

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 3: CLASSIFICATION AND BIODIVERSITY
CLASSIFICATION

SCORE

/70

PERCENTAGE

%

STEMUP

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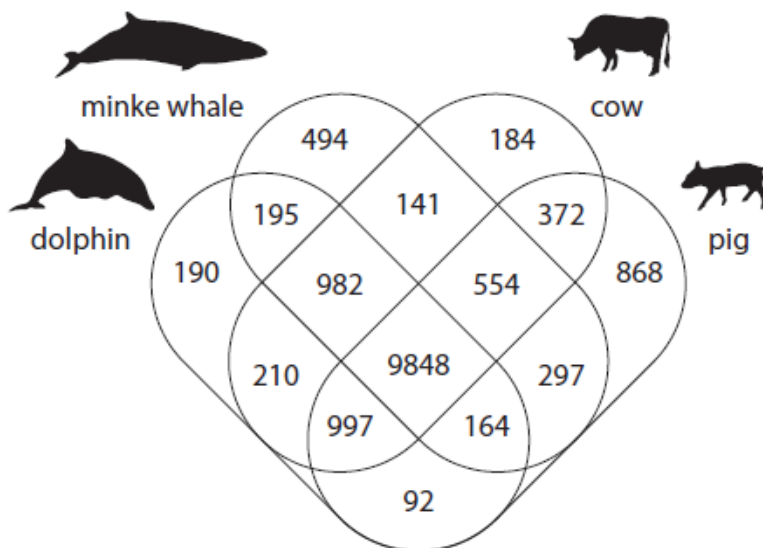
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Q1.

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)

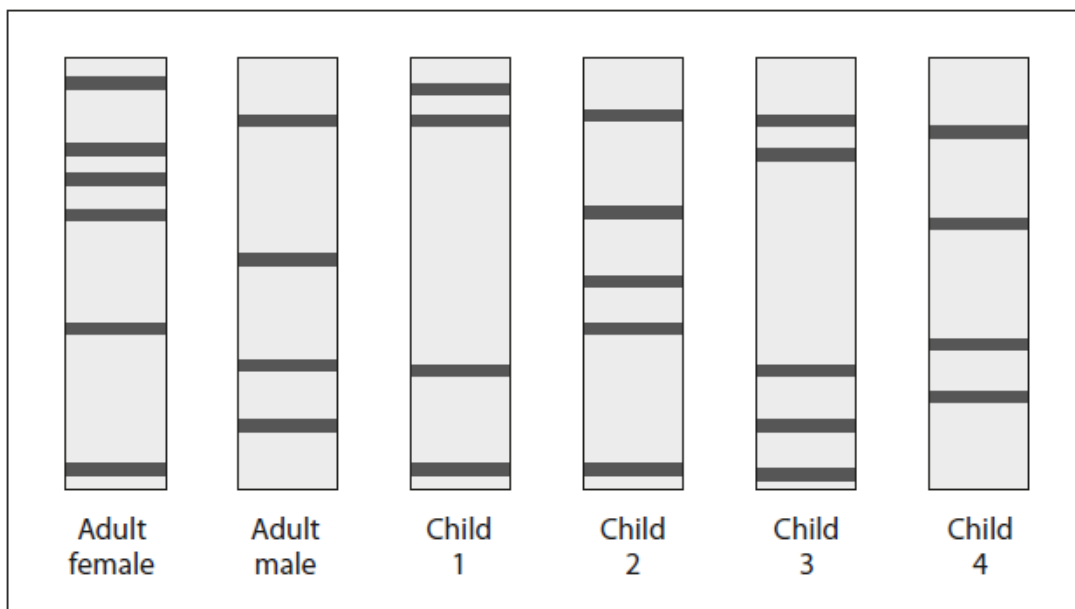
Answer %

(Total for question = 2 marks)

Q2.

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)

Q3.

The photographs below show three mammals.

