross

1. Count the number of purple and yellow kernels in five of the rows on your ear of corn and record the number on the chart. Be sure to use the same five rows for each calculation.

2. Count the number of smooth and shrunken seeds on the same five rows and record on the chart.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Number of Kernels</th>
<th>Kernel Percentage (divide count by total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kernel Coloration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purple</td>
<td>165</td>
<td>77.46%</td>
</tr>
<tr>
<td>Yellow</td>
<td>48</td>
<td>22.54%</td>
</tr>
<tr>
<td>Total (for 5 rows)</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>Kernel Texture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth</td>
<td>160</td>
<td>82.9%</td>
</tr>
<tr>
<td>Shrunken</td>
<td>33</td>
<td>17.1%</td>
</tr>
<tr>
<td>Total (for 5 rows)</td>
<td>193</td>
<td></td>
</tr>
</tbody>
</table>

3. Now count the number of each in your five rows on the ear of corn.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Number Counted</th>
<th>Percent: Number counted / total * 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple &amp; smooth</td>
<td>83</td>
<td>54.25%</td>
</tr>
<tr>
<td>Purple &amp; shrunken</td>
<td>32</td>
<td>20.92%</td>
</tr>
<tr>
<td>Yellow &amp; smooth</td>
<td>30</td>
<td>19.61%</td>
</tr>
<tr>
<td>Yellow &amp; shrunken</td>
<td>8</td>
<td>5.23%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>153</td>
<td></td>
</tr>
</tbody>
</table>

4. Complete the dihybrid cross (#6 below and at the top of the next page). Stop after #7 then complete #5 below.

5. Now look at Table 2: did you obtain a 9:3:3:1 ratio? If you did not, then the genes may be found on the same chromosome and do not assort independently. To determine if the deviations from your observed data are due to chance alone or if the data is significantly different, you need to use a chi square test. Proceed to #8.

Dihybrid Cross

6. We will now consider a dihybrid cross, which is a combination of the two monohybrids. Your ear of corn may be a result of a cross between plants that were both heterozygous for color and texture (PpSs x PpSs). Work out this cross in the Punnet square below.

```
Pp  Ps  Pp  Ps
Ss  Ss  Ss  Ss
```
7. Calculate the phenotypic ratios for each type of seed based on the punnett square above.

<table>
<thead>
<tr>
<th></th>
<th>Purple &amp; smooth</th>
<th>Yellow &amp; smooth</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>Purple &amp; smooth</td>
<td>Yellow &amp; smooth</td>
</tr>
<tr>
<td>Ps</td>
<td>Yellow &amp; smooth</td>
<td>Yellow &amp; smooth</td>
</tr>
<tr>
<td>pS</td>
<td>Purple &amp; smooth</td>
<td>Yellow &amp; smooth</td>
</tr>
<tr>
<td>ps</td>
<td>Yellow &amp; smooth</td>
<td>Yellow &amp; smooth</td>
</tr>
</tbody>
</table>

8. First calculate the expected number you should have gotten based on your total number assuming a 9:3:3:1 ratio. Calculate the individual chi square values for each row and add them all together to determine your overall chi square value.

<table>
<thead>
<tr>
<th></th>
<th>Expected Number</th>
<th>Observed Number</th>
<th>([\text{Observed - Expected}]^2 / \text{expected})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple &amp; smooth</td>
<td>Total x 9/16 = 9</td>
<td>83</td>
<td>0.104651163</td>
</tr>
<tr>
<td>Purple &amp; shrunk</td>
<td>Total x 3/16 = 3</td>
<td>32</td>
<td>0.310348628</td>
</tr>
<tr>
<td>Yellow &amp; smooth</td>
<td>Total x 3/16 = 3</td>
<td>30</td>
<td>0.034482759</td>
</tr>
<tr>
<td>Yellow &amp; shrunk</td>
<td>Total x 1/16 = 1</td>
<td>8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

CHI SQUARE VALUE = 0.84978749

9. Now determine if your chi square value is a good fit with your data. Your degrees of freedom (df) is the number of possible phenotypes minus 1. In your case, 4 - 1 = 3. Find the number in that row that is closest to your chi square value. Circle that number.

10. Explain what it means to have a "good fit" or a "poor fit". Does chi square analysis of real corn data support the hypothesis that the parental generation was PpSs x PpSs?

To have a good fit is to have a low chi square value and it means that the model you are using for testing is usable and suitable for tests. A poor fit has a high chi square value and is a bad model for testing and suggests a hypothesis may be false.

Our chi square analysis supports theory that the parental generation was PpSs x PpSs.

11. List two reasons why data might have a poor chi square fit?

Our data might have a poor chi square fit because we did not examine a large enough sample. However if we observe more kernels, our data will become more accurate. Another reason the data might have a poor chi square fit is because our hypothesis is incorrect. A low chi square fit indicates the hypothesis isn't up to par.
PROBLEM SET

Chi Square Problem Set

1. Problem: A large ear of corn has a total of 433 grains, including 271 Purple & starchy, 73 Purple & sweet, 63 Yellow & starchy, and 26 Yellow & sweet.

Your Tentative Hypothesis: This ear of corn was produced by a dihybrid cross (PpSs x PpSs) involving two pairs of heterozygous genes resulting in a theoretical (expected) ratio of 9:3:3:1.

Objective: Test your hypothesis using chi square and probability values.

\[
\chi^2 = \frac{(271-277.6)^2}{277.6} + \frac{(73-81.14)^2}{81.14} + \frac{(63-61.14)^2}{61.14} + \frac{(26-27.6)^2}{27.6} = 0.41
\]

This is a poor model.

2. Problem: In a certain reptile, eyes can be either black or yellow. Two black eyed lizards are crossed, and the result is 72 black eyed lizards, and 28 yellow-eyed lizards.

Your Tentative Hypothesis: The black eyed parents were Bb x Bb.

Objective: Test your hypothesis using chi square analysis. In this set, because only two values (traits) are examined, the degrees of freedom (df) is 1. SHOW ALL WORK!

\[
\begin{align*}
\chi^2 = & \frac{(72-75)^2}{75} = 0.12 \quad \frac{(28-25)^2}{25} = 0.36 \\
\end{align*}
\]

This is a good model.

3. Problem: A sample of mice (all from the same parents) shows

58 Black hair, black eyes
16 Black hair, red eyes
19 White hair, black eyes
7 White hair, red eyes

Your tentative hypothesis: (what are the parents?) HhEe x HhEe

Objective: Use a chi square analysis to support your hypothesis

\[
\begin{align*}
\chi^2 = & \frac{(56.3-56)^2}{56.3} = 0.051 \quad \frac{(18.8-16)^2}{18.8} = 0.002 \\
\end{align*}
\]

This is a good model.