Example 24
Chi-square goodness of fit
Setup

A geneticist thinks that two traits of pea plants are inherited independently (they occur on different chromosomes). The geneticist has performed an appropriate dihybrid cross and counted the phenotypes of the offspring. She expects a 9:3:3:1 ratio.

|	Yellow, smooth	Yellow, wrinkle	Green, smooth	Green, wrinkle	n
Observed	152	39	53	6	250

Example 24
Chi-square goodness of fit
Solution

1. State your question: Do the offspring from the dihybrid cross conform to the 9:3:3:1 ratio?
   a. Is it a good scientific question? Definable, measurable, and controllable
   b. Identify your population: Phenotype of offspring from dihybrid cross
   c. Identify your dependent variable: Observed offspring phenotypic frequency
   d. Identify your independent variable: Expected offspring phenotypic frequency
2. State your hypothesis set
   a. Verbal hypothesis: Below
   b. Statistical hypothesis (H_O, H_A)
      H_0: The observed frequency of offspring does conform to the expected 9:3:3:1 ratio.
      H_A: The observed frequency of offspring does not conform to the expected 9:3:3:1 ratio.
   c. Is your hypothesis set exhaustive? Yes
   d. Is your hypothesis set exclusive? Yes
3. State your significance level: $\alpha = 0.05$
4. Select the appropriate test.
   a. Variable scale:
      i. Dependent variable: Nominal (Counts)
         o Converted or transformed? No
      ii. Independent variable: Nominal (Counts)
         o Converted or transformed? No
   b. What information is given or available?
      i.   Sample data
   c. Number of samples: 1
   d. Are the data paired or unpaired? Unpaired
   e. What aspect of the variable do you want to compare?
      i.   Goodness of fit
   f. State the test to be used: X^2 (Goodness of fit)
      i.   Are assumptions of the test met? Yes
         o Random samples – Assumed
         o Independent samples – Assumed
         o No more than 20% of the expected values are less than 5 and none of the expected values are less than 1. – Yes

5. Conduct your sampling:

	Yellow, smooth	Yellow, wrinkle	Green, smooth	Green, wrinkle	n
Observed	152	39	53	6	250

6. Graph the data
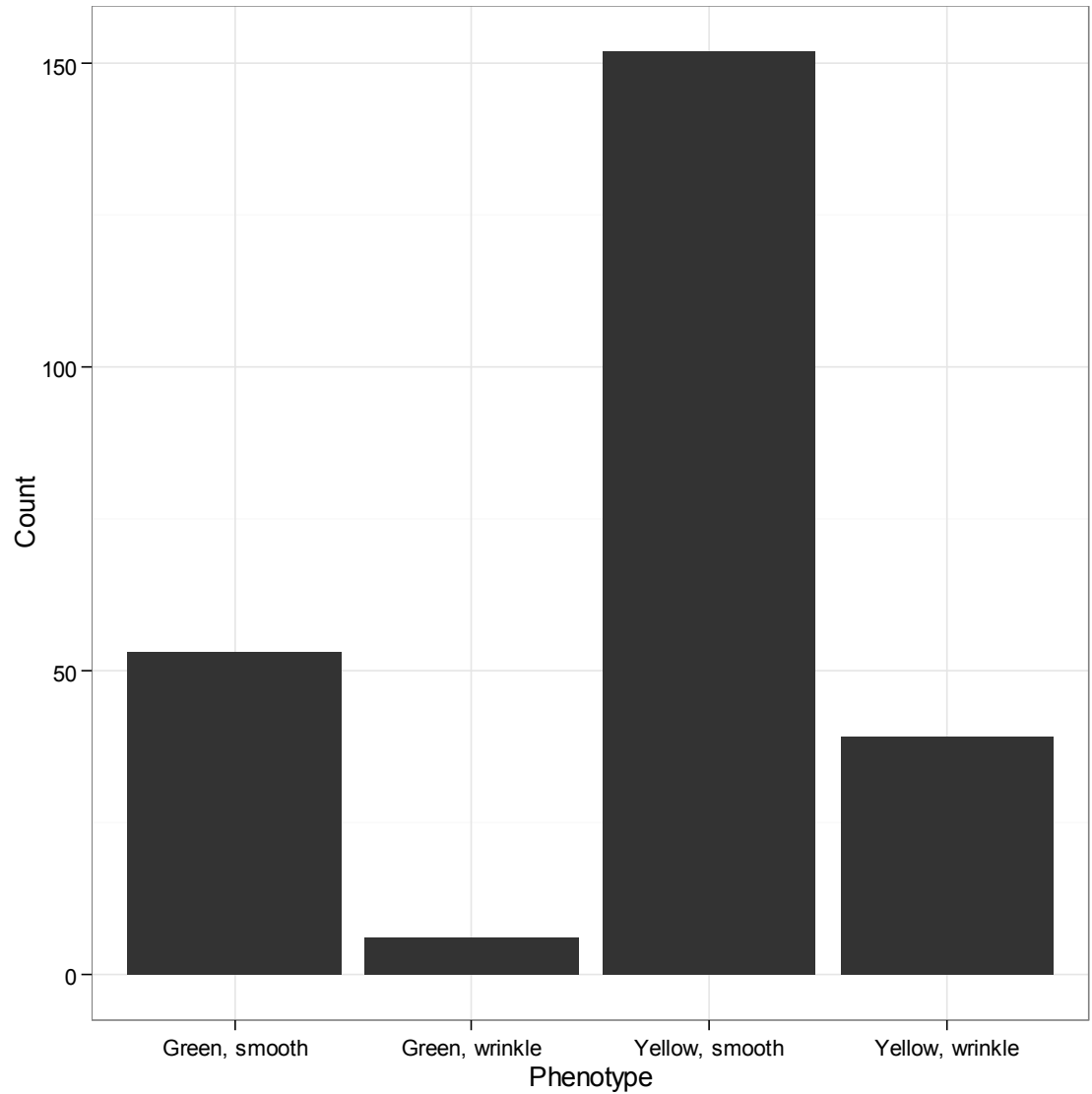
Figure 1. Frequency of phenotypes of peas (color and texture) from a putative dihybrid cross.

7. Summarize the data (Calculated the expected values).

9+3+3+1=16

9÷16=0.5625   0.5625*250=140.625
3÷16=0.1875   0.1875*250=46.875
1÷16=0.0625   0.0625*250=15.625

	Yellow, smooth	Yellow, wrinkle	Green, smooth	Green, wrinkle	n
Observed	152	39	53	6	250
Expected	140.625	46.875	46.875	15.625	250

8. Calculate your test statistic.

Chi-squared test for given probabilities

data: Peas$Frequency
X-squared = 8.9724, df = 3, p-value = 0.02966

9. Retain or reject your null hypothesis based on your test statistic.
The calculated p-value (0.030) is less than the significance level (0.05), so we reject the null hypothesis and retain the alternate hypothesis.

10. Interpret the results in biological terms.
The observed frequency of offspring does not conform to the expected 9:3:3:1 ratio (X^2 = 8.972, df = 3, p = 0.030).