

Answers to Critical Thinking and Review End of Chapter Questions:

1. Charles Darwin once said, "It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change." How does this statement relate to the definition of evolution?

Ans: Natural selection is the mechanism of evolution. Organisms that are the most fit are the most likely to survive to the age of reproduction and pass those advantageous traits on to their offspring. Fittest does not necessarily mean the strongest or the most intelligent but instead the traits that give the best advantage for survival in a particular environment.

2. During mating season, male giraffes slam their necks together in fighting bouts to determine which male is stronger and can mate with females. Explain how long necks may have evolved under this scenario, using Darwin's theory of evolution by natural selection.

Ans: Darwin recognized that, from one generation to the next, inherited traits favorable to survival in a given environment would be preserved, whereas unfavorable ones would be eliminated. The result would be adaptation, evolutionary modification that improves the chances of survival and reproductive success of the population in its environment. If male giraffes with long necks gained more mates they would leave more offspring, thereby, increasing the number of long necked giraffes in the population.

3. How do the three domains relate to the six kingdoms of classification?

Ans: Prokaryotes are organisms that lack membrane bound organelles, including a nucleus. Prokaryotes are classified into two domains, Archaea and Bacteria. Archaea are normally found in oxygen-deficient environments and are often adapted to harsh environments. The remaining prokaryotes are classified as Bacteria. Eukaryotes are organisms that have membrane bound organelles and a nucleus surrounded by a nuclear membrane. Eukaryotes are classified in the domain Eukarya and include the kingdoms Protista, Fungi, Plantae, and Animalia.

4. How are the following factors related in determining the growth rate: birth rate, death rate, immigration, and emigration?

Ans: Birth rates and immigration results in an increase in the growth rate. Death rate and emigration cause a reduction in the growth rate. If the Birth rate and immigration is equal to the death rate and emigration there will be a net zero change in the growth rate. If the Birth rate and immigration is greater than the death rate and emigration the growth rate will be positive. If the birth rate and immigration is less than the death rate and emigration the growth rate will be negative.

5. Draw a graph to represent the long-term growth of a population of bacteria cultured in a test tube containing a nutrient medium that is replenished. Now draw a graph to represent the growth in a test tube when the nutrient medium is not replenished. Explain the difference.

Ans: Bacteria that are grown in a test tube in which the nutrient medium is replenished will enter a stable or carrying capacity stage of a population growth cycle. Since the medium is being replaced there will be available nutrients for the bacteria to consume and toxic by-products will be removed when the nutrient media is replenished. Bacteria growing in a test tube in which the nutrient medium is not replaced will enter into a death phase as the supply of nutrients is depleted and toxic wastes accumulate.

6. Which of the following are density-dependent factors, and why: a hurricane, disease, and competition?

Ans: Density dependent factors are any environmental factor whose effect on a population changes as its population density changes.

- I. Hurricane – is not a density dependent factor since the effect of a hurricane on a population does not change based on the population size. A hurricane is a density-independent factor.
- II. Disease – is a density dependent factor since the occurrence of a disease within a population normally increases as the population grows due to stress and the members of a population encountering each other more frequently and the chance of transmitting an infectious disease more likely.
- III. Competition- is a density dependent factor. As population size increases competition for resources also increase.

7. How do survivorship curves relate to r selection and K selection in animals.

Ans: Populations described as r selection have traits that contribute to a high population growth rate. Small body size, early maturity, short life spans, large broods, and little or no parental care is typical of r strategies. K selection maximizes the chance of surviving in an environment where the number of individuals is near the carrying capacity. K selected species do not produce large numbers of offsprings, they have late reproduction, long life spans, low reproductive rates, and invest a lot of resources into parental care.

8. What is the difference between a source habitat and a sink habitat in terms of birth rates and death rates?

Ans: A source habitat is any habitat that increases the likelihood of survival and reproductive success for an individual living there. A sink habitat is a lower quality habitat where the local birth rate is less than the local death rate. Without immigration from other areas a sink population will decline and become extinct.

