



AP Bio FRQ Fridays

2023 #5
Cladograms & Convergent Evolution



FRQ Friday #20

2023 #5

Ruminants are hoofed animals, including cattle and sheep, that have a unique four-chambered stomach specialized to digest tough, fiber-filled grasses. Researchers studying ruminants are investigating the morphological and molecular characteristics of different ruminant families in order to determine the evolutionary relationships among the families. Cladograms of several ruminant families were constructed based on morphological data (Figure 1A) and molecular data (Figure 1B). Table 1 shows a sample of the morphological characteristics present in each family used to construct the cladogram in Figure 1A.

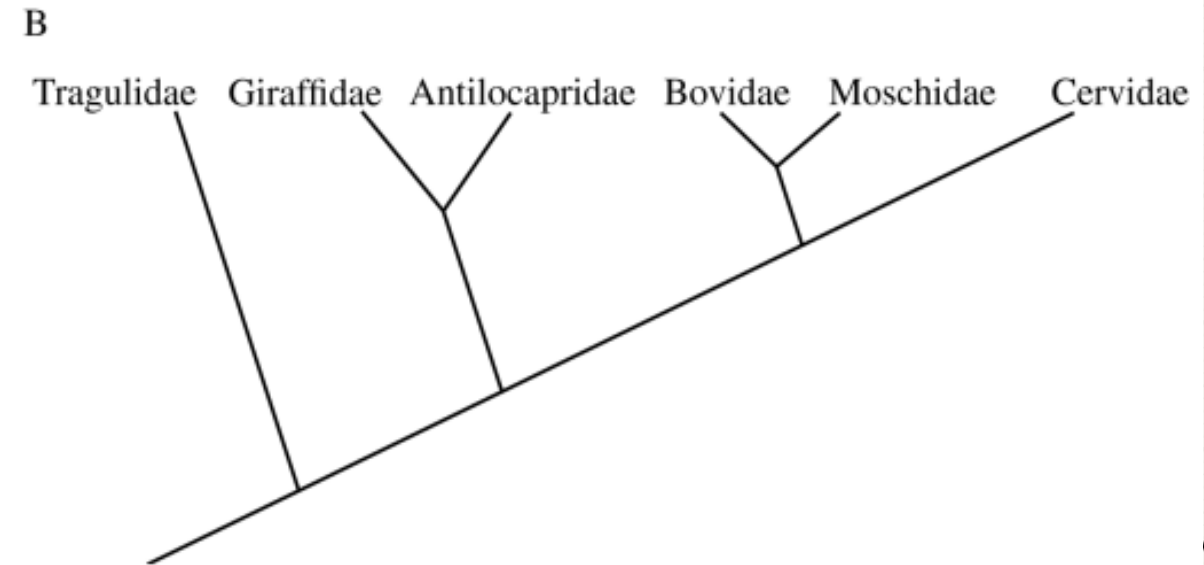
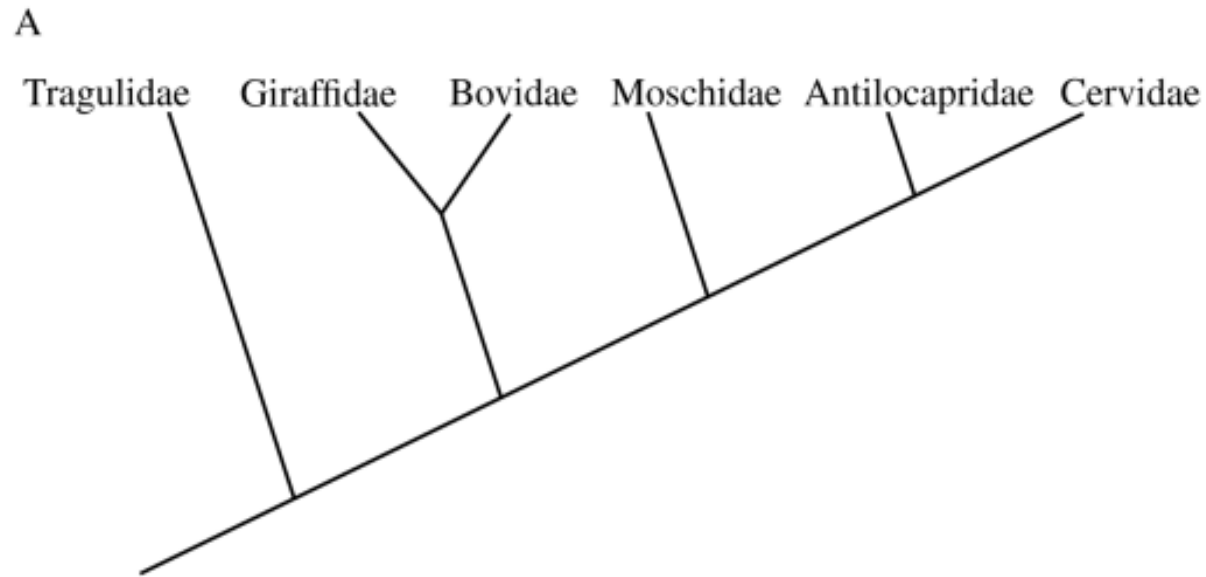


