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 gorillas, the world's largest and strongest primate, but one that is perilously close to extinction.

1. #  Gorillas are of great interest to us because they are related to humans. What is the smallest group to which both humans and gorillas belong?
   a) the primates  
   b) the apes (hominoids)  
   c) the New World Monkeys  
   d) the vertebrates

2. Gorillas inhabit two separate areas in equatorial Africa.

   The western group includes Gorilla gorilla gorilla (the Western Lowland Gorilla), and Gorilla gorilla diehli (the Cross River Gorilla). The eastern area has the Mountain Gorilla (Gorilla beringei beringei) and the Eastern Lowland Gorilla (Gorilla beringei graueri). The third "gorilla" in the name Gorilla gorilla gorilla indicates the 
   a) species.  
   b) genus.  
   c) tribe.  
   d) subspecies.
3. Gorilla experts obviously believe that the world population of gorillas should be divided into several different taxonomic groups. Is the same true of the human population?
   a) Yes.  b) No.

4. Judging from the names in question 2, we would assume that ... and ... can interbreed.
   a) Gorilla gorilla diehli ... Gorilla beringei beringei
   b) Gorilla gorilla gorilla ... Gorilla beringei graueri
   c) Gorilla beringei beringei ... Gorilla beringei graueri
   d) All of these pairs can probably interbreed.

5. # The western and eastern gorillas inhabit areas separated by almost 500 miles. Also, although gorillas are large, they are not travelers. The home range of a gorilla troop is less than three square miles. This implies that in the future, genetic differences between the eastern and western gorillas will probably
   a) decrease.  b) increase.  c) stay the same.

6. # When there is a problem that no one will talk about, it is referred to as the "800 pound gorilla in the room." Gorillas are big, but not that big. A very big male in nature can get up to 225 kg. This is about... pounds.
   a) 500  b) 320  c) 650  d) 680

   Most people would guess that gorillas are very tall, and would tower over a human. However, the largest standing males reach only about 6 feet. Standing females average less than 5 feet tall.

7. # One of the reasons gorillas are not very tall is because their legs are relatively short compared with human legs, as is clear from this picture of a human skeleton compared with a gorilla skeleton.

![Image of human and gorilla skeletons with indicated bone](image)

The indicated bone (same in both the human the gorilla) is the
   a) ulna.  b) humerus.  c) tibia.  d) femur.
8. This skeleton works well for a gorilla because gorillas spend most of their time knuckle-walking:

Because they are mostly used as legs, gorilla arms are massively muscled. This 1920s photo shows a gorilla that has been killed by trophy hunters. Look at the contrast between the gorilla’s arms and the arms of the man (5'10" tall) next to him!

Muscles contract when
a) myosin binds to actin and myosin heads bend.
b) actin binds to tropomyosin and actin curls into an alpha helix.
c) ATP causes myosin and actin to polymerize into actomyosin.
d) All of these are necessary for muscle contraction.
9. * Say a young gorilla is knuckle-walking at a moderate pace when he sees his favorite fruit on a tree up ahead. Gorillas’ eyes are very good, and probably have color vision. The absorption spectrum of the fruit is

![Absorption Spectrum Graph]

This means that the fruit is ... and this fact is being reported to the gorilla’s brain because
a) green ... rods in his eyes have become hyperpolarized.
b) red ... certain cones in the retina are originating action potentials.
c) yellow ... all cones are responding equally to the photons striking them.
d) red ... rods and cones are responding equally to the photons striking them.

10. * Then the gorilla looks to the side and sees that his hated rival is approaching the tree as well. The other gorilla is fairly far away, but our gorilla can recognize his rival's distinctive facial features. The gorilla has such a high-resolution, detailed view of the world mostly because
a) the aqueous humor is denser than the vitreous humor.
b) the pupil can vary the amount of light entering the eye by about 30 times.
c) the lens can bend any incoming light rays so they are parallel.
d) there are many cones crowded into the fovea centralis.

