



## **AP<sup>®</sup> Statistics (Operational) 2004 Sample Student Responses**

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A.

3. At an archaeological site that was an ancient swamp, the bones from 20 brontosaur skeletons have been unearthed. The bones do not show any sign of disease or malformation. It is thought that these animals wandered into a deep area of the swamp and became trapped in the swamp bottom. The 20 left femur bones (thigh bones) were located and 4 of these left femurs are to be randomly selected without replacement for DNA testing to determine gender.

(a) Let  $X$  be the number out of the 4 selected left femurs that are from males. Based on how these bones were sampled, explain why the probability distribution of  $X$  is not binomial.

For it to be binomial the probability of success (getting a male femur) has to be fixed. If there is no replacement then the success probability changes every time and is therefore not binomially distributed.

(b) Suppose that the group of 20 brontosaurus whose remains were found in the swamp had been made up of 10 males and 10 females. What is the probability that all 4 in the sample to be tested are male?

Prob. of 1<sup>st</sup> being male =  $\frac{1}{2}$   
Prob. of 2<sup>nd</sup> being male =  $\frac{9}{19}$   
Prob. of 3<sup>rd</sup> being male =  $\frac{8}{18}$   
Prob. of 4<sup>th</sup> being male =  $\frac{7}{17}$

Prob. of all 4 being male =  $\frac{1}{2} \cdot \frac{9}{19} \cdot \frac{8}{18} \cdot \frac{7}{17} = .0433$

- (c) The DNA testing revealed that all 4 femurs tested were from males. Based on this result and your answer from part (b), do you think that males and females were equally represented in the group of 20 brontosaurus stuck in the swamp? Explain.

It does not seem likely that males and females in the group were both 10 because the likelihood of getting 4 males if that were true is only 4.3%. It is possible, but not very likely. It is more reasonable to assume that there were more males than females present in the swamp.

- (d) Is it reasonable to generalize your conclusion in part (c) pertaining to the group of 20 brontosaurus to the population of all brontosaurus? Explain why or why not.

No, because this is a highly exclusive sample. Due to the fact that the bones were collected in a swamp it is possible that the males were gathering food or testing a path for females when they died. Therefore this is not a good indication of the population.

B.

3. At an archaeological site that was an ancient swamp, the bones from 20 brontosaur skeletons have been unearthed. The bones do not show any sign of disease or malformation. It is thought that these animals wandered into a deep area of the swamp and became trapped in the swamp bottom. The 20 left femur bones (thigh bones) were located and 4 of these left femurs are to be randomly selected without replacement for DNA testing to determine gender.

(a) Let  $X$  be the number out of the 4 selected left femurs that are from males. Based on how these bones were sampled, explain why the probability distribution of  $X$  is not binomial.

The distribution is not binomial because the probability of selecting the left femurs are not equal, and it is not independent. The probability of selecting a bone changes as it is selected without replacement. Each time the probability of drawing a particular bone is decreased, as the total number changes. Also, this is not independent. The probability that a particular bone will be drawn depends on the bone drawn before it. The probability changes of selecting a male femur or female femur bone.

(b) Suppose that the group of 20 brontosaurus whose remains were found in the swamp had been made up of 10 males and 10 females. What is the probability that all 4 in the sample to be tested are male?

$$\frac{10}{20} = .50$$

$$\frac{9}{19} = .47$$

$$\frac{8}{18} = .44$$

$$\frac{7}{17} = .41$$

$$(.50)(.47)(.44)(.41) = .0424$$

.0424 probability that it will all be male.

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B<sub>2</sub>

- (c) The DNA testing revealed that all 4 femurs tested were from males. Based on this result and your answer from part (b), do you think that males and females were equally represented in the group of 20 brontosaurus stuck in the swamp? Explain.

No, I do not think that males and females were equally represented in the group of brontosaurus stuck in the swamp. Even when there is an equal representation, there is only a less than 5% chance that all 4 bones are from a male. It's not something that happens very often. It's more likely that there is more male bones than female bones.

- (d) Is it reasonable to generalize your conclusion in part (c) pertaining to the group of 20 brontosaurus to the population of all brontosaurus? Explain why or why not.

No, it's not reasonable to generalize my conclusion of more males than females to the whole population of brontosaurus. My conclusion is based on a relatively small sample, and it pertains only to the brontosaurus that were trapped in the swamp. It's too far of a stretch to make that conclusion.