Questions

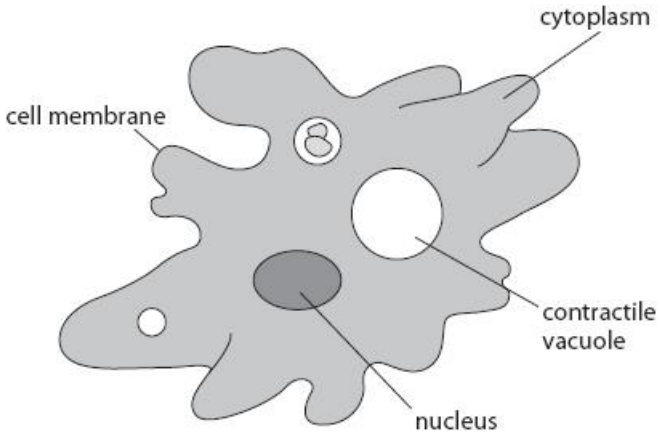
Q1.

Amoeba proteus is a single-celled organism that lives in pond water.

Amoeba has a structure called a contractile vacuole that removes excess water from the cell.

Water that moves into the cytoplasm is transported into the contractile vacuole. When full, the contractile vacuole moves to the surface of the cell and fuses with the cell membrane. This allows the water it contains to be removed from the cell.

The diagram shows *Amoeba* with a contractile vacuole.



Amoeba belongs to the domain

(1)

☒ **A** Eukaryota

☒ **B** Bacteria

☒ **C** Archaea

☒ **D** Animalia

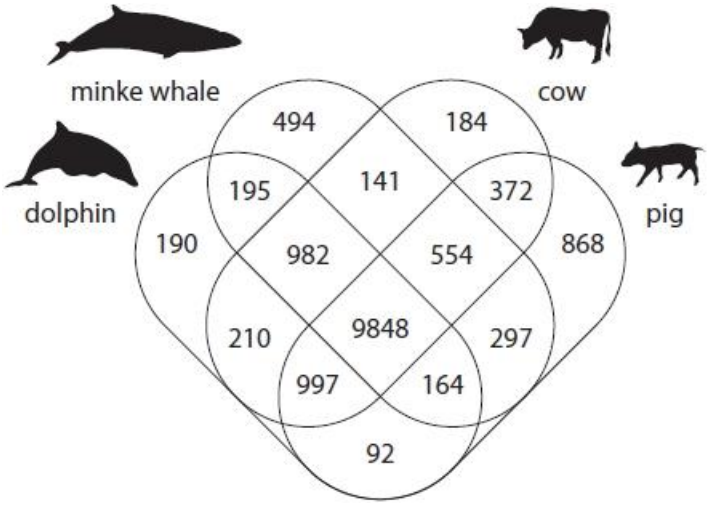
(Total for question = 1 mark)

Q2.

Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

The Venn diagram shows unique and shared gene families in the genomes of minke whales, dolphins, pigs and cows.



Calculate the percentage of a dolphin's gene families that are shared with the minke whale.

(2)

Answer ..... %

(Total for question = 2 marks)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Biologists classify organisms based on characteristics and on evolutionary relationships.

(i) Which of these groups contains the greatest variety of organisms?

(1)

- ☐ **A** genus
- ☐ **B** kingdom
- ☐ **C** phylum
- ☐ **D** species

(ii) Closely-related genera are grouped together in a

(1)

- ☐ **A** class
- ☐ **B** domain
- ☐ **C** family
- ☐ **D** order

(iii) Which of these is a kingdom?

(1)

- ☐ **A** Archaea
- ☐ **B** Bacteria
- ☐ **C** Eukarya
- ☐ **D** Protista

(Total for question = 3 marks)

Q4.

Biologists classify organisms based on characteristics and on evolutionary relationships.

(i) Explain the evidence that led to the three-domain model of classification replacing the five-kingdom model.

(3)

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(ii) Give a method that a scientist, with a new theory based upon experimental results, could use to share this with others in the scientific community.

(1)

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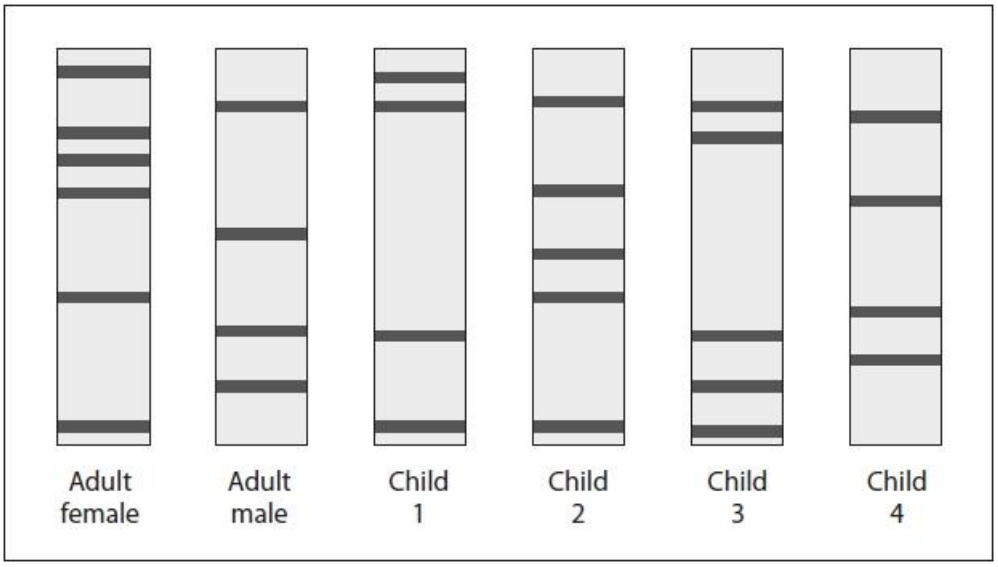
(Total for question = 4 marks)

Q5.

The polymerase chain reaction (PCR) and gel electrophoresis are used to produce DNA profiles.

The diagram shows DNA profiles, from an adult female, an adult male and each of four children.



Explain why gel electrophoresis produces individual DNA profiles.

(2)

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(Total for question = 2 marks)

Q6.

