Chapter 01: An Overview of Evolutionary Biology

MULTIPLE CHOICE

1. Charles Darwin's theory of evolution resulted in a _____ because it changed the way we understand how all living things came to be and how they function.
   a. paradigm shift
   b. null hypothesis
   c. physical theory
   d. static discovery

   ANS: A DIF: Moderate REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Remembering

2. Darwin realized that the often exquisite fit of species to their environment is primarily the result of
   a. paradigm shifts.
   b. natural selection.
   c. supernatural events.
   d. empirical research.

   ANS: B DIF: Easy REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Remembering

3. In describing the importance of Darwin's theory of evolution, Theodosius Dobzhansky argued that
   a. nothing in biology makes sense except in the light of evolution.
   b. this theory of evolution changes the way we think of Earth in the universe.
   c. evolution can now be used to control our destiny.
   d. we no longer need to invoke the supernatural for any cause.

   ANS: A DIF: Moderate REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Remembering

4. Darwin's theory of evolution provided explanations for all of the following EXCEPT
   a. the diversity of life on the planet.
   b. why the vast majority of species are extinct.
   c. why Earth is not the center of the universe.
   d. the similarities and differences among species.

   ANS: C DIF: Moderate REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Understanding

5. What is evolutionary biology?
   a. a description of the fossil record
   b. the field of science that deals with matter and its motion through space and time
   c. the study of interactions among organisms and their environment
   d. the study of the origin, maintenance, and diversity of life

   ANS: D DIF: Easy REF: 1.1
   OBJ: 1.1.a. Describe what evolutionary biology is. MSC: Remembering

6. To understand the evolution of a species, we need to know about its ancestors and what changes have occurred along the way. Darwin called this process
   a. natural selection.
   b. descent with modification.
   c. genetics.
   d. changes in fitness.

ANS: B DIF: Moderate REF: 1.1
OBJ: 1.1.a. Describe what evolutionary biology is. MSC: Remembering

7. Which of the following best summarizes the process of evolution by natural selection?
   a. Most mutations have harmful effects and therefore increase in frequency over time.
   b. Mutations that do not affect the fitness of individuals are selected to decrease in frequency over time.
   c. Natural selection results in mutations that disrupt finely tuned processes.
   d. Mutations that improve the fitness of individuals will tend to increase in frequency over time.

   ANS: D DIF: Moderate REF: 1.1
   OBJ: 1.1.a. Describe what evolutionary biology is. MSC: Understanding

8. Which process is demonstrated in the figure shown?

   a. artificial selection
   b. natural selection
   c. genetics
   d. paradigm shift

   ANS: A DIF: Moderate REF: 1.1
   OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Understanding

9. In what way are natural selection and artificial selection similar?
   a. Both result in increased frequency of beneficial traits.
   b. Both rely on human intervention to prevent deleterious mutations from increasing in frequency.
   c. Both have been occurring for the past 3.5 billion years.
   d. Neither are able to produce dramatic changes in traits.

   ANS: A DIF: Moderate REF: 1.1
   OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Analyzing

10. In what way is artificial selection different from natural selection?
    a. Artificial selection cannot result in changes in traits.
    b. Artificial selection relies on humans choosing which traits are beneficial.
    c. Artificial selection is only applied to plants.
    d. Artificial selection results in organisms that cannot survive and reproduce.

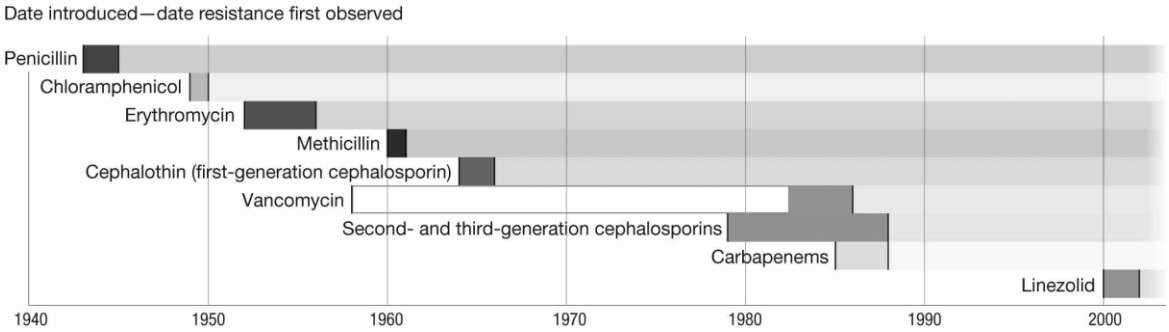
    ANS: B DIF: Moderate REF: 1.1
    OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Analyzing

