

Name _____ Period _____

Chapter 15: Tracing Evolutionary History

Guided Reading Activities

Big idea: Early earth and the origin of life

Answer the following questions as you read modules 15.1–15.3:

1. Ancient rocks constructed by ancient prokaryotic cells are referred to as stromatolites.
2. The prokaryotes that made the stromatolites were photosynthetic. Why does that suggest that these were actually not the first organisms that inhabited the planet?
This is due to the complex nature of photosynthesis, which makes it unlikely that it evolved so quickly.
3. List the four main stages by which scientists believe that life on Earth could have arisen.
(1) Abiotic synthesis of small organic molecules, (2) the synthesis of polymers, (3) creation of protocells, (4) origin of self-replicating molecules
4. The first photosynthetic bacteria were important to the development of life on Earth because they
 - a. removed O₂ from the atmosphere.
 - b. produced water vapor.
 - c. added O₂ to the atmosphere.
 - d. converted methane gas into sugar.
5. True or false: Lab experiments show that monomers can assemble into polymers without the aid of enzymes. If false, make it a correct statement.
True
6. Complete the following table, which describes the stages in the origin of life.

| | Abiotic synthesis of polymers | Formation of protocells | Self-replicating RNA |
|-------------|---|---|--|
| Description | <u>The spontaneous creation of polymers from monomers</u> | <u>The spontaneous formation of cells from collections of organic molecules</u> | <u>The ability of RNA to replicate itself from nucleotide monomers</u> |

7. Briefly describe the importance of ribozymes in the replication of RNA.
With the ability to self-replicate, ribozymes could begin to be shaped by the forces of natural selection. This would mark the beginning of the evolution of more diverse life forms.

Big idea: Major events in the history of life

Answer the following questions as you read modules 15.4–15.6:

1. The broad changes that have taken place on Earth since life began are referred to as macroevolution.
2. Which of the following was a key event in the history of life on Earth?
 - a. Colonization of land
 - b. Appearance of eukaryotic cells
 - c. Appearance of prokaryotic cells
 - d. All of the above
3. How long did it take for animals to evolve once multicellular eukaryotes appeared? Refer to Figure 15.4 on page 297 of your textbook.
About 1.5 billion years
4. What percentage of carbon-14 is left after 11,400 years? Refer to Figure 15.5 on page 298 of your textbook.
25%
5. True or false: Radiometric dating is based on the decay of radioactive isotopes over time. If false, make it a correct statement.
True
6. What key event marks the boundaries between eras in the geological record?
The boundaries are marked by mass extinctions.
7. During what period did the dinosaur flourish? For approximately how many years did dinosaurs walk the Earth?
They flourished during the Jurassic period. Dinosaurs were around for about 190 million years.

Big idea: Mechanisms of macroevolution

Answer the following questions as you read modules 15.7–15.13:

1. The theory of plate tectonics states that the Earth's crust is made up of a series of large plates.

2. Are South America and Africa getting closer or farther apart? Refer to Figure 15.7B on page 300 of your textbook.
They are getting farther apart.
3. True or false: Biogeography is the study of the distribution of all organisms on the planet. If false, make it a correct statement.
True
4. In 150 years, an earthquake strikes along the San Andreas fault causing a small chunk of California to break off and move off the coast. Briefly explain how this event could trigger macroevolution given enough time.
The organisms found in each environment would begin to be subjected to different selective forces. Given enough time, these forces could lead to organisms that are no longer able to interbreed.
5. Mass extinctions can obviously be viewed in a negative light, but is there anything positive that can come out of them?
They create new opportunities for life to evolve and fill the voids left by the extinctions.
6. Evidence suggests that we might be at the beginning of a sixth mass extinction. The difference between the previous five and this possible one is that this one is a result of what?
This extinction would be caused predominantly by human activities.
7. True or false: After the dinosaurs became extinct, marsupials expanded greatly through adaptive radiation, filling many of the open roles left behind by the dinosaurs. If false, make it a correct statement.
False, mammals expanded greatly after the extinction of the dinosaurs.
8. During adaptive radiations, the diversification of one type of organism can spur the development of a different type of organism. Briefly explain how this is possible and provide an example of such an event.
The diversification of land plants helped to spur the diversification of insects that pollinated them.
9. How far back do you have to go to find a common ancestor to Monotremes, mammals, and marsupials? Refer to Figure 15.10 on page 304 of your textbook.
 - a. Approximately 65 million years ago
 - b. Approximately 175 million years ago
 - c. Approximately 140 million years ago
 - d. Approximately 50 million years ago

