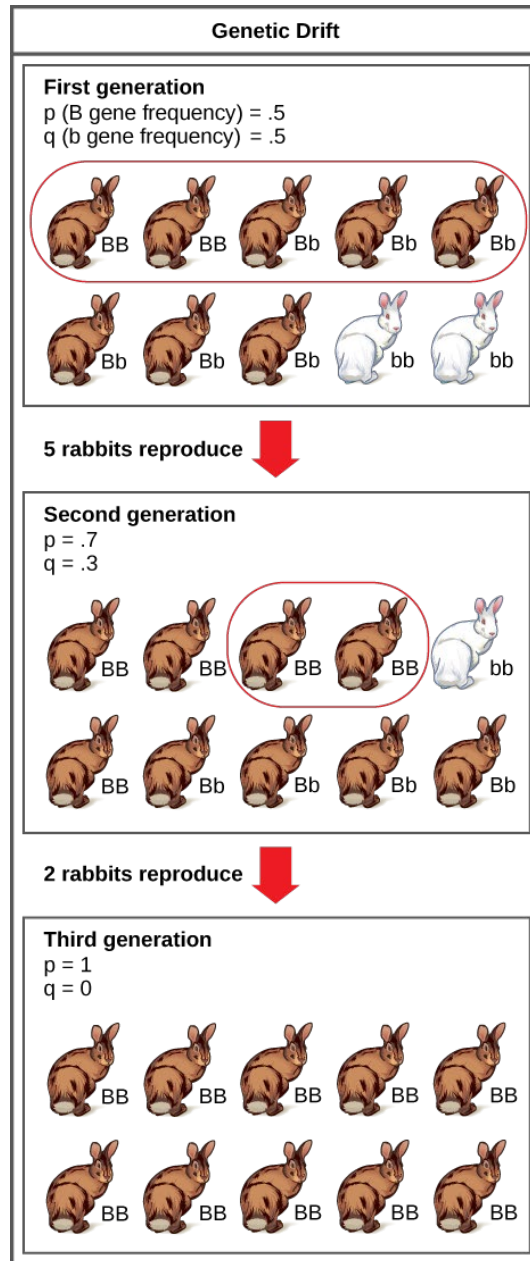**Biology 2e**
Unit 4: Evolutionary Processes
Chapter 19: The Evolution of Populations

