

Feathers of change

Evolution in a population is defined as a change in the frequency of its alleles. The Hardy–Weinberg principle is a tool that can be used to estimate the allele frequencies among a population from generation to generation. The population is considered to be in equilibrium as long as the following five conditions are met:

1. The population is large.
2. Members of the population show no preference in mating.
3. There are no mutations.
4. Members are not moving into or out of the population.
5. There is no natural selection.

If these conditions are met, the population's allele frequencies will stay the same from generation to generation and we will know no evolution took place within the population.

In this lab we will look at a population of turkeys that has met the five Hardy–Weinberg principle conditions and is currently in equilibrium. We will then look at a population of turkeys where the changing habitat conditions have produced turkeys with lighter coat patterns. How will natural selection affect the gene frequency and evolution within the population?

In turkeys, black feather patterns are dominant over bronze feather patterns. In the Hardy–Weinberg principle the following variables represent alleles.

Phenotype	Genotype	HW variable
Homozygous black	BB	p^2
Heterozygous black	Bb	$2pq$
Homozygous bronze	bb	q^2

Procedure

PART 1: CALCULATING THE GENE FREQUENCIES OF THE EQUILIBRIUM FIELD

We will run a simulation representing the equilibrium of a turkey population. Each student should trade one allele card at a time with other students continuously for 2 minutes. In this simulation each class member will represent a heterozygous black turkey.

Hypothesis: What is your prediction for allele frequency of the population at the end of this round? Add as a percent next to each allele.

p or B	
q or b	

After this activity, record the class totals in data table 1.

Data table 1

Genotype	Number of students	Number of alleles	Total of each
BB			
Bb			
bb			
Total number of students		Total number of alleles	

Determine the allelic frequencies by totaling the number of “B”s and the total of “b”s divided by the total number of alleles in the class.

Data table 2

HW symbol	Allele	Allele frequency (as percentage)
p	B	
q	b	

Analyze the class data using the variables and the equation ($p^2 + 2pq + q^2 = 1$) to determine if the equation will predict the allelic frequency for your classroom population.

Data table 3

Hardy–Weinberg calculation	Allele frequency (as decimal)
p^2	
$2pq$	
q^2	

PART 2: CALCULATING THE GENE FREQUENCIES FOR THE POPULATION WHERE BRONZE FEATHERED TURKEYS WERE SELECTED

In this simulation each class member will have either a homozygous bronze genotype or heterozygous genotype. All of the homozygous black genotypes have been removed from the population since we no longer want to have black turkeys.

Hypothesis: What is your prediction for the genotypic ratios in the population since all turkeys are homozygous recessive or heterozygous?

p or B	
q or b	

After the activity, record the class totals in the following table:

Data table 4

Genotype	Number of students	Number of alleles	Total of each
BB			
Bb			
bb			
Total number of students		Total number of alleles	

Determine the allelic frequencies by totaling the number of “B”s and the total of “b”s divided by the total number of alleles in the class in data table 5.

Data table 5

HW symbol	Allele	Allele frequency (as percentage)
p	B	
q	b	

Analyze the class data using the variables and the equation ($p^2 + 2pq + q^2 = 1$) to determine if the equation will predict the allelic frequency for your classroom population.

Data table 6

Hardy–Weinberg calculation	Allele frequency (as decimal)
p^2	
$2pq$	
q^2	

Reflection

1. In the first simulation, did your predictions agree with the allele frequencies calculated in data table 2?
2. If your class results in data table 2 did not agree, what are some of the possible reasons why?
3. In the second simulation, did your predictions agree with the allele frequencies calculated in data table 5?
4. If your class results in data table 5 did not agree, what are some of the possible reasons why?
5. Which condition(s) of the Hardy–Weinberg principle influenced the difference between the frequency of your alleles in your data tables 2 and 5?
6. If changing habitats continue to select for bronze turkeys, which variable in the Hardy–Weinberg principle would decrease the most? Which one would increase the most? Why?