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Chapter 1

1. The fluke of a whale and the fluke of a shark
   a. are homologous traits.
   b. arose through convergent evolution.
   c. are the result of natural selection.
   d. arose through convergent evolution and are the result of natural selection.
   e. are homologous traits, arose through convergent evolution, and are the result of natural selection.

ANSWER: d

2. Mammary glands in whales and humans
   a. were likely present in the most recent common ancestor of humans and whales.
   b. are homologous traits.
   c. A and B are correct.
   d. None of the given choices are correct.

ANSWER: c

3. Based on current fossil evidence,
   a. whales were likely fully aquatic before they evolved peg-like teeth or baleen.
   b. evolution of baleen forced whales to become fully aquatic.
   c. the teeth of extinct whales such as Dorudon were similar to those of extinct land mammals.
   d. whales were likely fully aquatic before they evolved peg-like teeth or baleen and the teeth of extinct whales such as Dorudon were similar to those of extinct land mammals.
   e. evolution of baleen forced whales to become fully aquatic and the teeth of extinct whales such as Dorudon were similar to those of extinct land mammals.

ANSWER: d

4. One important feature that links extinct organisms such as *Pakicetus* and *Indohyus* to cetaceans is
   a. the shape of a bone in the middle ear.
   b. the presence of forelimb flippers.
   c. the lack of hindlegs.
   d. peg-like teeth.

ANSWER: a

5. The placement of whales within the artiodactyls is supported by
   a. morphology of limb bones (e.g., the astragalus) in extinct whales.
   b. DNA evidence.
   c. the fact that some artiodactyls (e.g., hippos) spend a significant amount of time in the water.
   d. morphology of limb bones (e.g., the astragalus) in extinct whales and DNA evidence.
   e. morphology of limb bones (e.g., the astragalus) in extinct whales, DNA evidence, and the fact that some artiodactyls (e.g., hippos) spend a significant amount of time in the water.

ANSWER: d

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6. From examining the fossil record, scientists have postulated that long-term historic changes in cetacean diversity depended on
   a. changes in the abundance of diatoms, one of their main food sources.
   b. changes in the abundance of diatoms, which serve as food for animals that were preyed upon by cetaceans.
   c. changes in sea temperature.
   d. rising pollution levels in the ocean.
   e. changes in the abundance of organisms that prey on cetaceans.

ANSWER: b

7. Biologist Theodosius Dobzhansky wrote an essay in 1973 entitled "Nothing in _____ Makes Sense Except in the Light of _____."
   a. Evolution; Biology
   b. Biology; Phylogenetics
   c. Biology; Evolution
   d. Genetics; Biology

ANSWER: c

8. Which of the following is not a homology?
   a. the fluke of a whale and the tail fin of a tuna
   b. the mammary glands of a whale and of a platypus
   c. the ectotympanic of a human and the ectotympanic of a whale
   d. the lack of hind limbs in whales and dolphins

