Chapter 19 Active Reading Guide
Descent with Modification

As you study this chapter, read several paragraphs at a time to catch the flow of ideas and understand the reasoning that is being described. In some places, the text describes a narrative or story of events that led to Darwin’s theory of evolution. Therefore, first read the narrative to absorb the big picture and then return to answer the few questions that accompany this material.

Overview

1. Define evolution broadly and then give a narrower definition, as discussed in the overview.
   - Evolution: Descent with modification; the idea that living species are descendants of ancestral species that were different from the present-day ones. Evolution is also defined as the change in the genetic composition of a population from generation to generation.

Section 1

This section takes a look at the historical setting and influences on Darwin, and it sets the stage for our formal study of evolution.

2. How did each of the following sources view the origin of species?
   - Aristotle and Scala Naturae:
     - Aristotle viewed species as fixed. Through his observations of nature, he recognized certain “affinities” among organisms. He concluded that life forms could be arranged on a ladder or scale of increasing complexity called the scala naturae.
   - The Old Testament: Species were individually designed by God and therefore perfect.
   - Carolus Linnaeus:
     - He adopted a nested classification system grouping similar species into increasingly general categories. He did not ascribe the resemblances among species to evolutionary kinship, but rather to the pattern of their creation.

3. Explain the role of fossils in rock strata as a window to life in earlier times.
   - Many fossils are found in sedimentary rocks formed from sand and mud that settle to the bottom of seas, lakes and swamps. New layers of sediment cover older ones and compress them into layers of rock called strata. The fossils in particular strata provide a glimpse of some of the organisms that populated Earth at that time that the layer formed.

4. How would Georges Cuvier have explained the appearance of the record of life shown in the rock strata?
   - He opposed the idea of evolution. He speculated that each boundary between strata represented a sudden catastrophic event, such as flood that had destroyed many of the species living in that area.
5. James Hutton and Charles Lyell were geologists whose ideas strongly influenced Darwin’s thinking. What were the ideas each of them contributed?

- **James Hutton:** He proposed that Earth’s geologic features could be explained by gradual mechanisms such as valleys being formed by rivers wearing through rocks.
- **Charles Lyell:** He incorporated Hutton’s thinking into his proposal that the same geologic processes are operating today as in the past and at the same rate.

6. What is the importance of the principle of uniformitarianism?

- If geologic changes result from slow continuous actions rather than from sudden events, than Earth must be much older than the widely accepted age of a few thousand years.

7. Jean-Baptiste de Lamarck proposed a mechanism for how life changes over time. Explain the two principles of his mechanism.

- **Use and disuse:** The idea that parts of the body that are used extensively become larger and stronger, while those that are not used deteriorate.
- **Inheritance of acquired characteristics:** The idea that states that an organism could pass these modifications of use and disuse to its offspring.

8. Although Lamarck’s mechanism of evolution does not explain the changes in species over time, his thinking has been influential. What is considered to be the great importance of his ideas?

- Lamarck recognized that the match of organisms to their environments can be explained by gradual evolutionary change rather than special creation.

**Section 2**

9. Charles Darwin proposed that the mechanism of evolution is natural selection and that it explains how adaptations arise. What are adaptations? Give two examples of adaptations.

- Adoptions are inherited characteristics of organisms that enhance their survival and reproduction in specific environments.
- **Examples:**
  - **Butterflies:** Non toxic ones have adapted to look like their more poisonous cousins.
  - **Bats:** Have adapted their hearing to hunt at night via sonic response.

10. Explain the process of natural selection.

- In the process of natural selection individuals that have certain inherited traits tend to survive and reproduce at higher rates than other individuals because of those traits.
11. Let’s try to summarize Darwin’s observations that drive changes in species over time:

<table>
<thead>
<tr>
<th>Observation</th>
<th>Cite and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Variations in traits exist.</td>
<td>Variations in color and spot patterns of Asian ladybird beetles</td>
</tr>
<tr>
<td>2. These variations (traits) are heritable.</td>
<td>Variation in closely related species of elephants; offspring resemble close relatives more than other members of a population.</td>
</tr>
<tr>
<td>3. Species overproduce.</td>
<td>A single puffball fungus can produce billions of offspring</td>
</tr>
<tr>
<td>4. There is competition for resources; not all offspring survive.</td>
<td>Not all these offsprings puffball fungus survive.</td>
</tr>
</tbody>
</table>

12. From these four observations, what two inferences did Darwin make?

1. Individuals whose inherited traits give them a higher probability of surviving and reproducing in a given environment tend to leave more offspring than other individuals.

2. This unequal ability of individuals to survive and reproduce will lead to the accumulation of favorable traits in the population over generations.

13. It is important to remember that differences in heritable traits can lead to differential reproductive success. This means that the individuals who have the necessary traits to promote survival in the current environment will leave the most offspring. How can this differential reproductive success affect the match between organisms and their environment?

