Chapter 2: Early Evolutionary Ideas and Darwin's Insight

MULTIPLE CHOICE

1. Early Greek philosophers were among the first to
   a. develop a philosophy of a natural world driven by physical laws.
   b. describe the heavenly bodies as gods or personages.
   c. explain the world around them according to fixed laws of nature.
   d. A and C

   ANS: D DIF: Easy REF: 2.1 TOP: I.A.1
   MSC: Factual

2. Early Greek philosophers failed to exploit one of the greatest advantages of methodological naturalism, which is that explanations can
   a. be tested through observation and sometimes manipulation.
   b. shift from supernatural to natural.
   c. be based on fixed laws of nature.
   d. B and C
   e. All of the above

   ANS: A DIF: Medium REF: 2.1 TOP: I.B
   MSC: Factual

3. Unlike those before him, Aristotle
   a. formulated hypotheses without testing them.
   b. recognized the significance of testing one's hypotheses.
   c. was the first to develop a philosophy of a natural world driven by physical laws.
   d. B and C
   e. All of the above

   ANS: B DIF: Medium REF: 2.1 TOP: II.A.1
   MSC: Factual

4. After Aristotle, one advance in scientific methodology came through the use of logic. This allowed thinkers to
   a. formulate and test hypotheses based on evidence.
   b. recognize the significance of testing one's hypotheses.
   c. move carefully from facts to general principles.
   d. B and C
   e. All of the above

   ANS: C DIF: Medium REF: 2.1 TOP: II.B
   MSC: Conceptual

5. Even if philosophers accept and study the importance of change, a full theory of evolution by natural selection cannot exist without
   a. understanding the sorts of changes that have taken place.
   b. recognizing the significance of testing one's hypotheses.
   c. realizing that some species go extinct over time.
   d. realizing the vast expanses of time over which some changes take place.
   e. B and C

   ANS: D DIF: Easy REF: 2.2 TOP: III.A

MSC: Factual

6. Archbishop James Ussher calculated the age of Earth based on the Old Testament. He estimated that the creation of the world took place
   a. on exactly October 23, 4004 B.C.
   b. within a century of 3900 B.C.
   c. between 75,000 and 2–3 million years ago.
   d. an inconceivably long time ago.

   ANS: A DIF: Easy REF: 2.2 TOP: III.C.1
   MSC: Factual

7. James Hutton, a Scottish geologist and naturalist, argued that the geological processes of erosion and sedimentation suggested that the world was created
   a. on exactly October 23, 4004 B.C.
   b. in 3998 B.C.
   c. between 75,000 and 2–3 million years ago.
   d. an inconceivably long time ago.

   ANS: D DIF: Easy REF: 2.2 TOP: III.D.1
   MSC: Factual

8. Building on the ideas first proposed by Hutton, Lyell aimed to explain Earth's geological features using an approach known as uniformitarianism, which depends on
   a. large-scale geological events.
   b. the same geological processes currently observable.
   c. geological processes operating over very long periods of time.
   d. B and C

   ANS: D DIF: Easy REF: 2.2 TOP: III.D.2
   MSC: Factual

9. The approach known as catastrophism explains Earth's geological features appealing to
   a. sudden catastrophic geological events.
   b. large-scale geological events.
   c. the same geological processes currently observable.
   d. A and B

   ANS: D DIF: Easy REF: 2.2 TOP: III.D.2
   MSC: Factual

10. Greek philosophers, including Aristotle, developed a keen appreciation for the study of natural history. Which of the following contributions to the study of natural history did Aristotle make?
    a. His book, *Physics and Natural History of Animals*
    b. Distinguishing among 500 species of birds, mammals, and fishes
    c. Proposing a taxonomy of nature—a classification system of life
    d. All of the above

    ANS: D DIF: Easy REF: 2.3 TOP: IV.A
    MSC: Factual

11. Which of the following examples best illustrates the concept of spontaneous generation?
    a. During flooding, frogs spontaneously arise from mud.
    b. When a dried bean is moistened and kept moist, it spontaneously transforms into a bean sprout.

