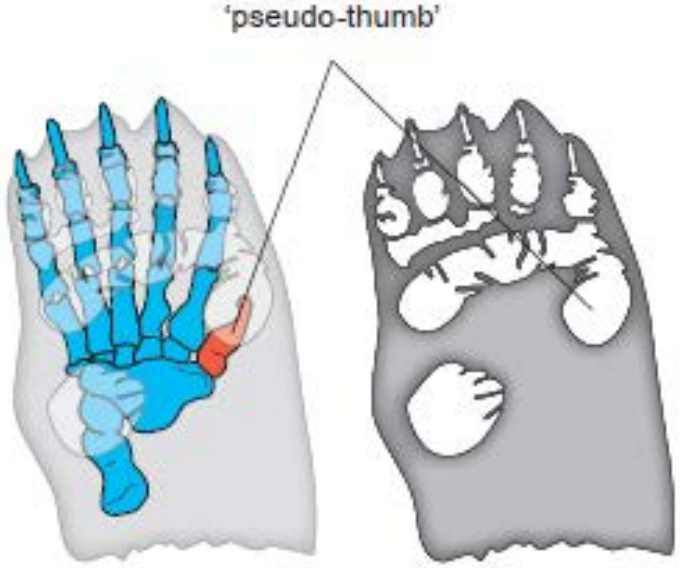
WJEC (Wales) Biology A-level
Topic 2.1: Biodiversity and Classification
Questions by Topic

1.

Giant pandas, *Ailuropoda melanoleuca* and red pandas, *Ailurus fulgens* are both mammals which are native to China. It was long believed that giant pandas and red pandas were close evolutionary relatives and there is much evidence to support this hypothesis:

- both animals live in similar habitats,
- both have digestive systems similarly adapted to their bamboo diet,
- both have a sixth digit, known as a pseudo-thumb, which they use to grip and shred bamboo shoots.



With the advent of DNA sequencing techniques, it has been possible to compare the DNA of different species to confirm how closely related they are to each other.
The table below shows mitochondrial DNA sequences from four species of mammal including giant panda and red panda.

Species	Mitochondrial DNA (mtDNA) codes
Black bear	.....ATTGGAGCAGACTTA.....
Giant panda	.....ATTGGCACTAATCTA.....
Red panda	.....ATTGGAACTAATCTT.....
Raccoon	.....ATCGGAACTAATCTT.....

(a) Use the table to identify which of the species is most closely related to the red panda. Explain your answer. [2]

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(b) In the study, mitochondrial DNA base pairs were analysed.
The following number of differences were found between giant panda DNA and that of the other species analysed:

Red panda	17
Black bear	12
Raccoon	21

One estimate of the mutation rate for the mitochondrial DNA sequence analysed is 3.95×10^{-7} mutations yr^{-1}.

Estimate how many years ago the giant panda and the red panda last shared a common ancestor. **Give your answer in standard form to two significant figures.** [3]

Answer: .....

(c) There has been some debate as to whether the pseudo-thumb in red pandas and giant pandas are examples of analogous or homologous structures. Distinguish between analogous and homologous structures. Explain why analogous features are not considered evidence of common ancestry. [3]

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(d) In 1977, Carl Woese proposed the three domain system based on analysis of differences in the nucleotide sequences of 16S rRNA genes. Identify the domain to which the giant panda would belong. Give a reason for your answer. [2]

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2. Complete the following table using the characteristics to identify each kingdom.

