## Unit 7 Progress Check: FRQ

2. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Researchers studying the phylogenetic relationships among African elephants (*Loxodonta africana*), Asian elephants (*Elephas maximus*), and woolly mammoths (*Mammuthus primigenius*) analyzed cytochrome *b* DNA sequences from several organisms of each species. Cytochrome *b* is a mitochondrial protein that functions in the electron transport chain. Partial sequences of cytochrome *b* mitochondrial DNA are often used in phylogenetic analyses. DNA was obtained from mammoth bone fragments radiocarbon dated to between 12,000 and 14,000 years ago and from living African and Asian elephants. Table 1 shows a partial cytochrome *b* DNA sequence for the reference individual (an African elephant) and some of the sample individuals studied. Dugongs (*Dugong dugon*) were identified as the outgroup in this study. Dugongs are marine mammals that are relatives of the larger group of elephant-like animals, the proboscideans.

Table 1. DNA sequence data for three species showing only the sequence differences

Reference *Loxodonta*	A A A A A A T C C T T C T T T A C A C T C C A
Loxodonta-1	• G • C G • • • • • • • T • • • G • • • • • • G
Loxodonta-2	• G • C G • • • • • • • T • • • G • • • • • T •
Elephas-1	• G G C • • • • • • • C T • C C C • G T C T • •
Elephas-2	• G G C • • • • • • • C T C C C C • G T C T • •
Mammuthus-1	C G • C • G • T • • • T • C • C T • T • • • •
Mammuthus-2	C G • C • G • T • • • T • C • C T • T • • • •

(a) Based on the data in Table 1, **identify** the animal that has the greatest number of sequence differences from the reference animal.

(b) Based on the data in Table 1, **complete the cladogram** using the template provided to indicate the evolutionary relationships of the four species: African elephants (*Loxodonta africana*), Asian elephants (*Elephas maximus*), woolly mammoths (*Mammuthus primigenius*), and dugongs (*Dugong dugon*).
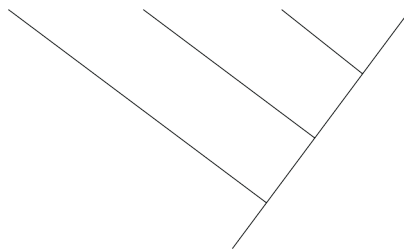
(c) Based on morphological and molecular data, researchers hypothesize that the split between dugongs and proboscideans likely occurred between 48 and 34 million years ago. **Explain** how molecular data from fossils and living organisms would support the existence of an evolutionary relationship between dugongs and proboscideans.

(d) There are six living species of mammals called hyraxes in the order Hyracoidea. These are small rabbit-like

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mammals that are also considered to be close relatives of both dugongs and elephants. All of these mammals are widely different morphologically. **Explain** how organisms that are widely different in morphology can have a close evolutionary relationship.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

✓

0	1

The response indicates that *Elephas*-2 has 13 sequence differences from the reference animal, and this is the greatest number of all animals in the table.

Part B

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

✓

0	1

The response indicates that from left to right, the order at the tips of the cladogram is: *Dugong, Elephas, Loxodonta, Mammathus*. *Loxodonta* and *Mammuthus* can also be reversed. (Common names can be used; full species names can also be used).

Part C

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

✓

0	1

The response indicates that molecular data, such as that for a widely conserved protein such as cytochrome b , show conserved similarities between organisms such as dugongs and proboscideans and can be used to support the existence of this relationship.

Part D

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

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✓

0	1

The response indicates that animals that are related once had a common ancestor with certain genetic characteristics. Adaption to different habitats leads to diversification of morphology but does not change evolutionary relationships.