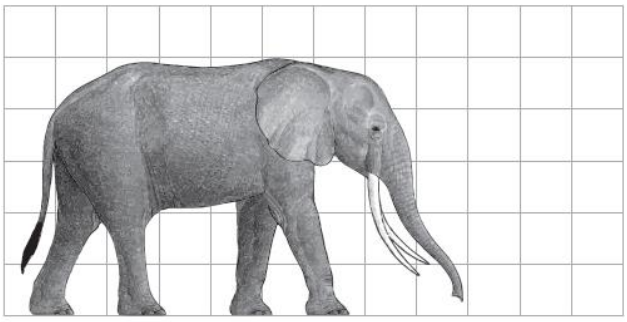
There are currently only three surviving species of elephant:

- Asian elephant, *Elephas maximus*
- African bush elephant, *Loxodonta africana*
- African forest elephant, *Loxodonta cyclotis*

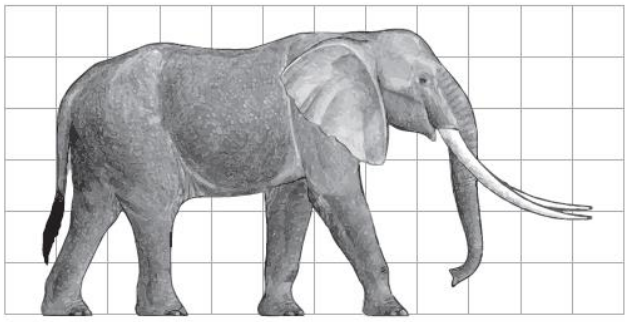
All African elephants used to be classified as a single species.

Recent comparisons of African elephants demonstrated that they are two separate species.

The diagrams show the appearance and locations of the two African elephant species.



African bush elephant



African forest elephant

(i) Give one reason why scientists used to classify African elephants as a single species.

(1)

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(ii) Scientists agreed to separate the African elephants into two species based on new evidence from DNA sequencing.

State how scientists reach agreement on new evidence.

(1)

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(Total for question = 2 marks)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Taxonomy is the branch of biology concerned with classifying organisms.

Scientists use a variety of methods to classify organisms into groups.

Which of the following groups contains the largest number of different types of organism?

(1)

- ☐ **A** class
- ☐ **B** order
- ☐ **C** phylum
- ☐ **D** species

(Total for question = 1 mark)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Taxonomy is the branch of biology concerned with classifying organisms.

Scientists use a variety of methods to classify organisms into groups.

One definition of a species is a group of organisms that has similar features and

(1)

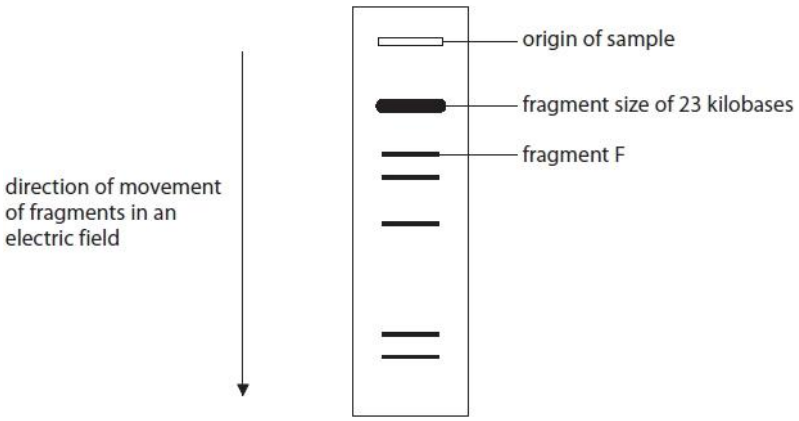
- ☐ **A** can mate to produce hybrid offspring
- ☐ **B** can produce fertile offspring
- ☐ **C** live in the same location
- ☐ **D** have no genetic variation

(Total for question = 1 mark)

Q9.

(b) Fragments of DNA can be separated by gel electrophoresis to produce a DNA profile.

The diagram shows an example of a DNA profile.



(i) Explain why fragments of DNA can be separated by gel electrophoresis.

(2)

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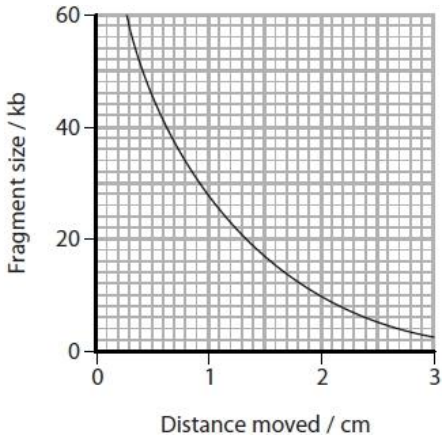
(ii) The graph shows the relationship between the distance moved in a gel and the fragment size.



Determine the size of fragment F.

(1)

Answer ..... kb

(Total for question = 3 marks)

Q10.

Taxonomy defines and names groups of organisms.

(i) Describe the information scientists can use to classify an organism as a new species.

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(ii) Explain why it may be difficult to classify a newly discovered organism as a separate species.

(2)

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(Total for question = 6 marks)

Q11.

Recently, scientists extracted mitochondrial DNA from a frozen Arctic mammoth.

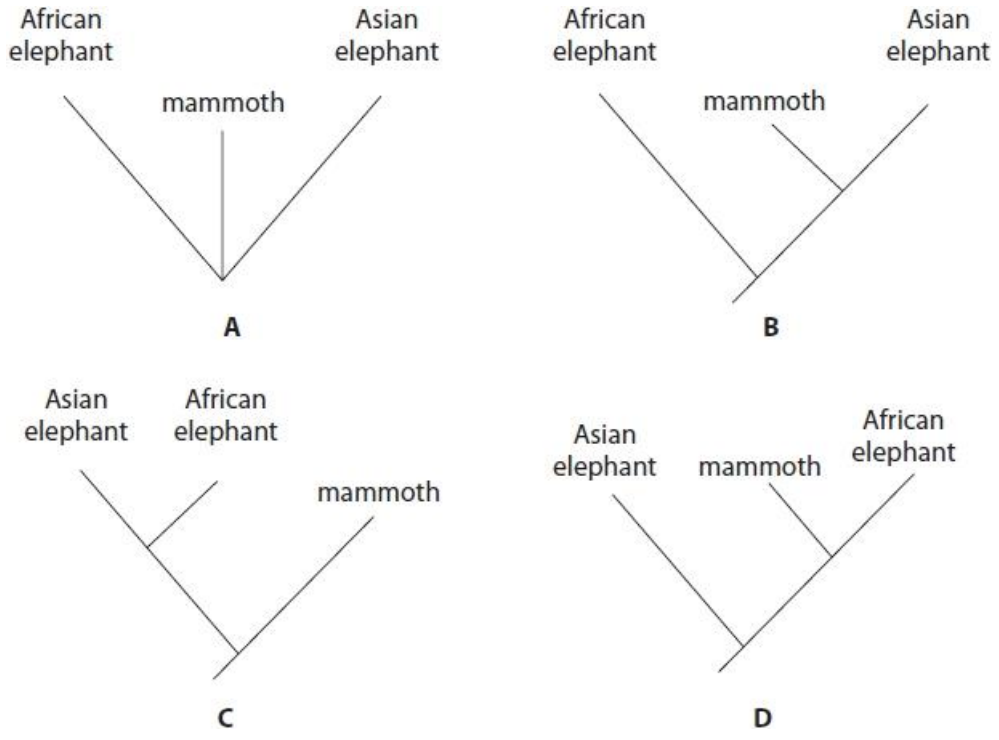
This DNA was sequenced and compared with the mitochondrial DNA from the Asian elephant and from the African bush elephant.