9. What is an organism's ecological niche, and why is a realized niche usually narrower, or more restricted, than a fundamental niche?

Ans: The potential, idealized ecological niche of an organism is its fundamental niche. Various factors such as competition with other species usually exclude it from part of its fundamental niche. The lifestyle an organism actually pursues, and the resources it actually uses, make up its

realized niche. Put differently, an organism is potentially capable of using much more of its environment's resources or of living in a wider assortment of habitats than it actually does.

10. What portion of the human's fundamental niche are we occupying today? Do you think our realized niche has changed over the past 200 years? Why or why not?

Ans: Answers will vary

11. What is the most likely limiting resource for plants and animals in deserts? How are limiting resources related to competition? Explain your answer.

Ans: Most limiting resources that scientists have investigated are simple variables such as the mineral content of soil, extremes of temperature, and amount of precipitation. Such investigations have disclosed that any resource that exceeds an organism's tolerance or is present in quantities smaller than the minimum required limits the occurrence of that organism in an ecosystem. In a desert the limiting resource for most plants and animals is available water. Many plants and animals that live in the desert have developed adaptations to conserve water.

12. What type of symbiotic relationship—mutualism, commensalism, or predation—do you think exists between the pygmy seahorse and the gorgonian coral pictured in Figure 5.22? Explain your answer.

Ans: The pygmy seahorse and the gorgonian coral live in a commensalism. A commensalism is a type of symbiosis in which one organism benefits and the other one is neither harmed nor helped.

13. How is predation related to the concept of energy flow through ecosystems (covered in Chapter 3)?

Ans: Predation transfers energy from a lower trophic level to a higher trophic level. Energy is transferred when animals eat other animals (for example, herbivore-carnivore interactions) and when animals eat plants (producer-herbivore interactions). The transfer of symbiotic relationships will vary depending on the nature of the relationship. In mutualism, energy may flow back and forth between the symbionts; in commensalism, no energy flow may take place, and in a parasitism energy is only flowing in one direction.

14. Some biologists think that protecting keystone species would help preserve biological diversity in an ecosystem. Explain.

Ans: Keystone species are vital in determining the nature and structure of the entire ecosystem—that is, its species composition and its ecosystem functioning. For this reason, identifying and protecting keystone species are crucial goals of conservation biologists because if a keystone species disappears from an ecosystem, many other organisms in that ecosystem may become more common, rare, or even disappear.

15. Why does species richness vary from one community to another?

Ans: Species richness is the number of species in a community. Species richness is determined by several factors, including abundance of potential ecological niches, closeness to the margins of adjacent communities, geographic isolation, dominance of one species over others, habitat stress, and geologic history.

16. What kinds of ecosystem services does a forest provide?

Ans: Services provided by forests include: purify air and water; produce and maintain soil; absorb carbon dioxide; provide wildlife habitat; and provide humans with wood and recreation.

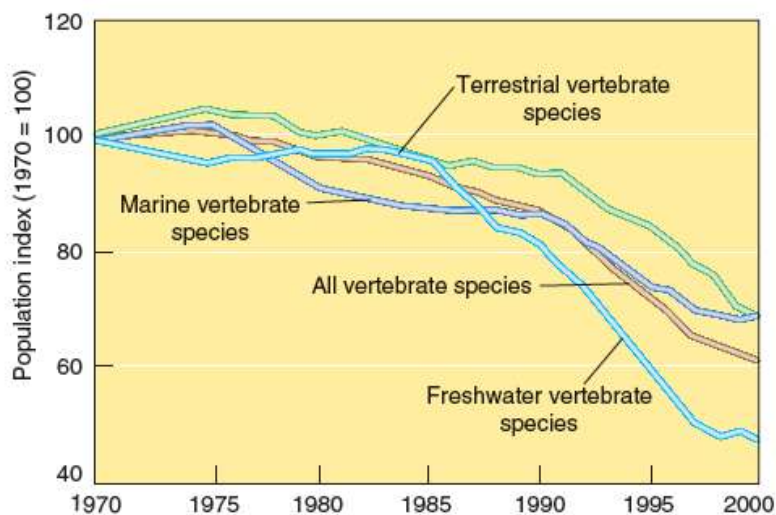
17. Describe an example of secondary succession. Begin your description with the specific disturbance that preceded it.