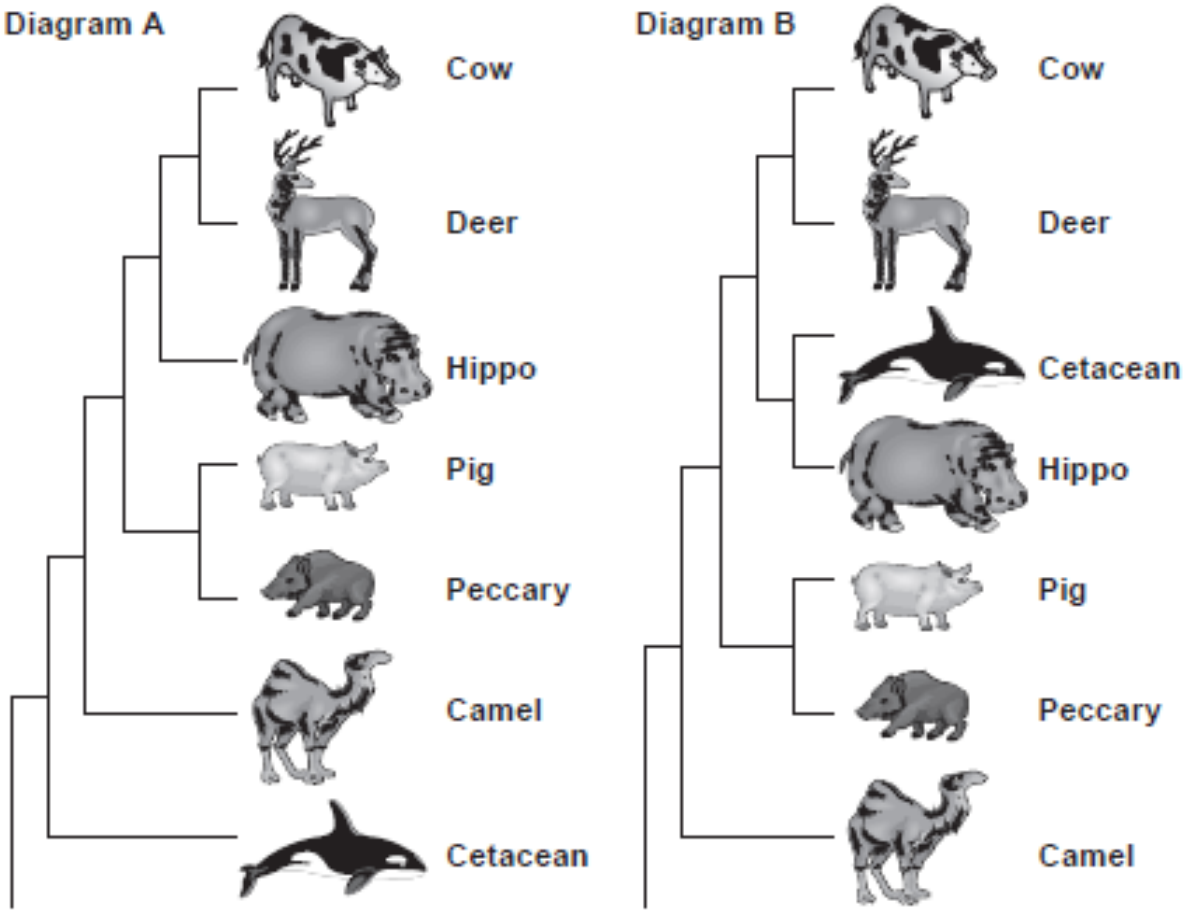
[5]

Characteristics	*Kingdom*
Heterotrophic eukaryotes Cell wall of chitin Reproduce by spores	
Heterotrophic Multicellular eukaryotes No cell wall Nervous coordination	
Eukaryotes Single celled No tissues differentiation	
Unicellular Microscopic No membrane bound organelles Cell wall not cellulose Cell wall made of murein	
Multicellular eukaryotes Photosynthetic Cellulose cell wall	

3. Whales and dolphins belong to a single group of carnivorous, marine mammals called the cetaceans (order Cetacea). Cetaceans are comprised of three sub-orders: Odontoceti (toothed whales including sperm whales and dolphins), Mysticeti (baleen whales), and Archaeoceti (the extinct ancestors of modern whales).

There have been a number of theories regarding the closest living relative to the cetaceans.

The diagrams below illustrate two of these theories. With the exception of the cetacean, all the mammals shown belong to the order Artiodactyla.



(a) State the term used to describe diagrams such as those shown above. [1]

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(b) The values given in the following table show the number of differences in the nucleotide sequence of the gene coding for the synthesis of the milk protein casein in different mammals.

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

(i) Use the information in the table to explain whether **Diagram A** or **Diagram B** represents the currently accepted theory regarding the closest living relative to the cetaceans. [3]

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(ii) Modern taxonomic classification combines Cetacea and Artiodactyla into a single order, the Cetiartiodactyla. Explain how this illustrates the "tentative nature" of biological classification. [2]

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(c) Both the common bottlenose dolphin *(Tursiops truncates)* and the killer whale *(Orcinis orca)* belong to a smaller taxonomic group of the sub-order Odontoceti called the Delphinidae. Name the group in the taxonomic hierarchy to which the Delphinidae belong. [1]