The percentage similarities in the DNA sequences are shown in the table.

Species	Percentage similarity in DNA sequence (%)		
	Mammoth	Asian elephant	African bush elephant
Mammoth	100	98	96
Asian elephant	98	100	95
African bush elephant	96	95	100

Which diagram shows the correct evolutionary relationship for these three species, based on the data in the table?

(1)



- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for question = 1 mark)

Q12.

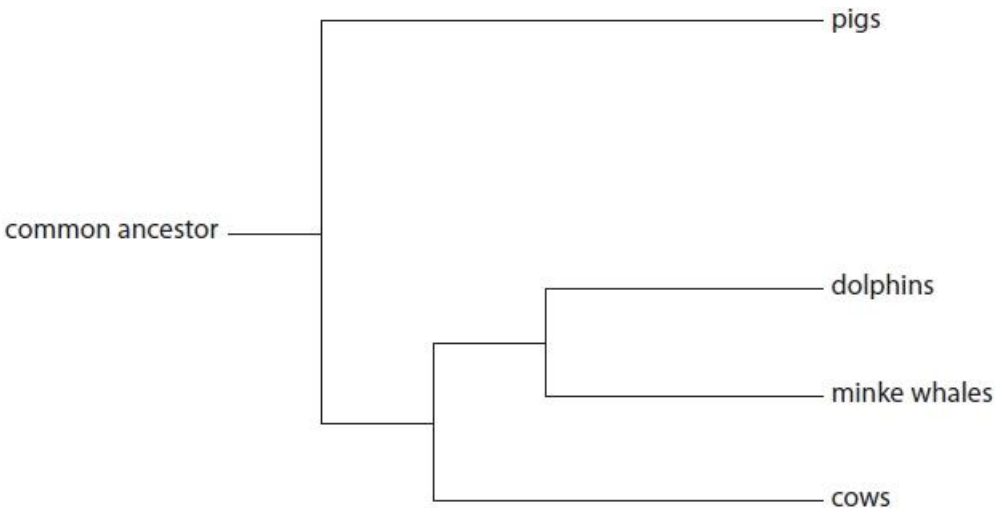
Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

Cetaceans evolved between 55 and 60 million years ago.

Their closest living relatives are thought to be pigs and cows.

The diagram shows the evolutionary relationship between minke whales, dolphins, pigs and cows.



Analyse the diagram to explain the evolutionary relationship between these four animals.

(3)

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(Total for question = 3 marks)

Q13.

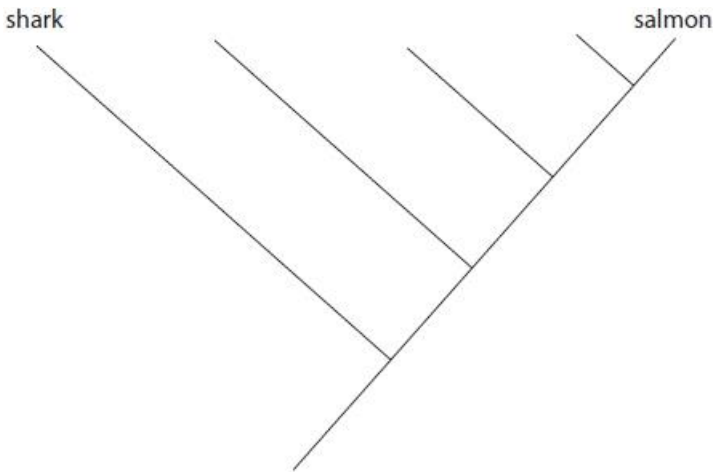
Gel electrophoresis is used to separate biological molecules such as proteins.

The table shows the number of bands each fish has in common with the other species.

Species	Shark	Salmon	Trout	Catfish	Sturgeon
Shark	8	2	2	2	2
Salmon		10	10	5	3
Trout			13	5	4
Catfish				10	2
Sturgeon					12

Analyse the data to complete the diagram showing the evolutionary relationships between these species of fish.

(2)



(Total for question = 2 marks)

Q14.

Fritillaria delavayi is a small plant (height 7 cm), that grows on rocky slopes on mountains in China.

The image shows *Fritillaria delavayi*.

For at least 2 000 years, this plant has been collected and used in Chinese medicine.
It is not known to be eaten by animals.

In less accessible regions, where few humans go, the plants are bright green with bright yellow flowers.

In locations where bulbs are collected in high numbers, most plants have greyish-brown leaves and flowers.

Scientists believe that the greyish-brown plants are the same species as the brightly-coloured plants.

(i) Describe how scientists can use gel electrophoresis to show that these plants belong to the same species.

(4)

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(ii) Explain why the features of the brightly-coloured plants enable them to grow successfully in the areas where they are not collected by humans.