Ans: Answers will vary. Disturbance may be a fire or abandoned farmland. Secondary succession on abandoned farmland in the southeastern United States proceeds in this sequence: crabgrass → horseweed → broomsedge and other weeds → pine trees → hardwood trees.

18. Draw a diagram of three concentric circles and label the circles to show the relationships among species, ecosystems, and communities. If you were adding symbiosis, predation, and competition to the simple system you have depicted, in which circle(s) would you place them?

Ans: Answers will vary

19. Study the graph and determine the overall trend in biological diversity of vertebrate species from 1970 to 2000. Sociobiologist E. O. Wilson says that the five forces responsible for this trend are habitat loss, invasive species, pollution, population growth, and overconsumption. Pick any two of these forces and relate them to energy use and/or climate change.



(Adapted from Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Biodiversity Synthesis*. Washington, D.C.: World Resources Institute [2005])

Ans: The overall trend is a decrease in the number of species. Part two answers will vary.

Answers to Review Questions

Evolution: How Populations Change Over Time

1. How do biologists define *evolution*?

Biologists define evolution as the cumulative genetic changes that occur over time in a population of organisms. Charles Darwin, a 19th century naturalist, proposed that the evolution of species resulted from the process of natural selection; a theory widely supported by the biologists today.

2. What are Darwin's four premises of evolution by natural selection?

Evolution by natural selection consists of four observations about the natural world: (1) high reproductive capacity (i.e., each species produces more offspring than will survive to maturity); (2) inheritable variation (i.e., the individuals in a population exhibit inheritable variation in their traits); (3) limits on population growth (i.e., organisms compete with one another for the resources needed to survive); and (4) differential reproductive success (i.e., those individuals with the most favorable combination of traits are most likely to survive and reproduce, passing their genetic characters on to the next generation).

3. What are the three domains of life? To which domain do you belong?

The three domains of life are Archaea, Bacteria, and Eukarya. Humans belong to the domain Eukarya.

Principles of Population Ecology

1. What is the effect of each of the following on population size: birth rate, death rate, immigration, and emigration?

Populations change over time. On a global scale, this change is due to the rate at which individuals produce offspring (the birth rate, b) and the rate at which organisms die (the death rate, d). Therefore, the growth rate of the global population (r) is equal to the birth rate minus the death rate ($r = b - d$). In local populations, however, the movement of individuals from one region to another [immigration (i) and emigration (e)] factor into estimates of population size. Thus, the growth rate of a local population equals the (birth rate minus the death rate) plus (immigration minus emigration) or $r = (b - d) + (i - e)$.

2. How do intrinsic rate of increase and carrying capacity produce the J-shaped and S-shaped population growth curves?

The exponential growth of a population that occurs under ideal conditions (i.e., unlimited resources) is referred to as the intrinsic rate of increase. If you plot the population number versus time of a population exhibiting a large intrinsic rate of increase, the graph will produce a J shape curve. If, however, the population size reaches its carrying capacity (i.e., the limit of the environment's ability to support a population), a characteristic S-shaped curve will result when the same variables are plotted.

3. What are two examples of density-dependent factors that affect population growth? What are two examples of density-independent factors?

Density-dependent factors are environmental factors whose effects on a population change as population density changes. Examples of density-dependent factors that affect population growth include predation, disease, and competition. Density-independent factors are environmental factors that affect the size of a population but are not influenced by changes in population density. Examples of density-independent factors that affect population growth include random weather events, such as blizzards, hurricanes and fires.