Tasmanian wolf (*Thylacinus cynocephalus*)



© The Zoological Society

Grey wolf (*Canis lupus*)



(Source: http://www.animalgalleries.org/Large-Land-Mammals/Wolf/Grey+Wolf+Mexican_Wolf_065+Canis+Lupus.jpg.php)

Dunnart (*Sminthopsis crassicaudata*)



5 cm

(Source: apscience.org.au)

The evolutionary relationships between these three mammals were investigated. The DNA base sequence of part of the gene for 12S ribosomal RNA from each mammal was analysed.

Tasmanian wolf	CCTGGCCTTACTGTTAATTCTTATTAGACCTAC
Grey wolf	CCTAGCCTTCCTATTAGTTTTAGTAGACTTAC
Dunnart	CCTAGCCTTACTGTTAATTTTATTAGACCTAC

(a) Explain which two of these mammals are most closely related in their evolutionary history.

(2)

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(b) The Tasmanian wolf is a marsupial mammal. In marsupials, the young are born in a tiny, immature form and move into a pouch on the abdomen of the mother to develop further.

The grey wolf is a placental mammal. The fetus develops inside the uterus and the larger young are born in a more mature form.

The ancestors of Tasmanian wolves and grey wolves once shared similar habitats.

Explain why grey wolves and their close relatives are now found in many parts of the world but Tasmanian wolves only survived on isolated islands.

(3)

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(Total for question = 5 marks)

Q4.

Tapirs are nocturnal mammals that are found in South America.

In 2013, the Journal of Mammalogy published an article describing the discovery of a new species of tapir, *Tapirus kabomani*.

Scientists already knew about the animal but thought that it was the same species as *Tapirus terrestris*.



© 20 minutos.es, Creative Commons

(a) Give **one** reason why scientists thought that *Tapirus kabomani* was the same species as *Tapirus terrestris*. (1)

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(b) These two species of tapir can be distinguished using gene sequencing. Describe how sufficient amounts of DNA could be obtained in preparation for gene sequencing. (4)

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(c) Explain how distinguishing *Tapirus kabomani* as a separate species could affect the index of diversity of the area. (2)

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(Total for question = 7 marks)

Q5.

The photograph shows a stonechat, *Saxicola dacotiae*.

The species breeds only on the island of Fuerteventura.



Which of the following is the best definition of a species?

Individuals of the same species can interbreed to produce

(1)

- ☐ **A** fertile offspring
- ☐ **B** hybrid offspring
- ☐ **C** sterile offspring
- ☐ **D** viable offspring

Q6.

Chester Zoo has 12 000 animals from 400 different species.

Chester Zoo aims "to be a major force in conserving biodiversity worldwide".

Chester Zoo supports an *in-situ* rhinoceros conservation and monitoring project in Chyulu Hills

National Park in Kenya.

It is difficult to find and count the black rhinoceros because they roam freely across a large area.

However, the DNA of a black rhinoceros can be obtained from its dung (faeces).

(i) Devise a method by which black rhinoceros dung could be used to estimate the number of black rhinoceros living in Chyulu Hills National Park.

(5)

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(ii) DNA from dung indicated that 14 black rhinoceros were present in the park.