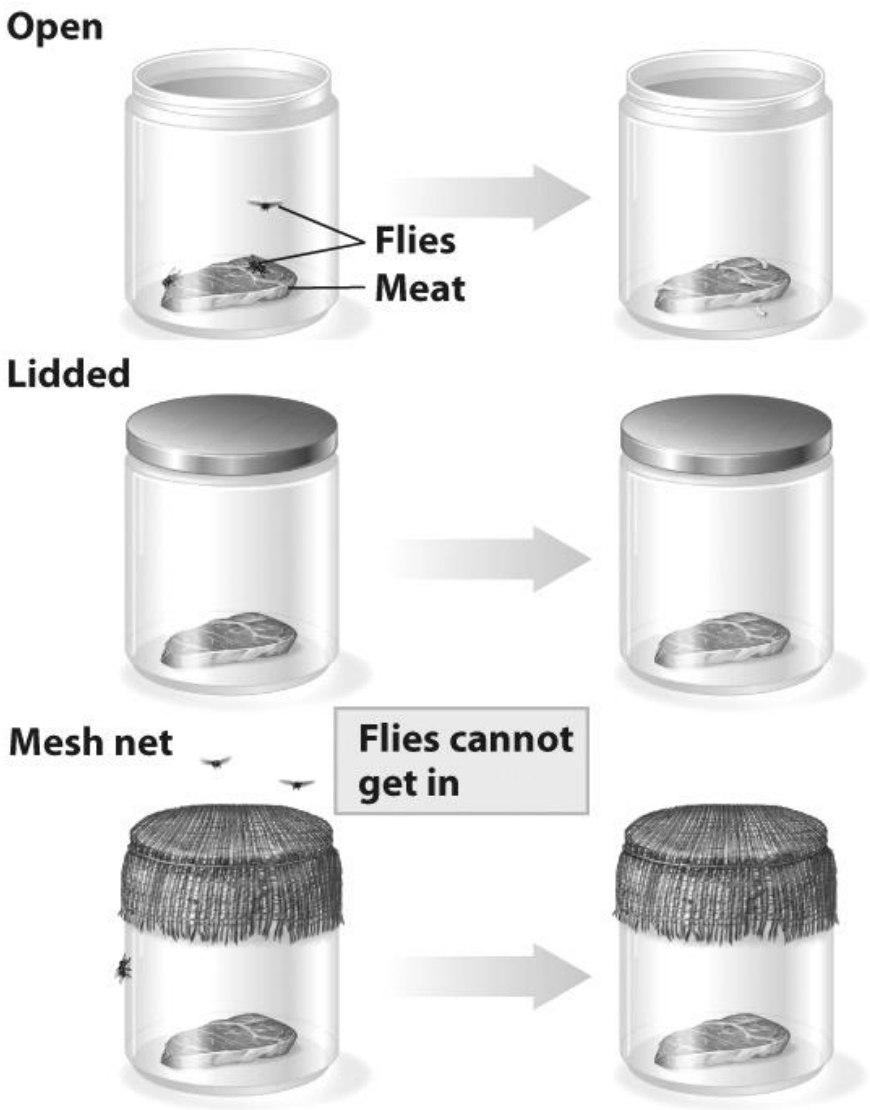
c. Some sea anemones spontaneously bud newly developed young from their outer skin.
d. A and B
e. All of the above

ANS: A DIF: Easy REF: 2.3 TOP: IV.B.1
MSC: Applied

12. Which of the following concepts was a commonality of early Greek theories?
a. Divine creation
b. Spontaneous generation
c. Uniformitarianism
d. Inheritance of acquired characteristics
e. All of the above

ANS: B DIF: Easy REF: 2.3 TOP: IV.B.1
MSC: Factual

13.