ANSWER: a

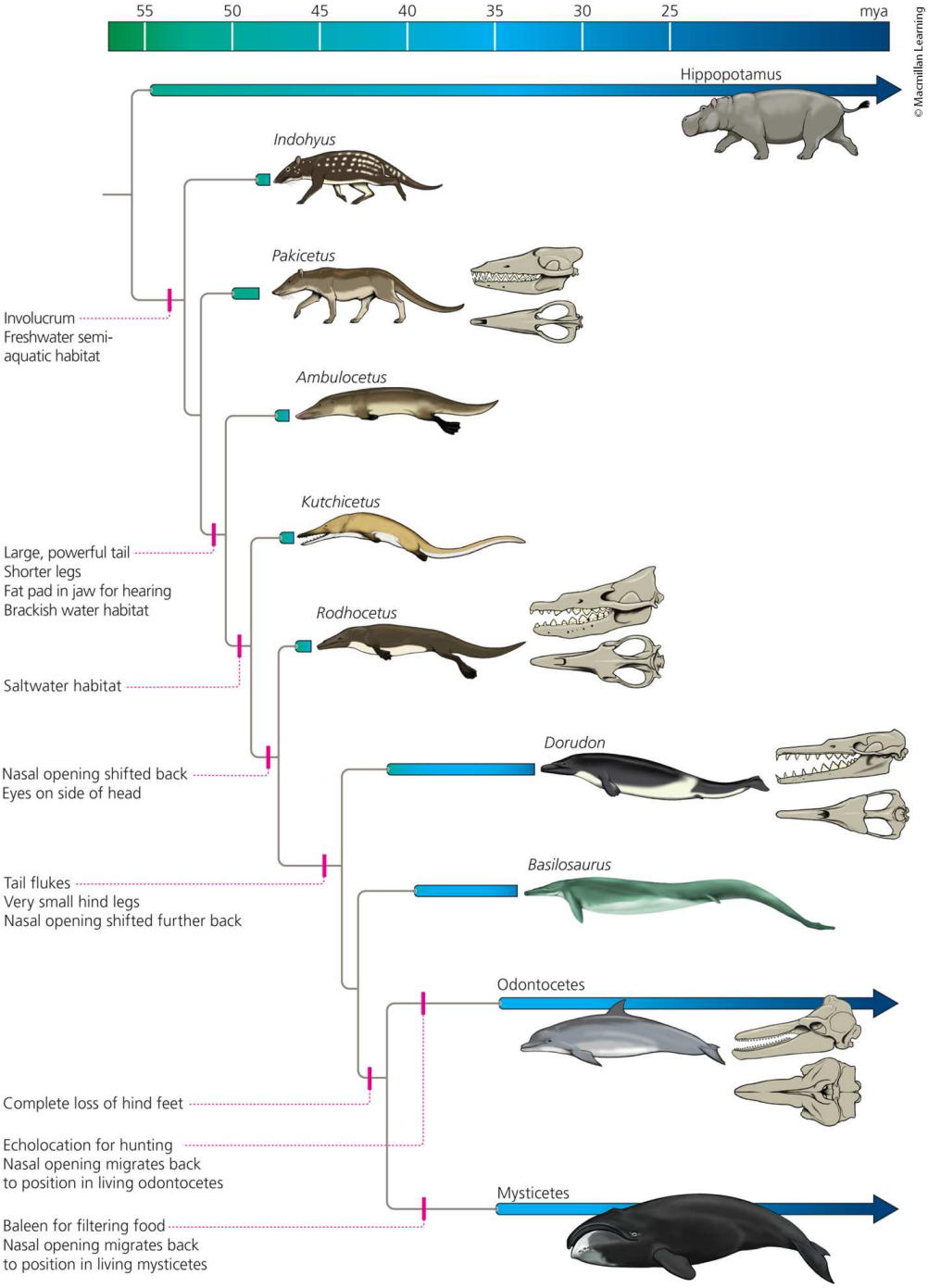
9. Given the phylogeny of extant and extinct cetaceans below, which of the following conclusions is correct?

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a. The hippopotamus belongs to the cetacean group.
b. The traits present in modern cetaceans appeared quickly and de novo.
c. All living cetaceans have completely lost their hind feet.
d. The hippopotamus belongs to the cetacean group and all living cetaceans have completely lost their hind feet.
e. None of the given choices are correct.

ANSWER: c

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10. Which of the following would explain why viruses such as SARS-CoV-2 evolve so rapidly?
    a. They have a high mutation rate.
    b. They have a high replication rate.
    c. They can undergo viral reassortment.
    d. None of the given choices are correct.
    e. All the given choices are correct.

ANSWER: e

11. The coronavirus that began to affect people in the city of Wuhan in China is
    a. pneumonia.
    b. COVID-19.
    c. SARS-CoV.
    d. SARS-CoV-2.

ANSWER: d

12. What type of virus is the SARS-CoV-2 virus?
    a. an enveloped RNA virus
    b. a non-enveloped RNA virus
    c. an enveloped DNA virus
    d. a non-enveloped DNA virus

ANSWER: a

13. Spike proteins are
    a. proteins on the viral surface used to aid the release of a new virus from the host cell.
    b. proteins on the surface of host cells used in the immune response against viruses.
    c. proteins on the viral surface used to aid in the entry of a virus into a host cell.
    d. All the given choices are correct.

ANSWER: c

14. What types of mutations are possible in viruses?
    a. beneficial
    b. neutral
    c. harmful
    d. All the given choices are correct.
    e. None of the given choices are correct.

ANSWER: d

15. Drawing on your knowledge of evolution, why is treatment and/or vaccination against viruses particularly difficult?
    a. Their high replication rate increases the probability of beneficial mutations.
    b. Their high mutation rate increases the probability of beneficial mutations.

