

## CHAPTER 2: THE DEVELOPMENT OF EVOLUTIONARY THEORY

Questions included in web quizzing are marked in bold

### Chapter Outline

#### I. Introduction

- A. Misconceptions about evolution result from the poor quality of education (particularly science education: biology) in the U.S.
- B. In the United States, evolution is considered to be anti-biblical and is often denigrated as being “only” a theory.
  - 1. Evolution is, in fact, a scientific theory that has a wealth of support and is the unifying theory of the biological sciences, including physical anthropology.

#### II. A Brief History of Evolutionary Thought

- A. Discoveries of evolutionary principles took place in Western Europe through many ideas borrowed from other non-western cultures.
- B. Charles Darwin is credited with explaining the basic mechanics of the evolutionary process and formulating the theory of **natural selection**; Alfred Russel Wallace independently reached the same conclusion.
- C. The predominant European worldview throughout the Middle Ages was that all aspects of nature including all life and their relationships never changed.
  - 1. Christian teachings that God created all life were taken literally.
    - a. The universe was perceived as being part of the Grand Design, created in 4004 B.C.
  - 2. The belief that the earth was very young, coupled with the notion of **fixity of species**, was a significant obstacle to the development of evolutionary thought.

#### III. The Scientific Revolution

- A. In Europe, the scientific revolution developed as fundamental ideas of the earth and the biological world were overturned. However, in Arabia and India, scholars developed concepts of planetary motion centuries earlier.
  - 1. In 1514, Copernicus argued that the earth was not the center of the universe.
  - 2. In the 1600s, Galileo Galilei restated Copernicus concepts and was sentenced to house arrest for the rest of his life.
  - 3. The laws of physics, motion, and gravity were developed throughout the 16<sup>th</sup> and 17<sup>th</sup> centuries.

#### IV. Precursors to the Theory of Evolution

- A. The first step to understanding the many forms of organic life was to list them and describe them.
  - 1. John Ray (1627-1705), a minister at Cambridge University, was first to recognize that groups of plants and animals could be distinguished from other groups by their ability to produce offspring.
    - a. These groups of **reproductively isolated** organisms were termed species.
    - b. Ray also coined the term *genus*, recognizing that similar *species* could be grouped together.
  - 2. Carolus Linnaeus (1707-1778), a Swedish naturalist and believer in the fixity of species, developed the **binomial nomenclature** system of classification plants in his publication, *Systema Naturae* (1735).
    - a. Taxonomy added class and order.

- b. Humans were classified as genus *Homo* species *sapiens*.
- 3. George-Louis Le Clerc de Buffon (1707-1788) stressed the importance of change in the universe and the dynamics between nature and living forms in *Natural History* (1749).
- 4. Erasmus Darwin (1731-1802), Charles Darwin's grandfather, was a freethinking physician who wrote about evolutionary ideas in poetic verse.
  - a. The degree to which he influenced his grandson's ideas is unclear.
- 5. Jean-Baptiste Lamarck (1744-1829) was the first to propose an explanation of the evolutionary process.
  - a. He proposed a theory of the inheritance of acquired characteristics, in which an animal's body parts are altered through use or disuse.
    - (i) These altered characteristics are transmitted to their offspring.
      - (a) Although this is biologically impossible, he nevertheless is credited with being the first to recognize the importance of the interaction between organisms and their environment in the evolutionary process.
- 6. Georges Cuvier (1769-1832) used the term *biology* to refer to the study of living organisms; a French vertebrate paleontologist, was an opponent of Lamarck's evolutionary ideas.
  - a. Cuvier introduced the concept of extinction to explain the existence of hitherto unknown fossil forms.
  - b. Cuvier was a proponent of **catastrophism**, the idea that the earth's geological features are a result of catastrophic events.
    - (i) These events destroyed old life forms, and the newer forms were the result of creation events.
- 7. Thomas Malthus (1766-1834), an English clergyman and economist, wrote *An Essay on the Principles of Population*.
  - a. He noted that population sizes increase exponentially but food supplies remain stable.
    - (i) This concept inspired both Charles Darwin and Alfred Wallace.
- 8. Charles Lyell (1797-1875), author of *Principles of Geology* (1830-1833), is considered the founder of modern geology.
  - a. He demonstrated that uniform processes (**uniformitarianism**) could account for present geological features.
    - (i) His ideas provided the "deep time" necessary for biological evolution to have occurred.

