Unit 8: Review Answers

Student Textbook pages 744–747

Answers to Understanding Concepts Questions

1. Phenotype frequency = 81% + 18.0 % = 99.0%
2. q^2 = 16.0/100 or 0.160
   q = 0.400
   $p + q = 1.00$
   $p = 1.00 - q$
   $p = 1.00 - 0.400$
   $p = 0.600$
   The frequency of the dominant allele is 0.600.
3. No. A population is at genetic equilibrium if there is no change in allele frequencies over time. When a population is evolving, a change in allele frequencies is occurring. Thus, a population at genetic equilibrium is not evolving.
4. Intraspecific competition refers to competition for limited resources among members of the same species. As a result of this competition, often only the best-adapted individuals survive to reproduce, reducing the growth rate. In many species, if offspring do not disperse away from their parent or parents, they will be in competition for limited resources. To avoid such competition, insect larvae often look completely different from adults and undergo a complete metamorphosis during their maturation. For instance, to eliminate competition for food between adult and young, the adult butterfly extracts nectar from flowers while immature caterpillars eat leaves.
5. q represents the frequency of the recessive allele in the population. q^2 represents the frequency of the homozygous recessive genotype in the population.
6. Because their gene pool is smaller, small populations are more likely to lose alleles if a chance event causes a reduction in the size of the population, thereby decreasing their genetic diversity. In general, large populations do not experience genetic drift, because chance events are unlikely to affect overall allele frequencies. For example, in a large population of gophers, predators are unlikely to kill all of the gophers with a particular allele, as they may in a small population.
7. Yes. Microevolution is the gradual change in allele frequencies in a population over time. Students may cite the text example of microevolution, i.e. the development of DDT-resistance in *Anopheles* mosquito populations over time, as a similar example.
8. A mutation is a change that occurs in the DNA of an individual. It is the environment that makes certain mutations relatively beneficial, neutral, or detrimental. Natural selection occurs when a mutation produces a phenotype that gives one individual a survival advantage over another.
9. Sexual selection. The peahen preferentially mates with peacocks that have long tails.
10. **(a)** interspecific competition
    (b) The yield increases when the weed population is controlled because interspecific competition for limited resources is decreased. With fewer weeds present, the crop has less competition for nutrients, water, space, and light.
11. **(a)** $D_p = \frac{N}{A}$
    $N = (1 \text{ lizard}/3.8 \text{ km}^2)(29 \text{ km}^2)(47)$
    $N = 359$ lizards
    (b) It was assumed that the distribution of this population was uniform throughout its habitat.
12. **(a)** uniform distribution
    (b) clumped distribution
    (c) uniform distribution
    (d) random distribution
    (e) clumped distribution
13. **(a)** mutualism
    (b) commensalism
    (c) parasitism
    (d) protective coloration
    (e) parasitism
    (f) commensalism with mosquito; parasitism with mammalian host
14. **(a)** Müllerian mimicry
    (b) Batesian mimicry

15. You would expect to find a uniform distribution pattern within a population where this process is occurring. Because the sponges exhibit territorial behaviour, it is likely that they will be evenly distributed based on the range of the inhibitory chemical they secrete.

16. Larger animals require a larger territory per individual to graze or hunt in to support their energy requirements, thus they are more affected by habitat loss.

17. Common examples of succession include organisms repopulating an area after a volcanic eruption or the passage of a glacier (primary succession), and after a forest fire or flood (secondary succession). Biotic factors that change during succession include types of species in the community, degree of biodiversity, and intraspecific and interspecific competition for these resources. Abiotic factors that change during succession include levels of nutrients, organic matter, moisture in the soil, soil pH, physical structure of the soil (in primary succession), and availability of light and living space.

18. The age pyramid would have a rectangular shape.

Answers to Applying Concepts Questions

19. $p = 0.70$

$p + q = 1.00$

$q = 1.00 - p$

$q = 1.00 - 0.70$

$q = 0.30$

$2pq = 2(0.70)(0.30)$

$2pq = 0.42$ or 42 %

The percentage of the next generation expected to be heterozygous for this trait is 42%.