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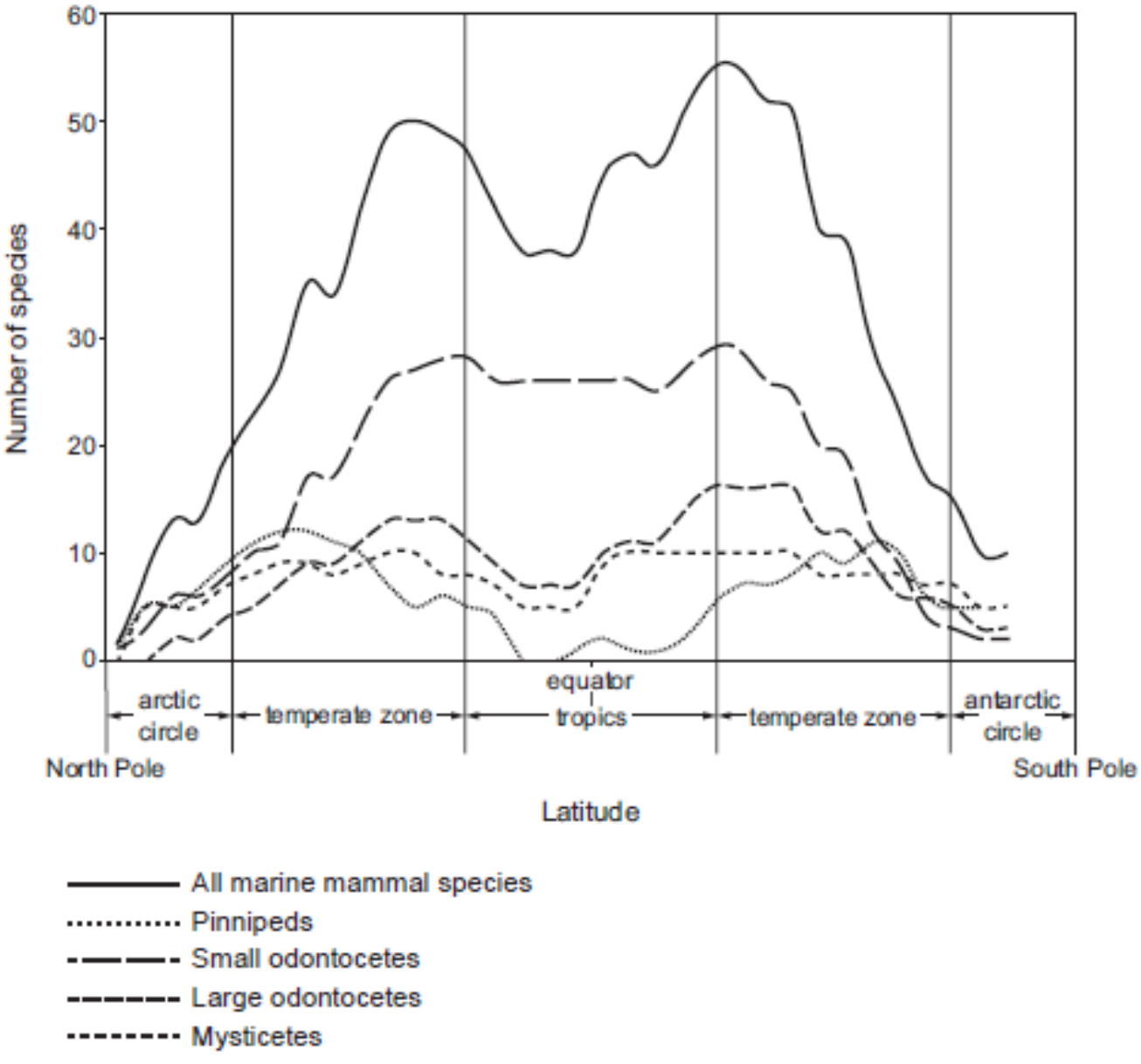
(d) In 2011, an international group of researchers used sightings from three oceanic surveys to predict patterns in the global distribution of marine mammals. The table lists the mammalian groups included in the survey.

Mammalian group	Examples
Pinnipeds	seals and sea lions
Small odontocetes	dolphins
Large odontocetes	sperm whales and killer whales
Mysticetes	baleen whales

The following graph shows the predicted number of species by latitude.