Francesco Redi's experiment, illustrated in the figure above, addressed the question of whether flies spontaneously generated from meat carcasses. Which of the following statements regarding this experiment is (are) true?

a. Meat in jars with an open lid developed maggots.
b. Meat in lidded jars did not develop maggots.
c. Meat left in jars with mesh covered lids developed maggots.
d. A and B

ANS: D DIF: Medium REF: 2.3 TOP: IV.B.2
MSC: Applied

14. Charles Darwin's grandfather Erasmus Darwin, an English physician and philosopher,
a. argued that all life developed from what he called a single living filament.
b. wrote a book called *Zoonomia*.
c. argued that humans descended from another primate species and once walked on all fours.
d. All of the above

ANS: D DIF: Medium REF: 2.3 TOP: IV.C.1
MSC: Factual

15. Despite his insights, Erasmus Darwin came up short of a full-blown theory of evolution by natural selection because
a. he failed to connect the struggle for existence to the evolutionary changes that would result from such a struggle.
b. he believed in Lamarck's theory of the inheritance of acquired characteristics.
c. All of the above
d. None of the above

ANS: C DIF: Medium REF: 2.3 TOP: IV.C.1
MSC: Factual

16. Robert Chambers, a Scottish geologist and author of *Vestiges of the Natural History of Creation*, is often overlooked for which very important contribution?
a. The theory of the inheritance of acquired characteristics
b. Thinking of evolution in terms of populations not individuals
c. Proposing the enormous influence of the environment on evolutionary change
d. All of the above

ANS: B DIF: Difficult REF: 2.3 TOP: IV.C.3
MSC: Factual

17. Lamarck's hypothesis that traits acquired during the lifetime of an individual are passed on to progeny
a. was interesting, reasonable, and based on an idea that was accepted by many scientists and nonscientists alike.
b. connected evolutionary change to environmental fit.
c. All of the above
d. None of the above

ANS: C DIF: Medium REF: 2.4 TOP: V.B
MSC: Conceptual

18. What were Darwin's two fundamental insights about the process of evolution?
a. The environment selects on variation in the traits of individual organisms; and organisms are in a constant struggle for existence.
b. The environment selects on variation in the traits of individual organisms; and all species have descended from one or a few common ancestors.
c. All species have descended from one or a few common ancestors; and populations, not individuals, evolve over time.

d. Populations, not individuals, evolve over time; and evolutionary change is connected to environmental fit.

ANS: B DIF: Difficult REF: 2.5 TOP: VI.A
MSC: Factual

19. To explain how varieties were on the path to becoming new species, Darwin introduced the concept of
a. descent and modification.
b. transformational change.
c. variational change.
d. All of the above

ANS: A DIF: Medium REF: 2.5 TOP: VI.E.1
MSC: Applied

20. Two important differences between the processes of natural selection and artificial selection are
a. descent and modification.
b. the selective agent and the traits being selected.
c. the pace of change and the period of time.
d. B and C

ANS: B DIF: Difficult REF: 2.6 TOP: VII
MSC: Conceptual

21. Darwin drew on the work of Thomas Malthus, a political economist, to convince his readers that
a. there is a competition for limited resources in nature.
b. many individuals in a population do not survive to the age of reproduction.
c. only a fraction of the surviving individuals in a population reproduce.
d. All of the above

ANS: D DIF: Medium REF: 2.6 TOP: VII.C
MSC: Factual

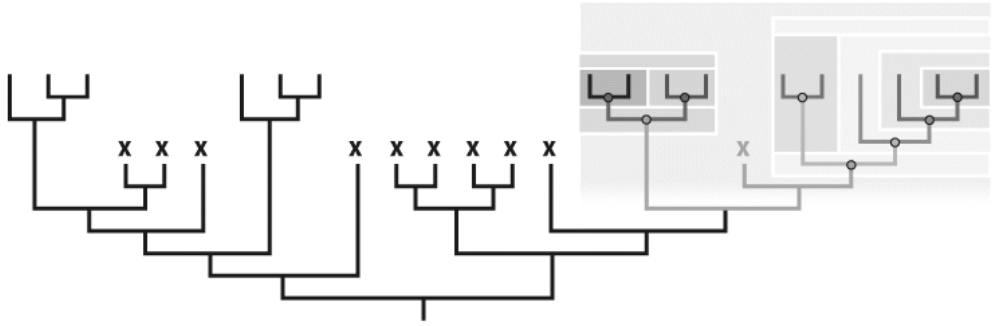
22. Darwin's tree of life metaphor
a. linked species in varying degrees of similarity according to their historical pattern of descent.
b. described the branching historical relationships among all living things.
c. applied to both the history and pattern of life's diversity.
d. All of the above

ANS: D DIF: Medium REF: 2.7 TOP: VIII.A
MSC: Applied

23. Darwin's hypothesis of common ancestry with branching descent explains
a. the hierarchical patterns of similarity observed in nature.
b. varieties nested within species, nesting within genera.
c. the history and pattern of life's diversity.
d. All of the above

ANS: D DIF: Easy REF: 2.7 TOP: VIII.B
MSC: Applied

24. **Hierarchical patterns of similarity**



In the figure above, the hierarchically arrayed groups indicated by the shaded grey boxes are called
a. nodes.
b. clades.
c. species.
d. genera.