(2)

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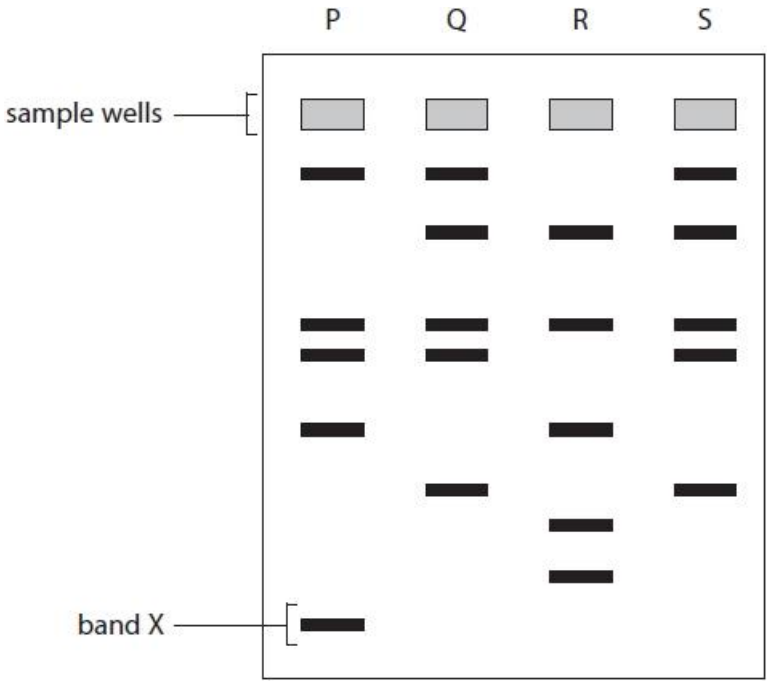
(Total for question = 6 marks)

Q15.

Gel electrophoresis is a method used to analyse DNA fragments from different organisms.

The diagram shows the results of gel electrophoresis of DNA samples from four organisms: P, Q, R and S.



What is shown by the band labelled X?

(1)

- ☒ **A** largest fragment of DNA that travelled the fastest
- ☒ **B** largest fragment of DNA that travelled the slowest
- ☒ **C** smallest fragment of DNA that travelled the fastest
- ☒ **D** smallest fragment of DNA that travelled the slowest

(Total for question = 1 mark)

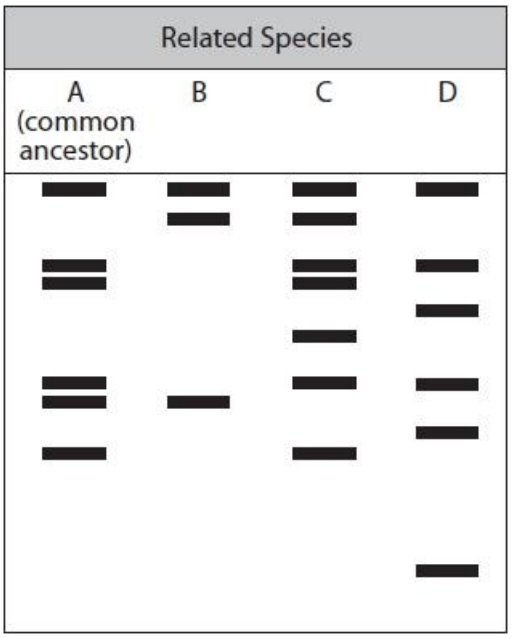
Q16.

Gel electrophoresis is a method used to analyse DNA fragments from different organisms.

Gel electrophoresis of DNA can be used to study the evolutionary relationships between species.

Scientists used gel electrophoresis to examine the relationship between four species: A, B, C and D.

The diagram shows the results.



Explain which species is most closely related to the common ancestor using these results.

(3)

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(Total for question = 3 marks)

Q17.

Gel electrophoresis is a method used to analyse DNA fragments from different organisms.

Describe evidence, other than the gel electrophoresis of DNA, that a scientist could use to establish the evolutionary relationships between species.

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(Total for question = 4 marks)

Q18.

Gel electrophoresis is used to separate biological molecules such as proteins.

Explain how gel electrophoresis separates molecules.

(2)

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(Total for question = 2 marks)

Q19.

The photograph shows an adult mayfly.

Rhithrogena germanica is commonly known as the March brown mayfly.

The classification hierarchy for this mayfly is:

Animalia
Arthropoda
Insecta
Ephemeropteroidea
Heptageniidae
Rhithrogena germanica

(i) State the genus of this mayfly.

(1)

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(ii) This mayfly belongs to the phylum Arthropoda.

Which is the order for this mayfly?

(1)

- ☒ **A** Animalia
- ☒ **B** Ephemeropteroidea
- ☒ **C** Heptageniidae
- ☒ **D** Insecta

(Total for question = 2 marks)

Q20.

Answer the question with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Mosquitoes transmit a number of diseases, including malaria.

The photograph shows a mosquito, *Anopheles gambiae*.

This mosquito transmits malaria.

Source: © Sinclair Stammers / Science photo library

(i) State the genus of this mosquito.

(1)

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(ii) Mosquitoes belong to the class Insecta.

Some of the insects in this class are subdivided into a group called Diptera.
What is the name of the classification group that includes Diptera?

(1)

- ☒ **A** Family
- ☒ **B** Genus
- ☒ **C** Order
- ☒ **D** Phylum

(iii) Which of the following organisms causes the symptoms of malaria?

(1)

- ☒ **A** *Anopheles gambiae*
- ☒ **B** *Plasmodium falciparum*
- ☒ **C** *Puccinia graminis*
- ☒ **D** *Salmonella enterica*

(Total for question = 3 marks)

Q21.

Taxonomy defines and names groups of organisms.

The correct hierarchy of classification categories is

(1)

- ☒ **A** domain, kingdom, phylum, class, order, family, genus, species
- ☒ **B** domain, kingdom, phylum, order, class, family, genus, species
- ☒ **C** kingdom, domain, order, phylum, class, genus, family, species
- ☒ **D** kingdom, phylum, domain, order, class, family, genus, species

(Total for question = 1 mark)

Q22.

Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

A wholphin is an extremely rare hybrid animal born from the mating of a female dolphin and a male killer whale.

Kekaimalu was a wholphin born in the United States in 1985. Kekaimalu was mated with a dolphin and on three occasions gave birth to live offspring.

Explain how this case study illustrates the limitations of the definition of a species.

(2)

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(Total for question = 2 marks)

Q23.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Taxonomy is the branch of biology concerned with classifying organisms.

Scientists use a variety of methods to classify organisms into groups.

Which molecules are separated using gel electrophoresis when classifying organisms?

(1)

- ☐ **A** DNA
- ☐ **B** lipids
- ☐ **C** polysaccharides
- ☐ **D** vitamins

(Total for question = 1 mark)

Q24.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The photograph shows an insect fossilised in amber resin.

