Chapter 19: Review Answers

Student Textbook pages 700–701

Answers to Understanding Concepts Questions

1. There are two perspectives possible for answering this question. Students may answer no, stating that microevolution is the gradual change in allele frequencies in a population. As such, a single mutation in one organism does not constitute microevolution. A mutation must be spread through the population to be microevolution. Conversely, students may answer yes, a new mutation alters allele frequencies and would thus be microevolution.

2. $B = 0.70$, $b = 0.30$.

Frequency of heterozygotes $= 2Bb = 0.42$.

3. $q = 0.40$.

$p = 1 - q = 1 - 0.40 = 0.60$

4. Percentage of heterozygotes $= 2pq(100)$.

$q = 0.332$, $p = 1 - q = 0.668$.

$2pq(100) = 44\%$.

Percentage of homozygous dominants $= 100\% - 44\% - 11\% = 45\%$

5. (a) $q = 0.37$ and $p = 0.63$

(b) Predicted number of each genotype: $YY = 176$, $Yy = 152$ and $yy = 72$

6. $q = 0.40$, $p^2 = 0.36$, $q^2 = 0.16$ and $2pq = 0.48$.

7. In small populations, chance events or encounters govern mate choice more frequently than mate preferences. These random encounters drive genetic drift.

8. Genetic drift may allow the expression of rare recessive alleles or traits due to random mating. Gene flow refers to movement of alleles from one population to another due to migration. It is conceivable that gene flow could result in the abundance of a genetic health problem if individuals with the problem migrated to the same place. This is highly unlikely, so the most probable cause would be genetic drift.

9. (a) Population 1: $q = 0.0316$, $p = 0.9684$. $2pq = 0.0612$

Population 2: $q = 0.0548$, $p = 0.9452$. $2pq = 0.104$.

(b) Population 2 is most likely to be from Africa because it has a higher rate of heterozygosity.

(c) Homozygotes for the dominant allele die from malaria. Homozygotes for the recessive allele die from sickle cell anemia. Heterozygotes have some immunity to malaria, and do not get sickle cell anemia, so they have a selective advantage over the homozygotes. Hence, they will be more common. This is called heterozygote advantage.

Answers to Applying Concepts Questions

10. (a) In 1998: 170 allele: 0.800. 172 allele: 0.200.

(b) In 2005: 170 allele: 0.890. 172 allele: 0.110.

(c) The population does not appear to be in genetic equilibrium since the frequencies appear to have changed.

(d) If the 172 allele is recessive, it could remain in the population in heterozygotes, and be hidden. If the heterozygotes are relatively rare, the allele will not be commonly expressed because that would require two heterozygotes to mate, which would rarely happen. If the allele is hidden, it cannot be selected for or against.

(e) Declining populations of the collard pika would result in genetic drift, which may be part of a population bottleneck. Either way, the result would be loss of genetic diversity, and a reduced ability to cope with environmental change.

11. (a) $q = 0.447$, $p = 0.553$.

(b) The percentage of heterozygotes would be $2pq(100) = 49.9\%$.

(c) In the published data, $q = 0.800$, which is much higher.

(d) Some possible answers include increasing the sample size and removing or tagging observed squirrels to prevent counting them twice.

(e) Differences are probably due to a different habitat with different selection pressures. Other possibilities could include genetic drift in one of the populations if it is small, and the founder effect if a population is established by fewer than 100 individuals. Counting errors are another possibility.

12. (a) $M = 0.560$; $N = 0.440$.

(b) $MM = 0.314$; $MN = 0.493$; $NN = 0.194$

(c) In the new colony, as time passes, genetic drift should reduce genetic diversity. Eventually, the population would become all *MM* or all *NN*.

13. (a) $q = 0.0500$ or 5.00%

(b) Carriers are heterozygotes, so students need to find $2pq$.

$p = 1 - 0.0500 = 0.950$.

$2pq = 9.50\%$.

(c) Inbreeding often increases the frequency of heterozygotes mating and so would tend to increase the frequency of recessive alleles.

14. $q = 0.200$ or 20%.

15. Natural selection is a process that results in a change in allele frequencies due to differential reproduction among the members of a population. Genetic drift is a change in allele frequencies due to random chance mating events in a population. Similarities include the following: both occur in populations, both describe changes in allele frequencies, and both result in changes in genotype and phenotype. Differences include the following: natural selection increases adaptiveness, genetic drift doesn't; population size in natural selection is not relevant, but in genetic drift the population must be small; natural selection is not chance driven, but genetic drift is.

16.

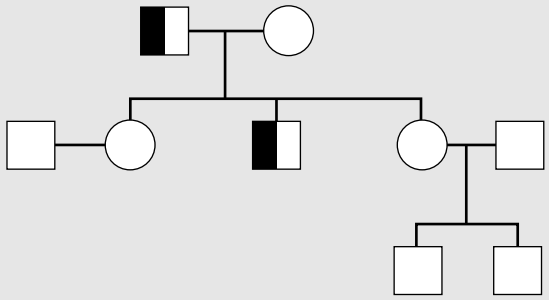

Figure 1

The pedigree must obey the rules of drawing pedigrees. Males are depicted as squares, females as circles. Carriers are vertically half black. Afflicted individuals are all black. Mates are connected with a horizontal line. Offspring of a mating pair are indicated with a short vertical line connected to a horizontal line that connects to all the biological offspring of the mating pair. This pedigree should show heterozygotes in the first generation (generation I) and no heterozygotes in the last generation. See Figure 1 for an example.

Answers to Making Connections Questions

17. Genetic analysis would provide data regarding the bears that were successfully reproducing in specific regions, allowing scientists to identify the best habitat for polar bears. Such habitats could be identified and recolonized with bears bred in captivity. Sperm and eggs from successful bears could be extracted and used to impregnate captive bears, or the successful males could be exposed to more females than normally through transportation programs. The decline in population suggests that the bears might be entering a population bottleneck. Alternatively, they could be undergoing some form of natural selection. Other processes at work might be extinction or extirpation as climate changes. The population is too large for genetic drift to have much effect on the bear population.

18. (a) $q_{ch} = 0.00250$; $q_{tk} = 0.0196$; $q_{j} = 0.00290$.

(b) The toxin producing fungi would be most abundant in Turkey because there would be more advantage for heterozygous individuals. Thus, the frequency of heterozygotes would be highest there, which means the allele frequency would also be the highest.

19. If the afflicted people reproduce, the allele frequency will increase, which would increase the frequency of the affliction.

20. Students should define evolution in a biologically acceptable way. Their evaluation of Tshetverikov's statement should be based on their definition of evolution. One example would be that evolution is any change in allele frequency in a population. A mutation changes allele frequency, so any mutation is evolution. Tshetverikov's statement is incorrect. Another example would be that evolution is the result of survival of the fittest. The mutation would have to be acted on by the environment for evolution to occur, so Tshetverikov's statement is correct. Students' answers should be evaluated based on their reasoning.