ANS: B DIF: Easy REF: 2.7 TOP: VIII.B
MSC: Factual

25. Both Wallace and Darwin traveled extensively and were struck by the strong patterns they observed in the geographic distribution of nature's diversity. Which of the following observations were made by Wallace?
a. Highly similar species are clustered in time and space.
b. Inheritance is a particulate rather than a blending process.
c. Geographic features seem to play an important role in the clustering of similar, closely related species.
d. A and C

ANS: D DIF: Medium REF: 2.7 TOP: VIII.C
MSC: Conceptual

26. Darwin faced which of the following major challenges to his theory?
a. Accounting for complex structure with multiple intricate parts
b. Explaining traits and organs of seemingly little importance
c. Understanding why natural selection does not exhaust the genetic variation in a population
d. All of the above

ANS: D DIF: Easy REF: 2.8 TOP: IX
MSC: Factual

27. While various religious leaders challenged almost all of Darwin's major conclusions,
a. all early experimental evolutionists agreed with Darwin.
b. many British scientists embraced Darwin's ideas on evolution.
c. many British scientists rejected Darwin's proposed mechanism of natural selection.
d. B and C

ANS: D DIF: Medium REF: 2.9 TOP: X.A
MSC: Factual

28. In the 1880s, experimental work by August Weisman demonstrated that traits acquired during a lifetime could not be inherited. This dealt a deathblow to previous theories of Lamarckian inheritance and left scientists with which of the following possible processes of evolution?
a. Sudden, large changes
b. Slow acting natural selection
c. Saltationism
d. All of the above

ANS: D DIF: Medium REF: 2.9 TOP: X.B

MSC: Applied

29. The rediscovery in 1900 of Mendel's now famous experiments from the 1850s and 1860s initially
    a. solved the argument about whether natural selection acted in a slow way on small genetic changes or in a sudden, saltational manner.
    b. added fuel to the argument about whether natural selection acted in a slow way on small genetic changes or in a sudden, saltational manner.
    c. All of the above
    d. None of the above

    ANS: B DIF: Medium REF: 2.9 TOP: X.C
    MSC: Applied

SHORT ANSWER

1.

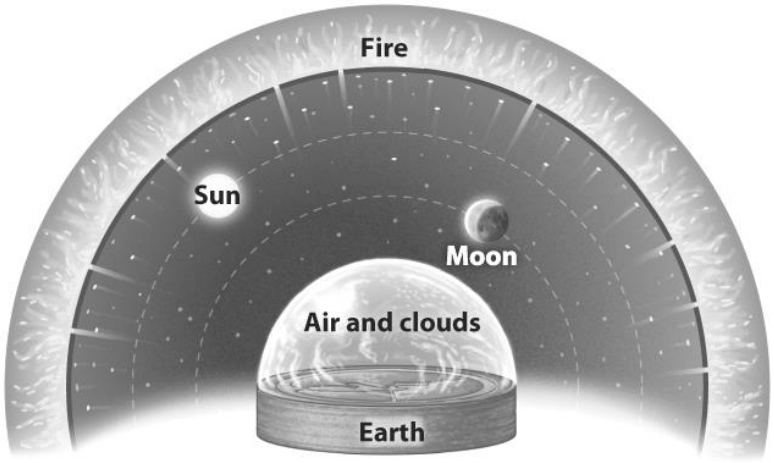


FIGURE 2.2 Anaximander's cosmology.
In Anaximander's cosmology, Earth is a disk surrounded by vast wheels on which the sun and moon rotate and a dome of fire from behind which the stars glow.