Figure 1. Cladogram of six ruminant families based on (A) morphological data and (B) molecular data



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TABLE 1. MORPHOLOGICAL CHARACTERISTICS FOUND IN EACH RUMINANT FAMILY

Characteristic Number	Morphological Characteristic	Tragulidae	Giraffidae	Bovidae	Moschidae	Antilocapridae	Cervidae
1	Extra tooth material			X		X	
2	Third stomach		X	X	X	X	X
3	Double opening for tear ducts					X	X



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(a) Describe how a scientist would use a comparison of the DNA sequences of different organisms to suggest the most likely evolutionary relationship among the organisms.

- The (DNA) sequences of organisms that are more closely related are more similar (than those of organisms that are less closely related).

They would compare the number of differences in the base sequence. Then they would determine relationship by seeing that fewer differences means a ~~fewer~~ more recent common ancestor and a closer relationship that compared to more differences.



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(b) Based on Figure 1, explain why Bovidae is likely to be more closely related to Moschidae than it is to Giraffidae.

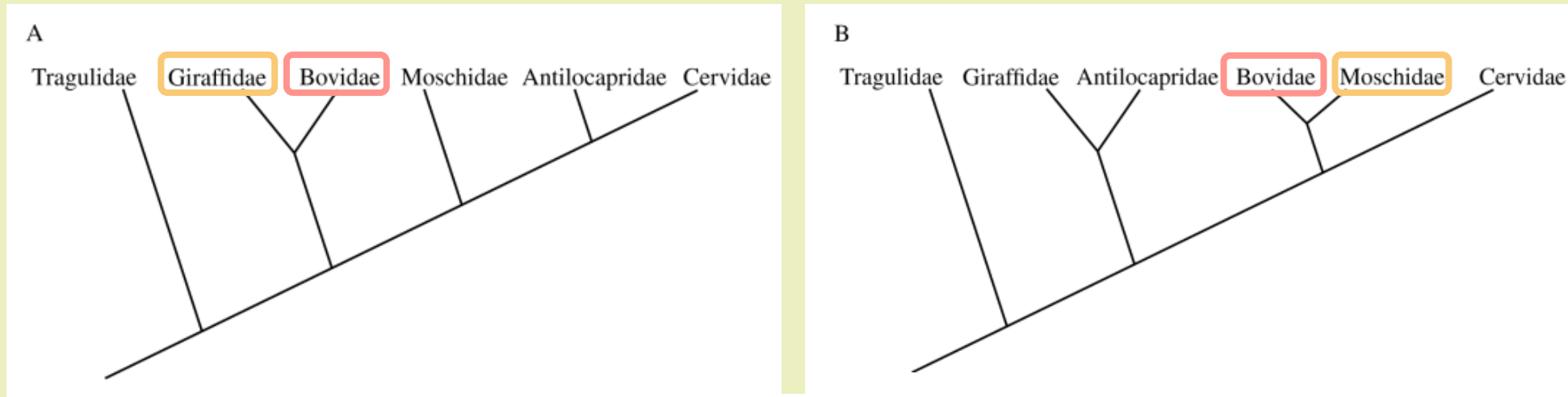


Figure 1. Cladogram of six ruminant families based on (A) morphological data and (B) molecular data

Accept one of the following:

- (The molecular data/Figure 1B support(s) this relationship, and) molecular data are more reliable (than are morphological data).
- (The molecular data/Figure 1B support(s) this relationship.) Morphological similarities may not reliably indicate evolutionary relatedness.



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(b) Based on Figure 1, **explain** why Bovidae is likely to be more closely related to Moschidae than it is to Giraffidae.

Accept one of the following:

- (The molecular data/Figure 1B support(s) this relationship, and) molecular data are more reliable (than are morphological data).
- (The molecular data/Figure 1B support(s) this relationship.) Morphological similarities may not reliably indicate evolutionary relatedness.

