1. a) Correct, of course.

2. d) Correct. Mammals, cartilaginous fish, bony fish, and amphibians are all vertebrates.

3. b) Correct. They’re all members of the kingdom Animalia and the phylum Chordata, but they belong to four different classes.

4. a) Correct. Dolphins and killer whales inherited their streamlined shape from their relatively recent common ancestor. Killer whales and penguins are both streamlined because of convergent evolution, not because their common ancestor (an ancient reptile) had a streamlined shape.

5. c) Correct. The critical question is which organism separated from the killer whale most recently. The mouse had a common mammal ancestor with the killer whale. For the whale-earthworm ancestor, we’d have to go back to the split between the protostomes and the deuterostomes. For the maple tree, we’d have to go back to before the founding of the animal and plant kingdoms.

c) No. Cladograms are based on when lineages separated. The reason we choose the order in d) is the recency of the common ancestor. But it is generally true that the longer organisms have been separated, the more different they are.

d) Correct. In cladistics, recency of the common ancestor is the critical question.

6. b) Correct. It would also be valid to write it O. orca or O. orca or Orinus orca, but the specific epithet should not start with an upper-case letter.

7. No. To argue this you’d have to have information that they can still interbreed with one another, and we just don’t know. That’s what the controversy is about.

b) Correct. This is the safest position–well, maybe.

c) No. To argue this you’d have to have information that they can’t still interbreed with one another.

8. a) Correct. 6,000 x 2.2 = 13,200 pounds.

10. c) Correct. 9.8 m = 39.4 x 9.8 = 386 inches. Say an average human is 5’6” tall. This is 66 inches. 386/66 = 5.85. Certainly this is a better estimate than all the other answers.

11. a) Correct.

12. d) Correct. The duodenum is the first part of the small intestine.

13. a) No, pH 12 is way too alkaline for seawater.

b) Correct, and you don’t need a calculator. Seawater has a pH of about 8, or slightly alkaline. Gastric juice is about pH 2. b) is the only answer that comes close to this.

c) No. This says that the seawater is at pH 7 (pretty close) but that the gastric juice is intensely alkaline. Gastric juice is acid.

d) No. Seawater is not over pH 14.

14. c) Correct. The stomach carries out partial digestion of proteins. No other digestion occurs there
because the stomach acid stops the action of salivary amylase (in humans). I don’t know if killer whales have amylase in their saliva, but probably not. Probably they don’t even have saliva.

c) No, the small intestine cannot store large amounts of food.

15. a) Correct. The fragments shown are peptides. This shows more and more bands that are getting smaller and smaller as the proteins are cut up into smaller peptides.
b) No. This shows increasing bands, but the bands are getting bigger.
c) No. No digestion is taking place here.
d) No. This shows more and smaller bands at the beginning than at the end.

16. b) Correct. Fats are the most energy-rich common macromolecule, with over 9 kcal/g. Proteins and carbohydrates both have 4 kcal/g. Surprisingly, alcohol has 7 kcal/g, almost as much as fat.

17. a) No, this is an oxidized electron acceptor, and contains little energy.
b) No, cAMP contains little energy, and is used more as a signaling molecule than an energy storage molecule.
c) No, glucose does contain energy, but it has no direct role in muscle contraction.
d) Correct. ATP binds to the myosin heads and moves them to the “cocked,” high-energy position.

18. a) No. A buildup of ATP would allow muscle contraction to continue.
b) No, if the Krebs cycle cannot work, then succinate won’t be formed.
c) Correct. Fermentation of pyruvate begins if muscle metabolism exceeds the supply of oxygen.
d) No. If the Krebs cycle is working, citrate would disappear. Also, the Krebs cycle could not work if glycolysis is not supplying the molecules it needs.

19. a) Any exercise will lower concentrations of ATP, but that is not the direct reason for continued oxygen consumption.
b) Correct. The lactate formed by fermentation must be oxidized back into pyruvate so it can be metabolized.
c) No. If oxygen is not present due to fast exercise, the electron transport system is not operating because it has no oxygen to which to pass its electrons.