11. Which of the following is an example of artificial selection?
    a. selection for pests resistant to pesticides
    b. selection for weeds that can grow in the presence of herbicides applied by farmers
    c. selection for cows that produce more milk
    d. selection for insects that transmit disease more efficiently

    ANS: C DIF: Moderate REF: 1.1

OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Applying

12. Looking at the figure, predict what will happen if a new antibiotic to the food poisoning bacteria *Campylobacter jejuni* is developed and prescribed heavily by physicians, beginning this year.



a. *Campylobacter jejuni* will be effectively treated for the next two to three decades.
b. *Campylobacter jejuni* will be effectively treated for the next two to five years.
c. The new antibiotic will make all former antibiotics for treating *Campylobacter jejuni* obsolete.
d. The new antibiotic will never work to treat *Campylobacter jejuni*.

ANS: B DIF: Moderate REF: 1.1
OBJ: 1.1.c. Explain how evolutionary biology informs our understanding of antibiotic resistance.
MSC: Applying

13. Antibiotic resistance evolves quickly because
a. antibiotics impose strong selection for resistance.
b. antibiotics cause new mutations in bacteria that result in antibiotic resistance.
c. natural selection causes evolution to slow down.
d. bacterial infections should not be treated with antibiotics.

ANS: A DIF: Moderate REF: 1.1
OBJ: 1.1.c. Explain how evolutionary biology informs our understanding of antibiotic resistance.
MSC: Understanding

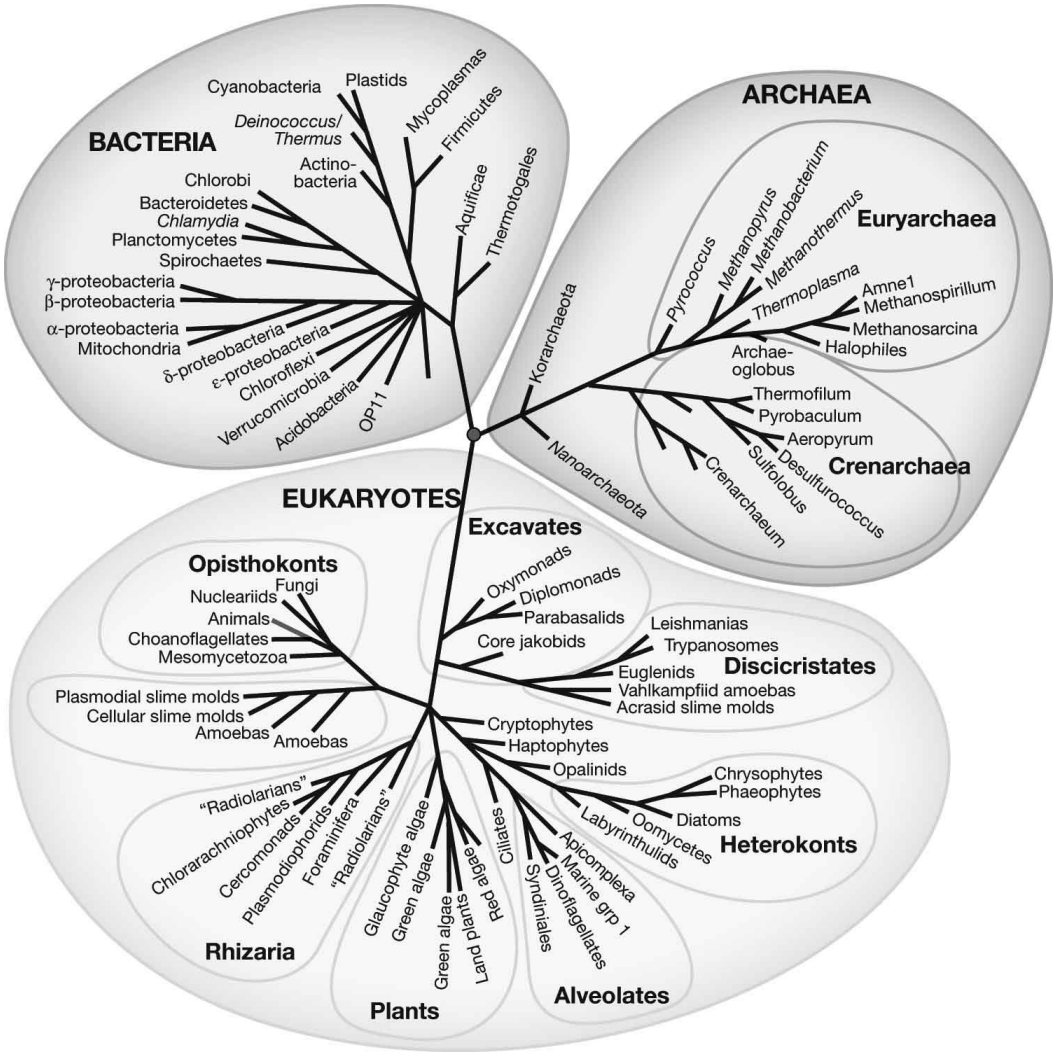
14. Why do physicians often prescribe antibiotics in combination?
a. to decrease the rate at which antibiotic resistance evolves and spreads
b. to prevent common side effects to the patient
c. to increase the likelihood that resistance mutations will arise in the bacteria
d. in case an infection is caused by both bacteria and viruses