## V. The Discovery of Natural Selection

- A. Charles Darwin (1809-1882) proposed the first credible mechanism for evolutionary change, natural selection, in *On the Origin of the Species* (1859).
  - 1. After graduating from Cambridge University, where he studied theology but also cultivated his interests in natural science and geology, he was recommended to join the five-year expedition of the HMS *Beagle*.
    - a. Darwin began the voyage as a believer in the fixity of species, but his observations of, among other things, fossils of giant ancient versions of living animals and varieties of Galápagos finches eventually convinced him to the contrary.
    - b. After his return to England in October 1836, he began to formulate his theory of natural selection.
      - (i) He wrote summaries of his ideas by 1844, but felt he needed more evidence before he published.

## VI. In Darwin's Shadow

- A. Alfred Russel Wallace (1823-1913) developed his own theory of natural selection after collecting bird and insect specimens in Southeast Asia.
  - 1. He first published some of his ideas in 1855, and then in 1858, Wallace wrote "On the Tendency of Varieties to Depart Indefinitely from the Original Type".

2. These papers caused Lyell and others to urge Darwin to publish his work. Wallace later sent his papers to Darwin which spurred him to put all his ideas in writing *On the Origin of Species* (1859.)

## VII. Natural Selection

- A. Darwin envisioned natural selection as a process in which individuals with favorable variations survive and reproduce at a higher rate than those with unfavorable variations. The basic processes, as he understood them, are as follows:
  1. All species are capable of producing offspring at a faster rate than food supplies increase.
  2. There is biological variation within all species.
  3. In each generation more offspring are produced than survive, and because of limited resources, there is competition among individuals (does not mean constant fighting.)
  4. Individuals who possess favorable traits have an advantage; they have greater **fitness** because favorable traits increase the likelihood that they will survive to adulthood and reproduce.
  5. The environmental context “determines” whether or not a trait is beneficial.
  6. Traits are inherited and passed on to the next generation. Because individuals who possess favorable traits contribute more offspring to the next generation, over time those favorable offspring at a higher rate than non-favorable traits, thus increasing in frequency through time and eventually producing new species (**reproductive success**).
  7. Over long periods of geological time, successful variations accumulate in populations, resulting into later generations being distinct, thus new species appear.
  8. Geographical isolation may lead to the formation of new species and different **selective pressures**.

## VIII. Natural Selection in Action

- A. One of the most frequently cited example of natural selection is the coloration changes of a species of moth, which in recent year has been critiqued but the premise remains valid.
  1. Prior to the 19<sup>th</sup> century in England, the most common variety of peppered moth was a mottled gray color. During the day, the moths would rest on the lichen-covered tree trunks and their coloration provided camouflage. There was also a dark gray variety of the same species which was eaten by birds more frequently. Yet, due to a change in the environment driven by industrialization, coal dust covered the tree trunks and the mottled gray moths became more conspicuous and targeted by birds and over time the moths (subjective to *selective pressures*) numbers dwindled.
  2. Evolutionary shifts in response to the environment are called adaptations.
  3. Natural selection has been demonstrated on the Galápagos Islands.
  4. Measurements of beak thickness that changed through time among the medium ground finch indicate the thicker-beaked individuals had greater reproductive success during droughts.
  5. Natural selection, through the use of antibiotics by humans, is responsible for the increased number of antibiotic-resistant strains of microorganisms.
  6. These examples of natural selection in action indicate that certain common principles apply.
    - a. *A trait must be inherited if natural selection is to act on it.*
    - a. *Natural selection cannot occur without variation in inherited characteristics.*
    - a. *Fitness is a relative measure that will change as the environment changes.* Fitness is differential reproductive success.
  7. In evolutionary terms, *natural selection can act only on traits that affect reproduction.*
- B. Natural selection can act through not only differential death rates, but also through differential **fertility** rates.
  1. *Differential net reproductive success*