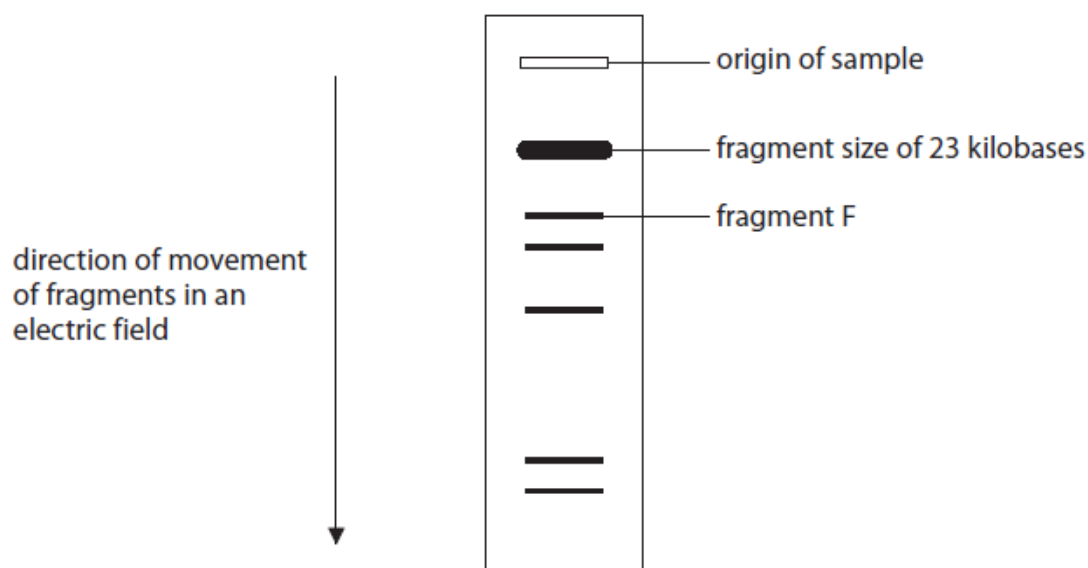
Explain why 14 black rhinoceros could be an underestimate of the population.

(2)

Q7.

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

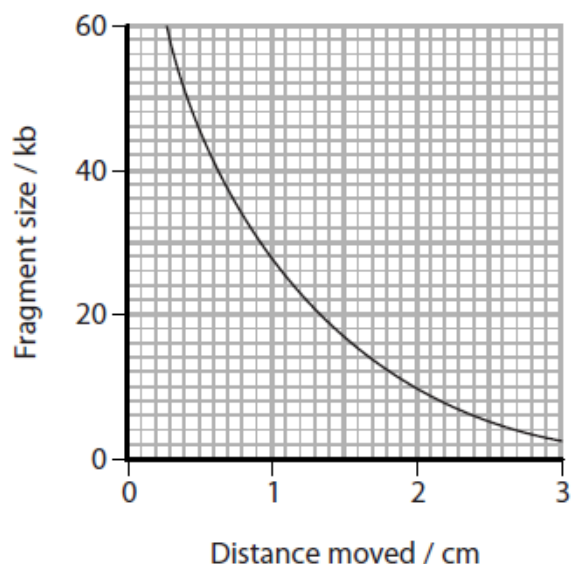
The diagram shows an example of a DNA profile.



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

(2)

(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)

Q8.

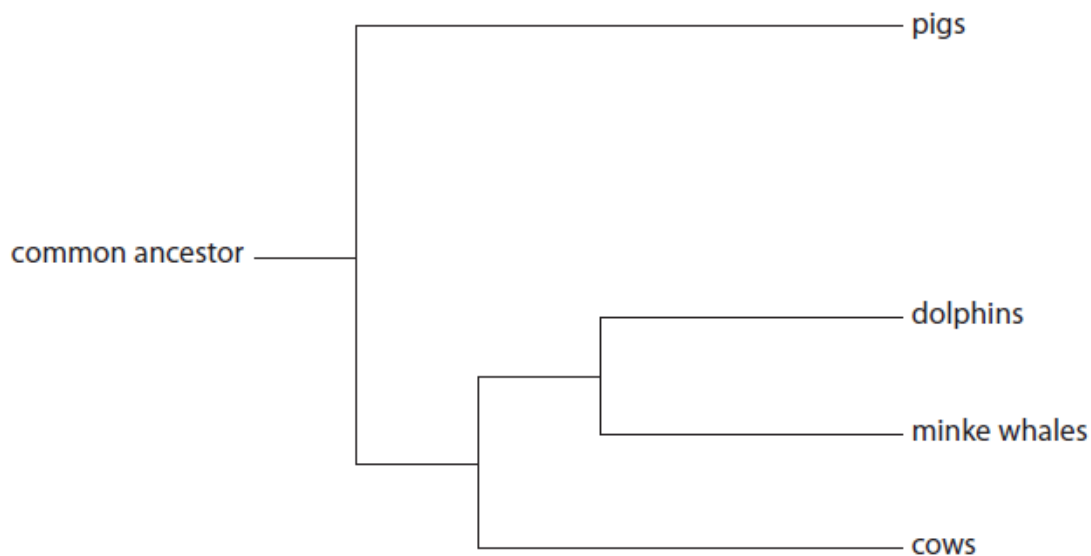
Minke whales, killer whales and dolphins are all cetaceans.

