

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

3.1.3 THE DEVELOPMENT OF SPECIES: EVOLUTION AND CLASSIFICATION

SCORE

/99

PERCENTAGE

%

STEMUP

These questions belong to OCR, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by OCR. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with OCR and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. OCR has not endorsed, approved or been involved in the production of it. OCR and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

OCR publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at ocr.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

1(a) Cambodia is thought to have the largest wild population of the Siamese crocodile, *Crocodylus siamensis*.

C.siamensis is a critically endangered species that is now virtually extinct in the wild in most other countries of Southeast Asia.

Studies of genetic diversity amongst the Cambodian population of *C.siamensis* in protected areas have provided some evidence that there was a recent genetic bottleneck event in the Tonle Sap Lake area.

(i) Using this example, explain what is meant by the term, genetic bottleneck.

[3]

(ii) Give **one** possible cause for the genetic bottleneck event that affected *C.siamensis*.

[1]

- (b) Crocodile farms have been established on the Tonle Sap Lake to develop captive-breeding programmes for *C.siamensis*.

Genetic analysis data of *C.siamensis* populations from two different crocodile farms is shown in the table below.

	Population from crocodile farm 1	Population from crocodile farm 2
Number of individuals in the population	45	15
Number of gene loci studied	35	40
Number of monomorphic genes	28	26

- (i) Using the data, calculate the percentage of polymorphic genes in the population of each crocodile farm.

Farm 1 %

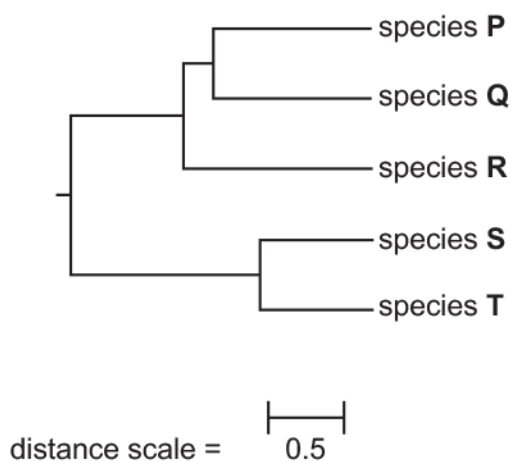
Farm 2 %

[2]

- (ii) Using the table and your answers to (i), comment on the suitability of each of these crocodile farms for developing a captive-breeding programme for *C.siamensis*.

[2]

2 A phylogenetic tree for five species is shown below.



The evolutionary distance between two species is calculated as the sum of the lengths of all the horizontal branches between the two species.

Which of the options, A to D, is the estimated evolutionary distance between species R and species T?

- A 8.0
- B 4.0
- C 2.0
- D 16.0

Your answer

[1]

3 The *cytochrome c oxidase* gene is a good DNA barcode.

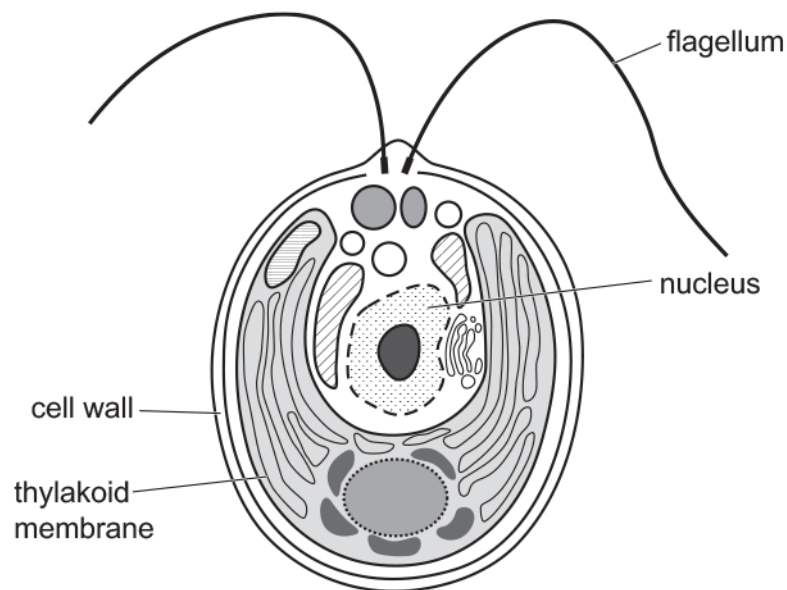
Which of the features, A to D, are needed for a good DNA barcode?