(Source: Bjoern Wylezich. 123rf.com/PAL)

Scientists have classified another fossilised insect found in amber resin as a new species of mosquito, *Priscoculex burmanicus*.

This mosquito is anatomically very similar to modern species of mosquito.

(i) Which of these processes produces new species without geographically separating populations?

(1)

- ☒ **A** allopatric speciation
- ☒ **B** genetic speciation
- ☒ **C** stabilising speciation
- ☒ **D** sympatric speciation

(ii) *Priscoculex burmanicus* became extinct about 100 million years ago.

State why it was difficult for scientists to decide if this insect belonged to a different species from modern mosquitoes.

(1)

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(iii) State how scientists would have reached agreement on classifying this mosquito.

(1)

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(iv) Complete the classification table for *Priscoculex burmanicus*.

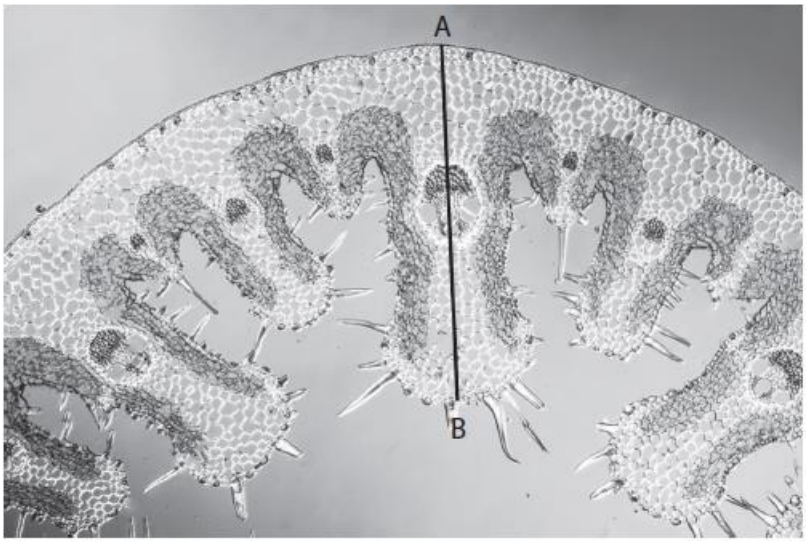
(2)

Taxon	Name
Domain	Eukarya
Kingdom	Animalia
	Arthropoda
	Diptera
Order	Culicidae
Family	Anophelinae
Genus	
Species	

(Total for question = 5 marks)

Q25.

The photograph shows a cross-section of a leaf from marram grass, *Ammophila arenaria*, as seen using a light microscope.



Source: © Dr. Norbert Lange/Shutterstock

Marram grass grows in sand dunes where little freshwater is available.

This plant has many adaptations that enable it to survive and grow in these conditions:

- leaves that are curved inwards
- leaves that have hairs
- stomata that are sunk in pits
- a thick waxy cuticle on the outside surface of the leaves

State the genus to which marram grass belongs.

(1)

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(Total for question = 1 mark)

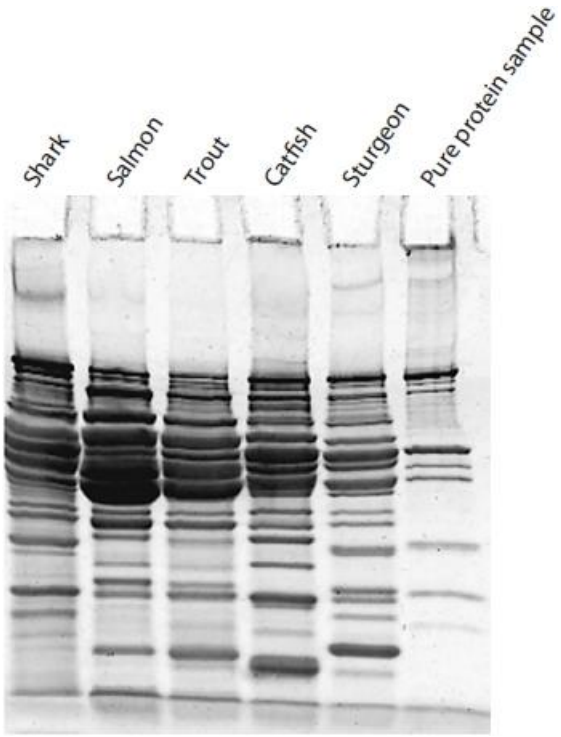
Q26.

Gel electrophoresis is used to separate biological molecules such as proteins.

Proteomics is the study of proteins that are produced in different species.

Scientists used gel electrophoresis to separate muscle proteins from five species of fish and from a pure protein sample.

The photograph shows the results of a gel separation of proteins from these fish and from the pure protein sample.



(i) Protein molecules in solution do not separate as easily as DNA fragments.

Explain how protein molecules in solution must be treated so that they can be separated by gel electrophoresis.

(2)

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(ii) Analyse the information shown in the photograph to explain how this banding pattern can be used to confirm that these are separate species of fish.

(4)

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(iii) Give a reason why pure protein samples were included in the gel.

(1)

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(iv) The bands in the photograph vary in thickness.

State what the thickness of the bands indicates.

(1)

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(Total for question = 8 marks)

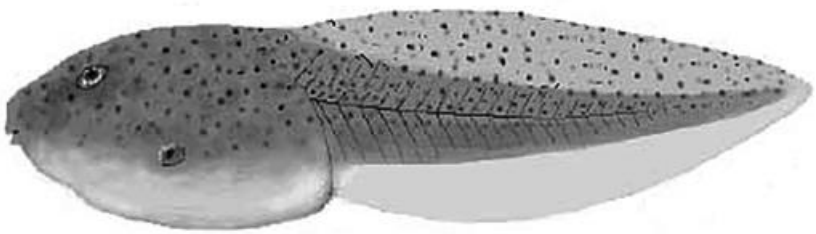
Q27.

The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



State the domain to which *Rana catesbeiana* belongs.

(1)

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(Total for question = 1 mark)

Q28.

A student measured the distribution of two plant species at the coast.

The distribution was measured from the high water line to 170 m inland.

State what is meant by the term species.

(1)

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(Total for question = 1 mark)

Q29.

Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

The five-kingdom model of classification is hierarchical.

Part of this hierarchy is:

kingdom
phylum
class
family
genus

Where in this hierarchy should the order Cetacea appear?

