Answers to Clemson University Biology Merit Exam
28 April 2018

1. d) Correct. Archaea are prokaryotes.

2. a) No, it is endothermic or “warm-blooded.”
   b) Correct. This would mean that elephants lay eggs like a bird.
   c) No, the elephant does not nourish its young with a placenta.
   d) No, elephants are bilaterally symmetrical.

3. a) No, this is a genus name and can stand by itself.
   b) No, this is an abbreviation for the binomial, and is accepted.
   c) Correct. The specific epithet cannot stand by itself. It must be present with the genus name.

4. a) Correct. This is why they went from being subspecies of *L. africana* to having separate binomial names.
   b) No, this was known way before the 1990s, and the different genus names reflect that.
   c) No, again, known for a long time, and that why there were always different genera.
   d) No, this was the situation in the 1990s. It was changed to answer a).

5. a) Correct. The Neogene extended from 23 million years ago to 1.6 million years ago. The others are far older (e.g., about 250 million years ago for the Permian).

6. a) Correct. This is pushing the envelope a little because *Ardipithecus* fossils are only known from 5.8 million years ago, but this is a far better choice than any of the others. *H. habilis*, for example, originated 2.5 million years ago.

7. b) Correct. We don’t think *Ardipithecus* had any more tools than chimpanzees do today. These chimp-sized hominins would have been no match for an elephant.

8. c) Correct. 4 m x 39.4 inches/m = 157.6 inches, or 13.1 feet. Big!

9. d) Correct. Humans have 12 pairs of ribs and 32 teeth. Note that the question says elephants have 21 pairs of ribs, not 21 ribs.

10. a) Correct. “Incisors” means “cutters.” The other teeth mentioned are the canines and the molars.

11. c) Correct. The radius and ulna are the two bones of the forearm that rotate around one another to allow us to rotate our hands. Metatarsals are in the feet and the scapula and clavicle are in the shoulder.

12. b) Correct. The elephant has a blocky body form and the giraffe is tall and thin. This and the elephant’s greater size mean that the elephant has a substantial problem getting rid of its body heat. It is thought that the ears of elephants are so big and mobile so the animal can use them as heat radiators and fans.

13. d) Correct. Cells benefit from a large surface/volume ratio, and this is achieved best by small cells.

14. a) Correct. Since demand is proportional to cell volume and supply is proportional to cell surface area, cells with large surface/volume ratios have the largest ratio of supply to demand.
   b) No. While this might be true, it is because of answer a).
   c) No. Small cells have to have more membrane per unit volume.

15. b) Correct. 330 kg = 726 pounds, a little less than five students.

16. c) Correct. The first step will be that an arriving action potential spills calcium from the sarcoplasmic reticulum. The calcium allows the binding sites on actin to be uncovered. The other steps all come later.
17. a) No. Depletion of neurotransmitters would probably not occur in slow exercise.
b) Correct. Slow exercise will be aerobic, and will probably end due to depletion of glycogen. Fast exercise will probably be anaerobic, and will generate lactic acid plus rapidly deplete stores of muscle glycogen because only 2 ATPs are being generated per glucose.
c) No. I've never heard of enzymes being denatured by body heat, unless by a lethal fever.

18. a) Correct. If the muscles go anaerobic, lactic acid will accumulate and glycolysis will only produce 2 ATPs per glucose. This will limit the duration of the exercise.
d) No, the best electron acceptor is very electronegative oxygen.

19. b) Correct. Water is the reduced electron acceptor and carbon dioxide is the oxidized energy source.

20. c) Correct. When oxygen becomes water by accepting electrons and hydrogens, it becomes a reduced electron acceptor.

21. d) Correct. Increased CO₂ is a far more potent stimulus for breathing than lack of oxygen is.

22. c) Correct. Imagine breathing through a cardboard tube over your nose and mouth. The air inside the tube would soon get foul and reduce air quality in the lungs. The elephant's lungs are big enough so it can pull all the air out of the tube and get in much fresh air in addition. But if a human tried to breathe through a six-foot artificial trunk, he probably would pass out before too long.