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c. Viral reassortment increases the pathogenicity of viruses.
d. Their high replication rate increases the probability of beneficial mutations, and their high mutation rate increases the probability of beneficial mutations.
e. Their high replication rate increases the probability of beneficial mutations, their high mutation rate increases the probability of beneficial mutations, and viral reassortment increases the pathogenicity of viruses.

ANSWER: e

16. Which of the following is not an example of evolution?
a. Beak size in a population of birds becomes larger from one generation to the next because larger beaked birds had higher reproductive success and passed the trait to their offspring.
b. Over long periods of time, whales gradually lost their hindlimbs.
c. When humans travel to a high altitude, their physiology changes to accommodate lower oxygen levels.
d. None of the given choices are correct.

ANSWER: c

17. New mutations
a. are random with respect to their effects on fitness.
b. are necessary for natural selection to cause evolutionary change.
c. are rare in a population.
d. All the given choices are correct.
e. are random with respect to their effects on fitness and are necessary for natural selection to cause evolutionary change.

ANSWER: e

18. Evolution occurs when
a. individuals in a population change in response to the environment.
b. the average value of trait in a population changes from one generation to the next.
c. individuals in a population change in response to the environment and the average value of trait in a population changes from one generation to the next.
d. None of the given choices are correct.

ANSWER: b

19. Darwin argued that similarities between living species are the result of
a. change over time.
b. descent with modification.
c. change in allele frequencies in a population over time.
d. differential survival and reproduction of individuals with adaptive traits.

ANSWER: b

20. Which of the following may result in evolutionary change in a population?

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a. genetic drift
b. natural selection
c. mutation
d. All the given choices are correct.
e. natural selection and mutation

ANSWER: d

21. Which of the following is not an example of an organism's phenotype?
a. a plant gall produced by gall flies
b. the waving behavior of fiddler crabs
c. a heterozygote that has one dominant and one recessive allele
d. the open circulatory system in a beetle

ANSWER: c

22. Describe three pieces of evidence found in extant cetaceans that supports the idea that their ancestors had hindlimbs.

ANSWER: Modern whales have vestigial pelvic bones embedded in their bodies, remnants of hindlimbs from their land-dwelling ancestors. During embryonic development, whales briefly form hindlimb buds that later stop growing due to gene regulation changes. Additionally, whale genomes still contain deactivated genes that once built functional hind legs

23. Describe how scientists used oxygen isotopes to determine whether extinct whales likely inhabited freshwater or saltwater.

ANSWER: Scientists measured the ratio of heavy to light oxygen isotopes in fossil whale teeth to determine the type of water the animals drank. Lower ratios indicated freshwater environments (like Pakicetus), while higher ratios suggested seawater (like later whales). The gradual shift in isotope ratios reflected the transition from land to estuaries to the open ocean.

24. Describe two examples from extant cetacean anatomy or development that reflect their ancestral past.

ANSWER: Whales retain vestigial pelvic bones, a leftover structure from their terrestrial ancestors. Their embryos also begin to develop hindlimb buds that later regress, mirroring their evolutionary transition from land to water.

25. You discover a new 50-million-year-old fossil that you believe might be an ancient cetacean. The creature looks nothing like a modern cetacean—it has four legs and clearly spent considerable time on land. Describe one feature that would indicate that this creature was, in fact, an early cetacean.

ANSWER: A distinctive feature indicating it was an early cetacean would be the presence of a thickened involucrum—a dense lip of bone in the middle ear found only in whales and their ancestors. This structure is unique to cetaceans and serves as a clear diagnostic trait linking fossils like Pakicetus to modern whales.

26. Describe one piece of evidence that indicates that early four-legged whales (such as Indohyus and Pakicetus) are more closely related to modern-day whales than they are to the closest living four-legged relative of modern whales, the hippopotamus.

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ANSWER: Both Indohyus and Pakicetus possess the distinctive cetacean involucrum in their ear bones, a trait absent in hippos and all other mammals. This shared anatomical feature demonstrates that they belong to the whale lineage rather than being more closely related to hippos

27. Sirenians (manatees and dugongs) are aquatic mammals that, like whales, lack hind limbs. Is lack of hindlimbs a homologous trait for sirenians and cetaceans?

ANSWER: No, the lack of hindlimbs in sirenians and cetaceans is not homologous; it is an example of convergent evolution. Both groups independently lost hindlimbs as adaptations to aquatic life, not because they inherited that trait from a common ancestor.

28. The SARS-CoV-2 virus has only ten genes, which is far fewer than nonviral organisms. Why do you think viruses are able to survive and replicate with so few genes compared to other organisms?