ANS: A DIF: Moderate REF: 1.1
OBJ: 1.1.c. Explain how evolutionary biology informs our understanding of antibiotic resistance.
MSC: Understanding

15. A branching tree showing historical relationships among species is known as a(n)
a. species network.
b. natural selection tree.
c. phylogenetic tree.
d. extinction chart.

ANS: C DIF: Easy REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Remembering

16.

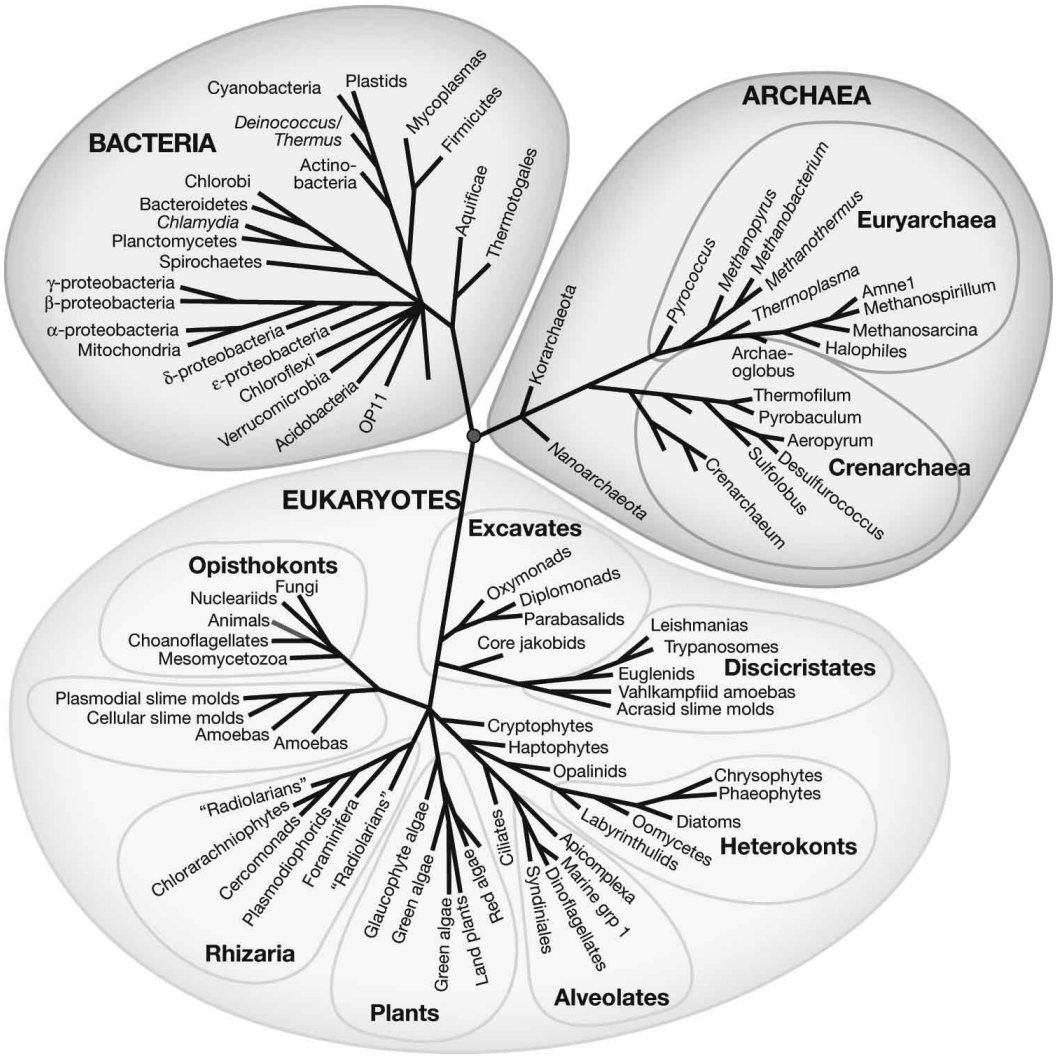


Each tip of the phylogenetic tree shown represents

a. extinction.
b. domain.
c. living or extant taxon.
d. speciation event.