20. **(a)** $q^2 = 1.00/10\ 000$

$q^2 = 0.000100$

$q = 0.0100$

The frequency of the recessive allele is 0.0100.

(b) $q^2 = 0.000100$

$q = 0.0100$

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.0100$

$p = 0.990$

The frequency of the dominant allele is 0.990.

(c) $2pq = 2(0.990)(0.0100)$

$2pq = 0.0198$

The frequency of heterozygotes in the population is 0.0198.

21. Half of population with recessive allele (f) = 50%

$q^2 = 50.0/100$

$q^2 = 0.500$

$q = 0.707$

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.707$

$p = 0.293$

The frequency of the dominant freckle allele (F) that would lead to these results is 0.293.

22. **(a)** $q^2 = 16.0/100.00$

$q^2 = 0.160$

$q = 0.400$

$p + q = 1.00$

$p = 1.00 - 0.400$

$p = 0.600$

The frequency of the dominant allele is 0.600. The frequency of the recessive allele is 0.400.

(b) $2pq = 2(0.600)(0.400) = 0.480$

48.0% of the population is expected to be heterozygous for this trait.

23. **(a)** $q^2 = 1.00/2500.00$

$q^2 = 0.000400$

$q = 0.0200$

The frequency if the recessive allele is 0.0200.

(b) Carriers have a heterozygous genotype.

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.0200$

$p = 0.980$

$2pq = 2(0.980)(0.0200)$

$2pq = 0.0392$

3.92 % of the population are carriers.

24. **(a)** In a class of 36, 12 were non-rollers and 24 were rollers.

$q^2 = 12.00/36.00$

$q^2 = 0.3333$

$q = 0.5773$

The frequency of the recessive allele is 0.5773.

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.5773$

$p = 0.4227$

The frequency of the dominant allele is 0.4227.

(b) $2pq = 2(0.4227)(0.5773) = 0.4880$, or 48.80 %

$(0.4880)(36) = 17.57$

You would expect 18 of the 24 tongue rollers to be heterozygous.

25. (a) For year 1:

$q = 24.00/176.00$

$q^2 = 0.1364$

$q = 0.3693$

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.3693$

$p = 0.6307$

The frequency of the recessive allele is 0.3693. The frequency of the dominant allele is 0.6307.

$q^2 = 0.1364$

$p^2 = (0.6307)^2$

$p^2 = 0.3978$

$2pq = 2(0.6307)(0.1364) = 0.4658$

The frequency of the homozygous dominant genotype is 0.3978.

The frequency of the heterozygous genotype is 0.4658.

The frequency of the homozygous recessive genotype is 0.1364.

For year 5:

$q = 7.00/56.00$

$q^2 = 0.125$

$q = 0.3536$

$p + q = 1.00$

$p = 1.00 - q$

$p = 1.00 - 0.3536$

$p = 0.6464$

The frequency of the recessive allele is 0.3536. The frequency of the dominant allele is 0.6464.

$q^2 = 0.125$

$p^2 = (0.6464)^2$

$p^2 = 0.4178$

$2pq = 2(0.6464)(0.125) = 0.4571$

The frequency of the homozygous dominant genotype is 0.4178.

The frequency of the heterozygous genotype is 0.4571.

The frequency of the homozygous recessive genotype is 0.125.

(b) In the observed population, more than one of the Hardy-Weinberg conditions is not being met. The population is not large enough to ensure that chance events do not alter allele frequencies, and natural selection is possibly occurring. Therefore, this population is evolving. The frequency of the dominant allele has increased over time, and the frequency of the recessive allele has decreased over time, giving evidence to this.

(c) Students may have included the following conditions: disease or parasites that affect squirrels of a specific coat colour preferentially, increased susceptibility to skin cancer in the light-coloured squirrels, higher visibility of light-coloured squirrels to predators, genetic disease linked to one particular genotype, and female preference for mating with male squirrels of a specific coat colour.