ANSWER: Viruses can survive with few genes because they hijack the host cell's machinery for replication and protein synthesis. They rely entirely on host enzymes and ribosomes, so their own genomes only need to code for essential structural and regulatory proteins.

29. Before DNA evidence, scientists had a difficult time discerning where cetaceans fit into the mammalian family tree. Based on morphological features used to classify artiodactyls, why would it have been difficult to link cetaceans to artiodactyls based on morphological evidence alone? How do more recent discoveries in the fossil record link cetaceans to artiodactyls?

ANSWER: Early whale fossils lacked obvious traits connecting them to artiodactyls, making the link unclear based solely on external morphology. Later fossil discoveries revealed that ancient whales had a double-pulley astragalus—a distinctive ankle bone shape shared with artiodactyls, confirming their close evolutionary relationship.

30. When scientists infected vaccinated and nonvaccinated mice with SARS-CoV, they found that after nine sequences of viral passage the spike protein was altered in one of the groups. Which group was it, and what is the evolutionary explanation for the differences between the groups?

ANSWER: The vaccinated mice showed altered spike proteins after repeated viral passages. Natural selection favored mutations that allowed the virus to evade antibodies produced by vaccination, demonstrating adaptive evolution in response to immune pressure.

31. Given what you learned about how a virus changes over time, how could you explain the emergence of drug resistance in bacterial pathogens? For example, certain strains of tuberculosis are resistant to many of the major classes of antibiotics traditionally used to fight this pathogen.

ANSWER: Like viruses, bacteria evolve drug resistance through random mutations that confer survival advantages under antibiotic exposure. Natural selection favors these resistant variants, allowing them to proliferate while sensitive bacteria die out.

32. The 2009 H1N1 pandemic strain included genes from influenza that normally infects pigs, birds, and humans. How is this possible? Why are mixed strains particularly likely to cause high mortality?

ANSWER: The H1N1 strain emerged when different influenza viruses exchanged genetic material inside a shared host (a process called reassortment). These hybrid strains can combine virulence factors from multiple sources, making them novel to immune systems and often more lethal.

33. What is a scientific theory, and how does this differ from how we often use the term in a nonscientific

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context?

ANSWER: In science, a theory is a well-supported explanation backed by extensive evidence that unifies observations and predicts future findings—like the theory of evolution. In everyday language, "theory" often means a mere guess or speculation, which misrepresents its scientific rigor.

34. Evolution is often described as a completely random process. Is this true? Why or why not?

ANSWER: No, evolution is not completely random. While mutations occur randomly, natural selection is a nonrandom process that consistently favors traits enhancing survival and reproduction, shaping populations over time.

35. What does the acronym SARS stands for?

a. Serious Acute Respiratory Sickness
b. Severe Acute Respiratory Syndrome
c. Severe Asian Respiratory Sickness
d. South Asian Respiratory Sickness

ANSWER: b

36. The spike proteins of SARS-CoV-2

a. allow the delivery of the virus DNA to the host cell.
b. allow the release of a new virus from the host cell.
c. bind to the ACE2 receptor of cells.
d. reside within the envelope of the virus.