23. a) Correct. During exercise, sympathetic stimulation increased the rate of depolarization of the SA node. During rest, sympathetic stimulation is declining.
b) No. The vagus slows the heart rate, so if its activity is declining, the heart rate should be speeding up.
c) No. The SA node is not exhausted, and it still initiates the heartbeat.

24. b) Correct. Both gradients will decline. First, the CO₂ and the oxygen in the blood are approaching resting values. Blood CO₂ is going down and blood oxygen is going up. Second, breathing is slowing, so the CO₂ in the lungs is rising and the oxygen is falling. Put both of these together and you can see that both gradients are being reduced. This is to be expected, since the demand for oxygen and the need to expel CO₂ are going down as the elephant recovers.

25. d) Correct. The SA node is in the right atrium. This handles deoxygenated blood from the body that is rich in CO₂. However, as the elephant recovers, oxygen is going up and CO₂ is going down.

26. b) Correct. The valve between the right atrium and right ventricle is the tricuspid valve.

27. a) Correct.

28. a) No. All action potentials have the same amplitude.
b) No. All action potentials have the same polarity.
c) Correct. The more intense the stimulus, the more frequent the action potentials will be.

29. d) Correct. The vision center is in the back of the cerebrum, in the occipital lobe.

30. a) Correct. The flowering plants are the Anthophyta. In Africa, the dominance of flowering plants is almost complete. The other plants in the question are club mosses, mosses, and conifers.

31. c) Correct. Endodermis is in roots, not stems or foliage.

32. a) No, the males might be able to help in predator defense.
b) No, this is a possibility, but why expel only the males? The females are competing against the other females in the group too.
c) Correct. The expulsion of the males is an anti-inbreeding measure. They probably share harmful recessive alleles with their family members, and these would be expressed in some offspring if the males were allowed to stay and mate with the local females.
d) No. The females could suffer from meiotic errors as well.

33. b) Correct. The “average” human menstrual cycle has 14 days before ovulation and 14 days after it, for a total of 28 days. Note how much shorter this is than the 14-week estrus cycle of the elephant.

34. d) Correct. The number of possible arrangements of maternal and paternal chromosomes is $2^n$, where $n$ is the haploid number. Elephants have a haploid number of 28, 5 more than humans. $2^5 = 32$ times more possible arrangements than humans.

35. a) Correct. Low fertility, much parental care of young, and long lifespan are all hallmarks of a K-selected species.

36. d) Correct, all of these are possible reasons. The source I consulted said the main reason is that they are never culled by predators, who would tend to kill the individuals most weakened by parasites

37. a) No. The small ears have been seen in the area before, so it’d probably not a new mutation.
b) No. The calf with the small ears is a female.
c) No. If it were dominant, either the mother or the father and possibly both would have had small ears.
d) Correct. This is the best possibility. Say that only ee confers the small ear phenotype. A mating of two Ee elephants could produce the “sudden” appearance of small ears from two big-eared parents.

38. a) No. If the hypothesis is correct, this would produce 25% small ears.
b) Correct. ee x ee produces all small-eared offspring.
c) No. Ee (father) x ee (calf) produces only 50% small ears.

39. a) Correct. This is not conclusive, but the calf could have one (e) band and the heterozygous mother would have and E and an e. The calf does not have an E allele, and this is the band that the calf is missing.
b) No. This would either be inconclusive or imply that the mother is the homozygote. If she were ee, she would have small ears. If she were EE, the offspring would not have small ears.
c) No. If they had identical banding, there is no positive evidence of a genetic difference between them.
d) No, a) will support, but not confirm, the hypothesis.

40. a) No. This would imply that the gene is active in both months x and y (both green and red), and it does not give any evidence that it is concerned with ear development.
c) Correct. If we’re right, the ear size gene should be active in month x but not in month y. This means that gene’s spot on the array should be red with no trace of green. Of course, this supports but does not prove the hypothesis. The gene we’ve targeted might be some other gene that is active in month x but not y. However, the result is still consistent with the hypothesis.