## IX. Constraints on 19<sup>th</sup> Century Evolutionary Theory

- A. Darwin argued that natural selection acts on variation within species, yet could not explain the source of this variation.
- B. Darwin also didn't know how favorable traits were passed from generation to generation.
  - 1. The laws of heredity were unknown, and most believed that parental traits were blended in the offspring.
  - 2. Gregor Mendel had worked out the modern principles of heredity, but his work was not recognized until the beginning of the 20<sup>th</sup> century.
  - 3. In 1953, the DNA structure was identified and the field of genetics became a supportive evidence for evolutionary theory.
  - 4. In 2003 the human **genome** was sequenced, followed by the chimpanzee genome in 2005.

**X. Opposition to Evolution Today**

- A. Darwin's formulation of evolution was offensive to Christians because it was in conflict with Biblical versions of the creation.
- B. Today, evolution is considered to be a fact by most biologists.
  - 1. Most belief systems do not emphasize **biological continuity** between species or offer scientific explanations for natural phenomena
  - 2. Scientific explanations are grounded in data analysis, hypothesis testing and interpretation, while religion is a system of faith based ideas not amenable to scientific testing and falsification.
    - a. Yet, evolutionary theories are accepted, in part, by the Catholic Church and most mainstream Protestants.
    - b. Most fundamentalists reject all scientific explanations of evolution.

**XI. A Brief History of Opposition to Evolution in the United States**

- A. After WWI conservative Christians in U.S. revived "traditional values" and avoided mention of Darwinism in public schools.
- B. "Scopes Monkey Trial", involved John Scopes who was arrested and tried for teaching evolution
  - 1. **Christian fundamentalists** opposed the teaching of evolution in public schools at the pre-baccalaureate level. They continue to do so, although recent attempts to legislate against the teaching of evolution have been overturned in courts.
    - a. Creationists have dropped the term "creationism" in attempts to mask their fundamentalist ideologies with less religious sounding terms such as "intelligent design theory."

***Key Terms and Concepts***

Christian fundamentalists	p. 46	Uniformitarianism	p. 34
Fertility	p. 44	Reproductively isolated	p. 31
Fixity of species	p. 29	Reproductive success	p. 41
Natural selection	p. 28	Selective pressures	p. 41
Binomial nomenclature	p. 31	Fitness	p. 40
Taxonomy	p. 31	Biological continuity	p. 45
Catastrophism	p. 32	Genome	p. 45

***Lecture Suggestions***

- 1. Students may be unaware that creationist/evolutionist debates have been ongoing for over 150 years. It is enlightening to demonstrate that many current "creationist" arguments are recycled ideas.
- 2. Most students have heard of Darwin, but few really understand the full impact of his ideas not only on scientific thought but also on his personal life. The author has found that, rather than lecturing,

showing a video on Darwin's life brings home these points. The video *Charles Darwin: Evolution's Voice* from A&E's *Biography* series is particularly relevant. Be sure to reinforce the fact that Darwin waited over twenty years to publish his ideas after returning from the voyage of the HMS *Beagle*, mostly because he was aware that his theories ran contrary to widely accepted Biblical doctrines.

3. Discuss the differences between subjective descriptions and objective explanations of change over time and the benefits and shortcomings of both.

### ***Internet Exercises***

1. Visit the National Center for Science Education's website, <http://ncse.com/> and read about creationist attempts to teach "creation science" in public schools. Use the "Critiques of Creationism" link and write a paragraph summarizing one of the critiques.
2. One historical figure that vehemently opposed Darwin's ideas was Louis Agassiz (1807-1873). Go to the University of California, Berkeley's Museum of Paleontology website for information on Agassiz <http://www.ucmp.berkeley.edu/> and write a brief paragraph on his life and ideas.
3. Go to the University of California, Berkeley's Museum of Paleontology website (<http://www.ucmp.berkeley.edu/fosrec/Scott.html>) for a discussion of antievolutionism. Why is it important that evolution be taught?
4. Visit the PBS Evolution website and select several of the lesson plans, activities, and videos about evolution to enhance understanding and class discussion on evolution ([www.pbs.org/evolution](http://www.pbs.org/evolution)).
5. There is an excellent series of lesson plans and activities for students to do online to enhance their understanding of evolution. Additionally, there are excellent video clips and documentaries about Darwin and evolution available through the PBS website, [www.pbs.org/evolution](http://www.pbs.org/evolution).