Bovidae shares fewer molecular differences with Moschidae than with Giraffidae as suggested by Figure 1B.

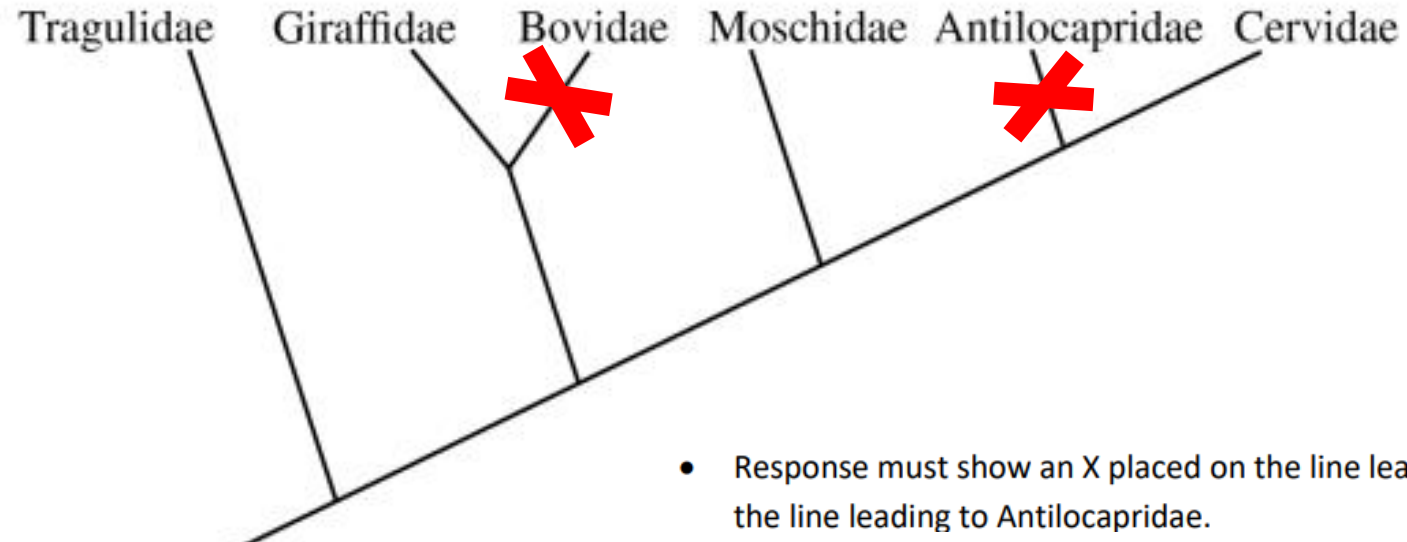
Molecular ~~data~~ comparisons are a more accurate representation of evolutionary closeness than morphological.



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(c) Using the template in the space provided for your response, **represent** the point(s) at which characteristic 1, listed in Table 1, evolved by marking “X” on the line(s) of the cladogram in the correct location(s).



- Response must show an X placed on the line leading to Bovidae and an X placed on the line leading to Antilocapridae.