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)

Q9.

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)

Q10.

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)

Q11.

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)

Q12.

Tibetan populations have a recessive allele that helps them to survive at high altitude.

In a village in Tibet, 1950 people out of a population of 2500 people carry two copies of this allele.

(i) Calculate the number of heterozygous people in the village.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer

(ii) This allele is currently found only in human populations in Tibet.

The allele has also been found in the fossil bones of an extinct form of modern humans called the Denisovans.

Fossils of Denisovans have been found in Tibet.

Explain why scientists think that the Denisovans belonged to the same species as modern humans.

(2)

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(Total for question = 5 marks)

Q13.

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)

Q14.

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)

Q15.

The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear
Magnification $\times 0.04$

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

(a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.

(i) Describe how small samples of DNA can be amplified.

(4)

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

(1)

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(b) Suggest how the scientists who conducted the study had their results accepted by other scientists.

(2)

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(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

(2)

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(ii) Genetic mutation

(2)

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(Total for question = 11 marks)

Q16.

Scientists are researching new methods of controlling malaria.

One group used a procedure called gene drive.

This procedure resulted in female mosquitoes that could not bite or could not lay eggs.

One of the scientists said:

'It will still be at least 5 to 10 years before we consider testing any mosquitoes with gene drive, but now we have some encouraging proof that we're on the right path.'

Explain why this group are sharing the results of their research.

(2)

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(Total for question = 2 marks)

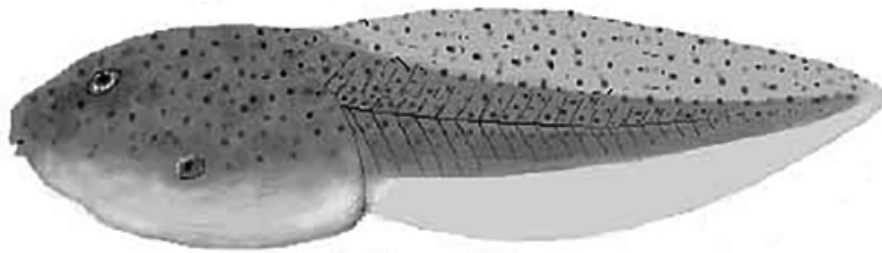
Q17.

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)

Q18.

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)

Q19.

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)

Q20.

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	<i>Plasmodium</i>	genus
☐ B	<i>Plasmodium</i>	species
☐ C	<i>Puccinia</i>	genus
☐ D	<i>Puccinia</i>	species

(Total for question = 1 mark)

Mark Scheme

Q1.

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)

Q2.

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 of different sized DNA (fragments) OR ACCEPT fragments therefore move through gel at different rates / smaller fragments move {further / faster} / converse for larger	(2)

Q3.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: - Tasmanian wolf and Dunnart more closely related (1) - because there are fewer base differences between Dunnart and the Tasmanian wolf than between the grey wolf and Tasmanian wolf (1)	For answers relating to grey wolf and Dunnart Base differences quantified {only 2 differences between Tasmanian wolf and Dunnart but 5 between grey wolf and Dunnart, and 7 between grey wolf and Tasmanian wolf}	(2)

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: - placental mammal/grey wolf has more successful reproduction than marsupial mammal/ Tasmanian wolf (1) - because young are born more {developed/mature} marsupial offspring very small so less likely to survive (1) - therefore grey wolves outcompete Tasmanian wolves unless Tasmanian wolves are geographically isolated (1)		(3)

Q4.