- A low interspecific variation
- B high intraspecific variation
- C short sequences of DNA
- D species specificity

Your answer

[1]

4 The structure and part of the classification of *Chlamydomonas reinhardtii*, a single-celled organism, is shown below.



Phylum: Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	Genus: <i>Chlamydomonas</i>
------------------------	---------------	-------------------	--------------------	--------------------------------

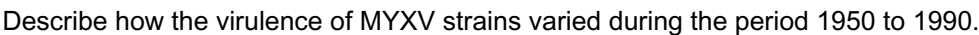
Which of the following statements is / are correct?

- 1: *C.reinhardtii* would be classified in the Kingdom, Bacteria.
 - 2: *C.reinhardtii* is a photosynthetic organism.
 - 3: Chlamydomonadaceae is the family taxon for *C.reinhardtii*.
- A 1, 2 and 3 are correct
B only 1 and 2 are correct
C only 2 and 3 are correct
D only 1 is correct

Your answer ☐

[1]

The graph shows how the virulence of MYXV changed over the period from 1950 to 1990.



[2]

(b) The article describes the interactions between pathogen virulence and host resistance to infection.

- (i) Explain how immunological and genetic factors would allow a population of wild rabbits to become more resistant to infection by MYXV.

[2]

- (ii) The article discusses how resistance to infection can be affected by two common agricultural practices: vaccination and selective breeding.

Explain how vaccination is used to protect poultry against pathogens such as Marek’s disease virus (MDV).

[3]

- (iii) Explain why vaccination might **not** prevent epidemics of Marek’s disease in poultry.

[2]

- (iv) Evaluate the suggestion that birds should be bred for susceptibility to MDV rather than resistance.

[4]

6(a) Plants are usually adapted to living in conditions of different light intensities.

The leaf of a plant that is adapted to living in shade will differ from the leaf of a plant that is adapted to living in sunlight.

Xerophytic plants are plants that are adapted to living in very dry conditions.

The table below gives a description of some adaptations of xerophytic plants.

Complete the table by indicating with a tick (✓) whether the adaptation is **behavioural**, **physiological** or **anatomical**.

Adaptation	Behavioural	Physiological	Anatomical
Stomata open only at night			
Stem becomes more rounded with fewer folds when water is available			
Stomata are located in sunken pits			

[3]

- (b) *Metasequoia occidentalis* is an extinct species of redwood tree that grew in forests approximately 39 million years ago.

A group of students wanted to find out if the leaves of *M. occidentalis* were adapted to sun or shade conditions.

They obtained three electron micrographs showing the ultrastructure of chloroplasts that had been extracted from:

- fossilised leaf samples of *M. occidentalis*
- leaf samples of *M. glyptostroboides*, a living *Metasequoia* species that had been growing in sun conditions
- leaf samples of *M. glyptostroboides* that had been growing in shade conditions.

- (i) Suggest **one** reason for using a living species of *Metasequoia* in this investigation.

[1]

- (ii) * One of the students made drawings of a chloroplast from each of the three electron micrographs. These are shown in Fig. 2.2a, Fig. 2.2b and Fig. 2.2c.

