

Using the Chi-Squared Test to Establish Linkage

Genes that are in close proximity on the same chromosome will result in the linked alleles being inherited together more often than not. We can use the chi-squared test to determine whether the results of a cross are due to linkage or to chance.

If genes are unlinked (and, therefore, assort independently) the phenotypic ratio of offspring in a cross between a dihybrid and a homozygous recessive individual is expected to be 1:1:1:1. If the two genes are linked, however, the observed phenotypic ratio of the offspring will not match the expected ratio.

In cosmos plants, purple stem (P) is dominant to green stem (p), and short petals (S) is dominant to long petals (s). PPSS plants were crossed with ppss plants to generate F₁ dihybrids (PpSs), which were then crossed with homozygous recessive individuals (ppss). The stem color and flower petal length of 900 offspring plants were recorded. It is hypothesized that the two genes are unlinked.

1. Calculate the expected number of each phenotype out of the 900 total offspring.
2. Complete Table 1 to help you calculate χ^2 .

Table 1: Calculation of χ^2

Offspring	Expected (e)	Observed (o)	(o-e)	(o-e) ²	(o-e) ² /e
Purple stem/short petals (P_s_)		220			
Green stem/short petals (ppS_)		210			
Purple stem/long petals (P_ss)		231			
Green stem/long petals (ppss)		239			
				χ^2	

3. What is the null hypothesis that you are testing? What about the hypothesis?
4. a) What does the χ^2 test tell us about the inheritance of the stem color and petal length genes?
b) How do we explain the difference between our observed and expected results?