**NAME:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**M&M Lab Activity- Advanced Worksheet**In 2011, the company that makes M&M’s published the proportion of each color that they make of plain M&M’s. M&M’S MILK CHOCOLATE: 24% cyan blue, 20% orange, 16% green, 14% bright yellow, 13% red, 13% brown. We want to explore how these proportions match the colors found in your bag of M&Ms. source: (<http://writethecompany.com/mms-then-now-in-between-part-2>)

We will now be conducting a Chi-square goodness of fit test. Previously we have done chi-square test of equality. In a Chi-square goodness of fit test we use given proportions as the expected numbers instead of assuming an equal number in each category.

**State your Null Hypothesis:**

|  |
| --- |
|  |

**Procedure:**

1. Fill in your observed number from your bag that you calculated during lab in Column A of Data Table A.
2. Determine the expected number of each color from the bag, using the published proportions from the M&M company (fill in Column B). Record the values in Column C of Data Table A.

$$Expected \# of specific color=\left(Total \#in bag\right)×\left(M\&M published proportion for that color\right)$$

1. Calculate the (observed-expected) in Column D Data Table A.
2. Calculate the squared values of (observed-expected) in Column E of Data Table A.
3. Calculate the Chi-Square value for each color in Column F Data Table A.
4. Calculate the sum of Chi-Squares.
5. Determine *degrees of freedom* (number of classes – 1).
6. Use the 0.05 probability level as the *significance level* to find the *critical value* based on the degrees of freedom (df) for this test. If the calculated sum of chi-squares value is less than the critical value, we accept the NULL hypothesis. If the calculated sum of chi-squares value is greater than the critical value, we reject the NULL hypothesis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| $$χ^{2} Table$$

|  |  |
| --- | --- |
|  | Probability |
| Degrees ofFreedom  | 0.9  | 0.5 | 0.1 | 0.05 | 0.01 |
| 1  | 0.02 | 0.46 | 2.71 | 3.84 | 6.63 |
| 2  | 0.21 | 1.39 | 4.61 | 5.99 | 9.21 |
| 3  | 0.58 | 2.37 | 6.25 | 7.81 | 11.34 |
| 4  | 1.06 | 3.36 | 7.78 | 9.49 | 13.28 |
| 5  | 1.61 | 4.35 | 9.24 | 11.07 | 15.09 |

 | \* If the $χ^{2}$ is smaller than the critical value for the indicated degrees of freedom, then we accept the null hypothesis that the variation in species distribution among habitat types is due to chance (random) variation.\*If the $χ^{2}$ is larger than the critical value for the indicated degrees of freedom (# classes1), then we reject the null hypothesis and conclude that the two species are not equally distributed among the habitat types. |

$Sum of χ^{2}=\sum\_{}^{}χ^{2}=\sum\_{}^{}\frac{\left(Observed Value-Expected Value\right)^{2}}{Expected Value}$

\*\*\*Remember, your chi-square value is the sum of $\frac{\left(Observed Value-Expected Value\right)^{2}}{Expected Value}$ for each cell in your table\*\*\*

**Data Table A.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F |
|  | Observed | Published Proportions | Expected | (Obs-Exp) | (Obs-Exp)2 | $$χ^{2}=\frac{(Obs-Exp)^{2}}{Exp}$$ |
| Red |  |  |  |  |  |  |
| Yellow |  |  |  |  |  |  |
| Blue |  |  |  |  |  |  |
| Orange |  |  |  |  |  |  |
| Green |  |  |  |  |  |  |
| Brown |  |  |  |  |  |  |
| $Sum of χ^{2}=\sum\_{}^{}\frac{\left(Obs-Exp\right)^{2}}{Exp}$  |  |
| Degrees of Freedom |  |
| Accept or reject null hypothesis? |  |

**Discussion and Analysis:**

Do the numbers of each color of M&M’s in your bag match the published proportions stated earlier? In other words, did you find a statistical difference between your bag and the published values? Explain.

Conclusion:

If you found a statistical difference, come up with a hypothesis as to why.

$χ^{2}$ tutorial http://www.ndsu.nodak.edu/instruct/mcclean/plsc431/mendel/mendel4.htm