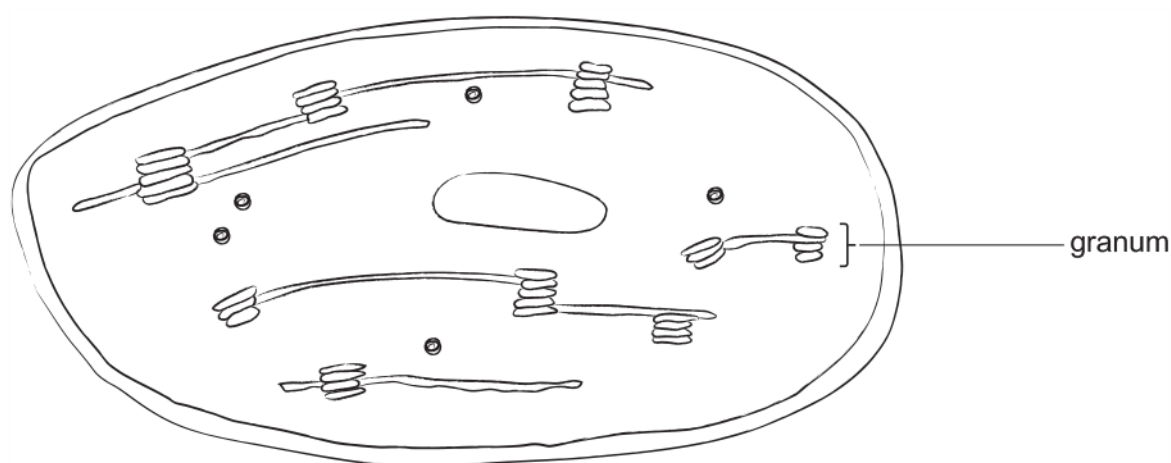


Fig. 2.2a chloroplast from *M. occidentalis*

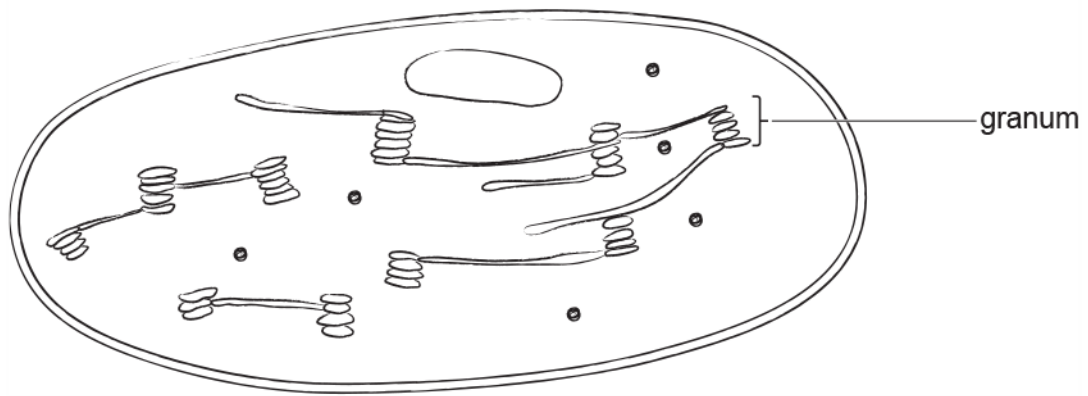


Fig. 2.2b chloroplast from *M. glyptostroboides* in sun conditions

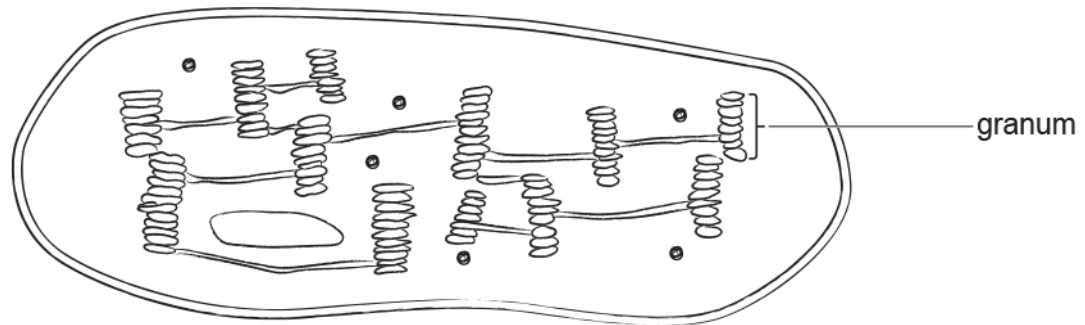


Fig. 2.2c chloroplast from *M. glyptostroboides* in shade conditions

The student concluded that:

M. occidentalis is likely to have grown in sun conditions with high light intensity.

Evaluate this conclusion.

Blank lined paper for writing.

7(a) It is believed that the common ancestor of chimpanzees, gorillas and humans dates back around seven million years ago to a forest-dwelling ape.

Fig. 6.1 shows part of the phylogenetic tree for classifying these primates.

