Chapter 15

Review the Concepts

Exercise 1: 1. M 2. C 3. B 4. L 5. E 6. K 7. A 8. I 9. G 10. D 11. N 12. J 13. H 14. F

Exercise 2: 1. simple molecules 2. energy from lightning, UV 3. small organic monomers 4. polymerization 5. polypeptides and lipids 6. simple RNA replication 7. lipid/polypeptide protobionts 8. self-replicating RNA molecules. 9. enclosure of RNA by "membrane" 10. natural selection 11. the first "cells"

Exercise 3: A. 11, Phanerozoic, Mesozoic B. 14, Phanerozoic, Cenozoic C. 5, Proterozoic D. 2 Archaean E. 8, Phanerozoic, Paleozoic F. 3, Proterozoic G. 13, Phanerozoic, Cenozoic H. 7, Phanerozoic, Paleozoic I. 9, Phanerozoic, Paleozoic J. 4, Proterozoic K. 1, Archaean L. 10, Phanerozoic, Paleozoic M. 12, Phanerozoic, Mesozoic N. 6, Phanerozoic, Paleozoic

Exercise 4: 1. The mammoth is approximately 17,190 years old. (After 5,730 years, the ^{14}C-to-^{12}C ratio would be half as great. After 11,460 years it would be 1/4 as great, and after 17,190 years it would be 1/8 as great.) The minimum and maximum ages of the fossil are 15,471 to 18,909 years.

2. Half the potassium-40 would disappear in the first 1.3 billion years, leaving 0.5 gram. Half of this would disappear by 2.6 billion years, leaving 0.25 gram.

Exercise 5: 1. S 2. O 3. G 4. J 5. N 6. Z 7. A 8. L 9. R 10. U 11. E 12. F 13. C 14. K 15. I 16. B 17. V 18. W 19. X 20. Y 21. T 22. D 23. M 24. P 25. Q 26. H

Exercise 6: 1. G 2. B 3. D 4. C 5. E 6. A 7. F

Exercise 7: 1. phylogeny 2. fossil 3. homologies 4. convergent 5. analogy 6. Systematics 7. taxonomists 8. binomial 9. genus 10. species 11. species 12. domain 13. phylogenetic 14. cladistics 15. clades 16. monophyletic 17. closely 18. ancestral 19. derived 20. out-group 21. parsimony 22. birds 23. derived 24. systematics 25. base 26. closely 27. mitochondria 28. ribosomal 29. clock 30. 550 31. hypotheses 32. 99% 33. yeasts 34. duplication 35. plants 36. animals 37. domain 38. Bacteria 39. Archaea 40. Eukarya 41. animals 42. kingdoms 43. horizontal 44. viral 45. bacteria

Exercise 8: 1. species 2. genus 3. family 4. order 5. class 6. phylum 7. kingdom 8. domain

Exercise 9: 1. mosses, ferns, conifers, flowering plants 2. green algae 3. homologies 4. shared derived characters; shared derived characters 5. chlorophyll *b* 6. protected embryos 7. chlorophyll *b*, or protected embryos, or vascular tissues 8. seeds 9. shared derived characters 10. out-group: green algae, mosses; in-group: ferns, conifers, flowering plants 11. clade or monophyletic taxon 12. conifers and flowering plants 13. green algae, mosses, ferns, conifers, flowering plants, plants with seeds, plants with vascular tissues, plants, organisms with chlorophyll *b*

Exercise 10: 1. B or F 2. F or B 3. D 4. A or C 5. C or A 6. E

Test Your Knowledge

Multiple Choice: 1. d 2. a 3. c 4. e 5. a 6. b 7. d 8. a 9. e 10. a 11. b 12. c 13. b

Essay: 1. Miller's experiment showed how simple organic compounds could have formed from inorganic chemicals on the primitive Earth. A flask containing warm water simulated the sea, while CH_4, H_2, and NH_3 simulated the early atmosphere. Electrical sparks introduced into the flask simulated lightning. A condenser cooled water vapor and caused "rain" that washed dissolved compounds into the "sea." As material circulated through the apparatus, the sparks triggered chemical reactions that formed a variety of organic compounds, including a mixture of amino acids. Scientists now think that the early atmosphere was made mostly of N_2 and CO_2. Experiments with this mixture have not produced organic molecules.

2. When the land masses fused, the total amount of shoreline and shallow coastal areas was reduced, and many marine species that inhabit shallow waters may have died as their habitats shrank. Ocean current would have shifted, altering climate. Less land would have been near the moderate coastal climate, so the climate in the interior may have become more harsh, leading to extinction of land species. There were also massive volcanic eruptions in what is now Siberia, which may have affected climate. Mass extinction of ancient species may have opened up opportunities for the adaptive radiation of the survivors into new species. Gymnosperms (cone-bearing plants) and reptiles diversified in the colder, drier climate on land.

3. These events occurred in the following order: First prokaryotes, origin of eukaryotes, origin of animals, appearance of first vertebrates, movement of plants and animals onto land, dominance of dinosaurs and cone-bearing plants, origin of flowering plants, diversification of mammals, appearance of humans.