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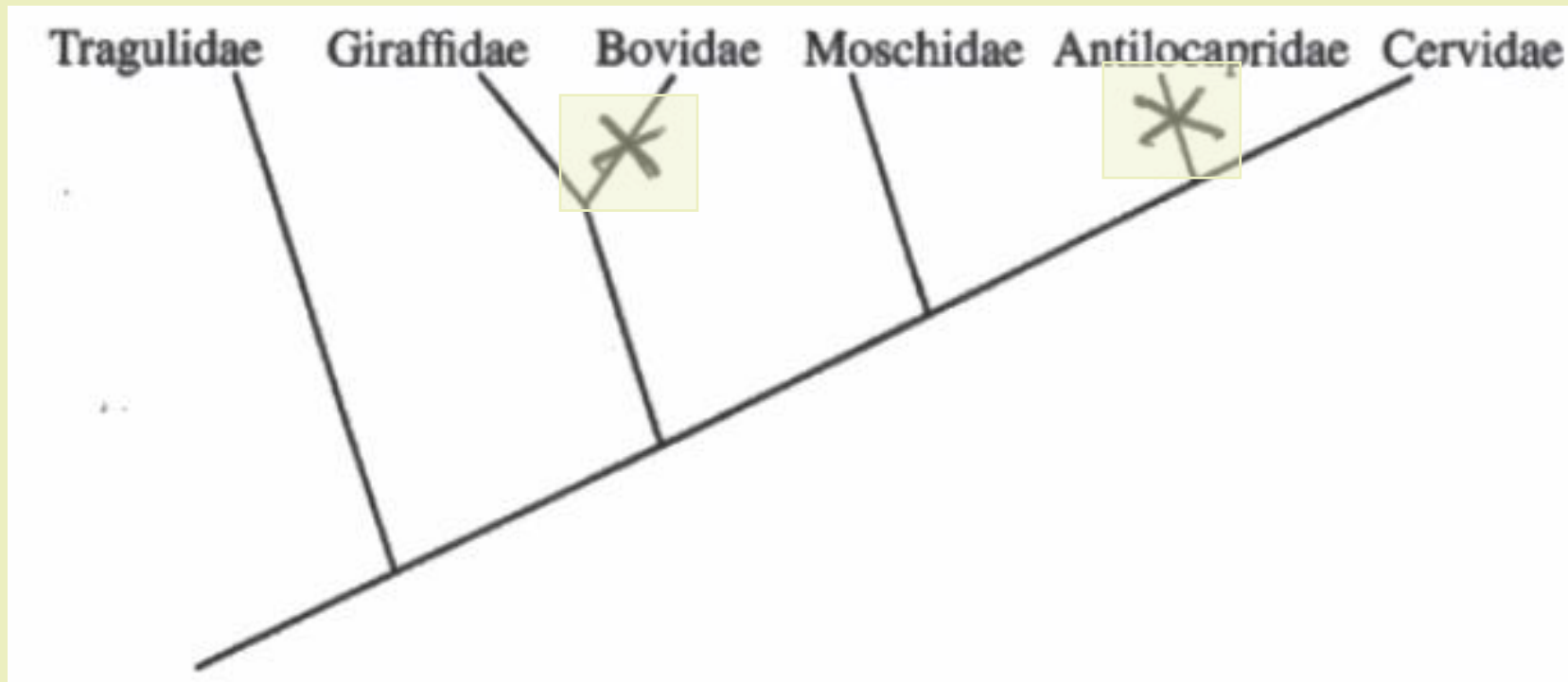


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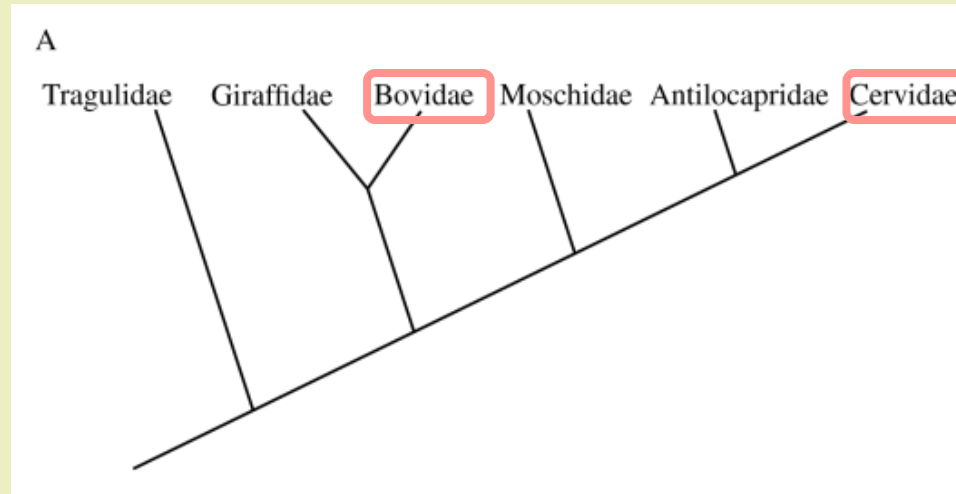
- Response must show an X placed on the line leading to Bovidae and an X placed on the line leading to Antilocapridae.



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(d) Based on Figure 1A, **explain** why a characteristic found only in the Cervidae and Bovidae families is more likely evidence of convergent evolution than it is of common ancestry.



Accept one of the following:

- There are other families that have the same common ancestor as the Bovidae and Cervidae families but do not have the characteristic.
- It is more likely that the characteristic arose independently in Cervidae and Bovidae than it arose in their common ancestor and was lost in Giraffidae, Moschidae, and Antilocapridae.



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d) If a characteristic was only found in Cervidae and Bovidae due to common ancestry, it would mean it has to evolve before their common ancestor; then be removed in Moschidae and Giraffidae. This would require 3 independent evolutionary events. Compare this to two evolutionary events due to convergent evolution in Bovidae and Cervidae. Typically, the reason with fewer evolutionary events is ~~the~~ more likely which in this case is convergent evolution evolving the characteristic twice.