ANSWER: c

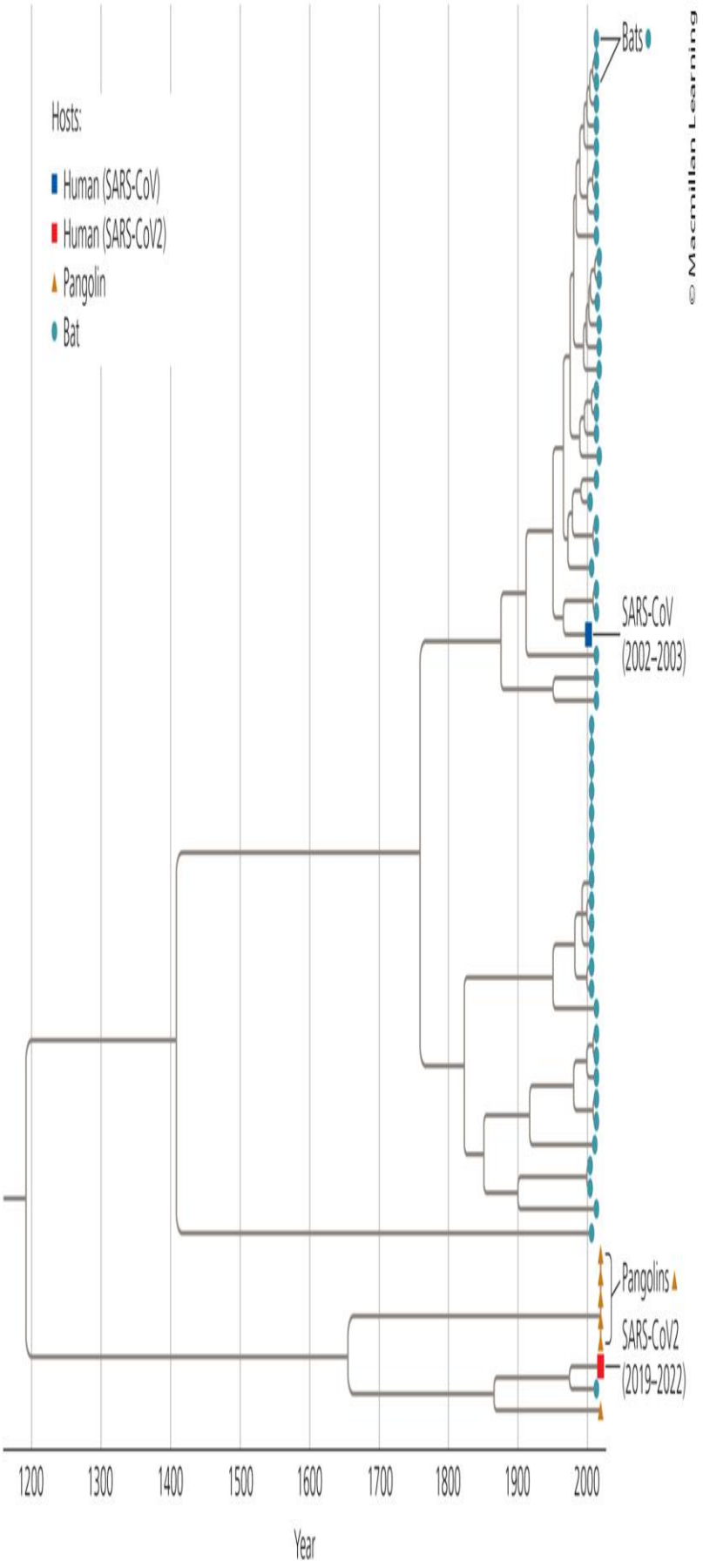
37. Based on the figure, SARS-CoV-2 probably evolved from the _____ virus.

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a. bat

b. omicron

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38. All the DNA in a cell is the cell's
    a. chromosome.
    b. gene.
    c. genome.
    d. genus.
    e. homology.

ANSWER: c

39. Simple changes to developmental genes can significantly impact the _____ of organisms.
    a. evolution
    b. genotype
    c. lineage
    d. mutations
    e. phenotype

ANSWER: e

40. The conserved regions of coronaviruses' spike proteins are potential targets for vaccines because they
    a. have a wide variety of diversity.
    b. bind to the ACE2 receptor on targeted host cells.
    c. have changed little over thousands of years of evolution.
    d. have no resistance to current vaccines.
    e. None of the options are true.

ANSWER: c

41. Are we concerned about future, new coronavirus outbreaks?

ANSWER: Yes. Both SARS-CoV and SARS-CoV-2 jumped from bats to an intermediate mammal host, and then to humans. MERS-CoV spread from bats to camels, and then to humans. There are thousands of other coronaviruses in mammals that can produce new outbreaks.

42. Why didn't the first generation of COVID-19 vaccines (designed in 2020) successfully treat against the 2021 Omicron variant?

ANSWER: Early COVID-19 vaccines were designed based on earlier variants of SARS-CoV-2. Omicron, a later variant, had mutated the structure of its spike protein. This adaptation allowed Omicron to become more effective at infecting targeted host cells and able to evade antibodies from early versions of the vaccine.

43. What is the name of a SARS-CoV-2 variant?
    a. Alpha
    b. Delta
    c. Omicron
    d. All of the above.

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e. None of the above.

ANSWER: d

44. What information can genomics reveal?

a. molecular mechanisms of adaptation

b. which genes have undergone strong selection

c. which future mutations that will occur

d. molecular mechanisms of adaptation and which genes have undergone strong selection

e. which genes have undergone strong selection and which future mutations that will occur

ANSWER: d

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