BIOTECHNOLOGY

Evolution of short corn

Focus question	How will producers' selection practices change allelic frequencies and drive evolution in a corn field?
Vocabulary	Dominant and recessive alleles, allelic frequencies, genotype, phenotype, evolution, Hardy-Weinberg equilibrium

Recent technological advances have shown that corn height has very little impact on production. Shorter corn has advantages such as:

1. Strong stalks due to the reduced height reduce the chances of the plant breaking or falling over due to high winds.
2. Shorter plants allow for materials such as fertilizers, pest control, and herbicides to be applied more precisely and efficiently.
3. Shorter plants give the ability to grow more plants in a smaller land area which minimizes land use.

Evolution in a population is defined as a change in the frequency of its alleles. The Hardy–Weinberg Equation 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 corn (a field of corn) that has met the five conditions and is currently in equilibrium. We will then look at a corn field where the farmer has used selection to produce short corn. How will the farmer's selection affect the gene frequency and evolution within the population?

In corn tall plants are dominant over short plants.

In the Hardy–Weinberg Equilibrium model the following variables represent alleles.

Phenotype	**Genotype**	**HW variable**
Homozygous Tall	AA	P^2
Heterozygous Tall	Aa	2pq
Homozygous Short	aa	q^2

Materials

- Allele cards
- Scratch paper for calculations
- Calculator

Procedure

Part 1: Calculating the gene frequencies of the equilibrium field

We will run a simulation representing the equilibrium corn field. In this simulation each class member will represent a heterozygous tall corn plant.

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

p or A	
q or a	

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

Data table 1

Genotype	Number of students	Number of alleles	Total of each
AA			
Aa			
aa			
Total number of students		**Total number of alleles**	

Determine the allelic frequencies by totaling the number of A's and the total of a's divided by the total number of alleles in the class.

Data table 2

HW symbol	Allele	Allele frequency (as percentage)
p	A	
q	a	

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 field where short corn was selected

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

Hypothesis: what is your prediction for the genotypic ratios in the field since all plants are homozygous recessive or heterozygous?

p or A	
q or a	

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

Data table 4

Genotype	**# 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	A	
q	a	

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	

Post analysis questions

1. Did your class results in data table 3 agree with the Hardy–Weinberg predictions?

2. If your class results in data table 3 did not agree, what are some of the possible reasons why?

3. Did your class results in data table 6 match the data in your data table 3? If not, what do you think contributed to the difference?

4. Which condition of the Hardy–Weinberg equilibrium influenced the greatest difference between your data table 3 and data table 6?

5. If farmers continued to artificially select for shorter plants which variable in the Hardy–Weinberg Equation would decrease the most? Which one would increase the most?

6. How does artificial selection drive evolution?

Rubric for self-assessment

Skill	Yes	No	Unsure
I understand the purpose of the Hardy–Weinberg Equation.			
I understand how allelic frequency can determine if evolution is occurring within a population.			
I understand how artificial selection can drive evolution within a given population.			