ANS: C DIF: Easy REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Remembering

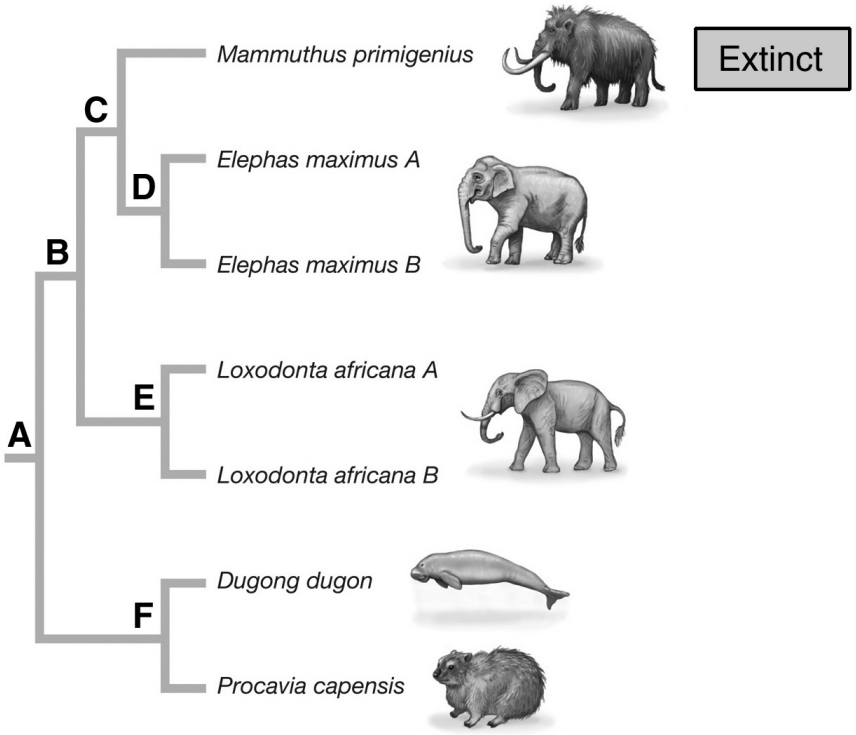
17. According to the phylogenetic tree shown, fungi are most closely related to which of the following?



a. plants
b. amoebas
c. animals
d. bacteria

ANS: C DIF: Moderate REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Applying

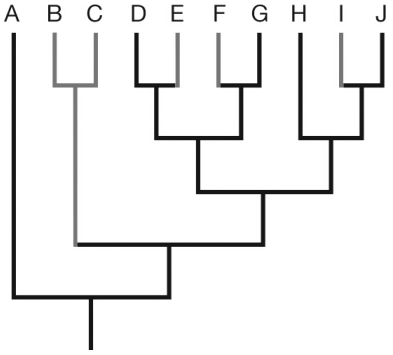
18. If you could protect from extinction only the lineages derived from two of the nodes in the figure, which pair would you save to yield the greatest phylogenetic diversity?



a. Nodes E and F
b. Nodes D and E
c. Nodes C and D
d. All of the choices are equivalent.

ANS: A DIF: Moderate REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Applying

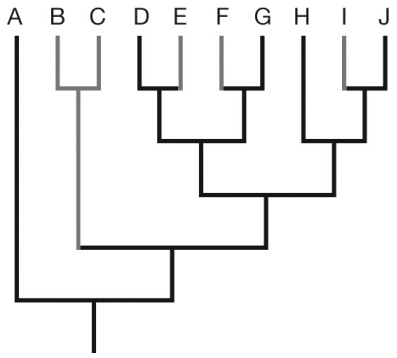
19. If we are interested in conserving phylogenetic diversity, the extinction of which group of species in the figure shown is a greater loss?



a. B and I
b. E, F, and I
c. G and J
d. B and C

ANS: D DIF: Moderate REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Applying

20. The loss of which species on the figure would represent the loss of the most significant phylogenetic diversity?



a. A
b. B
c. C
d. D

ANS: A DIF: Difficult REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges of conservation biology. MSC: Applying

21. What are the two major types of empirical research in evolutionary biology?
a. mutation and natural selection
b. observation and manipulation
c. empirical and theoretical
d. experiments and research

ANS: B DIF: Easy REF: 1.2
OBJ: 1.2.a. Define "empirical research" and describe its two main categories.
MSC: Remembering

22. Which of the following is an example of observational research?
a. removing all of the bee pollinators from a field and watching what happens to the other pollinators
b. calculating the predicted effect of different species of pollinators
c. measuring the behavior of different pollinators visiting flowers in a field
d. adding new flowers to a field and recording the effect on pollinators

ANS: C DIF: Moderate REF: 1.2
OBJ: 1.2.a. Define "empirical research" and describe its two main categories.
MSC: Understanding

23. Manipulative experiments
a. allow scientists to directly assess how changes in one component of a system influence the other components.
b. allow scientists to examine only correlations among data.
c. require altering multiple variables at the same time.
d. must be performed under laboratory conditions.