### ***Multiple Choice Questions***

1. In Europe during the Middle Ages, it was believed that
  - a. all species had evolved from a common ancestor
  - b. evolution was the result of natural selection acting upon genetic variation
  - c. all forms were created by God and did not change over time
  - d. most species had become extinct over time
  - e. life was created slowly, over millions of years

ANS: c                      REF: p. 29                      SOURCE: PICKUP

2. The discovery of evolutionary principles first took place in western Europe, made possible by
  - a. advances in scientific thinking that began in the 18<sup>th</sup> century
  - b. understanding by Christians that there was a recent origin of life on earth
  - c. the cohesive theory formulated by Arabs, Indians, and Chinese that species were continuously changing
  - d. advances in scientific thinking that date back to the 16<sup>th</sup> century.
  - e. the central importance placed on evolution by physical anthropologists.

ANS: d                      REF: p. 28                      SOURCE: NEW

3. What is the belief that species do not change but are the same as when first created known as?
  - a. fixity of species
  - b. the Great Chain of Being
  - c. truth
  - d. uniformitarianism

e. natural selection

ANS: a            REF: p. 29            SOURCE: PICKUP

4. Growing attacks on traditional beliefs resulted with growing awareness of biological diversity. \_\_\_\_\_ challenged a notion proposed by Aristotle to account for the movement of the sun and planets.
- Copernicus
  - Linnaeus
  - Darwin
  - Wallace
  - Mendel

ANS: a            REF: p. 30            SOURCE: NEW

5. Several events had combined to alter Western Europeans' ideas about the earth by the 18<sup>th</sup> century. These did *not* include
- the circumnavigation of the globe
  - the discovery of the New World
  - the notion of a sun-centered universe
  - a less than rigid feudal class system
  - “arguments from design”, meaning structures were engineered to meet purposes for which they were designed

ANS: d            REF: p. 28            SOURCE: NEW

6. By the 17<sup>th</sup> century, some scientists were beginning to break with long-held traditions and sought to investigate \_\_\_\_\_.
- natural phenomena
  - the supernatural forces that created life
  - the structure of the DNA molecule
  - how genetic mutations occur
  - fertility rates

ANS: a            REF: p. 31            SOURCE: NEW

7. \_\_\_\_\_ first recognized that species were groups of organisms that were distinguished from other such groups by their ability to mate with one another and produce fertile offspring.
- John Ray
  - Charles Darwin
  - Carolus Linnaeus
  - Alfred Russel Wallace
  - Jean-Baptiste Lamarck

ANS: a            REF: p. 31            SOURCE: NEW

8. \_\_\_\_\_ refined the existing system of classifying biological organisms into a binomial system.
- Jean-Baptiste Lamarck

- b. Georges Cuvier
- c. Carolus Linnaeus
- d. George-Louis Leclerc de Buffon
- e. Erasmus Darwin

ANS: c                      REF: p. 31                      SOURCE: NEW

9. Carolus Linnaeus
- a. established a binomial system of classification for plants and animals
  - b. was a proponent of evolutionary change
  - c. opposed all notions of fixity of species
  - d. was a supporter of Charles Darwin
  - e. developed theories of natural selection

ANS: a                      REF: p. 31                      SOURCE: PICKUP

10. \_\_\_\_\_ was an 18<sup>th</sup> century thinker who believed that living forms changed in response to the environment yet still rejected the idea that one species could give rise to another.
- a. Alfred Russel Wallace
  - b. Georges-Louis Leclerc de Buffon
  - c. Erasmus Darwin
  - d. John Ray
  - e. Georges Cuvier