The Greek philosopher Anaximander (ca. 610–546 B.C.) provided a mechanistic rather than divine explanation of the celestial bodies, as illustrated in the figure above. We now know the details were wrong. Explain why, given the state of knowledge during his lifetime, this was a conception of the universe that made sense and was a breakthrough.

ANS:
Answers will vary but should include: The mechanism works to explain the perceived motion of heavenly bodies around the earth, and the explanation is important because it is based on natural rather than supernatural phenomena.

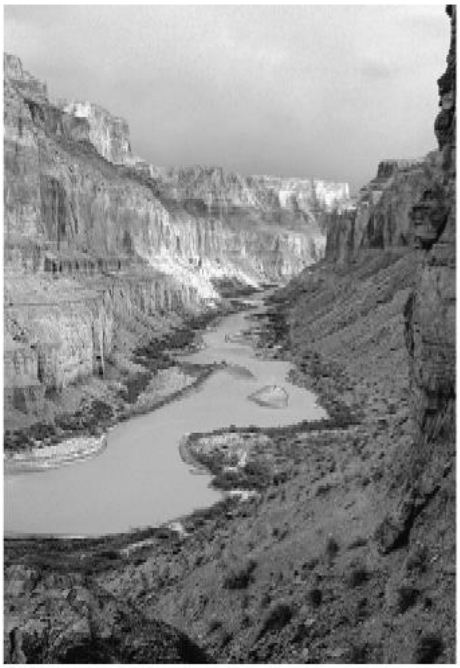
DIF: Medium REF: 2.1 TOP: I.A.1 MSC: Conceptual

2. The Greek philosopher Empedocles recognized that plant life preceded animal life. Xenophanes (570–470 B.C.) studied fossils in sedimentary rock and concluded that the rocks must have been underwater at one time. Explain why these were important shifts in logical thinking.

ANS:

Answers will vary but should include: These ideas implied that the world had changed in significant ways over time, which is necessary for significant breakthroughs in the development of evolutionary thinking.

DIF: Difficult REF: 2.2 TOP: III.B MSC: Conceptual

3.  

Explain and relate the two geological features shown in the figure above, employing the principle of uniformitarianism put forth by Charles Lyell in 1830.

ANS:
Answers will vary but should indicate that massive canyons (right) are the result of slow processes of erosion equivalent to those illustrated in the left panel.

DIF: Medium REF: 2.2 TOP: III.D.2 MSC: Applied

4. Darwin read Lyell's book, *Principles of Geology*, while serving as ship's naturalist on the *HMS Beagle.* Describe how Lyell's work influenced Darwin.

ANS:
Answers will vary but should include: Prior to publishing *On the Origin of Species*, Darwin published three books on geology; Darwin's ideas on the gradual changes associated with evolution are biological interpretations of Lyell's uniformitarian ideas; By explaining Earth's dramatic geological features through uniformitarianism, Lyell conceived the world as changing across enormous expanses of time.

DIF: Medium REF: 2.2 TOP: IV.A.2 MSC: Applied

5. Explain why the linear hierarchy of Aristotle's *scala naturae* is incompatible with Darwin's phylogenetic view of biological diversity.

ANS:

Answers will vary but should include: According to Aristotle's classification system, each species occupies a link in a chain of being, which lacks two critical concepts that were necessary for the development of evolutionary thinking—shared degrees of complexity and the potential to change or evolve.

DIF: Medium REF: 2.3 TOP: IV.A.2 MSC: Conceptual

6. The text presents several examples of the belief in spontaneous generation. Why do you think this theory persisted for thousands of years, until Darwin's time, even after the experiments of Francesco Redi?

ANS:
Answers will vary but should include the difficulty in observing a clear parental source.

DIF: Difficult REF: 2.3 TOP: IV.B.1 MSC: Conceptual

7. 

FIGURE 2.11 Lamarck, acquired characteristics, and shorebirds. Lamarck argued that the long legs of shorebirds such as this blacknecked stilt (*Himantopus mexicanus*) are the result of birds stretching their legs as far as possible to avoid sinking in the mud. This stretching itself, Lamarck postulated, not only lengthened the legs of individuals doing the stretching, but their new trait of "longer legs" was then passed down to offspring.