Visual Connection Questions

1. In plants, violet flower color (V) is dominant over white (v). If p = .8 and q = 0.2 in a population of 500 plants, how many individuals would you expect to be homozygous dominant (VV), heterozygous (Vv), and homozygous recessive (vv)? How many plants would you expect to have violet flowers, and how many would have white flowers?
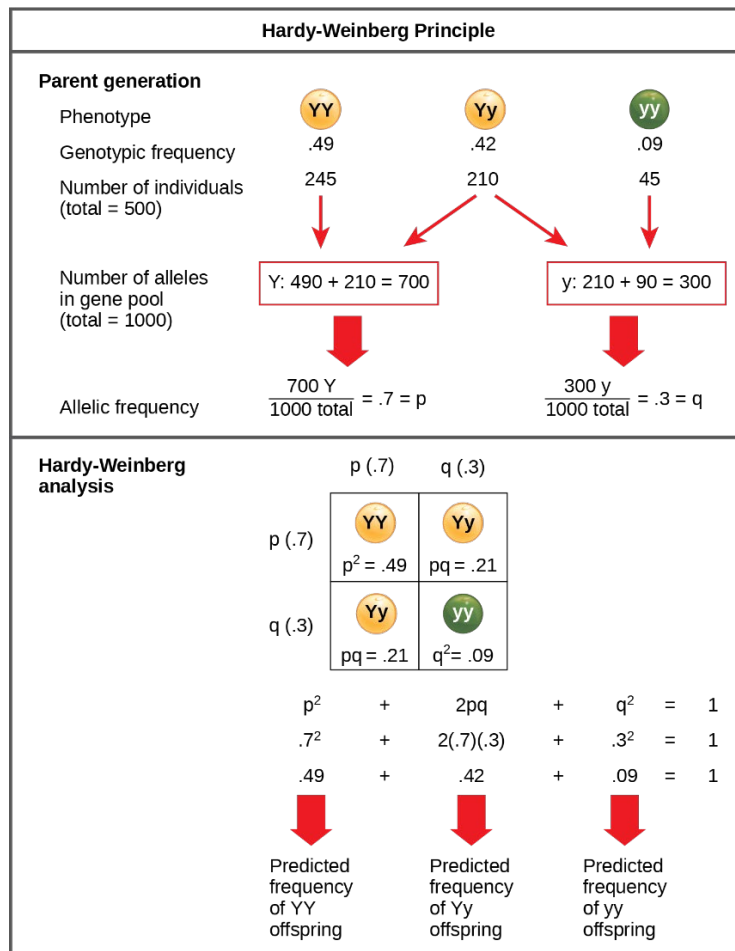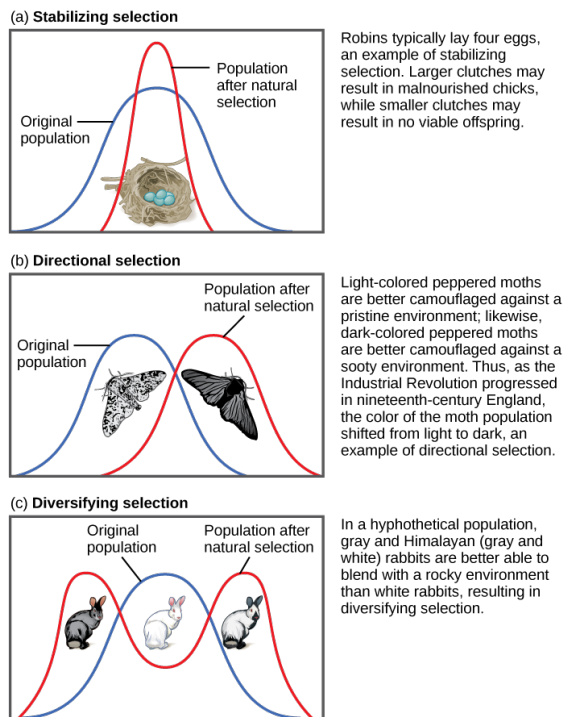

The expected distribution is 320 VV, 160Vv, and 20 vv plants. Plants with VV or Vv genotypes would have violet flowers, and plants with the vv genotype would have white flowers, so a total of 480 plants would be expected to have violet flowers, and 20 plants would have white flowers.

2. Do you think genetic drift would happen more quickly on an island or on the mainland?

Genetic Drift

First generation
p (B gene frequency) = .5
q (b gene frequency) = .5

BB   BB   Bb   Bb   Bb

Bb   Bb   Bb   bb   bb

5 rabbits reproduce

Second generation
p = .7
q = .3

BB   BB   BB   BB   bb

BB   Bb   Bb   Bb   Bb

2 rabbits reproduce

Third generation
p = 1
q = 0

BB   BB   BB   BB   BB

BB   BB   BB   BB   BB

Genetic drift is likely to occur more rapidly on an island where smaller populations are expected to occur.

3. In recent years, factories have become cleaner, and release less soot into the environment. What impact do you think this has had on the distribution of moth color in the population?

(a) Stabilizing selection

Population after natural selection

Original population

Robins typically lay four eggs, an example of stabilizing selection. Larger clutches may result in malnourished chicks, while smaller clutches may result in no viable offspring.

(b) Directional selection

Population after natural selection

Original population

Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark, an example of directional selection.

(c) Diversifying selection

Original population   Population after natural selection

In a hyphothetical population, gray and Himalayan (gray and white) rabbits are better able to blend with a rocky environment than white rabbits, resulting in diversifying selection.

Moths have shifted to a lighter color.

Review Questions
4. What is the difference between micro- and macroevolution?
c. Microevolution describes the evolution of organisms in populations, while macroevolution describes the evolution of species over long periods of time.