ANS: b                      REF: p. 31                      SOURCE: PICKUP

11. **Charles Darwin was not the only one to conceive of natural selection. Who published an article suggesting current species were descended from other species?**
- a. **Jean Baptiste Lamarck**
  - b. **Erasmus Darwin**
  - c. **Georges-Louis Leclerc de Buffon**
  - d. **Alfred Russel Wallace**
  - e. **John Scopes**

ANS: d                      REF: p. 39-40                      SOURCE: NEW

12. Who was the first to actually attempt to explain the mechanism by which species change?
- a. Carolus Linnaeus
  - b. Jean-Baptiste Lamarck
  - c. Charles Lyell
  - d. Charles Darwin
  - e. Erasmus Darwin

ANS: b                      REF: p. 32                      SOURCE: PICKUP

13. Who was the first to recognize the role of the environment as a significant factor in evolutionary change?
- a. Jean-Baptiste Lamarck
  - b. Georges Cuvier
  - c. Thomas Malthus
  - d. Charles Darwin

e. Charles Lyell

ANS: a                    REF: p. 32                    SOURCE: PICKUP

**14. Who coined the term “biology”?**

- a. Jean-Baptiste Lamarck
- b. Georges Cuvier
- c. Thomas Malthus
- d. Charles Darwin
- e. Charles Lyell

ANS: a                    REF: p. 32                    SOURCE: PICKUP

**15. What is the term for the theory stating that characteristics acquired during the lifetime of an individual could be passed on to that individual’s offspring?**

- a. natural selection
- b. catastrophism
- c. use-disuse theory
- d. uniformitarianism
- e. fixity of species

ANS: c                    REF: p. 32                    SOURCE: PICKUP

**16. What is the view that the extinction and the subsequent appearance of more modern forms could be explained by a series of disasters and creations?**

- a. natural selection
- b. catastrophism
- c. use-disuse theory
- d. uniformitarianism
- e. descent with modification

ANS: b                    REF: p. 32                    SOURCE: PICKUP

**17. \_\_\_\_\_ was the opponent of Jean-Baptiste Lamarck and the proposer of the view that the earth’s geological landscape is the result of violent cataclysmic events.**

- a. Charles Lyell
- b. Alfred Russel Wallace
- c. Thomas Malthus
- d. Erasmus Darwin
- e. Georges Cuvier

ANS: e                    REF: p. 32                    SOURCE: PICKUP

**18. \_\_\_\_\_ wrote the highly praised *Principles of Geology* in which was emphasized the principle of uniformitarianism.**

- a. Charles Darwin
- b. Charles Lyell
- c. Alfred Russel Wallace
- d. Jean-Baptiste Lamarck
- e. Thomas Malthus



ANS: b

REF: p. 34

SOURCE: PICKUP

19. Thomas Malthus did *not*

- a. propose that population size is kept in check by the availability of resources
- b. write *An Essay on the Principle of Population*
- c. influence the development of Darwin's and Wallace's theories of natural selection
- d. enter the discussion of evolution as an economist
- e. argue against limits to human population growth.

ANS: e

REF: p. 33

SOURCE: NEW

20. \_\_\_\_\_ proposed that population size increases at a faster rate than food supplies.

- a. Erasmus Darwin
- b. Alfred Russel Wallace
- c. Thomas Malthus
- d. Charles Lyell
- e. Jean-Baptiste Lamarck

ANS: c

REF: p. 33

SOURCE: NEW

21. Which concept, proposed by Charles Lyell, had a profound effect on 19<sup>th</sup> century scientific thought?

- a. recent origins for earth
- b. the role of catastrophic events in producing geological phenomena
- c. natural selection
- d. the immense age of the earth
- e. the inheritance of acquired characteristics

ANS: d

REF: p. 34

SOURCE: PICKUP

22. The principle of uniformitarianism

- a. stated that the geological processes that operated in the past are still occurring in the present
- b. was a problem for the development of evolutionary theories
- c. proposed that the earth was only a few thousand years old
- d. was the same as the theory of catastrophism
- e. was first proposed by Georges Cuvier