Lamarck's hypothesis of inheritance of acquired characteristics is illustrated and explained in the example of long legged shorebirds in the figure above. Describe your own Lamarckian explanation for another trait that you have observed in a living organism.

ANS:
Answers will vary.

DIF: Difficult REF: 2.4 TOP: V.B MSC: Applied

8. Write a short counter to Paley's argument that as it is virtually impossible for a fully working watch to come into being simply by chance, it is just as impossible for even more complex living creatures to come into being without a fully conscious creator.

ANS:
Answers will vary but should include that gradual changes occur over long periods of time, and organisms are naturally selected in terms of a good fit to their environment.

DIF: Difficult REF: 2.4 TOP: V.B MSC: Applied

9. In 1858, Darwin received a manuscript from Wallace in which Wallace proposed a theory very similar to his own. Darwin first presented his ideas in a joint paper with Wallace, which was read to the Linnaean Society, also in 1858. Why do you think history primarily associates Darwin's, not Wallace's, name with the theory of evolution?

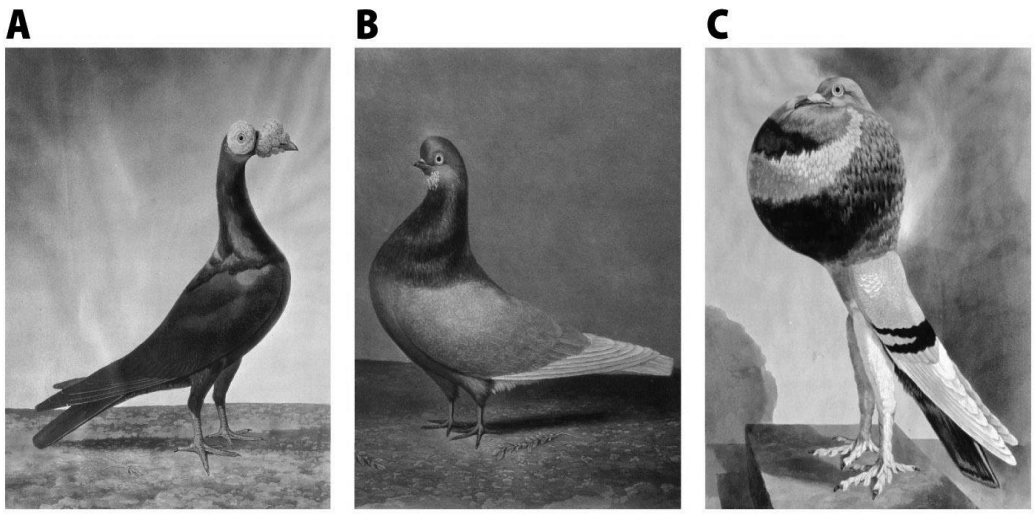
   ANS:
   Answers will vary but should include that Wallace generously agreed that Darwin deserved primary credit considering the evidence he had gathered. There also is the possibility that a student has read outside of the text and may mention class and opportunity differences.

   DIF: Medium REF: 2.5 TOP: VI.B MSC: Applied

10. Why was it such a brilliant strategy for Darwin to open *On the Origin of Species* with a discussion of artificial selection?

    ANS:
    Answers will vary but should include: Most people in the 1850s were familiar with dog and pigeon breeding, which helped his readers to relate to the book and made his theory of change over time more believable and approachable to the average reader.