(i) Describe the effect of latitude on the number of species of small odontocetes from the antarctic circle to the tropics. [2]

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(ii) State the environmental factor that is most likely to explain the distribution of all marine mammal species. [1]

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(iii) Why is the curve for all marine mammal species described as showing a bimodal distribution? [1]

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4. *(a)* In the table below give an example of a disease caused by an organism from each of the kingdoms shown. [3]

Kingdom	*Disease*
Prokaryotae	
Protoctista	
Fungi	

(b) The percentage (%) difference in the DNA between different organisms is directly related to the time since the species diverged from their common ancestor.

(i) There is 3.6% difference between the DNA of humans and orangutans, 2.3% difference between the DNA of humans and gorillas and a 1.6% difference between the DNA of humans and chimps. Arrange these organisms in terms of how closely they are related to humans. [1]

Humans

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(ii) There is a 0.7% difference between the DNA of the common chimp and the pygmy chimp and they diverged 3 million years ago.
Human DNA differs from the common chimp and the pygmy chimp by 1.6%.
Calculate how long ago humans and chimps diverged from their common ancestor.
Show your working. [2]

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(iii) Apart from DNA, give an example of another molecule which can be used to assess how closely organisms are related. [1]

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(c) Fossil evidence suggests that there have been other species of humans, for example *Homo neanderthalensis* and *Homo habilis*. Suggest why these are considered to be members of different species. [2]

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(Total 9 marks)

5.

(a) What term is used to describe the variation in number of species in different places? [1]

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(b) Identify **two** habitats where you would expect to find a high number of species. [2]

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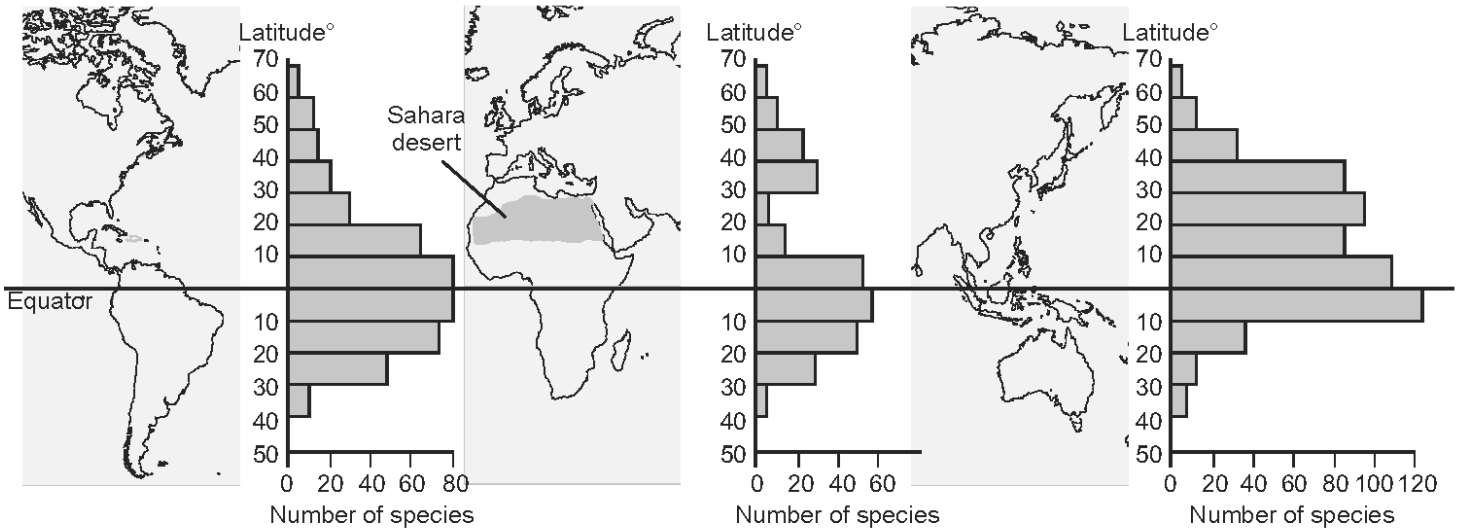
The diagram shows how the number of different species of a type of butterfly varies with latitude in different parts of the world.



(c) Describe the general relationship between latitude and number of species shown in the diagram. [1]

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(d) Suggest why there is a decrease in the number of species of this type of butterfly in the region covered by the Sahara desert. [2]

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6. The following statements describe some of the features of organisms in each of the five kingdoms.

Write the letter of the sentences **A** to **E** in the box that correctly identifies each of the five kingdoms.