ANS: a

REF: p. 34

SOURCE: PICKUP

23. Alfred Russel Wallace is best known for

- a. the principle of uniformitarianism
- b. being the co-discoverer of natural selection
- c. finding numerous important fossils during the 19<sup>th</sup> century
- d. finding numerous important fossils during the 18<sup>th</sup> century
- e. identifying changes in the coloration of a species moth

ANS: b

REF: p. 39-40

SOURCE: PICKUP

24. Charles Darwin

- a. grew up in modest circumstances

- b. began to doubt the fixity of species during a voyage around the world in the 1830s
- c. received no formal education
- d. spent two years in Africa where he developed the theory of natural selection
- e. was a physician who studied natural history as a hobby

ANS: b                      REF: p. 36-37                      SOURCE: PICKUP

**25. In formulating his theory of natural selection, Darwin did *not***

- a. recognize the importance of biological variation within a population**
- b. apply his knowledge of domesticated species to undomesticated ones**
- c. appreciate the fact that population size is limited by availability of food**
- d. wonder if he had enough supportive data**
- e. claim that favorable variations would tend to be destroyed, unfavorable ones be preserved.**

ANS: e                      REF: p. 37-38                      SOURCE: NEW

26. The fact that individuals who possess favorable traits are more likely to survive and reproduce than those who possess less favorable traits is the basis for which theory?

- a. uniformitarianism
- b. natural selection
- c. the inheritance of acquired characteristics
- d. catastrophism
- e. the fixity of species

ANS: b                      REF: p. 38                      SOURCE: PICKUP

**27. Which of the following concepts did NOT influence Darwin in developing his theory of evolution?**

- a. Population size increases more rapidly than food supplies.**
- b. There is competition among individuals for resources.**
- c. Species are unchanging types, and individual variation within a species is not important.**
- d. There is biological variation in all members of a species.**
- e. Favorable variations are passed on and accumulate in populations over time.**

ANS: c                      REF: p. 40-41                      SOURCE: PICKUP

**28. Darwin**

- a. was reluctant to publish his theories**
- b. wrote his theory of natural selection while still on board the *Beagle***
- c. published his theories as soon as he returned from his voyage on the *Beagle***
- d. was not concerned with public opinion and did not mind if his theories were criticized**
- e. knew his friends and colleagues would not be affected by the publication of his theory**

ANS: a                      REF: p. 38-39                      SOURCE: PICKUP

29. Which contemporary of Charles Darwin also developed a theory of evolution by means of natural selection?

- a. Charles Lyell
- b. Jean-Baptiste Lamarck
- c. Erasmus Darwin

- d. Alfred Russel Wallace
- e. Georges Cuvier

ANS: d                      REF: p. 39-40                      SOURCE: PICKUP

30. Regarding the example of the peppered moth, which of the following is not true
- a. the two color patterns resulted from genetic variation in the species
  - b. it has recently come under criticism
  - c. natural selection acted upon pre-existing variation in the population
  - d. the dark is more visible on the trees darkened by pollution
  - e. the most common variety of the peppered moth in England, prior to the 19<sup>th</sup> century, was a mottled gray color.

ANS: d                      REF: p. 41-42                      SOURCE: NEW

31. Which is the best example of natural selection?
- a. the peppered moth
  - b. the medium ground finch of the Galápagos
  - c. the recent *increase* in resistant strains of disease-causing microorganisms
  - d. the recent *decrease* in resistant strains of disease-causing microorganisms
  - e. Mendel's project with peas and beans

ANS: c                      REF: p. 42                      SOURCE: PICKUP

32. "Fitness," in an evolutionary sense, refers to an individual's
- a. strength
  - b. reproductive success
  - c. aggressiveness
  - d. size
  - e. age at death

ANS: b                      REF: p. 40                      SOURCE: PICKUP

33. When it came to explaining the origins of variation within species, Darwin
- a. used Mendel's theory of heredity
  - b. agreed with Lamarck that it was caused by an animal's inner needs
  - c. argued it was caused by differential use of an animal's body parts
  - d. had no idea of the true causes
  - e. used his research gathered while at Cambridge

