Name _____

## Mendelian Inheritance and Chi-Square Analysis in Corn

A chi-square is a statistical test to determine how well the actual data fit a predicted outcome. If the chi-square test fits then the prediction is considered accurate enough that the hypothesis cannot be rejected. Observe the corn cob pictured below.

We will first look at the trait of kernel color.

Which trait do you think might be dominant? _____, ... recessive _____?

What cross do you think might have produced this corn cob? _____ x _____

(This is your null hypothesis)

If that is correct, what would be the probability of the kernels being blue? _____, ... yellow? _____

I randomly selected 100 kernels in the image below. If your null hypothesis is correct, how many kernels would be expected to be blue? _____, ... yellow? _____ (Write these numbers in the table below.)

| | Blue | Yellow |
|---|---|---|
| Observed | | |
| Expected | | |

Now, we will count the number of blue and yellow kernels and see how well they fit our prediction.

A chi-square test is used to determine the percent chance that the observed difference between the predicted and observed value is due to chance alone. The agreed upon limit for this value is 0.05 or 5%.

$$\text{Chi-square value} \quad x^2 = \overset{\text{sum}}{\sum} \frac{(\overset{\text{observed}}{O} - \overset{\text{expected}}{E})^2}{\underset{\text{expected}}{E}}$$

| | Blue | Yellow |
|---|---|---|
| Observed | 67 | 33 |
| Expected 3:1 | 75 | 25 |
| | | |

Perform chi-square

| | Blue | Yellow |
|---|---|---|
| Observed | | |
| Expected | | |

Degrees of freedom – the number of possible outcomes – 1
In this cross, the kernels are either blue or yellow. 2 outcomes – 1 = 1 degree of freedom

Compare your value with the 0.05 value and the correct number of degrees of freedom.

| **Degrees of Freedom** | **Probability of exceeding critical value** | | |
|---|---|---|---|
| | 0.10 | 0.05 | 0.025 |
| 1 | 2.706 | 3.841 | 5.024 |
| 2 | 4.605 | 5.991 | 7.378 |
| 3 | 6.251 | 7.815 | 9.348 |
| 4 | 7.779 | 9.488 | 11.143 |

Do we reject the hypothesis? _____

Now using an actual corncob, run a chi-quare test for the same kernel color trait.

Hypothesis for parent genotypes: _____ x _____

Probability for prediction is blue _____, yellow _____.

Count 3 or 4 rows of kernels, recording the number of blue and yellow.

Multiply the total number counted by the predicted probability for each trait.

| | Blue | Yellow |
|---|---|---|
| Observed | | |
| Expected | | |

$$\underbrace{x^2}_{\text{Chi-square value}} = \overbrace{\sum}^{\text{sum}} \frac{(\overbrace{O}^{\text{observed}} - \overbrace{E}^{\text{expected}})^2}{\underbrace{E}_{\text{expected}}}$$

Perform a chi-square test.

Chi-quare critical value = _____

Was your hypothesis rejected?

**Dihybrid cross**

You have probably noticed that the kernels also have a variety of textures, some being smooth while others are wrinkled. This is also controlled by a single gene (S) for starchy smooth or shriveled sugary endosperm. Observe your corncob and come up with a hypothesis for the genotypes of each parent for both kernel color and texture genes. _____ x _____ (Example BbSs x BbSs)

Using your hypothesis, determine the probability for each of the following trait combinations.

Blue and Smooth _____

Blue and Shriveled_____

Yellow and Smooth _____

Yellow and Shriveled_____

Count 4 different rows of kernels, and record the number of each of the trait combinations.

Multiply the total number of kernels counted to determine the expected number of each phenotype.

How many degrees of freedom are there in this test?

| | Blue and Smooth | Blue and Shriveled | Yellow and Smooth | Yellow and Shriveled |
|---|---|---|---|---|
| **Observed** | | | | |
| **Expected** | | | | |

Perform a chi-square test on the data above. There will be two more data sets to test.

Chi-square critical value = _____ Degrees of freedom= _____

Does your data support your hypothesis? _____

Chi-square value

$$x^2 = \sum \frac{(O - E)^2}{E}$$

sum observed expected expected

| Degrees of Freedom | Probability of exceeding critical value | | |
|---|---|---|---|
| | 0.10 | 0.05 | 0.025 |
| 1 | 2.706 | 3.841 | 5.024 |
| 2 | 4.605 | 5.991 | 7.378 |
| 3 | 6.251 | 7.815 | 9.348 |
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