Clemson University Biology Merit Exam
11 April 2014

Please choose the best answer for each of the following questions. Questions marked with an "*" are worth 4 points each; questions marked with a "#" are worth 2 points each; the unmarked questions are worth 1 point each.

CAUTION: Incomplete erasures and smudges can be read as marks. To avoid having a choice read incorrectly, make your marks lightly at first. After you have made all your changes, blacken in your marks just before you turn in your answer sheet.

The theme of this exam is a one of the largest and most majestic birds of the world, the wandering albatross. Although few South Carolinians have ever seen this bird, you may remember Samuel Taylor Coleridge’s 1798 poem, “The Rime of the Ancient Mariner”:

‘God save thee, ancient Mariner!
From the fiends, that plague thee thus!—
Why look’st thou so?—With my cross-bow
I shot the ALBATROSS.”

1. The Latin name of the wandering albatross is Diomedea exulans. Here, “Diomedea” is the … and “exulans” is the
   a) genus … family.
   b) family … genus.
   c) genus … specific epithet.
   d) genus … species.

   The Latin word “exulans” means “exile” or “wanderer,” referring to the epic journeys made by the wandering albatross.

2. Albatrosses are members of the phylum
   a) Vertebrata.
   b) Chordata.
   c) Animalia.
   d) Eukarya.

# 3. Albatrosses are
   a) deuterostomes.
   b) ectothermic.
   c) autotrophic.
   d) radially symmetrical.
4. An albatross is obviously a bird, and recently biologists have decided that birds should be switched from the Class Aves to the Class Reptilia. Birds are now considered to be a type of crocodilian. Really! The primary reason for making this change was that now we believe that birds
   a) are genetically almost identical to reptiles.
   b) have a lifestyle that is very similar to that of reptiles.
   c) diverged from the reptiles rather recently in evolutionary time.
   d) have eggs and embryonic development that are very similar to those of reptiles.

   Albatrosses are renowned for their ability to glide thousands of kilometers over the ocean while hardly ever flapping their wings. They can use the difference in wind speed between the upper air and the calm air in the lee of large waves to constantly regain their altitude and speed. This is called dynamic soaring. As a matter of fact, they use less energy while flying than they do while sitting on their nest! However, this strategy only works where there are large waves and strong winds. Thus albatrosses are present in the colder north and south temperate zones, but cannot penetrate into the equatorial zones because conditions are calmer there.

5. In 1996, there was a major effort to determine the taxonomic relationships among the species of albatrosses. This used DNA that was outside the nucleus. The albatross organelle that contained this DNA was the
   a) ribosome.       b) centriole.    c) chloroplast.  d) mitochondrion.

6. ... of the organelles in the previous question would also be found in prokaryotic cells.
   a) One       b) Two       c) Three       d) Four

7. This study found that the split between a certain two groups of albatrosses occurred 10 million years ago. If you went back 10 million years, you would find
   a) no humans.
   b) a great number of australopithecine species.
   c) Homo sapiens engaging in competition with Neandertal man in Ice Age Europe.
   d) only Homo sapiens, who had occupied the whole Old World but was not present in the New World yet.

8. Just like man-made gliders, albatrosses need long, thin wings to glide so effortlessly:

   Wandering albatrosses have the largest wingspan of any bird. The largest wingspan ever reliably measured was 3.7 m. This is ... times the height of a six-foot man.
   a) 1.5       b) 2.0       c) 0.6       d) 3.7
9. Wandering albatrosses feed on squid, fish, and shrimp. The phylum that is not represented in this list is
   Sometimes albatrosses eat such a large quantity of food that they are too heavy to take off and are marooned on
   the water surface. And some of the squid they eat may have been already dead...because they have been
   vomited up by overeating whales.

10. One source says that wandering albatrosses feed at night. If sight is the main way they find their prey, then they are using ... to transduce the dim light into action potentials.
   a) the organ of Corti b) cones.
   c) ampullae of Lorenzini. d) rods.

11. Considering their diet, the main enzymes that albatrosses would use to break down their food would be those that digest ... bonds.
   a) peptide b) glycosidic c) beta d) phosphodiester

12. The result of this digestion in humans would be that large numbers of ... would be absorbed into the
   a) monosaccharides ... lacteals. b) nucleotides ... pancreas.
   c) fatty acids ... rugae. d) amino acids ... capillaries in villi.

13. Say that you’re studying an albatross colony on chilly island of South Georgia in the South Atlantic. Since dawn, you’ve been peering through a telescope and making notes. Finally, you can take the hunger no more and you eat a candy bar. The graph below shows the concentrations of glucose in your hepatic portal vein (leading from your gut to your liver, thin solid line) and in your hepatic vein (leading from your liver to your heart, heavy dashed line).

