

- (a) The usual Mendelian ratio for four phenotypes controlled by two independent genes after crosses of individuals heterozygous for both genes is 9:3:3:1. Interactions between genes can cause phenotypic ratios to be different. This sort of interaction is called *epistasis*.

Consider the following example with two genes. The genotype $A-$ is a short-hand notation for either AA or Aa . Suppose that presence of an allele A results in a black phenotype while presence of an allele B in the absence of A produces a gray phenotype. When both A and B are absent, the observed color is white.

The following table describes the probability distribution of genotypes and phenotypes for offspring from an $AaBb \times AaBb$ cross if the previous genetic description is true.

Genotype	Phenotype	Probability
$A - B -$	black	9/16
$A - bb$	black	3/16
$aaB -$	gray	3/16
$aabb$	white	1/16

In an observed cross of two individuals believed to be of genotype $AaBb$, there are 200 offspring with the following observed counts: 160 black, 34 gray, and 6 white.

Test the hypothesis that the offspring probabilities for black, gray, and white are in a 12:3:1 ratio as predicted by the previous theory versus the alternative that they are different using a chi-square test for goodness-of-fit. State hypotheses, compute a test statistic, and use the chi-square table to find a range for the p -value. Interpret the results in the context of the problem.

- (b) In a different genetic experiment, offspring are either short or tall and green or yellow. Observed counts of 250 individuals are tabulated here.

Height	Color	
	Green	Yellow
Tall	165	25
Short	50	10

Use a chi-square test to test if these two traits are independent of one another. State hypotheses, compute a test statistic, and use the chi-square table to find a range for the p -value. Interpret the results in the context of the problem.

- (c) Let p_1 be the proportion of green individuals among tall plants and p_2 be the proportion of green individuals among short plants in the relevant populations for which these individuals are a representative sample. For the hypothesis test $H_0 : p_1 = p_2$ versus the alternative $p_1 > p_2$, the p -value from Fisher's Exact Test is equal to the following probability. (Fill in the blanks with numbers and circle one option from each set.)

The probability of drawing 165 red balls [OR MORE | OR FEWER | EXACTLY] from a bucket with _____ red balls and _____ white balls when _____ balls are drawn from the bucket at random [WITH | WITHOUT] replacement.