

5.2 Classification & Cladistics

Question Paper

Course	DP IB Biology
Section	5. Evolution & Biodiversity
Topic	5.2 Classification & Cladistics
Difficulty	Hard

Time allowed: 60
Score: /44
Percentage: /100

Question 1a

a)

Ailuropoda melanoleuca, the giant panda, and *Ailurus fulgens*, the red panda, are both native to China. They share the following similarities:

- They live in similar environments
- They both digest bamboo as a primary source of food
- They both have a pseudo-thumb (a sixth digit) used to grip and shred food such as bamboo

The following table shows the differences between a comparable sequence of mitochondrial DNA of the giant panda and the red panda.

Mammal	DNA sequence
Giant panda	ATT GGA GCA GAC TTA
Red panda	ATT GGC ACT GAC CTA

A group of students concluded that the giant panda and the red panda are closely related.

Use the information provided to evaluate this conclusion.

[3 marks]

[3 marks]

Question 1b

b)

After careful deliberation, the group of students decided that the giant panda and red panda were, in fact, not closely related.

Suggest an explanation for the existence of a pseudo-thumb in both species.

[2 marks]

[2 marks]

Question 1c

c)

The base sequence of a different section of mitochondrial DNA (mtDNA) were analysed to determine the differences between giant panda and red panda DNA. In total, there were eight differences between the mtDNA of the two species.

Mitochondrial DNA is estimated to mutate at a rate of 1.87×10^{-7} mutations site⁻¹ year⁻¹. Use the information given to calculate how long ago the giant panda and the red panda evolved from a common ancestor. Show your working and round your answer to three significant figures.

[2 marks]

[2 marks]

Question 1d

d)

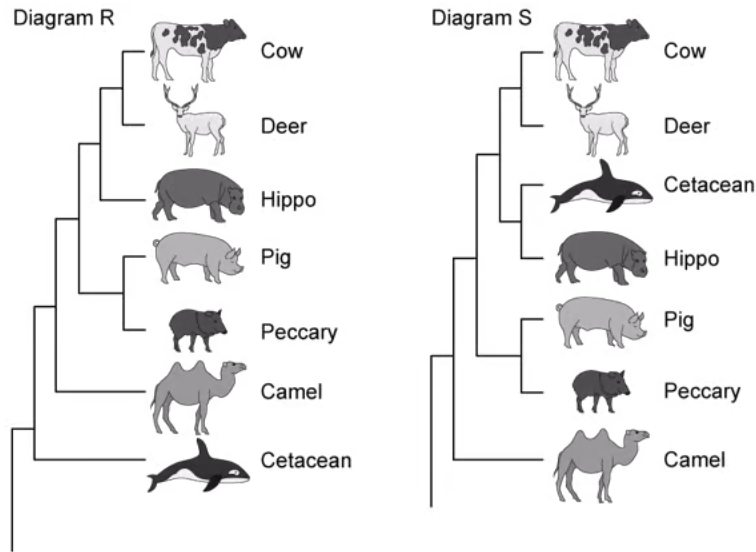
Explain the difference between a taxon and a clade.

[2 marks]

[2 marks]

Question 2a

a)
Cetaceans is an order of carnivorous aquatic mammals which include dolphins, whales and porpoises. The following diagram shows two proposals that have been put forward regarding the closest living relative of the cetaceans, represented by diagrams **R** and **S**.



Compare and contrast the information in diagrams **R** and **S**.

[4 marks]

[4 marks]

Question 2b

b)

Casein is a protein found in the milk of most mammals. Scientists investigated the differences in the DNA base sequence of the gene coding for casein in the mammals shown in diagrams **R** and **S**. The following table shows their results.

Sperm Whale	3							
Dolphin	3	2						
Hippo	4	3	3					
Cow	9	8	8	8				
Camel	12	11	11	12	14			
Deer	11	10	10	10	4	16		
Pig	11	10	10	11	13	14	13	
Peccary	14	12	13	14	16	16	18	7
	Baleen Whale	Sperm Whale	Dolphin	Hippo	Cow	Camel	Deer	Pig

Scientists concluded that diagram **S** best represents the currently accepted theory regarding the evolutionary origin of cetacean.

Based on the information provided, evaluate this conclusion.

[3 marks]

[3 marks]

Question 2c

c)

More recently, scientists decided to merge the order *Cetacea* and *Artiodactyla* into a single order called *Cetartiodactyla* based on new sequencing results.

Explain the importance of classifying organisms correctly according to their clade.

[1 mark]

[1 mark]

Question 2d

d)

Based on the information provided in part a), deduce **four other** taxonomic groupings/levels of classification that would be similar for dolphins and whales.