10. Complete the following table, which describes the different ways in which changes in developmental genes can drive great evolutionary effects.

| | Changes in rate and timing | Changes in spatial pattern | New genes and changes in genes | Changes in gene regulation |
|--------------------|--|--|---|---|
| Description | A change in the timing or rate of developmental events | Changes in patterns of expression that have effects on body form | Duplications of genes that may result in the formation of new body structures | Changes that can occur as a result of a gene being regulated differently in different organisms |
| Example | Development of the human skull | Expression of homeotic genes in tetrapods and snakes | The different numbers of homeotic genes in fruit flies and mice | Changes in gene expression in stickleback fish |

11. An example of change in rate and time in humans is the development of our skull from the fetus to the adult.
12. A structure that evolves for one use and, over time, begins to be used for a different function is an example of a(n) exaptation. Provide two examples.
The feathers of birds and the flippers of penguins
13. True or false: Many complex structures that are seen in organisms today are a result of quick, evolutionary leaps. If false, make it a correct statement.
False, they would have been the result of gradual changes and the creation of many intermediate stages.
14. According to Figure 15.13 on page 307 of your textbook, how long ago did the evolution of modern horses begin? What is considered the ancestor of the modern horse?
About 5 million years ago; Hyracotherium is considered the ancestor of the modern horse.

Big idea: Phylogeny and the tree of life

Answer the following questions as you read modules 15.14–15.19:

- The evolutionary progression of a species or a group of species is known as phylogeny.
- Briefly explain how two organisms that live in different areas of the world can have similar adaptations and even resemble one another. Provide an example of such an occurrence.
In convergent evolution, organisms come to share characteristics because of the similarity of their environments. Examples are the Australian and North American moles.
- True or false: The fingers of humans and chimpanzees are an example of analogy. If false, make it a correct statement.
False, chimps and humans evolved from a shared ancestor.

4. Systematics is a part of biology that deals with the classification of organisms based on shared characteristics and the determination of their evolutionary connectedness.
5. The binomial scientific name of humans is *Homo sapiens*. What genus do we belong to?
Homo
6. Which of the following includes all of the others?
 - a. Species
 - b. Family
 - c. Phylum
 - d. Order
7. The amnion, hair, mammary glands, gestation, and long gestation would all be considered shared derived characters. Refer to Figure 15.16A on page 310 of your textbook.
8. The simplest explanation for a set of observations is known as _____.
 - a. parsimony
 - b. ingroup
 - c. cladistics
 - d. shared ancestral characters
9. Examine the phylogenetic tree in Figure 15.16B on page 311 of your textbook and identify the outgroup.
Lizards and snakes
10. True or false: The more recently two species branched away from each other, then the more similar their sequences of DNA should be. If false, make it a correct statement.
True
11. A method for establishing evolutionary relatedness using DNA or other molecules is known as molecular systematics.

12. A biologist discovers that the genes that code for crucial enzymes in glycolysis (look back at Chapter 6) are remarkably similar in humans, yeast, and oak trees. What can she infer from these data?

She can infer that these organisms share remarkably similar biochemical pathways.

13. Eukaryotes have DNA in their mitochondria that code for molecules used in cellular respiration. The vast majority of eukaryotic DNA is housed in the nucleus. The process of cellular respiration produces substances that can mutate DNA. Would mitochondrial DNA be good for establishing a molecular clock? Briefly explain your answer either way.

Based on the idea that you need a known and relatively stable rate of mutation, mitochondrial DNA may not be the best source of DNA for a molecular clock because that DNA may be more prone to mutation.

14. List the three major events depicted in Figure 15.19A on page 314 of your textbook.

Divergence of bacteria; gene transfer from mitochondrial ancestor; gene transfer from chloroplast ancestor

15. Horizontal gene transfer is a process by which DNA can be transferred from one genome to another through the following ways:

Viral infection, plasmid exchange, and the fusion of two organisms

CONNECTING THE BIG IDEAS

Use your knowledge of the information contained within this chapter's "Big Ideas" to answer this question.

Homology and analogy are commonly confused. How are they different? Do they both provide support for evolution by natural selection? Explain your answer.