Question Number	Correct Answer	Additional guidance	Mark
(a)	both species look alike and are active at night (1)	morphologically and behaviourally similar	(1)

Question Number	Correct Answer	Additional guidance	Mark
(b)	A description that makes reference to the following: - sample of {cells / DNA} (1) - DNA polymerase chain reaction (1) - procedure repeated several times (1) - temperature requirements (1)	e.g. 55 °C, 72 °C, 95 °C	(4)

Question Number	Correct Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following points: - increases biodiversity / index of diversity increases (1) - as the value for {N / numerator} increases in the index of diversity (1)	Accept justification consistent with formula Correct answer gains full marks	(2)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A (fertile offspring)		(1)

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An experimental method that makes reference to five of the following steps: • use of experts to identify and collect many samples of rhinoceros dung from all areas of the park (1) • DNA extracted from rhinoceros cells and amplified using PCR (1) • use of { restriction endonucleases / appropriate primers } to obtain short tandem repeat sequences from DNA (1) • use of gel electrophoresis to separate DNA fragments (1) • description of method used to visualise fragments (1) • each different pattern of bands represents one individual rhinoceros (1)	e.g. radioactive probe / fluorescent probe / Southern blotting / UV light / autoradiography / X- rays	

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • no dung found from some rhinoceros, so they were not counted (1) • closely related individuals have similar DNA profiles, so they may not be distinguished as separate individuals (1)		(2)

Q7.

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)		

Q8.

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)

Q9.

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)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	<i>Rhithrogena</i>	DO NOT ACCEPT <i>Rhithrogena germanica</i>	(1)

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

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	<i>Anopheles</i>	DO NOT ACCEPT <i>Anopheles gambiae</i>	(1)CL

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

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

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	- calculation of q (1) - calculation of p (1) - calculation of number of heterozygotes (1)	Correct answer: 516 Accept answers with range of 517 and 528 with incorrect rounding for two marks Correct answer gains full marks Accept ECF for mp3 for 2pq x 2500	3

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - only Tibetans and Denisovans have the allele (1) - so (the presence of the allele) suggests that Denisovans and Tibetans must have interbred (1) - and produced fertile offspring (1)	Accept Allele is present in Tibetans and Denisovans	2

Q13.

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)

Q14.

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

Q15.

Question Number	Answer	Additional guidance	Mark
(a)(i)	- reference to {polymerase chain reaction / PCR} ; - polymerase (enzyme) {added / eq} ; - idea of need for primers and nucleotides ; {90-98} (°C) → {50-65} (°C) → {70-75} (°C) ; - idea that cycle needs to be repeated {several times / to make several copies of DNA / eq} ;	1. Accept as a ref to PCR machine	(4)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	(DNA) {profiling / fingerprinting / (gel) electrophoresis} ;	Ignore Southern blotting, PCR Accept DNA profile / DNA fingerprint	(1)

Question Number	Answer	Additional guidance	Mark
(b)	1. idea of work appearing in a (Scientific) journal or being presented at a conference ; 2. idea that validity or reliability is considered ; 3. by other scientists / ref to peer review ;	1. Accept publishing a paper, scientific meeting	(2)

Question Number	Answer	Additional guidance	Mark
(c)(i)	1. reference to different {conditions / environments /eq} (in each region) ; 2. idea of different selection pressures ; 3. idea of {restricted gene flow / separate gene pools} ; 4. reference to reproductive isolation;	1. Accept appropriate named factor e.g. temperature 3. Ignore different allele frequency	(2)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	1. idea of different {alleles/ gene pool} ; 2. idea that this leads to {new / different} phenotypes ; 3. idea of new {allele / gene} can be {advantage / disadvantage} ; 4. reference to (advantageous) {(mutated) gene / (new) allele} passed onto offspring ;	1. Ignore allele frequency 2. Accept traits / characteristics / features	(2)

Q16.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - because they want to validate their results (1) - by other members of the scientific community {checking / repeating / discussing / criticising} their work (1)	ACCEPT peer review to check ...	(2)

Q17.

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

Q18.

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

Q19.

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

Q20.

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