   ![Graph of glucose concentration over time]

   Note that the glucose concentration fluctuates in your hepatic portal vein, but hardly changes in your hepatic vein. The reason for the difference between the two vessels is that
   a) as glucose travels from the gut, it is absorbed into atherosclerotic plaques.
   b) the liver can digest glucose and make smaller monosaccharides.
   c) the liver breaks down glycogen during fasting, and makes glycogen during feeding.
   d) after you ate, the pancreas secreted insulin, which caused the breakdown of glycogen in the liver
   and muscle cells.

14. If you had diabetes, would these curves be different?
   a) Yes. The dashed line would be higher and would go much higher after eating. The solid line would be higher before eating too.
   b) Yes. The solid line would start higher and not go as high. The dashed line would be the same.
   c) Yes. The lines would be reversed, with the solid line being constant and the dashed line changing dramatically.
   d) No. Both lines would be about the same as they are above.

15. When the hepatic vein blood reaches your heart, it will go by the ... first.
   a) atrioventricular node b) mitral valve c) sinoatrial node d) septum
# 16. The blood that reaches the structure above will be have an oxygen concentration that is relatively ...
and a CO₂ concentration that is relatively
a) high ... low.  b) low ... high.  c) low ... low.  d) high ... high.

# 17. The circulatory system of an albatross is also very similar to yours. This means that blood that leaves
the ... side of the heart will have relatively ... pressure and will go to the ... circulation.
   a) left ... low ... systemic  b) right ... low ... pulmonary
   c) left ... high ... pulmonary  d) right ... high ... systemic

* 18. The graph below describes the movement of oxygen in the lungs of the albatross early in the
pulmonary circulation. The axes are the light lines and the line describing oxygen movement is the
dark line. Negative y values mean that the oxygen is moving opposite to the usual direction for that
location. The origin is (0, 0).

The x axis shows ... and the y axis shows
a) lung oxygen concentration ... rate of movement of oxygen out of the blood.
b) blood oxygen concentration ... rate of movement of oxygen into the blood.
c) (lung oxygen concentration – blood oxygen concentration) ... rate of movement of oxygen into
the blood.
d) (blood oxygen concentration – lung oxygen concentration) ... rate of movement of oxygen into
the blood.

* 19. The hardest an albatross ever works is when it is trying to take off. It has to run over the surface of
the water with its webbed feet and then lurch into the air and hope it can catch the wind under its
wings. If an albatross is trying to take off, it will be working at the ... of the graph in the previous
question.
   a) upper right  b) lower right  c) upper left  d) lower left
* 20. If the controls on your breathing rate and albatross breathing rate are the same, a(n) ... in blood ...
will cause the greatest increase in the rate of breathing.
   a) decrease ... oxygen  b) increase ... oxygen
c) decrease ... CO₂  d) increase ... CO₂

21. The protein that will carry oxygen in the albatross' blood is
a) COX1.  b) hexokinase.  c) hemoglobin.  d) myosin.

22. The organelle where this oxygen will probably be consumed is
a) mitochondria.  b) lysosomes.  c) rough ER.  d) nucleus.

* 23. When the oxygen is "consumed" in this organelle, most of the time it becomes
a) carbon dioxide.  b) pyruvate.  c) an acetyl group.  d) water.
# 24. Albatrosses may spend years at sea, and have no access to fresh water. A human in this situation would rapidly die because the seawater he would drink would ... his cells. However, an albatross has a gland in tubes on the side of his nose:

[Image of albatross]

This gland allows the albatross to survive drinking seawater because it releases a salt solution that is more ... than seawater.

a) burst ... concentrated  
b) dehydrate ... concentrated  
c) dehydrate ... dilute  
d) burst ... dilute

# 25. Wandering albatrosses nest on remote islands north of Antarctica like South Georgia and the Kerguelen Islands. They build their nests in large colonies crowded onto isolated, exposed ridges overlooking the ocean. When we examine the distribution of nests within the colony, we find it is regular. The best biological explanation for this distribution is that nesting albatrosses

a) ignore one another.  
b) help each other raise their young.  
c) help protect one another from predators.  
d) peck at any bird that gets too close to them.

* 26. Albatrosses who are building nests pull up grassy vegetation and incorporate it into the nest mound, which can be 1 m wide at the base. This means they tear up many grass roots. Which of the following structures would be found in grass roots but not in any other part of the grass plant?

a) xylem  
b) spongy mesophyll  
c) endosperm  
d) endodermis.

* 27. The remote home islands of the albatrosses are cold. Under these conditions, you would expect that the cellular respiration rate of a grass plant and the cellular respiration rate of an albatross would be, respectively, ... than each would be in an environment with a moderate temperature.

a) higher and lower  
b) lower and higher  
c) higher and higher  
d) lower and lower

28. Albatrosses have an unusual life history for a bird. They don’t breed until they’re about 11 years old, and then only lay one egg every second year. They can live to be 50 years old. All this makes them sound very

a) K-selected.  
b) r-selected.