ANS: d                      REF: p. 38-40                      SOURCE: NEW

34. Which is among the reasons that about half of Americans believe that evolution does not occur?
- a. the mechanisms of evolution are simple and easily explained
  - b. the mechanisms of evolution are complex and do not lend themselves to simple explanations
  - c. most people possess extensive familiarity with the principles of genetics
  - d. most have not read and studied "On the Tendency of Varieties to Depart Indefinitely From the Original Type", by Alfred Russel Wallace
  - e. many people do not want clear-cut answers

ANS: b                      REF: p. 45                      SOURCE: NEW

### ***True/False Questions***

1. Evolution is a theory that has considerable support from genetic evidence.  
ANS: True                      REF: p. 27-28                      SOURCE: PICKUP
2. The concept of evolution is unique to Western science.  
ANS: False                      REF: p. 28                      SOURCE: PICKUP
3. We credit Erasmus Darwin with significantly influencing Charles Darwin's evolutionary thinking.  
ANS: False                      REF: p. 32                      SOURCE: PICKUP
4. The theory of the inheritance of acquired characteristics has recently displaced natural selection as mainstream science's most accepted theory of evolutionary change.  
ANS: False                      REF: p. 42-43                      SOURCE: PICKUP
5. Charles Lyell, author of *Principles of Geology*, is considered the founder of modern geology.  
ANS: True                      REF: p. 34                      SOURCE: PICKUP
6. Charles Darwin recognized the importance of beak variation in finches while visiting the Galápagos Islands.  
ANS: False                      REF: p. 37                      SOURCE: PICKUP
7. Charles Darwin acknowledged the importance of sexual reproduction when formulating his theory of natural selection.  
ANS: True                      REF: p. 38                      SOURCE: PICKUP
8. Charles Darwin refrained from immediately publishing his theory of natural selection because he was aware of its controversial nature.  
ANS: True                      REF: p. 38                      SOURCE: PICKUP
9. There are no well-documented examples of natural selection operating in natural populations.  
ANS: False                      REF: p. 41- 44                      SOURCE: PICKUP
10. Creationism is considered a science because it has testable hypotheses.  
ANS: False                      REF: p. 47                      SOURCE: PICKUP

### ***Short Answer Questions***

1. Explain how traditionally held views prevented wide acceptance of evolutionary theories in 19<sup>th</sup> century Europe and America. Give a specific example.  
ANS: Will vary      REF: p. 28-31      SOURCE: PICKUP
2. Outline Lamarck's theory of inheritance of acquired characteristics. According to this theory, what was the environment's role in biological change?  
ANS: Will vary      REF: p. 32-33      SOURCE: PICKUP
3. Discuss the ideas of two individuals who significantly affected Darwin's formulation of the theory of natural selection.  
ANS: Will vary      REF: p. 32-34      SOURCE: PICKUP
4. How is natural selection related to environmental factors? How can selective pressures change? Give an example.  
ANS: Will vary      REF: p. 41-44      SOURCE: PICKUP
5. Although natural selection acts on the individual, it is argued that populations evolve. Explain.  
ANS: Will vary      REF: p. 41      SOURCE: PICKUP
6. Discuss the definition of fitness as it pertains to natural selection.  
ANS: Will vary      REF: p. 40-41      SOURCE: PICKUP

### ***Essay Questions***

1. Many people argue that evolution is "only a theory." Define *theory*, and then describe how evolution does or does not fit the definition.  
ANS: Will vary      REF: p. 28      SOURCE: PICKUP
2. Explain what is meant by differential net reproductive success. Give an example of how this mechanism works.  
ANS: Will vary      REF: p. 44      SOURCE: NEW
3. Many people in the United States believe in the biblical creation. What factors may account for the fact that many people do not accept evolution as an explanation for the origins and diversity of life?  
ANS: Will vary      REF: p. 45      SOURCE: PICKUP
4. Explain why Charles Lyell's principle of uniformitarianism was important to Charles Darwin and Alfred Russel Wallace as they developed their theories of biological evolution.  
ANS: Will vary      REF: p. 35      SOURCE: PICKUP