ANS: A DIF: Moderate REF: 1.2
OBJ: 1.2.a. Define "empirical research" and describe its two main categories.
MSC: Understanding

24. More than 100 years ago, Charles Darwin and his colleague Thomas Huxley hypothesized that humans share a common ancestor, based on
a. anatomical evidence.
b. fossil evidence gathered during Darwin's voyage on the *HMS Beagle*.
c. manipulative experiments.
d. mathematical modeling.

ANS: A DIF: Easy REF: 1.2

OBJ: 1.2.b. Explain how molecular genetics informs our understanding of the relationships among humans and great apes. MSC: Remembering

25. Humans have 23 pairs of chromosomes and chimps have 24 pairs. How has this difference best been explained?
    a. Humans and chimps are not related.
    b. Chimps gained a chromosome during their evolution, which explains why they differ from humans.
    c. Humans and chimps share very little genetic material.
    d. Humans have one chromosome that is the result of a fusion of two chromosomes in our ancestors.

    ANS: D DIF: Moderate REF: 1.2
    OBJ: 1.2.b. Explain how molecular genetics informs our understanding of the relationships among humans and great apes. MSC: Remembering

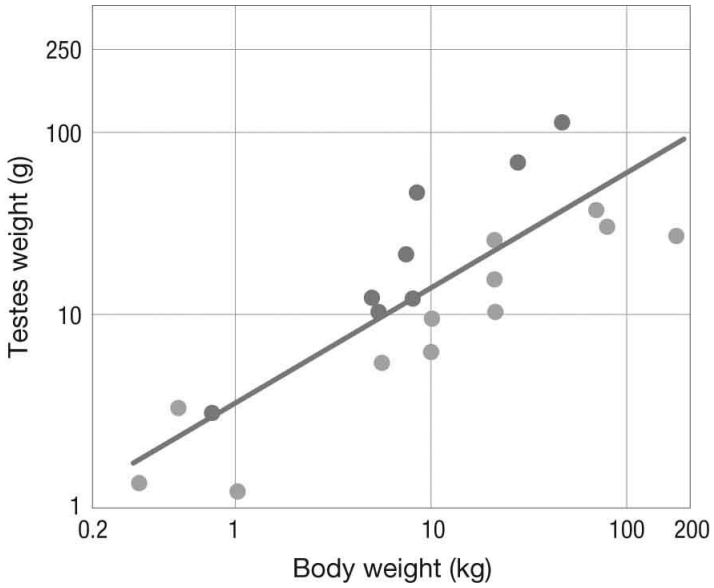
26. If chimpanzee and human genomes differ only about 1.3% at the level of DNA base pairs, how might we explain the dramatic differences in appearance, behavior, cultures, and so on between humans and chimps?
    a. There is a correlation between increased rates of divergence with known functions of alleles in humans and chimps.
    b. Natural selection has been acting on clusters of genes associated with both survival and reproduction in humans and chimps.
    c. Important differences exist in the expression of genes in humans and chimps.
    d. Humans and chimps have been diverging from each other for much longer than they have with other primates.

    ANS: C DIF: Moderate REF: 1.2
    OBJ: 1.2.b. Explain how molecular genetics informs our understanding of the relationships among humans and great apes. MSC: Understanding

27. If testes size is correlated with number of sperm produced, under what condition is larger testes size more likely to be evolutionarily advantageous?
    a. Females mate with a single male.
    b. Males mate with a single female.
    c. Females mate with multiple males.
    d. Males mate with multiple females.

    ANS: C DIF: Moderate REF: 1.2
    OBJ: 1.2.c. Describe how primate breeding systems can influence the evolution of testes size.
    MSC: Understanding

28. In the figure below, the lighter gray circles represent single-male breeding systems in primates and the darker gray circles indicate multi-male systems. Which of the following statements is consistent with these data?



a. Single-male breeding systems select for smaller testes size because sperm are not needed to increase reproductive success.
b. Body weight does not influence testes size because selection only favors large testes in multi-male systems.
c. Species with multi-male systems evolve larger testes because they have higher body weights.
d. Selection favors large testes relative to body weight when a male's sperm must compete directly with other males.

ANS: D DIF: Difficult REF: 1.2
OBJ: 1.2.c. Describe how primate breeding systems can influence the evolution of testes size.
MSC: Analyzing

29. Mathematical models are useful for
a. disproving the theory of evolution by natural selection.
b. providing observations of the natural world.
c. manipulating experimental conditions in the laboratory.
d. helping us understand how complicated systems work.

