

TOPIC: THE HARDY-WEINBERG PRINCIPLE

Introduction to Hardy-Weinberg

◆ Hardy-Weinberg equation: predicts genotype frequencies for gene with ___ alleles in a diploid population.

- Assumes _____ mating & no changes to _____ frequency.
- Populations that match this prediction are said to be in Hardy-Weinberg _____.

◆ Recall: p = the frequency of the _____ allele (A). q = the frequency of the _____ allele (a).

- Because there are only 2 alleles: $p + q = 1$

◆ Predicting expected genotypes using p and q :

- Chance of being a AA homozygote: _____.
- Chance of being a Aa heterozygote: _____.
- Chance of being a aa homozygote: _____.



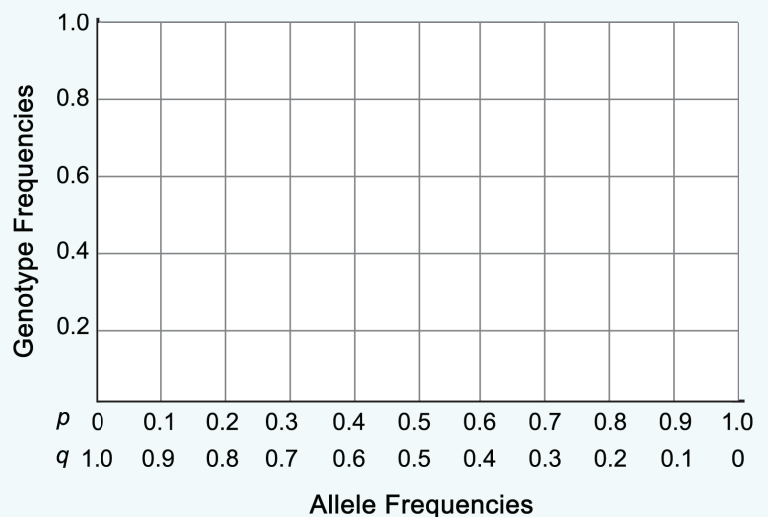
◆ Hardy-Weinberg Equation: $p^2 + 2pq + q^2 = \underline{\hspace{1cm}}$

EXAMPLE

The table below gives the allele frequencies (p & q) for 4 populations (A, B, C, D) in Hardy-Weinberg equilibrium.

Based on the information in the table, fill in the values for p^2 , q^2 , and $2pq$ for each population. Then, using the graph provided, plot the genotype frequencies for populations A, B, C, & D.

	Allele Frequencies		Genotype Frequencies		
	p	q	p^2	$2pq$	q^2
A	0	1			
B	0.2	0.8			
C	0.4	0.6			
D	0.5	0.5			



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PRACTICE

In the Hardy-Weinberg equation, what does the term $2pq$ represent?

- a) The probability of being a homozygote for the first allele.
- b) The probability of being a homozygote for the second allele.
- c) The probability of being a heterozygote.
- d) The combined probability of all genotypes.

PRACTICE

Which of the following statements about the Hardy-Weinberg equation are true?

- I) For a gene with two alleles, q^2 represents the frequency of one of the homozygotes.
 - II) If p and q both equal 0.5, you expect 50% of the population to be heterozygous.
 - III) The p^2 and q^2 terms will be equal as they both represent the probability of being a homozygote.
- a) I & II only. b) II & III only. c) I & III only. d) I, II, & III.

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Predicting Allele or Genotype Frequencies Using Hardy-Weinberg

- ◆ HW can be used to predict _____ or _____ frequencies for populations.
 - Assumes the population is in HW _____.
- ◆ Use the following generalized steps:

Steps to solve:

1. Remember your equations:

Allele Frequencies	Genotype Frequencies
$p + q = 1.$	$p^2 + 2pq + q^2 = 1$

2. Identify which variables are given.
3. Identify which variable or variables the problem is asking for.
4. Solve for the missing variable(s).

- ◆ *Recall:* If the traits have a simple dominance relationship:

- AA & Aa genotypes will display the dominant trait.
- aa genotypes will display the recessive trait.

A. Calculating Genotype Frequency from Allele Frequency

- ◆ Plug p & q into the HW (_____ freq.) equation.
- ◆ Find the predicted genotype frequencies if the frequency of the A allele = 0.2 and the frequency of the a allele = 0.8.

