

## **Big Idea 1: Chapter Questions**

### **Big Idea 1A: Hardy-Weinberg Equilibrium**

1. You have sampled a population in which you know that the percentage of homozygous recessive individuals is 24%. Using this knowledge calculate the following:
  - a. The frequency of the recessive genotype
  - b. The frequency of the recessive allele
  - c. The frequency of the dominant allele
  - d. The frequency of the homozygous dominant genotype
  - e. The frequency of the heterozygous genotype
2. Within a population of butterflies, the color brown is dominant over the color white. Forty percent of this population is white. Calculate the following:
  - a. The percentage of butterflies in the population that are heterozygous
  - b. The frequency of homozygous dominant individuals
  - c. Describe how and why the allelic frequencies in this population can change through a particular environmental change of your choosing.
3. Cystic fibrosis is a recessive condition that affects about 1 in 2,500 babies in the Caucasian population of the United States. Calculate the following
  - a. The frequency of the recessive allele in the population
  - b. The frequency of the dominant allele in the population
  - c. The percentage of carriers in the population
4. An apple grower discovered that most of his trees were infested with black rot fungus. He sprayed the tree with fungicide, which killed 99% of the fungus. Five weeks later, most of the trees were infested again, so he sprayed again, using the same quantity of the same fungicide. This time, only about half the fungus was killed. Explain why the spray did not work as well the second time.

### **Big Idea 1B: Heredity**

5. A man with AB type blood marries a woman with O type blood. They have 6 children. How many would you expect to have A type blood?
6. You perform a cross between heterozygous tall pea plants with yellow pods (TtYy) and short pea plants with green pods (ttYY). The cross produces 2,069 progeny. How many would you expect to be short? How many would you expect to be tall with green pods?
7. In pea plants, tall stems are dominant over short stems, smooth pods are dominant over wrinkled pods, and grey seeds are dominant over white seeds. You perform a cross between trihybrid plants (tall pea plants with smooth grey seeds, GgSsTt). What is the expected frequency of plants recessive for all three traits? What is the expected frequency of tall plants with smooth white seeds?
8. Megan and Michael each have a sibling with sickle-cell disease. Neither Megan, Michael, or any of their parents has the disease, nor have any of them been tested to reveal sickle-cell trait. Based on this incomplete information,

calculate the probability that if Megan and Michael have a child together, the child will have sickle-cell disease.

9. A rooster with gray feathers is mated with a hen of the same phenotype. Among their offspring, 15 chicks are gray, 6 are black, and 8 are white. What is the simplest explanation for the inheritance of these colors in chickens? What offspring would you predict from the mating of a gray rooster and a black hen?

### **Big Idea 1C: Population Genetics**

10. In a species of wildflowers, the frequency of A, the dominant allele for purple flowers, is 0.8, and the frequency of a, the recessive allele for white flowers is 0.2. In one starting population, the frequencies of genotypes do not conform to Hardy-Weinberg equilibrium: 60% of the plants are AA and 40% of the plants are Aa (no plants have white flowers). Assuming that all the conditions for Hardy-Weinberg theorem are met, prove that genotype will reach equilibrium in the next generations.
11. How does Mendel's work, of which Darwin was unaware, provide support for Darwin's theory of evolution by natural selection?
12. Using an imaginary population of organisms, detail how it could evolve into two distinct species. Describe the environment of the population and the factors that led to its separation into two species.
13. Write a paragraph explaining why remote islands have a proportionately greater number of indigenous species than do islands close to the mainland.
14. Discuss the evolutionary advantages of asexual reproduction.
15. Your mother is very impressed by all the talk about evolution that you have been doing. She heard you mention hybrid species and now she wants you to explain why any two species cannot just come together to produce a hybrid offspring. Explain.

### **Big Idea 1D: Origins & Phylogeny**

16. Describe the minimum structural, metabolic, and genetic components of a primitive cell.
17. Using the principles of phylogenetics, write a paragraph providing evidence for LUCA.
18. You have been hired as a curator at the Museum of Natural History in NYC and are guiding a group of students through their Hall of Vertebrate Origins, Dinosaur Wing, and the Wing of Mammals and their Extinct relatives. Provide a basic explanation for how phylogenetic trees are constructed and interpreted.

## Answers

1. a. 0.24  
b. 0.49  
c. 0.51  
d. 0.26  
e. 0.5
2. a. 47%  
b. 0.14  
c. Answers will vary
3. a. 0.02  
b. 0.98  
c. 0.04
4. The 1% of the fungal population which remained after the first spraying had a trait which protected it from the fungicide. This trait was passed genetically to its offspring when they repopulated the apple orchard.
5. 3
6. 1034 or 1035, 1034 or 1035
7. 0.016, 0.14
8. 6%
9. The alleles for black feathers and white feathers in chickens are incompletely dominant. The offspring of a gray and a black chicken would be 50% black and 50% gray.
10. Assuming Hardy-Weinberg conditions are met, random mating would indicate that there is a 39% chance that a heterozygous individual would mate with another heterozygous individual. In this mating 25% of the offspring would be expected to be homozygous recessive. The population will be at equilibrium when 4% of the population is homozygous recessive, 32% is heterozygous, and 64% is homozygous dominant.
11. Mendel's work provided support for Darwin's theory of evolution by natural selection by explaining how "favorable" traits could be passed from parent to offspring and how these traits could be recombined in offspring to increase variation in the population.
12. Answers will vary
13. Small populations on remote islands are more affected by genetic drift than those near shore. In addition, remote islands tend to have less competition from existing species allowing "founder" populations to diverge and fill available niches.
14. Asexual reproduction is advantageous because successful individuals pass all of their genetic information to their offspring, insuring that they are also successful. In addition, asexual reproduction uses less energy and does not require the individual to locate a mate to reproduce.
15. Species cannot produce hybrids due to various isolating mechanisms, such as different habitats, different mating seasons, or different mating behaviors. Those that do attempt to mate might not be able to produce hybrid offspring due to mechanical or gametic isolation, the inability to physically mate and the inability of gametes to fuse and replicate, respectively.

16. To be considered a cell, the object in question must be enclosed in a phospholipid membrane and contain genetic information encoded in nucleic acids. It must be self-replicating and metabolize energy using ATP as a storage molecule.
17. The last universal common ancestor is thought to exist based on properties shared by all living things on Earth. For example, all living things use DNA as their genetic code; all living things use the same genetic code for translating RNA to 20 amino acids to synthesize proteins. Only the L-isomers of these amino acids are used in living things. ATP is used as energy currency in all cells.
18. Phylogenetic trees are constructed based on shared genetic codes or physical attributes of a species. The more closely related two species are the closer their branches appear on the tree. A tree is selected based on maximum parsimony, that is that the simplest explanation is the correct one.