(1)

☒ **A** between kingdom and phylum

☒ **B** between phylum and class

☒ **C** between class and family

☒ **D** between family and genus

(Total for question = 1 mark)

Q30.

Malaria is a serious and sometimes fatal disease.

Scientists are constantly looking for new ways of controlling this disease.

Which row of the table shows the name of the pathogen that causes malaria, and its classification group?

(1)

	Name of pathogen	Classification group
☒ **A**	*Plasmodium*	genus
☒ **B**	*Plasmodium*	species
☒ **C**	*Puccinia*	genus
☒ **D**	*Puccinia*	species

(Total for question = 1 mark)

Q31.

The photograph shows a satin bowerbird, *Ptilonorhynchus violaceus*, in its bower.

(Source: ©Imogen Warren / Shutterstock)

The classification hierarchy for the satin bowerbird is:

Eukarya
Animalia
Chordata
Aves
Passeriformes
Ptilonorhynchidae
Ptilonorhynchus
violaceus

(i) Which of these is the phylum for the satin bowerbird?

(1)

- ☒ **A** Animalia
- ☒ **B** Chordata
- ☒ **C** Eukarya
- ☒ **D** Vertebrata

(ii) Which of these is the genus for the satin bowerbird?

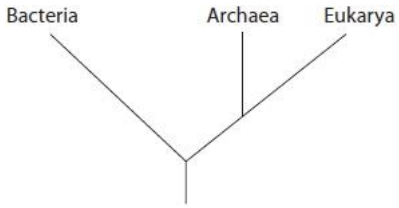
(1)

- ☒ **A** Aves
- ☒ **B** Bower
- ☒ **C** *Ptilonorhynchus*
- ☒ **D** *violaceus*

(Total for question = 2 marks)

Q32.
The photograph shows part of a bacterial cell surrounded by viruses, as seen using an electron microscope.

The diagram shows the three-domain model of classification as suggested by Carl Woese.



This model was based on the comparison of many different characteristics.

Some of the characteristics used by Woese are shown in the table.

Characteristic	Archaea	Bacteria	Eukarya
Membrane lipids	branched carbon chains attached to glycerol by **ether** linkage	straight carbon chains attached to glycerol by **ester** linkage	straight carbon chains attached to glycerol by **ester** linkage
First amino acid in protein synthesis	methionine	formylmethionine	methionine
Antibiotic sensitivity	no	yes	no
rRNA loop sequence	absent	present	absent
Ribosome size	70 S	70 S	80 S

(i) Analyse the information to explain the evidence for the three-domain model of classification.

(3)

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(ii) Many scientists agree with this three-domain model.

State how these scientists would have reached agreement about this model.

(1)

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(Total for question = 4 marks)

Q33.

There are currently only three surviving species of elephant:

- Asian elephant, *Elephas maximus*
- African bush elephant, *Loxodonta africana*
- African forest elephant, *Loxodonta cyclotis*

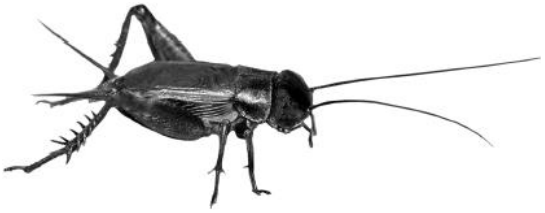
Complete the table showing the classification of the African bush elephant.

(2)

Domain	.....
Kingdom	Animalia
Phylum	Chordata
.....	Mammalia
Order	Proboscidae
Family	Elephantidae
Genus	.....
Species	.....

(Total for question = 2 marks)

Q34.
The photograph shows a species of insect, *Gryllus pennsylvannicus*.



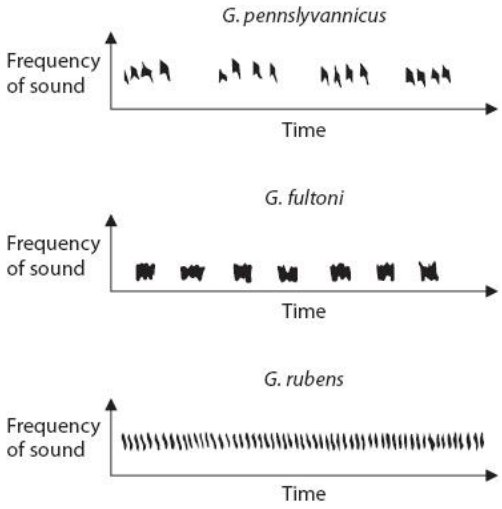
Scientists used to think that *G. pennslyvannicus* and two other species, *G. fultoni* and *G. rubens*, belonged to the same species.

The insects live in North Carolina in the USA.

Scientists have produced evidence that these insects have evolved into three distinct species from a common ancestor.

They recorded the male mating calls of each species and produced a graph representing the sound made. The graph is called a sonogram.

The diagram shows the sonogram for each species.



Explain how gel electrophoresis could be used to identify which species is most closely related to the common ancestor.

(4)

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(Total for question = 4 marks)

Mark Scheme

Q1.

Question number	Answer	Mark
	The only correct answer is A B is not correct because bacteria do not have a nucleus C is not correct because archaea do not have a nucleus D is not correct because Animalia are multicellular / is a kingdom	**(1)**

Q2.

Question Number	Answer	Additional Guidance	Mark
	• total number of dolphin's gene families and number of shared gene families **(1)** • percentage of gene families shared **(1)**	Example of calculation 12 678 and 11 189 = 88.26 / 88.3 / 88 **Accept** ecf if one value incorrect	**(2)**

Q3.