4. When plates collide, their edges may crumple and form mountain ranges. The Himalayas formed this way when India collided with Eurasia. Volcanoes often arise where plates grind past each other or one plate overrides another.

5. Domain Eukarya, Kingdom Animalia, Phylum Chordata, Subphylum Vertebrata, Class Mammalia, Order Primates, Family Hominidae, Genus *Homo*, Species *sapiens*.

6. Cladistics is a method that groups organisms into clades according to their evolutionary descent. A clade is an ancestral species and all its descendants. (In other words, the clade is monophyletic.) The organisms of a clade have shared derived characters unique to the clade. Ideally, each genus, order, or phylum in the taxonomic hierarchy is a clade. Cladistics has shaken the tree of life a bit. It suggests, for example, that eukaryotes are more closely related to archaea than they are to bacteria, even though archaea and bacteria are both prokaryotes.

Apply the Concepts

Multiple Choice: 1. e 2. c 3. b 4. c 5. d 6. c 7. b 8. a 9. b 10. c 11. a 12. c 13. e 14. b

Essay: 1. There would be 200 mg after 5,730 years, and 100 mg after 11,460 years. The tree was buried about 11,460 years ago.

2. The fact that UV light breaks chemical bonds poses some problems for the hypothesized role of UV in the origin of organic compounds. If UV light provided energy for the reactions that caused inorganic compounds to combine and form simple organic compounds, why did it not then cause these same organic compounds to break apart?

3. Sediments from the end of the Cretaceous contain a layer of iridium, an element rare on Earth but common in meteorites. The iridium layer may be fallout from a huge cloud of dust produced when a large meteorite or asteroid hit the Earth, probably near Mexico, where a large crater has been discovered. The dust could have blocked light and disrupted the climate for an extended period, killing off many plants and the dinosaurs that depended on them. At the same time, continental drift may have caused climatic changes. Massive volcanic eruptions in what is now India released particles into the atmosphere, perhaps contributing to the cooling. Finally, it is possible that a combination of factors is responsible for the demise of the dinosaurs. Many forms of marine life also perished; any of these hypotheses could account for the extinction of both dinosaurs and marine species.

4. One way to determine how closely related the birds are would be to compare their DNA base sequences or protein amino acid sequences. The greater the similarity between base sequences or amino acid sequences, the closer the relationship.

5. Apparently, the similarities between the two groups of vultures are analogous, not homologous. The birds probably have similar lifestyles and live in similar environments. They have apparently been similarly shaped by natural selection, even though they are not closely related. This is called convergent evolution.

6. If the "vultures" of America and Africa are not descended from a vulture ancestor, they do not form a clade. If the vultures do not share derived "vulture" characters that they inherited from a common ancestor, then "vultures" is not a monophyletic taxon.

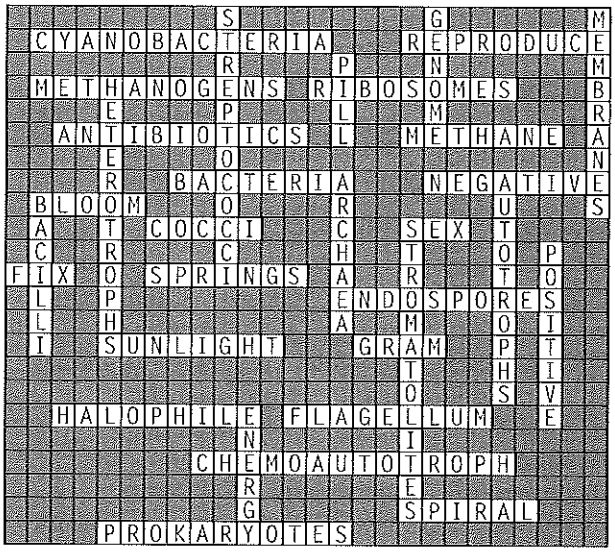
7. Complex structures such as the eye can evolve from much simper structures having the same basic function. In fact, several stages of eye evolution are seen among living mollusks—from a simple patch of light-detecting cells, to a cup-light structure that can locate a light source, to a complex camera-like eye with an iris and lens that can form sharp images. Natural selection could have shaped a complex eye from a simple light detector in many gradual steps.

Chapter 16

Review the Concepts

Exercise 1: 1. B 2. A 3. B 4. A 5. B 6. A 7. A 8. A 9. B 10. B 11. A

Exercise 2:



Exercise 3: 1. photoheterotroph 2. chemoautotroph 3. chemoheterotroph 4. photoautotroph 5. photoautotroph 6. chemoheterotroph

Exercise 4: 1. S, A 2. Q, B 3. O, B 4. T, B 5. O, B 6. M, A 7. N, B 8. Q, B 9. R, B 10. N, B 11. P, A 12. M, A

Exercise 5: 1. prokaryotes 2. eukaryotes 3. pathogens 4. poisons (toxins) 5. exotoxins 6. diarrhea 7. beef 8. botulinum 9. endotoxin 10. typhoid 11. sexually 12. endospores