ANS: D DIF: Easy REF: 1.2
OBJ: 1.2.d. Describe the role of mathematical models of biological systems in evolutionary biology.
MSC: Understanding

30. In which of the following scenarios are models being used to make predictions and plan for the future?
a. A policeman clocks the speed of a motorist with a radar gun.
b. Someone checks the weather forecast for the weekend.
c. An evolutionary biologist estimates fitness by measuring gene frequencies over time.
d. A scientist changes the number of males and females in a population and observes the evolutionary response.

ANS: B DIF: Moderate REF: 1.2
OBJ: 1.2.d. Describe the role of mathematical models of biological systems in evolutionary biology.
MSC: Applying

31. Sir Ronald A. Fisher developed a sex ratio model partly because so much observational data suggested that the 1:1 sex ratio was common in nature and he wanted to understand why. What is the natural ordering when it comes to empirical and theoretical approaches?

a. Good theory should postdate data collecting.
b. Good theory should precede data collecting.
c. Good theory can either precede or postdate data collecting.
d. Good theory should precede hypothesis collecting.

ANS: C DIF: Easy REF: 1.2
OBJ: 1.2.d. Describe the role of mathematical models of biological systems in evolutionary biology.
MSC: Understanding

32. In developing his sex ratio theory, Sir Ronald A. Fisher assumed that sex ratio is under genetic control. Why is this an important assumption?
a. Only traits under genetic control can evolve by natural selection.
b. Sex ratio is under genetic control in humans.
c. Fisher wanted to include every possible variable in his model.
d. Traits that are not under genetic control cannot affect an individual's reproductive success.

ANS: A DIF: Moderate REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Understanding

33. Imagine a population that has 50 males and 25 females. Which of the following parental sex ratio strategies will be most successful?
a. produce all sons
b. produce all daughters
c. produce half sons and half daughters
d. produce 2/3 sons and 1/3 daughters

ANS: B DIF: Moderate REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Applying

34. Sir Ronald A. Fisher's prediction that sex ratios should be 1:1 relies on the principle that
a. the genetic basis of sex is chromosomal.
b. total reproductive success of males is higher than that of females.
c. male births are less common than female births.
d. the rarer sex will have better mating prospects than the more common sex.

ANS: D DIF: Moderate REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Understanding

35. During the observations of a species of blue moon butterflies on the Samoan island of Upolu, 99% of the butterflies were female and only 1% were male. Only five years later the male:female sex ratio was 1:1. What caused this?
a. *Wolbachia* lost the ability to kill all male butterflies.
b. Genetic changes in the Upolu butterflies resulted in suppression of the male-killing effect of *Wolbachia*.
c. Upolu butterflies evolved to become resistant to *Wolbachia* infection.
d. Upolu was recolonized by butterflies from the nearby island Savali, where sex ratios were closer to 1:1.

ANS: B DIF: Moderate REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Understanding

SHORT ANSWER

1. In *On the Origin of Species*, Charles Darwin brought together two ideas that resulted in a paradigm shift in biology. What were these two ideas?

   ANS:
   1. The diversity of life has descended from preexisting species, which share a common ancestor.
   2.The fit of species to their environments is primarily the result of natural selection.

   DIF: Easy REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Remembering

2. Describe Charles Darwin's theory of evolution by natural selection.

   ANS:
   A gradual process in which forms of organisms that are better suited to their environment increase in frequency in a population over sufficient periods of time.