11. # Our gorilla leaps into action and starts running toward the tree. Gorilla muscle contraction is triggered when an action potential arrives at a muscle. An action potential begins when the neuron membrane
a) expels calcium and becomes hyperpolarized.
b) opens its volatage-gated potassium gates.
c) allows large amounts of sodium to enter the neuron.
d) temporarily reverses the sodium-potassium pump.

12. # Our gorilla reaches the tree first, stands upright, and hoots and shakes the branches of the tree to claim it. The rival stops at a distance. This was unusual exertion, and our gorilla is breathing deeply. Gorillas need oxygen because oxygen serves as their
a) electron source. b) energy storage compound.
c) energy source. d) final electron acceptor.

13. During this exertion, the gorilla organelles that were actually consuming the oxygen were the
a) mitochondria. b) glyoxysomes. c) ribosomes. d) peroxisomes.
14. # Oh no! The rival is not retreating—he is standing up, beating his chest, slapping the ground, hooting, and coming closer and closer in a series of short charges. Our gorilla shakes the tree branches even more vigorously and growls and hoots. Now his exertion is so great that oxygen briefly disappears from his muscle cells. As a result, his cells stop carrying out ... and begin to produce ... using
a) glycolysis ... pyruvate ... the Krebs cycle.
b) electron transport ... lactate ... fermentation.
c) the Krebs cycle ... CO₂ ... electron transport.
d) fermentation ... pyruvate ... glycolysis.

15. * As the gorilla exercises more and more, his combination of **venous** oxygen and carbon dioxide will move along the heavy line on the ... graph below, and an exhausted gorilla will be at point ... on that graph.

![Graph](image)

16. * Lowland gorillas live almost at sea level, but mountain gorillas inhabit the cloud forests of the Virunga Volcanoes, at altitudes up to 14,000 feet (as high as Pike’s Peak, Colorado). At those altitudes, the temperature is cold and the atmosphere is thin. Assume that the correct line above is from a **lowland** gorilla. The high-altitude atmosphere would place the line for the mountain gorilla ... the correct line above.

a) directly above  b) directly below  c) to the right of  d) to the left of

17. Both of these young gorillas live in a "troop" of 15 individuals. The leader is a powerful 20-year-old male called a silverback because of gray hair on his back. All the noise has attracted his attention, and now the silverback rushes at our gorilla's rival and scares him away. Then he ambles right past our gorilla without looking at him, reaches up for the prized fruit, and eats it. The fact that gorillas eat plant material almost exclusively makes them
a) autotrophic.  b) heterotrophic.

18. The soft, sugary part of the fruit the silverback just ate developed mainly from the ... of a flower on the tree.

a) petal  b) anther  c) style  d) ovary

19. # Gorillas like fruit, but the tree invested the energy and resources needed to produce the fruit because the fruit would increase the chance that
a) the seeds would be dispersed to new habitats.
b) all the eggs of the tree would be fertilized.
c) pollinators would be attracted to the tree.
d) the parent tree would reproduce the next year.
20. * Phloem in the tree played a role in the development of this fruit. Phloem
   a) brought water and minerals from the roots to the fruit.
   b) brought organic matter from the leaves to the fruit.
   c) protected the fruit from water loss in the hot sun.
   d) photosynthesized for the fruit.

21. # The process of photosynthesis uses ... to directly synthesize
   a) CO₂ and O₂ → pyruvic acid.
   b) CO₂ and O₂ → ATP, NADPH, and sugar.
   c) H₂O, NH₃ and O₂ → proteins.
   d) CO₂ and H₂O → sugar.

22. * The roles of ATP and NADPH in photosynthesis are to
   a) serve as final electron acceptors for the Calvin cycle.
   b) split water.
   c) transfer solar energy from the light reactions to the Calvin cycle.
   d) provide activation energy for the light reactions.

23. After the big silverback took the fruit, our young gorilla knuckle-walked away, breathing hard. However, after a few minutes his concentrations of blood oxygen and carbon dioxide were back to normal. This recovery demonstrates a property of life called
   a) homeostasis.
   b) irritability.
   c) buffering.
   d) disequilibrium.