[1 mark]

[1 mark]

Question 3a

a)

DNA hybridisation is a technique used to determine the genetic similarity between species. The double stranded DNA of two different species is mixed and then heated until the strands separate. This provides an opportunity for hybridisation between the different DNA strands to occur. The mixture is then cooled in order to allow new hybrid double stranded DNA molecules to form. The greater the degree of hybridisation, the more genetically similar the two species are.

Scientists investigated the genetic similarity between four species of bacteria (**A** to **D**) by allowing their DNA to hybridise with each other. The results of this investigation are shown in the table below.

Bacterial species	DNA-DNA relatedness / % with:			
	Species A	Species B	Species C	Species D
A	100	32	36	24
B	57	100	42	28
C	35	39	100	21
D	26	28	24	100

i)

Identify the species of bacteria that is most closely related to the other bacterial species.

[1 mark]

ii)

Explain your answer at part i).

[1 mark]

[2 marks]

Question 3b

b)
Scientists concluded that species **D** was the first to branch off from the common ancestor that they all share.
Based on the information provided, comment on this conclusion.

[2 marks]

[2 marks]

Question 3c

c)
The group of scientists also investigated the similarity of the protein molecules that make up peptidoglycan in the cell walls of the bacterial species. The amino acid sequence of species **A** was compared to those of species **B** to **D**.

The results are shown in the table below:

Bacterial species	Percentage similarity
A	100
B	99.4
C	98.7
D	97.8

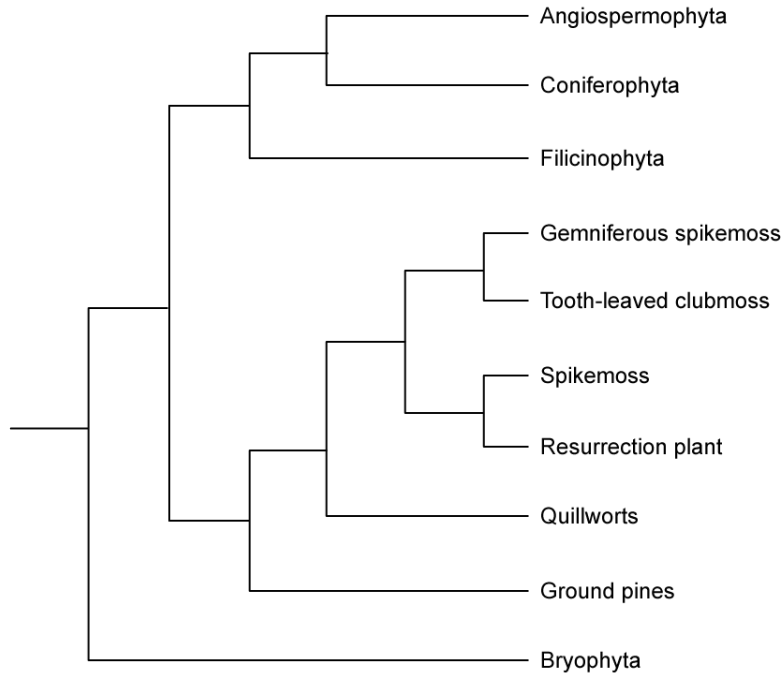
Based on the information provided and your knowledge of protein synthesis, explain the reason why the bacterial species show such a high level of similarity between the protein molecules, even though there are differences in their DNA.

[1 mark]

[1 mark]

Question 4a

a)
The following diagram shows a cladogram that indicates the evolutionary relationship of plants. Note that different taxonomic groups are represented in the cladogram.



Identify the plant phyla which are the most closely related.

[1 mark]

[1 mark]

Question 4b

b)
Bryophyta are found in a variety of environments and are typically very small in size. Filicinophyta are able to grow to much larger sizes than Bryophyta.

Using your knowledge of plant phyla characteristics, explain the difference in size between Bryophyta and Filicinophyta.

[2 marks]

[2 marks]

Question 4c

c)

The common names of some plant genera and species were given in this cladogram.

Using the information given in part a), explain how using the common names could cause confusion when studying this cladogram.

[2 marks]

[2 marks]

Question 4d

d)

Gemiferous spikemoss, tooth-leaved clubmoss, spikemoss and the resurrection plant can all be considered members of the same clade.

Explain this statement.

[1 mark]

[1 mark]

Question 5a

One mark is available for clarity of communication throughout this question.

a)

The binomial naming system is an important tool to facilitate cooperation and collaboration between groups of scientists.

Discuss how the binomial system will facilitate cooperation and collaboration between scientists.

[3 marks]

[3 marks]

Question 5b

b)

Compare and contrast the domain Eubacteria with the domain Eukaryotes.

[5 marks]**[5 marks]****Question 5c**

c)

Constructing the evolutionary relationship between organisms based on morphology alone will not always deliver accurate results.

Outline the advancements that have been made in constructing cladograms in the field of cladistics.

[7 marks]**[7 marks]**