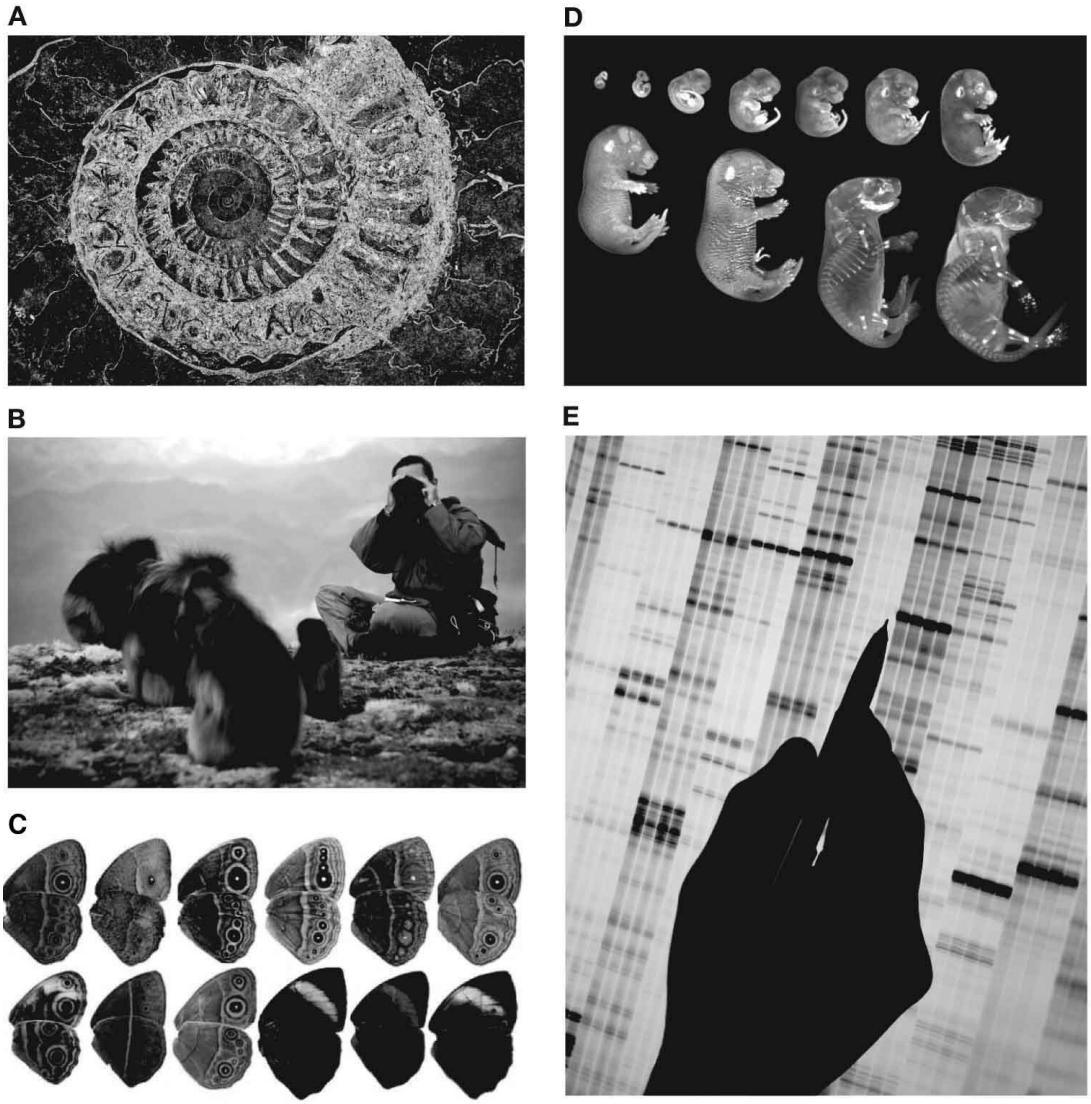
   DIF: Easy REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Remembering

3. Charles Darwin's theory of natural selection is considered a paradigm shift—a theory that has wide-ranging effects. Describe another paradigm shift that has occurred in biology. Make a case for why this shift has fundamentally changed the way scientists see the world and the sorts of questions they ask.

   ANS:
   Answers will vary. An example from the text includes the following: when astronomers discovered that Earth was not at the center of the universe, the way that we thought of Earth and our place in nature was radically changed.

   DIF: Moderate REF: 1.0
   OBJ: 1.0.a. Explain the paradigm shift that occurred in biology when Darwin laid out his theory of evolution. MSC: Applying

4. Sources for the data that evolutionary biologists use to test their hypotheses are derived from many subdisciplines of the biological sciences. Identify the five data sources shown in the photographs.



ANS:
A. Data from the fossil record (Paleontology); B. behavioral data; C. morphological data (Morphology); D. embryological data (Embryology); and E. molecular data (Genetics).

DIF: Moderate REF: 1.1 OBJ: 1.1.a. Describe what evolutionary biology is.
MSC: Remembering

5. How has artificial selection been used to shape the characteristics of food-producing plants?

ANS:
Using the most desirable plants as parental stock for the next generation has resulted in plants that are, for example, hardier, quicker growing, and better tasting.

DIF: Easy REF: 1.1
OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Applying

6. Charles Darwin used the process of artificial selection during domestication as an analogy to explain natural selection. In what ways are artificial and natural selection similar? In what ways do they differ?

ANS:
They are similar in that both processes take the best individuals to be parents for the next generation and thus the most desirable traits will increase in frequency. They differ in what makes individuals the "best" and what traits are "desirable." Under natural selection, the best individuals are those that have the highest survival and reproductive rates. Under artificial selection, the breeder decides what individuals and traits are best.

DIF: Moderate REF: 1.1
OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Analyzing

7. Given the fact that humans are the ones producing and distributing pesticides, why do we call the development of pesticide resistance natural selection rather than artificial selection?

ANS:
The distinction between natural and artificial selection refers not to whether humans are involved but to whether they deliberately choose which organisms will survive and reproduce.