Question Number	Answer	Mark
(i)	**The only correct answer is B kingdom** **A** *is not correct because it does not contain the greatest variety of organisms* **C** *is not correct because it does not contain the greatest variety of organisms* **D** *is not correct because it does not contain the greatest variety of organisms*	**(1)**

Question Number	Answer Additional guidance	Mark
(ii)	**The only correct answer is C family** **A** *is not correct because closely related genera are not grouped in a class* **B** *is not correct because closely related genera are not grouped in a domain* **D** *is not correct because closely related genera are not grouped in an order*	**(1)**

Question Number	Answer	Mark
(iii)	**The only correct answer is D Protista** **A** *is not correct because archaea is a domain* **B** *is not correct because bacteria is a domain* **C** *is not correct because eukarya is a domain*	**(1)**

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to the following points: • used techniques of molecular phylogeny / such as protein biochemistry (1) • which found similarities and differences between archaeaand bacteria (1) • **such as** membrane structure, membrane proteins, membrane bound organelles, (1)	allow bioinformatics **examples of evidence** lipid structure, ribosome, plasmids,operons, antibiotic resistance, chloroplasts	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	• peer reviewed journals / scientific conferences		**(1)**

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • because of the {differences in / hypervariable regions} (in each individual's DNA) (1) • so produce fragments of different lengths (1) **OR** • different {fragments / lengths} of DNA are separated out (1)	**ACCEPT** unique DNA **ACCEPT** each individual has different abundance ofdifferent sized DNA (fragments) **OR** **ACCEPT** fragments therefore move through gel at different rates / smaller fragments move {further /faster} / converse for larger	(2)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to one the following: • similar appearance (1) • have **not** observed if they could breed together / produce fertile offspring (1)	ACCEPT similar trunk / tusks IGNORE colour / size	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: publish in journals / presented at conferences / peer review / writing papers / other scientists repeating the work (1)		(1)

Q7.

Question Number	Answer	Mark
	The only correct answer is C phylum ***A*** *is not correct because it is not the largest group* ***B*** *is not correct because it is not the largest group* ***D*** *is not correct because it is not the largest group*	**(1)**

Q8.

Question Number	Answer	Mark
	The only correct answer is B produce fertile offspring ***A*** *is not correct because same species do not produce hybrid offspring* ***C*** *is not correct because same species do not always live in same location* ***D*** *is not correct because same species do not have no genetic variation*	**(1)**

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two of the following: • {DNA / fragments} {are negatively charged / have a phosphate group} (1) • therefore the {DNA / fragments} move {when a potential difference is applied / towards the positive electrode} (1) • {smaller / lighter} fragments move further / {larger / heavier} fragments move shorter distance (1)	ACCEPT current / charge / voltage / electric field towards (positive) anode ACCEPT small fragments faster / larger fragments slower	

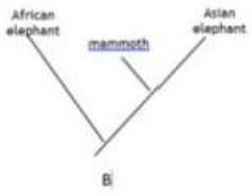
Question Number	Answer	Additional Guidance	Mark
(ii)	7 / 7.0 / 8 / 8.0 / 9 / 9.0 (kb)		

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to four of the following: • compare {anatomy / morphology / physical characteristics} (1) • observe behaviour / (occupy different) niches (1) • use {electrophoresis / DNA profiling / DNA sequencing / protein biochemistry molecular phylogeny / bioinformatics} (1) • unable to breed with other species and produce fertile offspring (1)	**ACCEPT** converse	(4)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • some species can interbreed and produce fertile offspring / difficult to determine if can interbreed and produce fertile offspring (1) • species are {evolving / changing} over time (1) • there is variation within a species / sexual dimorphism / polymorphism (1)	**ACCEPT** ring species or sibling species	(2)

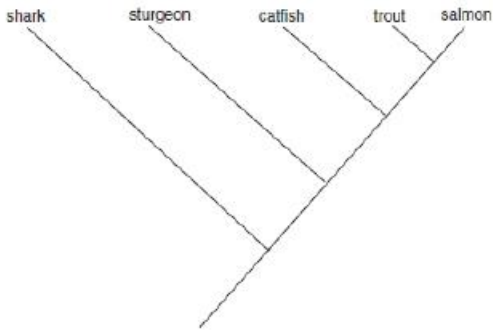
Q11.

Question Number	Answer	Additional Guidance	Mark
	B 		**(1)**

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • dolphins and (minke) whales are the most closely-related as they evolved from the same {species / (recent) common ancestor} **(1)** • the common ancestor of dolphins and minke whales evolved from the same common ancestor as cows **(1)** • pigs are the most distantly-related because they were the {first / earliest} animals to diverge **(1)** • the more closely-related the animals are the {more similar their DNA will be / fewer mutations} **(1)**	**Accept** an account that talks about branching points or speciation **Accept** because their (shared) common ancestor is furthest away **Accept** converse	**(3)**

Q13.

Question Number	Answer	Additional Guidance	Mark
		all correct = 2 one or two correct =1	**(2)**

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that includes four of the following: • obtain DNA (from the two types of plants) (1) • {use of restriction enzymes to cut DNA into fragments / use of PCR to amplify DNA} (1) • {DNA / fragments} (loaded) on (agarose) gel with {current passed through / voltage or potential difference applied} (1) • fragments of DNA are separated (1) • {same / similar} (banding) pattern suggests they are the same species (1)	Accept movement of (negatively charged) DNA moves to positive electrode Accept description / diagram of banding pattern Accept shorter fragments travel further Accept converse	**Exp (4)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that includes two of the following: • (if leaf is green it contains) chlorophyll / photosynthetic pigments (1) • so more {light / more wavelengths of light} absorbed for photosynthesis (1) • so more glucose produced for growth (1) OR • (if flower is brightly coloured) it attracts {pollinators / insects} (1) • so (more likely to) reproduce successfully (1) • to produce seeds / pass trait on (1)	Accept more light / wavelengths of light leads to higher rate of photosynthesis Accept more GALP / TP / GP for growth Accept so increased genetic variation (as less self- pollination) Accept asexual reproduction (through bulb) still possible if pollination does not occur	**Exp (2)**

Q15.

Question Number	Answer	Mark
	The only correct answer is C smallest fragment of DNA that travelled the fastest ***A*** *is not correct because it is not the largest fragment of DNA* ***B*** *is not correct because it is not the largest fragment of DNA* ***D*** *is not correct because smallest fragment of DNA does not travel the slowest*	**COMP (1)**

Q16.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following points: • species C (is the most closely related) (1) • as the bands of DNA on the gel most closely match / align with / same pattern (1) • species C has 5 bands in same location (1) • species B has 2 bands and species D has 3 bands (1)	allow converse for least related	**EXP (3)**

Q17.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to **four** of the following: • using information about similar morphology / anatomy (1) • using information about reproduction such as the fertility of hybrids / mate recognition and behaviour (1) • using information about the similarity in proteins / molecular phylogeny (1) • looking at information about ecological niche and where species are found (1) • use of bioinformatics / sequence DNA / sequence amino acid/ use genetic barcodes (1)	allow reference to sexual dimorphism noting that some species male and female have very different morphology allow look up in genetic databases	**EXP (4)**

Q18.