5. Population genetics is the study of:
a. how selective forces change the allele frequencies in a population over time

6. Which of the following populations is not in Hardy-Weinberg equilibrium?
d. a population undergoing natural selection

7. One of the original Amish colonies rose from a ship of colonists that came from Europe. The ship's captain, who had polydactyly, a rare dominant trait, was one of the original colonists. Today, we see a much higher frequency of polydactyly in the Amish population. This is an example of:
d. b and c (genetic drift, founder effect)

8. When male lions reach sexual maturity, they leave their group in search of a new pride. This can alter the allele frequencies of the population through which of the following mechanisms?
c. gene flow

9. Which of the following evolutionary forces can introduce new genetic variation into a population?
b. mutation and gene flow

10. What is assortative mating?
a. when individuals mate with those who are similar to themselves

11. When closely related individuals mate with each other, or inbreed, the offspring are often not as fit as the offspring of two unrelated individuals. Why?
c. Inbreeding can bring together rare, deleterious mutations that lead to harmful phenotypes.

12. What is a cline?
d. gradual geographic variation across an ecological gradient

13. Which type of selection results in greater genetic variability in a population?
c. diversifying selection

14. When males and females of a population look or act differently, it is referred to as

_____.
a. sexual dimorphism

15. The good genes hypothesis is a theory that explains what?
d. why individuals of one sex develop impressive ornamental traits

Critical Thinking Questions

16. Solve for the genetic structure of a population with 12 homozygous recessive individuals (yy), 8 homozygous dominant individuals (YY), and 4 heterozygous individuals (Yy).
p = (8*2 + 4)/48 = .42; q = (12*2 + 4)/48 = .58; p2 = .17; 2pq = .48; q2 = .34

17. Explain the Hardy-Weinberg principle of equilibrium theory.
The Hardy-Weinberg principle of equilibrium is used to describe the genetic makeup of a population. The theory states that a population's allele and genotype frequencies are inherently stable: unless some kind of evolutionary force is acting upon the population, generation after generation of the population would carry the same genes, and individuals would, as a whole, look essentially the same.

18. Imagine you are trying to test whether a population of flowers is undergoing evolution. You suspect there is selection pressure on the color of the flower: bees seem to cluster around the red flowers more often than the blue flowers. In a separate experiment, you discover blue

flower color is dominant to red flower color. In a field, you count 600 blue flowers and 200 red flowers. What would you expect the genetic structure of the flowers to be?

Red is recessive so $q^2 = 200/800 = 0.25$; $q = 0.5$; $p = 1-q = 0.5$; $p^2 = 0.25$; $2pq = 0.5$. You would expect 200 homozygous blue flowers, 400 heterozygous blue flowers, and 200 red flowers.

19. Describe a situation in which a population would undergo the bottleneck effect and explain what impact that would have on the population's gene pool.

A hurricane kills a large percentage of a population of sand-dwelling crustaceans—only a few individuals survive. The alleles carried by those surviving individuals would represent the entire population's gene pool. If those surviving individuals are not representative of the original population, the post-hurricane gene pool will differ from the original gene pool.

20. Describe natural selection and give an example of natural selection at work in a population.

The theory of natural selection stems from the observation that some individuals in a population survive longer and have more offspring than others: thus, more of their genes are passed to the next generation. For example, a big, powerful male gorilla is much more likely than a smaller, weaker one to become the population's silverback: the pack's leader who mates far more than the other males of the group. Therefore, the pack leader will father more offspring who share half of his genes and are likely to grow bigger and stronger like their father. Over time, the genes for bigger size will increase in frequency in the population, and the average body size, as a result, grow larger on average.

21. Explain what a cline is and provide examples.

A cline is a type of geographic variation that is seen in populations of a given species that vary gradually across an ecological gradient. For example, warm-blooded animals tend to have larger bodies in the cooler climates closer to the earth's poles, allowing them to better conserve heat. This is considered a latitudinal cline. Flowering plants tend to bloom at different times depending on where they are along the slope of a mountain. This is known as an altitudinal cline.

22. Give an example of a trait that may have evolved as a result of the handicap principle and explain your reasoning.

The peacock's tail is a good example of the handicap principle. The tail, which makes the males more visible to predators and less able to escape, is clearly a disadvantage to the bird's survival. But because it is a disadvantage, only the most fit males should be able to survive with it. Thus, the tail serves as an honest signal of quality to the females of the population; therefore, the male will earn more matings and greater reproductive success.

23. List the ways in which evolution can affect population variation and describe how they influence allele frequencies.

There are several ways evolution can affect population variation: stabilizing selection, directional selection, diversifying selection, frequency-dependent selection, and sexual selection. As these influence the allele frequencies in a population, individuals can either

become more or less related, and the phenotypes displayed can become more similar or more disparate.