24. # Now that the excitement is over, the young gorilla's heart rate is slowing down as well. Much of this slowing occurs because his ... is no longer secreting as much
   a) adrenal cortex → norepinephrine.
   b) adrenal medulla → epinephrine.
   c) parathyroid glands → PTH.
   d) pancreas → insulin.

25. * The gorilla's heart is structured like a human heart. The diagram below shows the heart and circulatory system. Note that the heart is on its side (it is possible to go from chamber A to chamber B, but not possible to go from chamber A to chamber C). If "A" below is the right atrium, then ... must be the ... and the vena cava must be

   ![Diagram of heart and circulatory system]
   a) H → pulmonary artery → E.
   b) E → aorta → F.
   c) J → body → E.
   d) I → lungs → G.
26. The silverback liked the taste of the fruit, which had a high concentration of sucrose. Sucrose is
a) a carbohydrate. b) a disaccharide.
c) formed by dehydration synthesis. d) All of these.

27. * Assuming that gorilla digestive anatomy is the same as that of humans, the fragments of the
fruit will pass by or through the following digestive locations in the silverback:
1. the pharynx
2. the pyloric sphincter
3. villi
4. rugae
5. the common bile duct
6. the appendix
The order in which these structures will be encountered is
a) 1 2 4 5 6 3 b) 4 1 2 3 5 6 c) 1 4 2 5 3 6 d) 4 2 1 3 5 6

28. * The fruit has a pH of 3.5. The silverback’s gastric juice has a pH of 2.0. This means that the
concentration of hydrogen ions in the stomach is about ... times that in the fruit. By the way, you
do not need a calculator for this. Only one of these answers is even close.
a) 30 b) 0.5 c) 4,000 d) 0.05

29. # Farther down in the silverback’s gut, the molecules below have been liberated from the fruit.
\[
\begin{align*}
\text{CH}_3\text{—CH—C—OH} & \quad \text{OH} & \quad \text{OH} & \quad \text{OH} \\
\text{CH}_3\text{—CH—CH}_2 & \quad \text{—CH—C—OH} & \quad \text{CH}_2\text{—CH—CH}_2 \\
N\text{H}_2 & & \\
\end{align*}
\]
The middle molecule has a long chain of "CH2s" in its middle portion. These molecules came from
digestion of ... in the fruit.
a) starch and protein b) protein and fat c) starch d) nucleic acids

30. # Almost all gorillas have type B blood. In humans, having type B blood means that the red blood
cells have ... on their surfaces and there are ... in the plasma.
a) B antigens ... anti-A antibodies b) A antigens ... anti-B antibodies
c) anti-B antibodies ... A antigens d) anti-A antibodies ... B antigens

31. The silverback of a troop will allow young males to court pregnant females or immature females,
but will not allow them to mate with females who might get pregnant. Also, if a silverback takes
over a new troop, he will kill all the baby gorillas he finds. The most direct evolutionary reason
for this silverback behavior is that the silverback
a) maintains his social dominance by bullying females and young males.
b) is controlling the population so that the troop does not exhaust its food resources.
c) is protecting the females of the troop from the inexpert mating attempts of young males.
d) is ensuring that all the baby gorillas in the troop have his DNA.

32. # Female gorillas have a 30-day menstrual cycle similar to that of a human. Assuming gorilla-
human similarity, if a female gorilla has just started menstruation today, we can expect her next
ovulation in about ... days.
a) 5 b) 7 c) 10 d) 14

33. * Like chimpanzees, gorillas have 48 chromosomes. This means that they can have ... different
chromosome arrangements of maternal and paternal chromosomes at metaphase I of meiosis as
humans have.
a) half as many b) twice as many c) the same number of
34. * If you looked at a diploid gorilla cell in *mitotic telophase*, you would expect to see ... chromosomes with ... chromatids. Each cell would contain .... molecules of chromosomal DNA.  
   a) 48 ... 0 ... 48  
   b) 24 ... 48 ... 48  
   c) 24 ... 48 ... 96  
   d) 48 ... 96 ... 48