Steps to solve:

1. Remember your equations:

Allele Frequencies	Genotype Frequencies
$p + q = 1.$	$p^2 + 2pq + q^2 = 1$

2. Identify which variables are given.
3. Identify which variable or variables the problem is asking for.
4. Solve for the missing variable(s).

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B. Calculating Allele Frequency from a Genotype Frequency

- ◆ Work backward from genotype to find the _____ freq.
- ◆ Predict the allele frequency for both alleles if the population is 1% *aa* homozygotes.

Steps to solve:

1. Remember your equations:

Allele Frequencies	Genotype Frequencies
$p + q = 1.$	$p^2 + 2pq + q^2 = 1$

2. Identify which variables are given.
3. Identify which variable or variables the problem is asking for.
4. Solve for the missing variable(s).

C. Calculating Allele Frequency from Phenotype Frequency

- ◆ When given a phenotype freq. convert to _____ freq.
 - For simple dominance:

	Dominant Trait		Recessive Trait
Genotypes:	<i>AA</i>	<i>Aa</i>	<i>aa</i>
Genotype frequencies:	_____	+ _____	_____

- ◆ In a population, 64% of individuals display the dominant trait.
What percent of the population do you predict to be heterozygous?

Steps to solve:

1. Remember your equations:

Allele Frequencies	Genotype Frequencies
$p + q = 1.$	$p^2 + 2pq + q^2 = 1$

2. Identify which variables are given.
3. Identify which variable or variables the problem is asking for.
4. Solve for the missing variable(s).

- PTC is a chemical that elicits a bitter taste response in some people. The ability to taste PTC depends on the presence of the PTC-tasting allele. Individuals with at least one copy of the PTC-tasting allele taste PTC as bitter. It is estimated that about 70% of the population taste PTC. Assuming that the population is in Hardy-Weinberg equilibrium for this trait, what percent of the population would you expect to be heterozygous for this trait?

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Testing if a Population is in Hardy-Weinberg Equilibrium

- ◆ To test if a population is in HW equilibrium, compare _____ genotype frequencies to HW _____:
- ◆ HW equilibrium is sometimes used as a *null model*. If the population is _____ in HW, we assume one of two things:
_____ mating OR _____.

A sample from a particular population has:

250 AA 100 Aa 150 aa

Is this population in Hardy-Weinberg equilibrium? _____

Step 1		Allele Frequency
Actual	p	
	q	
	Total	

Steps 2+3		Genotype Freq.	# of Individuals
Expected	AA		
	Aa		
	aa		
	Total		

Steps to solve:

1. Calculate allele frequencies:

$$p = \frac{2(\#AA) + \#Aa}{2(\#individuals)} \quad q = \frac{\#Aa + 2(\#aa)}{2(\#individuals)}$$

2. Plug p & q into HW equation to calculate

expected genotype frequencies.

$$AA = p^2 \quad Aa = 2pq \quad aa = q^2$$

3. Multiply expected genotype frequencies by the number of individuals in the sample.
4. Compare to the original data.

PRACTICE

In a population of glass frogs (*Hyalinobatrachium munozorum*) you collect 200 individuals. Of those, you determine that 160 are homozygous for the H allele, 10 are homozygous for the h allele, and 30 are heterozygous. Is this population in Hardy-Weinberg equilibrium? If not, why not?

- a) Yes. The population is in Hardy-Weinberg equilibrium.
- b) No. There are more heterozygotes than predicted by the Hardy-Weinberg equation.
- c) No. There are fewer HH homozygotes than predicted by the Hardy-Weinberg equation.
- d) No. There are more HH homozygotes than predicted by the Hardy-Weinberg equation.

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PRACTICE

Jorge and Claire are given the following data on fur density in red pandas at zoos in the United States. Is the following population in Hardy-Weinberg equilibrium?

160 homozygous for the F allele, 137 heterozygotes, and 29 homozygous for the f allele.

- a) Yes, the population is in Hardy-Weinberg equilibrium.
- b) No, we would expect there to be more heterozygotes in the population.
- c) No, we would expect there to be more ff homozygotes in the population.
- d) No, we would expect there to be more FF homozygotes in the population.