(d) If light-coloured fur were dominant to black, natural selection processes would be selecting against the dominant allele. The frequency of the dominant allele would have decreased and the frequency of the recessive allele would have increased.

26. (a) For 1970—1980:

$$cgr = \frac{\Delta N}{N}$$

$$= \frac{(4440 \times 10^6 \text{ people}) - (3699 \times 10^6 \text{ people})}{(3699 \times 10^6 \text{ people})}$$

$$= 0.200$$

For 1980—1990:

$$cgr = \frac{\Delta N}{N}$$

$$= \frac{(5280 \times 10^6 \text{ people}) - (4440 \times 10^6 \text{ people})}{(4440 \times 10^6 \text{ people})}$$

$$= 0.189$$

For 1990—2000:

$$cgr = \frac{\Delta N}{N}$$

$$= \frac{(6068 \times 10^6 \text{ people}) - (5280 \times 10^6 \text{ people})}{(5280 \times 10^6 \text{ people})}$$

$$= 0.149$$

(b) The *cgr* of the human population was decreasing during this time period.

(c) People may be living longer on average so it may take a while for the decrease in *cgr* to cause a decrease in population. Also, because the human population is so large, the number of children being born is still very high despite the decreasing growth rate. As such, it will take time before population growth slows.

(d) Answers may include any of the following factors: increased mortality due to increased incidence of disease, depleted global resources such as food and water due to overpopulation pressures, war, increased incidence of severe weather due to global warming resulting loss of life and famine, and a cultural trend toward smaller families.

27. (a) $gr = \frac{\Delta N}{\Delta t}$

$gr = \frac{[b + i] - [d + e]}{\Delta t}$

$gr = \frac{52 \text{ shrikes} - 116 \text{ shrikes}}{5 \text{ years}}$

$gr = -12.8$ shrikes/year ≈ –13 shrikes/year

(b) Final number of individuals in population = $\Delta N + N = (52 - 116) + 232 = 168$ shrikes

28. $D_p = \frac{N}{A}$

$N = (9 \text{ plants/m}^2)(100 \text{ m})(100 \text{ m})$

$N = 90\ 000$ plants

Four limiting factors that could cause decreased production in the plants if the density increased are lack of light due to shading by crowded plants, spread of disease or pests in a crowded population, over-competition for resources such as water and minerals, and poor root development due to overcrowding.

30. (a) $cgr = \frac{\Delta N}{N}$

$\Delta N = (0.30)(812 \text{ gophers})$

$\Delta N = 243.6$ gophers ≈ 244 gophers

Final number of individuals in population
$= \Delta N + N$

$= 244$ gophers $+ 812$ gophers

$= 1056$ gophers

(b) $cgr = \frac{\Delta N}{N}$

$\Delta N = (0.30)(1056 \text{ gophers})$

$\Delta N = 316.8$ gophers ≈ 317 gophers

Final number of individuals in population
$= \Delta N + N$

$= 317$ gophers $+ 1056$ gophers

$= 1373$ gophers

(c) Students may include any of the following factors: a scarcity of resources such as shelter, food and water; increased disease and parasites; increased predation; harsh weather, drought, floods, and forest fire; human activity such as destruction of habitat, introduction of toxins into the environment, and construction of hazards.

(d) Density-dependent factors include a scarcity of resources such as shelter, food, and water; increased disease and parasites; and increased predation. Density-independent factors include harsh weather, drought, floods, and forest fire; human activity such as destruction of habitat; introduction of toxins into the environment; and construction of hazards.

30. (a) Students' graphs will show an increasing trend between years 1 and 6 and then a sudden drop between years 6 and 7.