29. The albatross parents take turns sitting on the nest when the nestling is young, and then leave on long foraging trips to feed the chicks. This process is very demanding, lasting 11-12 months before the chick leaves the nest. Don’t change your answer to the previous question but is this information about parental investment in the young consistent with the answer you gave for the previous question?

a) Yes, it is very consistent with that answer.  
b) This information is irrelevant, neither supporting nor weakening the previous answer.  
c) This information contradicts my answer in the previous question.

Albatross nestlings lay down so much fat that at one point they are heavier than their parents! However, they use up most of the fat as they grow their flight feathers.
30. Albatross parents feed their nestlings food that they catch at sea, but also an energy-rich liquid called “stomach oil” that the parents make themselves. A reference says that stomach oil consists of “wax esters and triglycerides.” This means it could be classified as mostly a mixture of a) carbohydrates. b) proteins. c) monosaccharides. d) lipids.

The reference goes on to say that seabirds that make stomach oil can vomit it on attacking predators, and it has a very offensive smell. It concludes, “The smell can persist on clothing for months or even years.”

31. Albatrosses originally established breeding colonies on islands without land mammals, and the survivorship of nestlings was good. However, many of these islands have now been colonized by nest predators like rats and cats. These cause a high mortality of eggs and nestlings. However, as illustrated by the lifespan data, survival of adults is still good. If we compared the survivorship curve of an albatross cohort before the arrival of rats and cats with the curve today, we would probably see a transition from a curve shaped like ... to one shaped like

![Graphs showing different survivorship curves](image)

a) 2 ... 1.

b) 4 ... 3.

c) 4 ... 1.

d) 3 ... 4.

32. A more recent mortality development is that more adult albatrosses are seeking food around long-line fishing boats that lower baited hooks into the water. The albatrosses dash in as the line is lowered, snap up the bait, get hooked, and then drown when they are dragged underwater. This increases adult mortality. This increasing mortality will put selection pressure on albatrosses to a) breed every year instead of every two years.
b) start breeding before age 11.
c) lay more than one egg at a time.
d) All of these.

33. Albatrosses mate for life, returning every two years to breed on the same island. However, there is some doubt about whether they are totally faithful to each other during this lifelong pairing. Remember how you were observing the colony on South Georgia Island? Your advisor has done Southern blots of female, male and chick for four nesting pairs. Do any of these show evidence of infidelity by the females? The lanes are mother, father, and chick, left to right.

![Southern blots](image)

a) Yes, all four do.
b) Yes, two of the four do.
c) Yes, one does.
d) No, there is no evidence of infidelity here.
34. There are many cases above where a male or a female has a band that doesn’t appear in the chick. This happens as a result of an event in
   a) S phase.  b) prophase II.  c) anaphase I.  d) mitotic prophase.

35. The same albatross pair breeds repeatedly in the same colony. If your advisor could locate one of the breeding pairs above two years from now and could do the same Southern blot on the male, female, and new chick, he would find that, compared to this year, the pattern of bands in the male and female lanes would be ..., the pattern of bands in the chick lane would probably be ... Of course, assume that no infidelity takes place in either year.
   a) the same ... the same.  b) different ... different.
   c) different ... the same.  d) the same ... different.

36. While it is unknown how many chromosomes wandering albatrosses have, the related storm petrel has 80. This means that a storm petrel can make ... genetically different gametes than humans can. Assume that no crossing-over occurs.
   a) more  b) fewer

37. Many fragments of DNA are presented in question 33. Your advisor sequences them all and then makes a graph that shows the relationship between two variables in all the sequences:

![Graph](image)

If the x axis of this graph is percent of ..., the y axis could be percent of ... in the DNA.
   a) A ... purines  b) C ... C
   c) purines ... pyrimidines  d) A ... C

38. The wandering albatross colony on South Georgia consists of about 1500 nesting pairs spread over a roughly circular area about 250 m in diameter. “Successful fledging” means that the parents raised their chick to the point where it left the nest. In kittiwakes, an English seagull, birds that nest in the center of the colony are more mature and better at raising young, and have higher fledging success than the young parent birds on the edge of the colony. Also, nests in the center of the colony are less subject to predation. Your advisor has compiled data that shows the percent of successful nests in both the center portion and the edge portion of the colony. How should these results be reported?
   a) a line graph  b) a pie chart  c) a bar graph or table

39. In the center area, 270 out of 300 nests successfully fledged their nestling. In the much larger edge area, 730 out of 1200 nests were successful. If our null hypothesis is that both areas have the average success rate of the whole colony, the expected value for the number of successful nests in the center would be
   a) 300.  b) 270.  c) 200.  d) 130.

40. So what can we conclude from your advisor’s study?
   a) There is no relation between nesting position and fledging success.
   b) We must reject the hypothesis of equal fledging success in the edge and center of the colony.
   c) Center nesters fledge more successfully because their predation rate is lower.
   d) Center nesters fledge more successfully because they are more experienced parents.