Question Number	Answer	Additional Guidance	Mark
	An explanation that that makes reference to two the following: • using current / p.d. / electrodes (1) • because molecules are charged (1) • because {larger / longer / heavier} molecules move {shorter distance / move slower} (1)	**ACCEPT** Mps if reference is to DNA **ACCEPT** converse	**(2)**

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	*Rhithrogena*	DO NOT ACCEPT *Rhithrogena germanica*	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is B** ***A*** *is not correct because Animalia is the kingdom* ***C*** *is not correct because Heptageniidae is the family* ***D*** *is not correct because Insecta is the class*	**(1)**

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	• *Anopheles*	**DO NOT ACCEPT** *Anopheles gambiae*	(1)CL

Question Number	Answer	Mark
(ii)	**The only correct answer is C Order** ***A*** *is incorrect because organisms in orders are sub-divided into families* ***B*** *is incorrect because organisms in families are sub-divided into a genus* ***D*** *is incorrect because organisms in phylum are sub-divided into classes*	(1)

Question Number	Answer	Mark
(iii)	**The only correct answer is B** *Plasmodium falciparum* ***A*** *is incorrect because Anopheles gambiae is the vector and not the pathogen* ***C*** *is incorrect because Puccinia graminis causes stem rust* ***D*** *is incorrect because Salmonella enterica causes food poisoning*	(1)

Q21.

Question Number	Answer	Mark
	The only correct answer is A ***B*** *is not correct because it is incorrect order* ***C*** *is not correct because it is incorrect order* ***D*** *is not correct because it is incorrect order*	**(1)**

Q22.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • because dolphins and killer whales are separate species so should not be able to interbreed to produce fertile {offspring / hybrids} **(1)** • but {Kekaimalu / the offspring from the mating of the whale and dolphin} was fertile **(1)**	**Accept** separate species are not able to interbreed to produce fertile offspring **Accept** but Kekaimalu {reproduced / produced offspring}	**(2)**

Q23.

Question Number	Answer	Mark
	The only correct answer is A DNA ***B*** *is not correct because lipids are not used in classification* ***C*** *is not correct because polysaccharides are not used in classification* ***D*** *is not correct because vitamins are not used in classification*	**(1)**

Q24.

Question Number	Answer	Additional Guidance	Mark
(i)	D sympatric speciation A is incorrect because allopatric speciation requiresgeographical separation B is incorrect because genetic speciation is the wrongterm C is incorrect because stabilising selection is the wrongterm		1
(ii)	*An answer that makes reference to:* • have not seen if they can breed and produce fertile offspring with modern mosquitoes (1)		1
(iii)	*An answer that makes reference to:* • peer review / published in journals / conferences(1)		1
(iv)	• Phylum and class (1) • Prisoculex and burmanicus (1)		2

Q25.

Question Number	Answer	Additional Guidance	Mark
	• ***Ammophila*** (1)	reject Ammophila arenaria	(1)

Q26.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two of the following points: • proteins digested / hydrolysed / digestive enzyme / protease (1) • therefore {smaller lengths / components / fragments / (poly)peptides} (1) • change pH / use buffer / use detergent (1) • therefore molecules charged / denatured / unfolded (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that that makes reference to four of the following: • the banding patterns are different (1) • different species have bands in different positions / different species have bands of different thickness (1) • because different fish or species have different proteins (1) • therefore different fish or species have different genetic material (1) • because DNA / genes code for protein (1)	**ACCEPT** converse **ACCEPT** converse **ACCEPT** converse	**(4)**

Question Number	Answer	Additional Guidance	Mark
(iii)	• identify the proteins (in the fish) / compare (pure protein sample) with fish protein		(1)

Question Number	Answer	Additional Guidance	Mark
(iv)	• amount / abundance (of protein / fragment)	**ACCEPT** mass / weight / concentration / density **REJECT** heaviness / size / charge	(1)

Q27.

Question Number	Answer	Additional Guidance	Mark
	Eukarya / Eukaryota / Eukaryotes / Eukaryotae	**DO NOT ACCEPT** Animalia eukaryotes	(1)

Q28.

Question Number	Answer	Additional Guidance	Mark
	organisms that interbreed to produce fertile offspring	**ACCEPT** mate / reproduce	(1)

Q29.

Question Number	Answer	Mark
	The only correct answer is C ***A*** *is not correct because order goes between class and family* ***B*** *is not correct because order goes between class and family* ***D*** *is not correct because order goes between class and family*	**(1)**

Q30.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is A **B** is incorrect because *Plasmodium* is the genus name not the species name **C** is incorrect because *Plasmodium* causes malaria not *Puccinia* **D** is incorrect because *Plasmodium* causes malaria not *Puccinia*		(1) COMP

Q31.

Question Number	Answer	Mark
(i)	**The only correct answer is** **B Chordata** A is not correct as Animalia is not a phylum P C is not correct as Eukarya is not a phylum D is not correct as Vertebrata is not a phylum	**COMP** **(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is** **C** *Ptilonorhynchus* A is not correct as aves is not a genus B is not correct as bower is not a genus D is not correct as *violaceus* is not a genus	**COMP (1)**

Q32.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • each domain has unique characteristics (1) • Archaea and Eukarya share three characteristics (1) • Archaea and Eukarya are more closely related / have a more recent common ancestor (1) • differences in {membrane lipids / ribosome size} evolved after Archaea and Eukarya split (1)	**ACCEPT** Archaea and Eukarya share more characteristics / share no rRNA loop, no antibiotic sensitivity and methionine **ACCEPT** branched carbon chains / ether linkage / 80 S	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• peer review / (scientific) paper / (scientific) journal / (scientific) conference		**(1)**

Q33.

Question Number	Answer	Additional Guidance	Mark
	Any two correct rows for 1 mark: Domain — **Eukarya** Kingdom — Animalia Phylum — Chordata **Class** — Mammalia Order — Proboscidea Family — Elephantidae Genus — ***Loxodonta*** Species — ***africana***	ACCEPT Eukaryote / Eukaryota Upper case for *Loxodonta* Lower case for *africana*	**(2)**

Q34.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following: • use of restriction enzymes to cut DNA into fragments (1) • use of agar and electric current to {separate bands / move DNA} (1) • therefore (DNA) fragments move different distances based on {mass / size / length / charge} (1) • use {radioactive probes / dye / UV light / fluorescence / Southern blotting / autoradiograph} to see bands (1) • the species with the most similar {pattern / bands} is most closely related to the common ancestor (1)		**(4)**