(b) For year 1:

$D_p = \frac{N}{A}$

$N = (17.5 \text{ snails/m}^2)(5 \text{ m}^2)$

$N = 87.5$ snails

For year 3:

$D_p = \frac{N}{A}$

$N = (108.9 \text{ snails/m}^2)(5 \text{ m}^2)$

$N = 544.5$ snails

For year 1 to year 3:

$cgr = \frac{\Delta N}{N}$

$= \frac{544.5 \text{ snails} - 87.5 \text{ snails}}{87.5 \text{ snails}}$

$= 5.22$

(c) $D_p = \frac{N}{A}$

$N = (143.8 \text{ snails/m}^2)(5 \text{ m}^2)$

$N = 719$ snails

(d) Factors may include any of the following: a particularly harsh winter; scarcity of resources due to over population; decreased population of plants that snails rely upon as food; drought; introduction of a new predator to the area; an outbreak of disease or a parasite infestation; destruction of the snails' habitat to put in a new road; contamination of their environment by a new chemical plant nearby; a forest fire; flooding; and increased competition for resources from another species.

Answers to Making Connections Questions

31. (a) Both alleles begin with an identical frequency of 0.5. Over time, the long wing allele (*L*) approaches (but does not reach) 1.0. The short wing allele (*l*) approaches but does not reach 0.0.

(b) In this experiment, natural selection is working against the short wing phenotypes, as this appears to hinder their ability to mate. As a result, the allele frequencies in the population are changing, with the frequency of the recessive short wing allele (*l*) approaching zero.

(c) Most students will realize that, because the long wing allele is dominant, some long wing flies will be heterozygous. Thus, the short wing allele (*l*) will probably never become zero.

32. (a) As succession moves through its stages from early to late, the following changes are depicted on the graph: Net productivity initially increases quickly and then levels off near the middle of succession, reaching its highest level of net productivity. It remains steady until the late stages of the process. Biomass increases slowly at the beginning and then increases more rapidly toward the middle of succession. It continues to increase steadily until the end of the graph. Biodiversity increases steadily at the beginning of succession, peaks in the middle and then dips near the late stages of succession.

(b) Net productivity increases rapidly as highly productive early colonizers with *r*-selected life strategies increase in great number. As competition increases and resources become more limited, net productivity levels off. Biomass increases slowly in the early stages as grasses, annual herbs, and other early colonizers colonize the site. It increases more rapidly toward the middle of succession, as trees and bushes become established, and continues to increase steadily as the community grows. Biodiversity increases steadily at the beginning of succession and peaks in the middle as the early species now provide habitat, food, and other resources for later species. Finally, it dips during the late stages of succession, as interspecific competition reduces biodiversity slightly.

33. These species do not produce many young and hence cannot replace their population rapidly. Also, they tend to be highly specialized for survival and reproduction in their particular habitats. Therefore, small changes to their habitat may have large impacts on their survival.

34. Students may identify some of the following values of high biodiversity: increased stability and resiliency of ecosystem functioning; aesthetic value; source of new drugs, new foods, and other beneficial products; source of economic income if managed properly (e.g., sale of exotic species or ecotourism). Countries can promote ecotourism, sale of exotic foods, or sale of exotic species for pets (e.g., aquarium fish). However, care should be taken to conduct these activities in an environmentally sustainable way.

35. (a) Nigeria's population will probably grow fastest over time, because most of its population is in or entering their reproductive years. The populations of Finland and Sweden are relatively stable.

(b) A decrease in the birth rate in Finland would probably cause its population to decline slightly over time, but a decrease in the birth rate in Greece would likely have a greater effect, because its population already appears to be in decline. A decrease in the birth rate in Nigeria could have a dramatic effect in slowing the rate of population growth, although the population would continue to grow because of the large number of young people.

(c) Students may suggest that, as the work force of Finland and especially Greece reaches retirement age, there will be not enough younger people to fill their places, which could hurt the economy of both countries. Students may also suggest that in Nigeria, insufficient employment opportunities could result in more widespread poverty. Accept any other reasonable answer.

(d) Students should predict that as more people contract HIV and die of AIDS, the death rate in Nigeria would increase, which would slow the population's growth rate or even put it into decline.