35. * Gorilla noses are quite variable, and often an individual can be recognized by nose structure alone. Let's say that noses can be long, medium, or short in length, and either wide or narrow. We observe the results of several naturally-occurring matings:

<table>
<thead>
<tr>
<th>Mating</th>
<th>Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>long, wide x long, wide</td>
<td>all long, wide</td>
</tr>
<tr>
<td>short, narrow x long, narrow</td>
<td>all medium, narrow</td>
</tr>
<tr>
<td>medium, wide x medium, narrow</td>
<td>1/4 long, wide</td>
</tr>
<tr>
<td></td>
<td>1/2 medium, wide</td>
</tr>
<tr>
<td></td>
<td>1/4 short, wide</td>
</tr>
<tr>
<td>short, wide x medium, narrow</td>
<td>1/2 medium, wide</td>
</tr>
<tr>
<td>short, wide x short, narrow</td>
<td>1/2 short, wide</td>
</tr>
<tr>
<td></td>
<td>all short, wide</td>
</tr>
</tbody>
</table>

Which of the following is the most convincing hypothesis about how nose *length* is governed?  
   a) It is governed at one locus, but that locus can hold three possible alleles. One of these alleles gives a short nose, one gives a medium nose, and one gives a long nose.  
   b) It is governed at two loci. Long results when there are dominant alleles at both loci, short when there is a dominant allele at one locus, and medium when there are no dominant alleles at either locus.  
   c) It is governed at one locus and has two alleles. Long and short are the homozygotes and medium is the heterozygote.  
   d) None of these are consistent with the data above.

36. # Someone suggests that nose *width* is governed by the same locus or loci as nose length. Do you agree?  
   a) Yes. We'd like more matings to be sure, but this could certainly be true.  
   b) No, the data above show that this is not true.

37. * Nose shape is affected by a protein that acts during embryonic development. There is a single-base mutation of the gene for this protein that does not affect the amino acid sequence of the protein. A change in base sequence might not result in any change in the amino acid sequence of the final protein because  
   a) the mutation appears in an intron.  
   b) the mutated codon codes for the same amino acid as the unmutated codon.  
   c) posttranslational processing has removed the mutated section of the protein.  
   d) All of these would explain the lack of change in the protein.

38. * You’re interested in this gene and want to introduce it into bacteria so you can study it. You will use a plasmid as the vector. You will want to use a restriction enzyme that  
   a) cuts the plasmid once and the gorilla DNA on either side of the gene.  
   b) has the maximum number of restriction sites inside the gene, but none on the plasmid.  
   c) has the maximum number of restriction sites on the plasmid, but none inside the gene.  
   d) has a large number of restriction sites inside both the gene and the plasmid.
39. Young male gorillas that become old enough to breed are expelled from existing troops or leave on their own and become "floaters" in the areas between troops. If the silverback of a troop is killed, the females of the troop will disperse and each female will attempt to find one of these floater males to follow. This female response will ... the rate of speciation between gorilla troops because it will tend to
   a) speed up ... bring together new combinations of alleles that will accentuate the differences between the troops.
   b) slow down ... keep the allelic frequencies of neighboring troops the same.
   c) speed up ... increase the percentage of heterozygous loci, which will increase the diversity of offspring from each mating.
   d) slow down ... increase the mutation rate.

40. There are probably only 50,000 to 100,000 gorillas of all types left in the wild. The situation is far more dire for the mountain gorilla, where the world population may be only 600. What bad genetic result do we expect for a small population, even if the environment is constant?
   a) The Allee Effect will cause heterozygotes to enjoy a greater selective advantage.
   b) Natural selection will intensify because of competition.
   c) Rare alleles will go extinct due to genetic drift.
   d) The increasing tendency towards random mating will disrupt Hardy-Weinberg equilibrium.