    DIF: Medium REF: 2.5 TOP: VI.D MSC: Applied

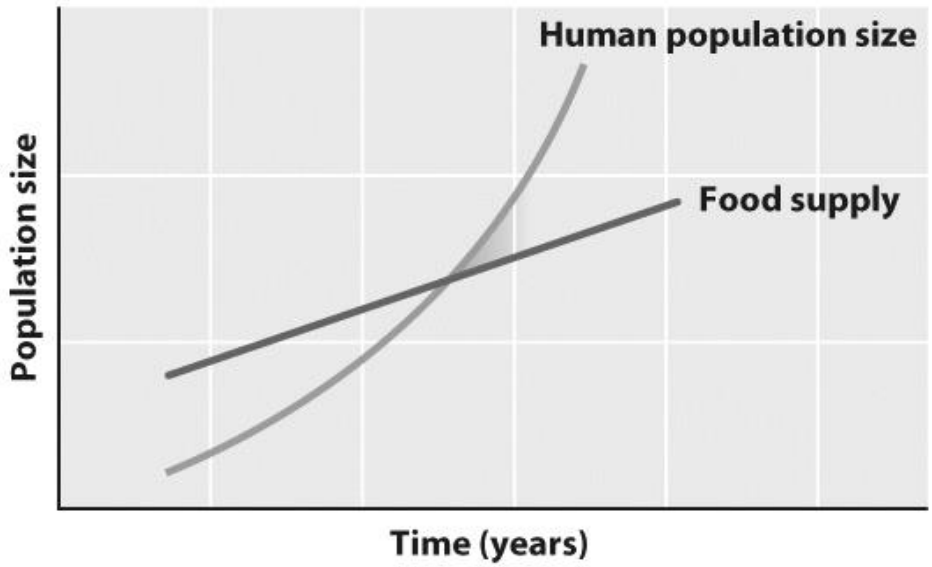
11. 

    Choose one of the three pigeon varieties from the figure above, and describe what steps breeders may have gone through to produce the unusual characteristics depicted.

    ANS:
    Answers will vary but should include the selection of pigeons in subsequent generations with traits closest to the attributes of the varieties pictured.

    DIF: Easy REF: 2.5 TOP: VI.C MSC: Applied

12.

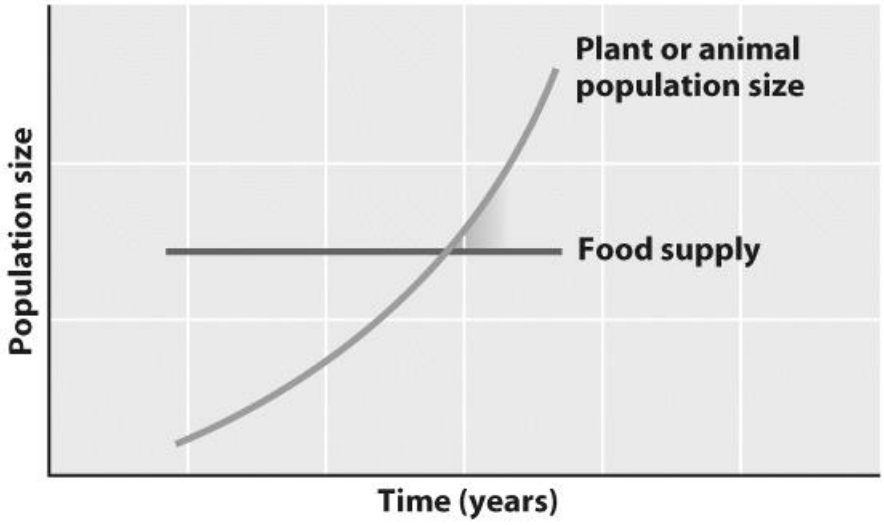


Give an explanation of the English economist Thomas Robert Malthus' argument, presented in the figure above.

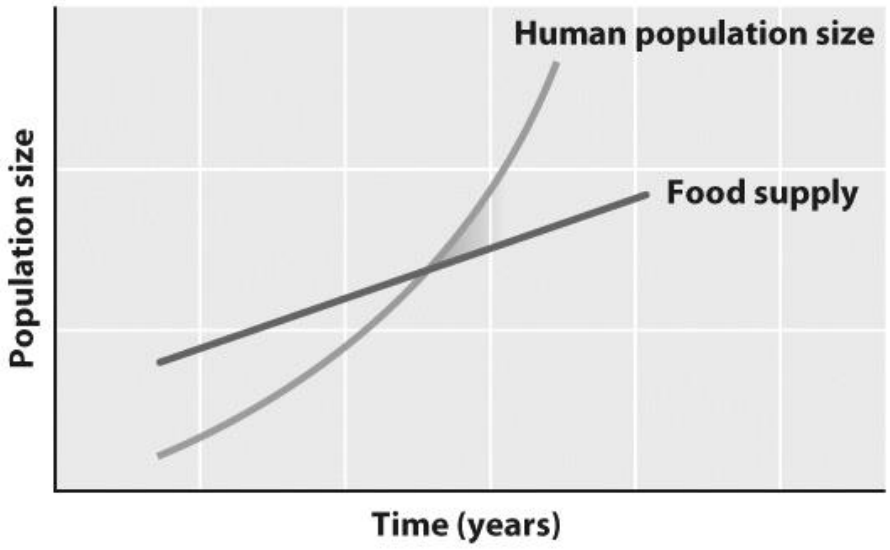
ANS:
Answers will vary but should include: When human population growth outstrips food supply, famine or other checks on the population will result.