A Eukaryotic organisms possessing cell walls and large vacuoles in their cells.

B Eukaryotic organisms that are non-photosynthetic but possess cell walls.

C Heterotrophic organisms showing nervous co-ordination.

D Unicelluar organisms with no internal or nuclear membranes but possessing a cell wall.

E Small organisms possessing both internal and nuclear membranes.

[4]

Prokaryote ☐

Protoctista ☐

Fungi ☐

Plantae ☐

Animalia ☐

(Total 4 Marks)

7. *(a)* Table 1 gives some features of three kingdoms of living organisms. Complete the table by stating the name of each kingdom. [3]

Table 1

Features	*Kingdom*
Unicellular, no nuclear membrane, cell wall made of murein, not cellulose	
Thread-like hyphae forming a mycelium, cell wall made of chitin	
Multicellular, cells have cellulose cell wall	

(b) Table 2 gives some details of human classification, in hierarchical order.

Table 2

Taxon	*Human*
Kingdom	Animalia
	Chordata
	Mammalia
	Primates
	Hominidae
	Homo
Species	sapiens

Name the class and the family to which the human belongs. [2]

Class .....

Family .....

(c) (i) Fossil evidence suggests that *Homo sapiens* and *Homo neanderthalensis* coexisted for at least 40 000 years. State why these two human forms might be classified as separate species despite having many common features. [2]

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(ii) Name a biological technique that can be used to confirm that *H. sapiens* and *H. neanderthalensis* are separate species. [1]

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(Total 8 marks)

8. The table below shows certain characteristics of four kingdoms. If the characteristic is present in members of the kingdom this is shown with a tick (✓). If the characteristic is not present this is shown with a cross (**X**).

Complete the table below by giving the name of each kingdom

[4]

		Kingdom			
		.....	.....	.....	.....
Characteristic	Eukaryotic	✓	✓	X	✓
	Chloroplast	✓	X	X	some species
	Cell wall	✓	X	✓	some species
	Nucleus	✓	✓	X	✓

9. The Snow Leopard, *Panthera uncia,* is an endangered species of big cat that is found in the mountainous regions of central Asia.

(a) (i) Complete the table below for the classification of the snow leopard. [2]

Kingdom	Animalia
Phylum	Chordata
	Mammalia
Order	Carnivora
	Felidae
Genus	
Species	

(ii) The snow leopard belongs to the phylum Chordata. Excluding characteristics common to the phylum in general, state **one** characteristic that is common to all vertebrates. [1]

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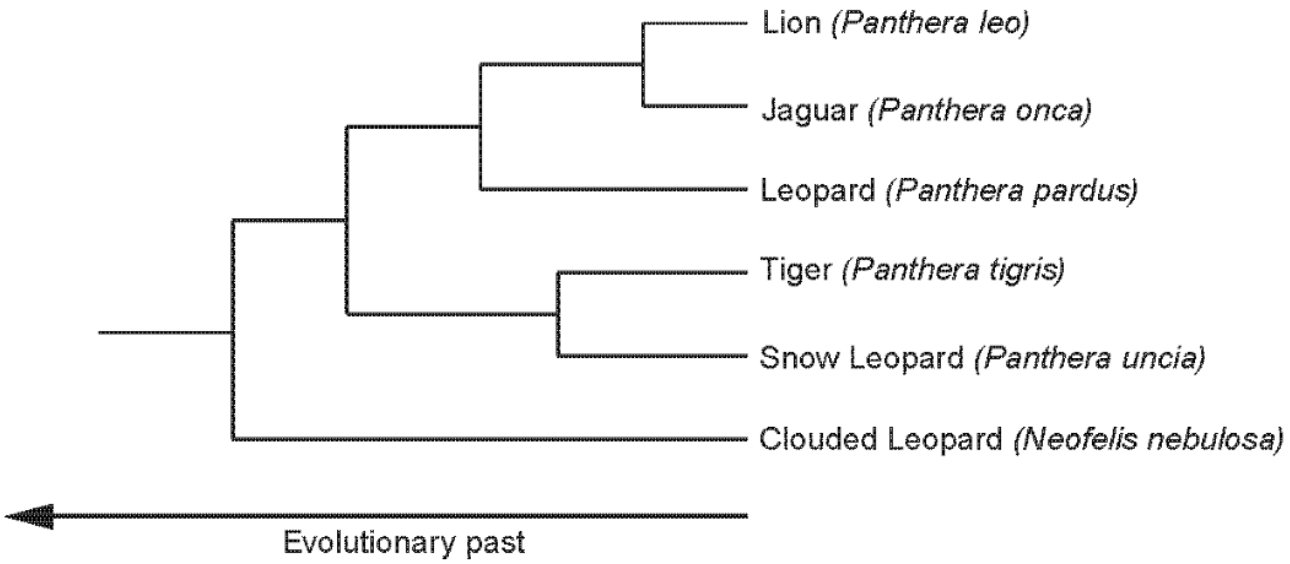
(b) Below is part of the phylogenetic tree for the Felidae.