20. a) Correct. The only time oxygen is consumed is in the final step of electron transport. Carbon dioxide is produced during the Krebs cycle and the formation of acetyl-CoA, often considered to be part of the Krebs cycle.

21. d) Correct. Hemoglobin has four protein chains, each with an iron-containing heme group.

22. b) Correct. When oxygen is abundant, Hb takes it up and becomes HbO2. When oxygen is low, hemoglobin dissociates and releases its oxygen. Therefore we will form HbO2 in the lungs, form Hb in the muscles, and release oxygen from all the Hb as oxygen concentrations decline during a dive.

23. a) Correct. To absorb the most oxygen, the diffusion gradient from the alveoli to the blood should be as steep as possible. If the blood in the lungs has high oxygen, no oxygen will be absorbed.

24. c) Correct. The oxygenated blood is about to be pumped out to the body.
25. a) No. F and J are OK, but the pulmonary artery in that case would be H.
   b) No. E and G might be OK, but the lungs would have to be J. The blood enters the left atrium from the lungs.
   c) No. If B is the right atrium, the left ventricle is C and the aorta is G, the lungs would be I. E would be correct for the pulmonary artery.
   d) Correct. Take a look:

   ![Diagram of heart and blood flow](image)

26. c) Correct. The main factor governing breathing rate is CO2 buildup that makes the cerebrospinal fluid acid.
   d) No, the blood becomes too acid.

27. b) Correct. The SA node is the pacemaker of the heart.

28. a) Correct. The vagus nerve (parasympathetic) opens potassium channels. The potassium leaks out, making the inside of the SA node more negative and taking it farther from threshold depolarization.

29. d) Correct. Sympathetic nerves open calcium channels. The calcium enters the SA node, making it more positive and bringing it closer to threshold depolarization.

30. c) Correct. Hirudinea are leeches.

31. d) Correct. Quaternary structures are formed by two or more peptide chains. Tertiary would be the twists and turns of one chain.

32. b) Correct. 3, 4 and 1 happen in the nucleus and 5, 6 and 2 happen in the cytoplasm.

33. a) Correct. This was the Crick and Brenner experiment of 1961. In order the others were the Hershey-Chase, Griffith, and Meselson and Stahl experiments.

34. Take a look at the diagram with certain bands emphasized:
On the Restriction Enzyme 1 gel, there is no consistent evidence of a restriction fragment that is not found in normals but is found in all bent-fin whales. On Restriction Enzyme 2, there is such evidence. The three highlighted bands in the normals become the six highlighted bands in the bent-fin whales. This means that the mutation causes the creation of an additional restriction site. Therefore:

d) Correct.

35.  
c) **Correct.** The normal x normal = bent mating could be a mating between two heterozygotes that produces a recessive offspring. This could not have happened if bent were dominant because then at least one of the parents would have to be bent. The other matings could have happened whether bent is dominant or recessive. All this doesn’t mean that the colleague is right, just that the few results do not conflict with his hypothesis.

36.  
b) **Correct.** The fact that the offspring have a different phenotype from both parents suggests partial dominance.

c) No, this makes it seem as if white is completely dominant.

37.  
a) **Correct.** “Gray-and-black” is the phenotype of the heterozygote. Therefore, the frequency of the white allele is $(1)(0.35) + (0.5)(0.1) + (0)(0.55) = 0.40$.

38.  
c) **Correct.** [white allele] = 0.4 and [gray allele] = 0.6. If the whales were mating randomly, you would expect the phenotypic frequencies to be 0.36 gray, 0.48 gray-and-black, and 0.16 white. The big loser here is gray-and-mottled, which is only 0.1 of the population instead of 0.48. The grays and the whites are mating within their groups and are not mating with each other.

39.  
d) **Correct.** The fact that the reproductive rate is so slow and the mortality of the young is severe means that the population will not be dominated by young whales. But the fact that the mortality is slight after six months means that there isn’t much mortality of adult whales. If the population is stable, the number of young whales moving into the adult category must equal the number of adult whales moving into the old category, so the population will have equal representation of all age classes.

40.  
d) **Correct.** All of those statements are true of both mitochondria and chloroplasts.