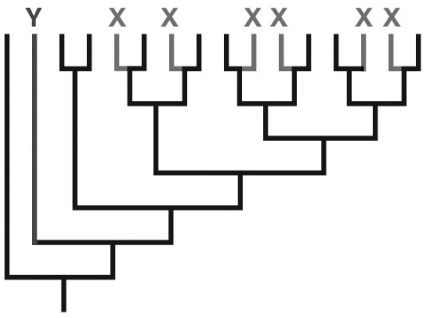
DIF: Moderate REF: 1.1
OBJ: 1.1.b. Compare artificial selection with natural selection in regard to the domestication of crops and livestock. MSC: Understanding

8. The majority of antibiotic use in the United States is for agriculture, primarily in livestock. Why is this a problem?

ANS:
Antibiotic-resistant strains of bacteria can evolve in farm animals and then spread to humans, decreasing the probability of having an effective antibiotic at hand for use in human infections.

DIF: Moderate REF: 1.1
OBJ: 1.1.c. Explain how evolutionary biology informs our understanding of antibiotic resistance.
MSC: Understanding

9. If you are interested in preserving phylogenetic diversity as part of a conservation strategy, would you be more concerned about the loss of all of the species labeled with an X or of the one species labeled with a Y?



ANS:
Loss of the Y species would produce a greater loss of phylogenetic diversity than loss of all of the X species.

DIF: Moderate REF: 1.1
OBJ: 1.1.d. Explain how a phylogenetic perspective can change how scientists address the challenges

of conservation biology. MSC: Applying

10. Evolutionary biologists, like most scientists, use two empirical approaches to study evolution, observation and manipulation. What is the difference between these approaches?

    ANS:
    Observation involves gathering data without making any changes in a natural system. Manipulation requires changing one or more components of a system to determine its/their effects.

    DIF: Easy REF: 1.2
    OBJ: 1.2.a. Define "empirical research" and describe its two main categories.
    MSC: Understanding

11. In performing manipulative experiments, scientists usually try to alter only one variable at a time. Why do they do this?

    ANS:
    By changing only one variable at a time and observing the consequences of that change, the researcher is better able to determine the specific effect of each variable.

    DIF: Easy REF: 1.2
    OBJ: 1.2.a. Define "empirical research" and describe its two main categories.
    MSC: Understanding

12. In comparing pairs of genes in the human and chimp genomes, Tarjei Mikkelsen and his colleagues first determined the expected degree of divergence between the two genomes based on the accumulation of neutral mutations. Why is this an important first step in understanding how evolution is occurring in these species?

    ANS:
    The rate of neutral evolution serves as a baseline for comparison. If some pairs of genes are evolving faster than this baseline rate, then scientists could infer that those genes are not evolving neutrally but rather have experienced natural selection.

    DIF: Moderate REF: 1.2
    OBJ: 1.2.b. Explain how molecular genetics informs our understanding of the relationships among humans and great apes. MSC: Understanding

13. A comparison of gene clusters in humans and chimps from Tarjei Mikkelsen and colleagues revealed that some types of genes were evolving particularly rapidly. Name one type of gene cluster that they found to evolve rapidly and explain why you think it shows this type of evolution.

    ANS:
    Possible answers include the following: Gene clusters associated with survival and reproduction evolve rapidly, likely because selection is strongest on genes directly affecting fitness. Gene clusters associated with disease resistance are evolving rapidly, likely due to the constantly changing selective pressure from coevolving parasites and pathogens.

    DIF: Difficult REF: 1.2
    OBJ: 1.2.b. Explain how molecular genetics informs our understanding of the relationships among humans and great apes. MSC: Understanding

14. Sir Ronald A. Fisher's sex ratio model predicts a 1:1 female:male sex ratio. Under what conditions might you expect a different ratio to evolve?

ANS:
If one of the assumptions of Fisher's model is not met in a system, then the ratio may not be 1:1. For example, if the cost of producing and raising males differs from that of females, then we might expect a different equilibrium sex ratio.

DIF: Difficult REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Understanding

15. In a population with 50 males and 25 females that produce a total of 100 offspring, calculate how many grandoffspring per child a parent will have if (a) the parent produces half sons and half daughters, or (b) the parent produces 1/4 sons and 3/4 daughters. Which strategy will be favored by natural selection in this population?

ANS:
Using the equation $k(N/m) + (1-k)(N/f)$, we calculate that parent (a) will produce:
$(1/2)(100/50) + (1/2)(100/25) = 3$ grandoffspring per child
and parent (b) will produce:
$(1/4)(100/50) + (3/4)(100/25) = 3.5$ grandoffspring per child.

Parent (b) will be favored because it produces more offspring of the rare sex.

DIF: Difficult REF: 1.2
OBJ: 1.2.e. Explain why many species display an even sex ratio.
MSC: Applying