4. What are the three main survivorship curves?

Survivorship is the probability that a given individual in a population will survive to a particular age. The three main survivorship curves are: (1) type I survivorship, in which death is greatest in old age; (2) type II survivorship, in which death is spread evenly across all age groups; and (3) type III survivorship, in which death is greatest among the young. Type I survivorship is typically exhibited by humans and elephants, while type III survivorship is typically exhibited by many fish species. Type II survivorship, however, is relatively rare in nature (i.e., only a few species of lizards are known to exhibit this type of survivorship).

5. How does a metapopulation differ from a local population?

A metapopulation is a set of local populations among which individuals are distributed in distinct habitat patches across a landscape. The distribution of local populations across the landscape occurs because of local differences in elevation, temperature, amount of precipitation, soil moisture, and availability of soil minerals.

Biological Communities

1. What is an ecological niche?

An ecological niche is the totality of an organism's adaptations, its use of resources, and the lifestyle to which it is fitted. It is the organism's role within the structure and function of an ecosystem. More specifically, the potential, idealized ecological niche of an organism is its fundamental niche; while the lifestyle an organism actually pursues and the resources it actually uses make up its realized niche.

2. What is the principle of competitive exclusion? Of resource partitioning?

The principle of competitive exclusion holds that no two species can indefinitely occupy the same niche in the same community because one species will eventually exclude the other as a result of competition for limited resources. However, coexistence can occur if the overlap in the two species' niches is reduced. When resources are used differently by various species, competition is reduced. This is referred to as resource partitioning.

3. What is symbiosis? What are the three kinds of symbiosis?

Symbiosis is any intimate relationship or association between members of two or more species. The three kinds of symbiosis include mutualism (both partners benefit), commensalism (one organism benefits and the other is neither harmed nor helped), and parasitism (one organism benefits while the other is adversely affected).

4. Describe how evolution has affected predator-prey relationships.

Predation, the consumption of one species by another, has resulted in the coevolution of both predator and prey strategies. Predators have evolved greater efficiencies in ways to catch prey, while prey has evolved better ways to escape from predators. Adaptations related to predator-prey interactions include predator strategies such as pursuit and ambush, and prey strategies such as plant defenses (spines, thorns, thick wax, etc.) and animal defenses (warning coloration, cryptic coloration, etc.).

5. What is a keystone species? Why do we consider the wolf a keystone species?

A keystone species is a species, often a predator, which exerts a profound influence on a community in excess of that expected by its relative abundance. The gray wolf is considered a keystone species because, in their absence, an entire ecosystem can significantly diminish in terms of biological diversity.

Species Richness in a Community

1. What are two determinants of species richness? Give an example of each.

Species richness is the number of species in a community. Determinants of species richness include: the abundance of potential ecological niches, closeness to the margins of adjacent communities, geographic isolation, dominance of one species over others, habitat stress, and geologic history. When the abundance of potential ecological niches is sizable (for example, in a complex community such as a tropical rain forest), species richness is usually greater. Likewise, species richness is usually greater at the margins of adjacent communities rather than in their centers, due to the variety of ecological niches available (for example, in ecotones). Species richness is inversely related to the geographic isolation of a community (as in isolated island communities), and reduced when any one species occupies a position of dominance within a community (i.e., species competition). Additionally, species richness tends to be inversely related to the

environmental stress of a habitat (i.e., low species richness in a polluted stream), and greatly affected by the geological history of an area (i.e., large species richness in old, stable ecological communities such as tropical rain forests).

2. What are ecosystem services? Describe some ecosystem services a forest provides.

Ecosystem services are important environmental benefits that ecosystems provide to people. Ecosystem services provided by forests include: purification of air and water; production and maintenance of soil; absorption of carbon dioxide; wildlife habitats; wood production; and recreational areas for humans.

Community Development

1. What is ecological succession? How do primary and secondary succession differ?

The process of community development over time, which involves species in one stage being replaced by different species, is called ecological succession. When ecological succession begins in an environment that has not been inhabited before (i.e., on bare rock surfaces or recently formed volcanic lava), it is referred to as primary succession. Secondary succession is the change in species composition that takes place after some disturbance destroys the existing vegetation. In secondary succession soil is already present.