

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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Table of Contents Population Genetics Lab Answers Kim Foglia

1. Understanding the eBook Population Genetics Lab Answers Kim Foglia
 - The Rise of Digital Reading Population Genetics Lab Answers Kim Foglia
 - Advantages of eBooks Over Traditional Books
2. Identifying Population Genetics Lab Answers Kim Foglia
 - 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 Population Genetics Lab Answers Kim Foglia
 - User-Friendly Interface
4. Exploring eBook Recommendations from Population Genetics Lab Answers Kim Foglia
 - Personalized Recommendations
 - Population Genetics Lab Answers Kim Foglia User Reviews and Ratings
 - Population Genetics Lab Answers Kim Foglia and Bestseller Lists
5. Accessing Population Genetics Lab Answers Kim Foglia Free and Paid eBooks
 - Population Genetics Lab Answers Kim Foglia Public Domain eBooks
 - Population Genetics Lab Answers Kim Foglia eBook Subscription Services
 - Population Genetics Lab Answers Kim Foglia Budget-Friendly Options
6. Navigating Population Genetics Lab Answers Kim Foglia eBook Formats

- ePub, PDF, MOBI, and More
 - Population Genetics Lab Answers Kim Foglia Compatibility with Devices
 - Population Genetics Lab Answers Kim Foglia Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Population Genetics Lab Answers Kim Foglia
 - Highlighting and Note-Taking Population Genetics Lab Answers Kim Foglia
 - Interactive Elements Population Genetics Lab Answers Kim Foglia
 8. Staying Engaged with Population Genetics Lab Answers Kim Foglia
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Population Genetics Lab Answers Kim Foglia
 9. Balancing eBooks and Physical Books Population Genetics Lab Answers Kim Foglia
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Population Genetics Lab Answers Kim Foglia
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Population Genetics Lab Answers Kim Foglia
 - Setting Reading Goals Population Genetics Lab Answers Kim Foglia
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Population Genetics Lab Answers Kim Foglia
 - Fact-Checking eBook Content of Population Genetics Lab Answers Kim Foglia
 - 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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