(i) Using evidence from the diagram, state which **two** cat species are likely to be most closely related. [1]

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(ii) Explain how the results of DNA profiling tests could have been used to determine that these two species were the most closely related. [1]

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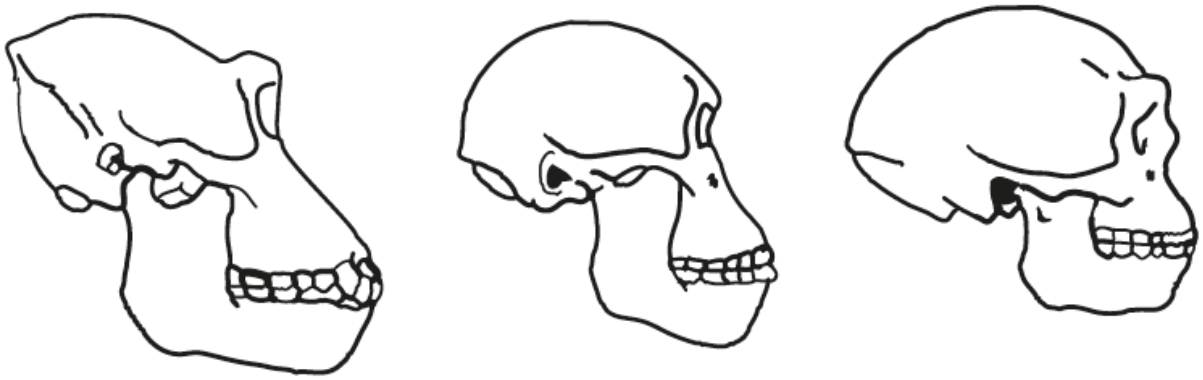
10. The diagram below shows skulls from three different primates. *Australopithecus afarensis* and *Homo erectus* have been extinct for over a million years.



Gorilla gorilla *Australopithecus afarensis* *Homo erectus*

(a) Name the **class** to which **all** these primates belong.

[1]

(b) Define the term *species*.

[2]

(c) (i) With reference to the diagrams opposite suggest why scientists regard *Homo erectus* as being more closely related to *Australopithecus afarensis* than *Gorilla gorilla*.

[1]

(ii) Using their classification, identify which primate is most closely related to modern humans, and explain your answer.

[2]

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11. The Archaea are a domain of single-celled microorganisms. These microbes are prokaryotes. Most Archaea possess a cell wall which is assembled from surface-layer proteins. These form an S-layer which is a rigid array of protein molecules that cover the outside of the cell. This layer provides both chemical and physical protection. Unlike bacteria, most Archaea lack peptidoglycan in their cell walls.

(a) (i) Describe two major features of a eukaryote which would allow you to distinguish it from a prokaryote. [1]

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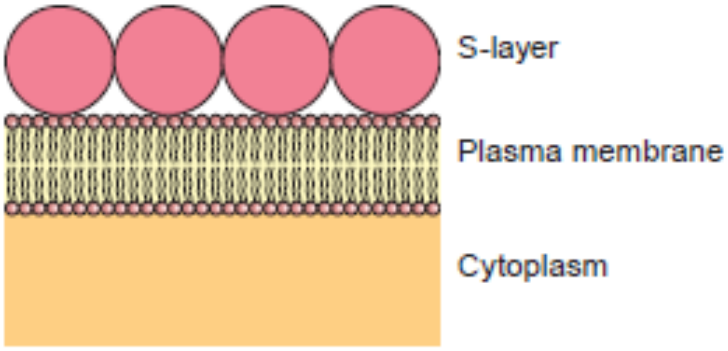
One type of cell wall found in Archaea is shown below.



(ii) Apart from the lack of peptidoglycan, describe how the cell walls of Gram negative bacteria would differ from those of Archaea. [2]

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