Hardy-Weinberg Theorem

Jessica Harwood
Douglas Wilkin, Ph.D.

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-content, web-based collaborative model termed the **FlexBook**®textbook, CK-12 intends to pioneer the generation and distribution of high-quality educational content that will serve both as core text as well as provide an adaptive environment for learning, powered through the **FlexBook Platform**®.

Printed: March 17, 2015

flexbook
next generation textbooks

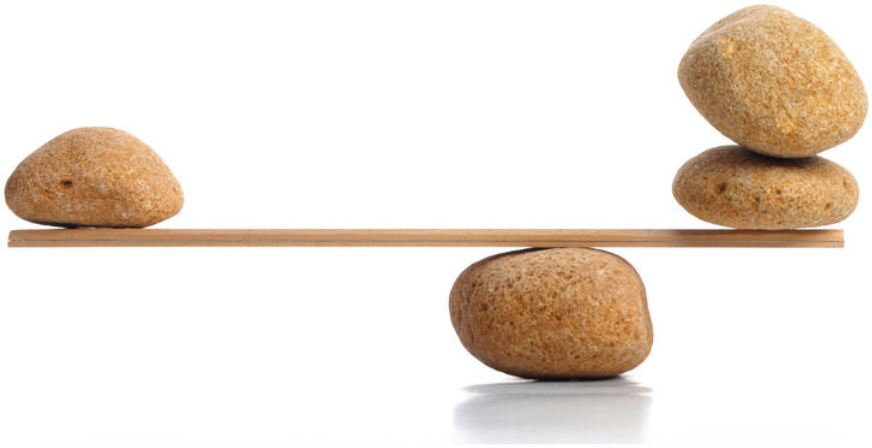
AUTHORS
Jessica Harwood
Douglas Wilkin, Ph.D.

EDITOR
Douglas Wilkin, Ph.D.

CONTRIBUTORS
Doris Kraus, Ph.D.
Niamh Gray-Wilson
Jean Brainard, Ph.D.
Sarah Johnson
Jane Willan
Corliss Karasov

CHAPTER 1 Hardy-Weinberg Theorem

- Define genetic equilibrium.
- List the five conditions necessary for genetic equilibrium.
- Explain the Hardy-Weinberg model.



Can these stones keep balance indefinitely?

If balance, or equilibrium, is to be maintained, there must be no outside influences on the stones. Equilibrium can also be maintained within a population's genes; that means, no evolution can occur. But outside influences usually prevent equilibrium from staying established.

Hardy-Weinberg Equilibrium

Sometimes understanding how common a gene is within a population is necessary. Or, more specifically, you may want to know how common a certain form of that gene is within the population, such as a recessive form. This can be done using the Hardy-Weinberg model, but it can only be done if the frequencies of the genes are not changing.

The **Hardy-Weinberg model** describes how a population can remain at **genetic equilibrium**, referred to as the Hardy-Weinberg equilibrium. Genetic equilibrium occurs when there is no evolution within the population. In other words, the frequency of **alleles** (variants of a gene) will be the same from one generation to another. For example, let's assume that red hair is determined by the inheritance of a gene with two alleles—*R* and *r*. The dominant allele, *R*, encodes for non-red hair, while the recessive allele, *r*, encodes for red hair. If a population's **gene pool** contains 90% *R* and 10% *r* alleles, then the next generation would also have 90% *R* and 10% *r* alleles. However, this only works under a strict set of conditions.

The five conditions that must be met for genetic equilibrium to occur include:

1. No change in the DNA sequence.
2. No **migration** (moving into or out of a population).
3. A very large population size.
4. Random mating.
5. No natural selection.

These five conditions rarely occur in nature. When one or more of the conditions does not exist, then evolution can occur. As a result, allele frequencies are constantly changing, and populations are constantly evolving.

The Hardy-Weinberg model also serves a mathematical formula used to predict allele frequencies in a population at genetic equilibrium. If you know the allele frequencies of one generation, you can use this formula to predict the next generation. Again, this only works if all five conditions are being met in a population.

Summary

- If a population stays at genetic equilibrium, then no evolution takes place.
- The Hardy-Weinberg model states that a population will remain at genetic equilibrium as long as five conditions are met: (1) No change in the DNA sequence, (2) No migration, (3) A very large population size, (4) Random mating, and (5) No natural selection.

Explore More

Use the resource below to answer the questions that follow.

- **Hardy-Weinberg Equilibrium Model** at http://anthro.palomar.edu/synthetic/synth_2.htm .

1. What is happening when there is a change in the frequencies of alleles in the gene pool of a population?
2. Is it likely for gene pool frequencies to remain unchanged?
3. List four conditions that must be met for evolution not to occur.
4. In the Hardy-Weinberg equation, what does p represent?

Review

1. What is an allele?
2. What is meant by genetic equilibrium?
3. What conditions are required for the Hardy-Weinberg model to apply?
4. Why is Hardy-Weinberg equlilibrium unlikely?