DIF: Medium REF: 2.6 TOP: VII.C MSC: Applied

13. A)



B)



Compare Darwin's adaptation of Malthus' argument to plants and animals in nature (Graph A) with Graph B, representing Malthus' original argument.

ANS:
Answers will vary but should include: The food supply curve is flatter in Graph A than in Graph B; and in Graph B, the food supply curve also increases, illustrating the result of human innovation in food production.

DIF: Medium REF: 2.6 TOP: VII.C MSC: Applied

14.

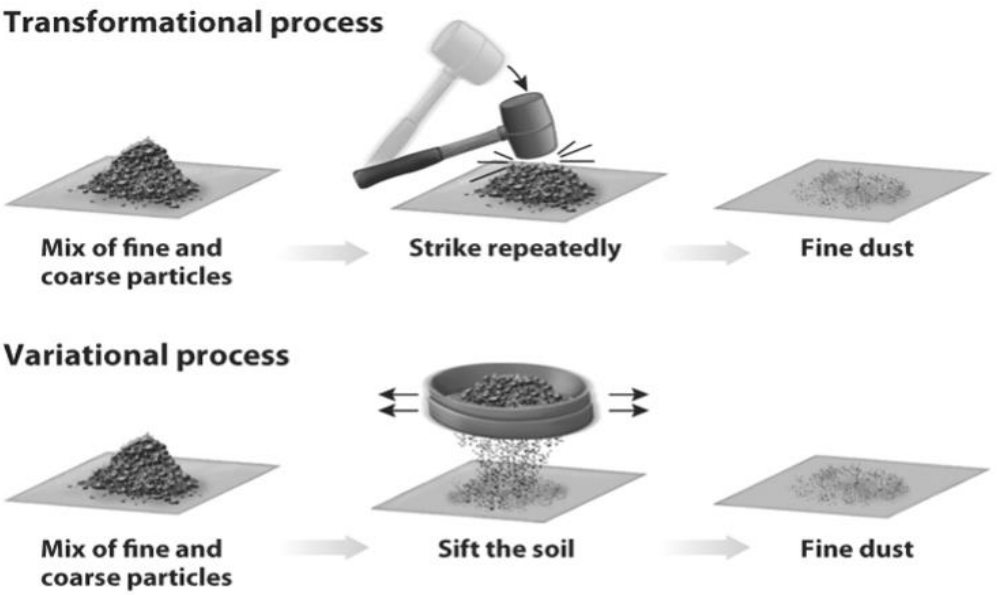


FIGURE 2.19 Different processes of change. In a transformational process, the ensemble changes because each individual member changes. In a variational process, the ensemble changes because something sorts among the variants in the original ensemble. In this example, crushing the soil particles is a transformational process— the ensemble shifts toward smaller particles because the individual particles are reduced. Sifting the soil is a variational process—the ensemble shifts toward smaller particles because the larger particles are sorted out.

Before Darwin, scientists such as Lamarck envisioned evolutionary change as transformational—properties of an ensemble change because every member of the ensemble changes. Darwin's theory of evolutionary change was, by contrast, a variational one—the properties of an ensemble change because of the action of some sorting process acting on preexisting variation within the ensemble. Referring to the figure above, describe the kind of sorting process that takes place (a) when we use artificial selection to change the characteristics of a breed of animals or plants and (b) when natural selection operates on a population.

ANS:
Answers will vary but should include: (a) For artificial selection, the sorting process is determined by the breeder who makes choices about which individuals will breed. (b) For natural selection, the sorting process is determined by which variants survive and reproduce most successfully.

DIF: Difficult REF: 2.6 TOP: VII.D MSC: Applied