- When such advantages increase the number of offspring that survive and reproduce, the traits that are favored will likely appear at a greater frequency in the next generations.

14. To demonstrate your understanding of this section, complete the following sentence:

Individuals________________ do not evolve. _Populations________________ evolve.

Hold the ideas in this section firmly in your brain! If you are ever asked to explain Darwin’s theory of evolution by natural selection (a common AP essay question), do not pull out the phrase “survival of the fittest.” Instead, cite the points made in question 11 and explain the inferences that are drawn from them.
Section 3

15. Use Figure 19.14 in your text to explain how research with soapberry bugs demonstrated observable evolutionary change.
   - Museum specimens showed that the average beak length of soapberry bugs was comparable to that of soapberry bugs feeding on Native species in Southern Florida. Contemporary data suggest that a change in the size of the soapberry bug’s food source, as seen with the introduction of the goldenrain tree, can result in evolution by natural selection for matching beak size.

16. MRSA is in the news today because it is becoming increasingly more common. What is it?
   - MRSA is methicillin-resistant Staphylococcus aureus, a flesh-eating strain of bacterium.

17. How did it become so dangerous? Explain the evolution of MRSA’s resistance to methicillin.
   - MRSA became very dangerous because over time, doctors used a variety of antibiotics such as penicillin, to combat MRSA. Each time a new antibiotic was used to fight the disease some S.aureus populations would develop resistance to the new drug. In 1959 doctors used the powerful antibiotic methicillin. Members of S.aureus population that were resistant to methicillin reproduced at higher rates leading to the spread of methicillin-resistant S.aureus (MRSA)

18. Do antibiotics cause bacteria to become resistant? Explain your response.
   - No. A drug does not create resistant pathogens. It selects for resistant individuals that are already present in the population.

19. Let’s make a list of the four evidences for evolution that are described in this concept. Give an example of each.

<table>
<thead>
<tr>
<th>Evidence for Evolution</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct observations of evolutionary change</td>
<td>The evolution of MRSA</td>
</tr>
<tr>
<td>Homology</td>
<td>Similarities between mammalian forelimbs</td>
</tr>
<tr>
<td>Fossil Record</td>
<td>Fossils that show ancestors of cetaceans had hind limbs.</td>
</tr>
<tr>
<td>Biogeography</td>
<td>The creation of the evolution tree of horses, based on fossil locations</td>
</tr>
</tbody>
</table>

20. How does the fossil record give evidence for evolution?
   - The fossil record documents the pattern of evolution showing that past organisms differed from present-day organisms and that many species have become extinct.

21. What is meant by each of the following terms? Give an example of each.
   - Homologous structures—Structures in different species that are similar because of common ancestry. Ex. Mammalian forelimbs
   - Vestigial structures—A feature of an organism that is a historical remnant of a structure that served a function in the organism’s ancestors. Ex. Skeletons of some snakes retain vestiges of the pelvis and leg bones.
   - Analogous structures—Having characteristics that are similar because of convergent evolution, not homology. Ex. The wing of a butterfly and the wing of a bat both make flight possible
22. How do homologous structures give evidence for evolution?
   - Homologous structures represent variations on a structural theme that was present in the common ancestors of a species.

23. What is summarized in an evolutionary tree?
   - An evolutionary tree reflects evolutionary relationships among groups of organisms.

24. Figure 19.20 in your text shows an evolutionary tree. What is indicated by each branch point in the figure?
   - Each branch point represents the common ancestor of the lineage.

25. Organisms that are only distantly related can resemble each other. Explain
   - Convergent evolution, and describe how analogous structures can arise.
   Convergent evolution is the independent evolution of similar features in different lineages. In such examples as the marsupials of Australia, in which species share features because of convergent evolution, the resemblance is said to be analogous. Analogous features share similar functions but not common ancestry.

26. Convergent evolution might be summarized like this: Similar problem, similar solution. Can you give two examples of convergent evolution?
   - Sugar Glider and flying squirrel-The ability to glide through the air evolved independently in these two distantly related animals.
   - Evolution of wings in birds and bats.

### Study Tip
Homologous structures show evidence of relatedness (whale fin, bat wing).
Analogous structures are similar solutions to similar problems but do not indicate close relatedness (bird wing, butterfly wing).

27. What is biogeography? How is it affected by continental drift and the presence of endemic species?
   - Biogeography is the geographic distribution of species. The geographic distribution of organisms is influenced by many factors, including continental, the slow movement of Earth’s movement over time and the presence of endemic species, species that are found nowhere else in the world.
Let’s wrap up all of these ideas with a final summary.

ORGANIZE YOUR THOUGHTS
1. Evolution is change in species over time.
2. Heritable variations exist within a population.
3. These variations can result in differential reproductive success.
4. Over generations, this can result in changes in the genetic composition of the population.

And remember: Individuals do not evolve! Populations evolve.