CHAPTER 34
VERTEBRATES

Learning objectives

Invertebrate Chordates and the Origin of Vertebrates

1. Describe the four derived traits that define the phylum Chordata.
2. Describe the structure and way of life of larval and adult lancelets and tunicates.
3. Explain what lancelets suggest about the evolution of the chordate brain.

Craniates are Chordates with a Head

4. Discuss the importance of genetic duplication in chordate evolution.
5. Explain the fate of the neural crest cells in craniate development.
6. Explain what *Haikouella* and *Myllokunmingia* tell us about craniate evolution.
7. Describe the ancestral and derived features of the hagfish.

Vertebrates are Craniates with a Backbone

8. Describe the way of life and unique characters of the lamprey.
    a. Describe conodonts, and explain why they are considered vertebrates.
9. Describe the trends in mineralized structures in early vertebrates.

Gnathostomes are Vertebrates with Jaws

10. Explain one hypothesis for the evolution of the jaws of gnathostomes.
11. List the shared, derived characters that characterize gnathostomes.
12. Describe the evidence that suggests that the loss of bone in Chondrichthyes is a derived feature.
13. Describe the features of sharks that are adaptive for their active, predatory lifestyle.
14. Describe and distinguish between Chondrichthyes and Osteichthyes, noting the main traits of each group.
15. Identify and describe the main subgroups of Osteichthyes.
16. Name the three living lineages of lobe-fins.

Tetrapods are Gnathostomes with Limbs

17. Define and distinguish among gnathostomes, tetrapods, and amniotes.
18. Explain what *Acanthostega* suggests about the origin of tetrapods.
19. Describe the common traits of amphibians and distinguish among the three orders of living amphibians.

Amniotes have Tetrapods with Amniotic Eggs

20. Describe an amniotic egg and explain its significance in the evolution of reptiles and mammals.
21. Explain why the reptile clade includes birds.
22. Describe a number of reptile features that are adaptive for life on land.
23. Explain why non-bird reptiles should be called "ectothermic" rather than "cold-blooded".
24. Define and describe the parareptiles.

25. Distinguish between the lepidosaurs and the archosaurs.
26. Compare the interpretations of dinosaurs as ectotherms or endotherms.
27. Describe the specialized adaptations of snakes that make them successful predators.
28. List the modifications of birds that are adaptive for flight.
29. Summarize the evidence supporting the fact that birds evolved from theropod dinosaur ancestors.
30. Explain the significance of *Archaeopteryx*.

Mammals are Amniotes with Hair and Milk

31. Describe the derived traits characteristic of mammals.
32. Describe the evolutionary origin of mammals.
33. Distinguish among monotreme, marsupial, and eutherian mammals.
34. Describe the general characteristics of primates. Note in particular the features associated with an arboreal existence.
35. Distinguish between the two subgroups of primates and describe their early evolutionary relationship.

Humans are Bipedal Mammals with Large Brains

36. Define the term hominin.
37. Describe the evolutionary changes that occurred in the course of human evolution from about 35 million to 5 million years ago.
38. Explain what *Sahelanthropus* tells us about hominid evolution.
39. Describe the evolution of *Homo sapiens* from australopith ancestors. Clarify the order in which distinctive human traits arose.
40. Explain what analyses of mitochondrial DNA and Y chromosome suggest about human origins.
41. Explain the significance of the *FOXP2* gene. Describe the role that natural selection on this gene may have played in the evolution of human cognition.