Name: _____ Circle Hour: 1 2 3 4

Chi-Squared Statistical Analysis

Observed results from a genetic cross rarely come out exactly how they were predicted, and the question is: Are the differences between the predicted and observed results significantly different? The chi-square (X^2) goodness-of-fit test is a simple tool used in comparing observed and predicted results to answer that question. Put simply, the chi-square tests whether or not the differences observed are due to chance.

Step 1: Creating hypothesis:

Null Hypothesis (H0) – "there is no significant difference between predicted and observed results"

Alternative Hypothesis (H1) – "there is a significant difference between the predicted and observed results"

Step 2: Calculating the chi-square:

$$\chi^2 = \sum \frac{(O-P)^2}{P}$$

Where $\sum$ is the sum, **O** is the observed value, and **P** is the predicted value.

Step 3: Interpret results by referring to the percentage points (p = .05)

Degrees of Freedom (df) – Number of categories minus 1

TABLE 35. Upper percentage points of the chi-square distribution. From Gill (1978).

d.f.	p					
	0.3	0.2	0.1	0.05	0.01	0.001
1	1.07	1.64	2.71	3.84	6.64	10.8
2	2.41	3.22	4.60	5.99	9.21	13.8
3	3.66	4.64	6.25	7.82	11.3	16.3
4	4.88	5.99	7.78	9.49	13.3	18.5
5	6.06	7.29	9.24	11.1	15.1	20.5

Sample Problem:

In a cross between Pp and Pp (where P = purple flower color and p = white flower color). Following a normal dominant/recessive Mendelian pattern of inheritance, we would PREDICT a 3:1 ratio of purple : white flowers. However, when we count the offspring, we OBSERVE 290 purple and 110 white. Is this significantly different from the 3:1 ratio we predicted? (NOTE: Out of 400 offspring, we would predict 300 : 100)

$$\frac{(290-300)^2}{300} + \frac{(110-100)^2}{100} = 1.33$$

Referring to the table: p = .05 and df = 1 = 3.84

We REJECT H0 if $X^2 > 3.84$ but it is NOT so we fail to reject the H0….there is NO significant difference between observed and expected.

Try these out!!

1. In pea plants, the dwarf variety (t) is recessive to the tall variety (T).
   a. In a cross between a heterozygous tall plant and a dwarf plant, what is your PREDICTED phenotype ratio?

   b. If you obtain 550 seeds from this cross, how many do you PREDICT to be tall? How many short?

   c. You actually plant the 550 seeds and of the 550 offspring 330 are tall and 220 are dwarf. You want to determine if there is a significant difference between the numbers you observed and the numbers you predicted.
      a. Make a null and alternative hypothesis:

      b. Calculate the X^2:

      c. Using the table on the previous page, with p = .05, form a conclusion regarding H0/H1.

2. A genetics engineer was attempting to cross a tiger and a cheetah. She predicted a phenotypic outcome of the traits she was observing to be in the following ratio 4 stripes only: 3 spots only: 9 both stripes and spots.

   When the cross was performed and she counted the individuals she found 50 with stripes only, 41 with spots only and 85 with both. Perform the chi-squared test to determine if there is a significant difference between her observed and expected.

3. In the garden pea, yellow seed color is dominant to green, and round pod shape is dominant to the wrinkled form. In a cross between two plants both heterozygous (yellow, round), compare in a chi-squared test whether the predicted results are significantly different from the observed. *NOTE: If there is a HUGE difference…the traits might be linked…on the SAME chromosome…in violation of the law of independent assortment!!

OBSERVED results:
556 yellow, round
193 green, round
184 yellow wrinkled
61 green, constricted