

## AP Biology Laboratory 8

# Population Genetics and Evolution

### Objectives

- Estimate the frequency of alleles in a population using Hardy-Weinberg equations.
- Demonstrate that allele frequencies can change in a population over time.

### Background

In the early 1900s, many biologists attempted to explain evolution in terms of the emerging science of genetics. Because the  $F_2$  of monohybrid cross show a 3:1 ratio of dominant to recessive phenotypes many assumed that populations would evolve toward similar ratios of phenotypes. Two mathematicians, Godfrey Hardy and Wilhelm Weinberg, realized that the frequency of alleles in a population was independent of the alleles' inheritance pattern from parents to offspring. They postulated an ideal breeding population with the following properties:

1. Population size is infinite, or very large.
2. Mating is random. Mating pairs show no preference for one phenotype over another.
3. There is no mutation.
4. There is no exchange with other populations. No immigration or emigration occurs.
5. There is no selection for one phenotype over another. All phenotypes have an equal chance of reproducing.

If these conditions are met, the population's allele and genotype frequencies will remain statistically constant over time, a condition referred to as Hardy-Weinberg equilibrium. If we determine the frequency of a pair of alleles in a population, we can sample that population over several generations to determine if the frequency changes. If it does, we know that the population is evolving with respect to that pair of alleles.

Hardy and Weinberg developed mathematical formulas for estimating the frequencies of alleles in populations. Consider the following data on Rh blood type for a hypothetical human population of 6000:

**Results of Testing for Human Rh Blood Type**

Blood Type	Number of People
Rh+	4680
Rh-	1320
Total	6000

Assume that Rh blood type is inherited through two alleles:  $D$ , a dominant allele for Rh+ blood type, and  $d$ , a recessive allele for Rh- blood type.

Using Hardy-Weinberg equations, let

$p$  = frequency of the dominant allele ( $D$ )

$q$  = frequency of the recessive allele ( $d$ )

Each person is either Rh+ or Rh-, therefore,

$$p + q = 1 \text{ or } 100\% \text{ of the population.}$$

Since humans are diploid, individuals may be homozygous dominant ( $DD$ ), heterozygous ( $Dd$ ) or homozygous recessive ( $dd$ ). The basic equation must be expanded to represent all the genotype frequencies. Thus,

$$(p + q)(p + q) = 1$$

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**Victor M. Corman**



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## **Table of Contents Ap Biology Lab Eight Population Genetics Evolution Answers**

1. Understanding the eBook Ap Biology Lab Eight Population Genetics Evolution Answers
  - The Rise of Digital Reading Ap Biology Lab Eight Population Genetics Evolution Answers
  - Advantages of eBooks Over Traditional Books
2. Identifying Ap Biology Lab Eight Population Genetics Evolution Answers
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Ap Biology Lab Eight Population Genetics Evolution Answers
  - User-Friendly Interface
4. Exploring eBook Recommendations from Ap Biology Lab Eight Population Genetics Evolution Answers
  - Personalized Recommendations
  - Ap Biology Lab Eight Population Genetics Evolution Answers User Reviews and Ratings
  - Ap Biology Lab Eight Population Genetics Evolution Answers and Bestseller Lists
5. Accessing Ap Biology Lab Eight Population Genetics Evolution Answers Free and Paid eBooks
  - Ap Biology Lab Eight Population Genetics Evolution Answers Public Domain eBooks
  - Ap Biology Lab Eight Population Genetics Evolution Answers eBook Subscription Services
  - Ap Biology Lab Eight Population Genetics Evolution Answers Budget-Friendly Options

6. Navigating Ap Biology Lab Eight Population Genetics Evolution Answers eBook Formats
  - ePub, PDF, MOBI, and More
  - Ap Biology Lab Eight Population Genetics Evolution Answers Compatibility with Devices
  - Ap Biology Lab Eight Population Genetics Evolution Answers Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Ap Biology Lab Eight Population Genetics Evolution Answers
  - Highlighting and Note-Taking Ap Biology Lab Eight Population Genetics Evolution Answers
  - Interactive Elements Ap Biology Lab Eight Population Genetics Evolution Answers
8. Staying Engaged with Ap Biology Lab Eight Population Genetics Evolution Answers
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Ap Biology Lab Eight Population Genetics Evolution Answers
9. Balancing eBooks and Physical Books Ap Biology Lab Eight Population Genetics Evolution Answers
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Ap Biology Lab Eight Population Genetics Evolution Answers
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Ap Biology Lab Eight Population Genetics Evolution Answers
  - Setting Reading Goals Ap Biology Lab Eight Population Genetics Evolution Answers
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Ap Biology Lab Eight Population Genetics Evolution Answers
  - Fact-Checking eBook Content of Ap Biology Lab Eight Population Genetics Evolution Answers
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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