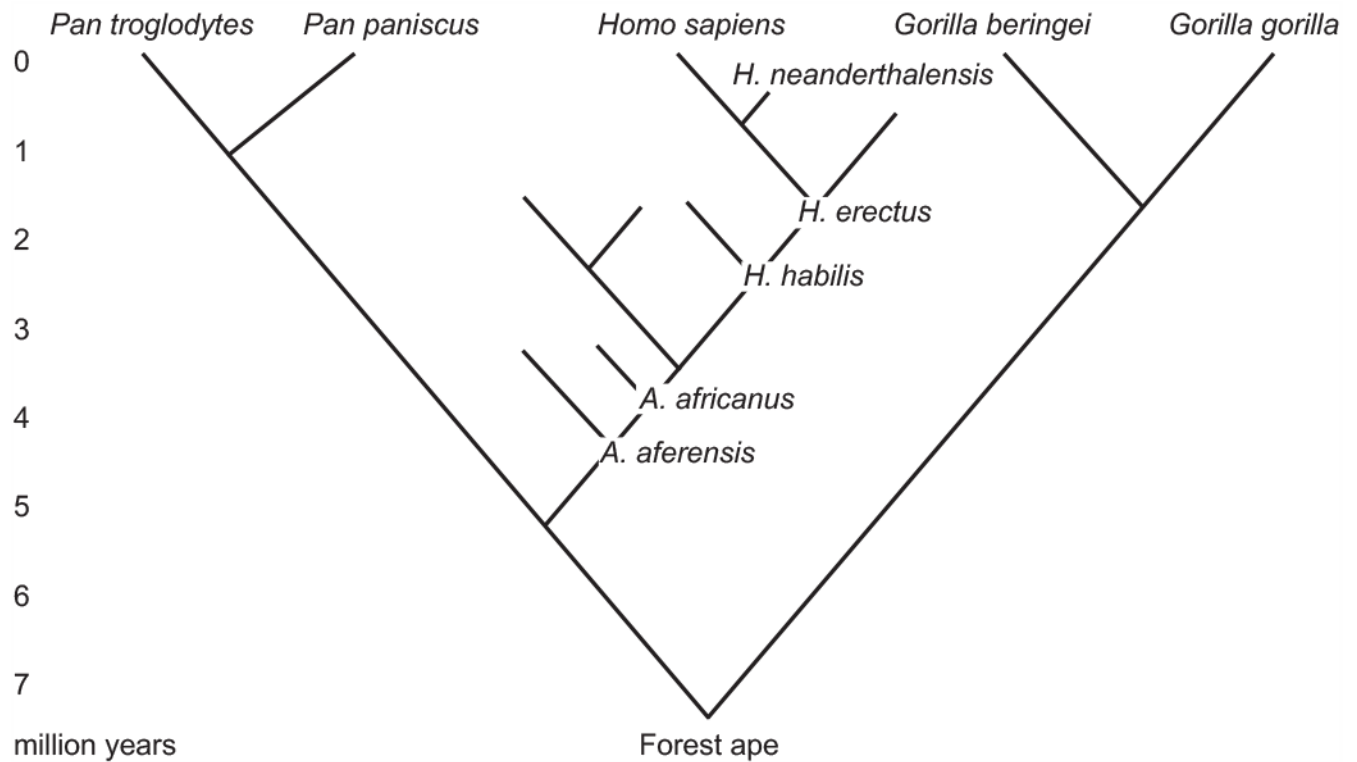


Fig. 6.1

(i) Using Fig. 6.1, state how many species of primates that descended from forest apes are still alive today.

----- [1]

(ii) Using Fig. 6.1, explain why *Homo sapiens* are more closely related to *Pan paniscus* than *Gorilla gorilla*.

----- [1]

(b) State the name of **three** types of monomers or molecules that can be used in the genetic classification of a species.

1 _____

2 _____

3 _____

[3]

8(a) The evolution of language in humans is one of the most challenging topics to research due to a lack of direct evidence. Instead, evidence must be drawn from indirect sources such as fossils, genetics and anatomical comparisons with other species.

Scientists have proposed several theories to explain language evolution.

Suggest **one** way in which scientists formally communicate their ideas to other scientists.

[1]

(b) The following text is a description of a theory of language evolution.

The Obligatory Reciprocal Altruism Theory (ORAT)

The obligatory reciprocal altruism theory states that honesty is required for language to evolve. In the context of language, reciprocal altruism means that if you speak truthfully to me, I'll speak truthfully to you. However, for language to be used across a whole community, trust and reciprocal communication must be enforced by all instead of being left to individual choice. Therefore, society as a whole must have been subjected to moral regulation.

Compare the obligatory reciprocal altruism theory with other **named** theories of language evolution.

[3]

(c) Bipedalism in hominids is an example of adaptation.

Suggest how bipedalism could have facilitated language evolution.

[2]

(d) Complete the passage using the most appropriate word(s):

Genomes acquire mutations over time. This leads to within a
population. In the presence of a particular selection, some mutations
provide organisms with a survival advantage. Sexual reproduction of surviving organisms
results in a population of organisms that are adapted to their environment. This process is
known as and is a mechanism of evolution.

[3]

- 9 A student investigated biodiversity in adjacent woodland and wetland habitats. The results are summarised in the table below.

Species	Woodland	Wetland
P	5	11
Q	2	0
R	23	10
S	0	9
total (N)	30	30

Simpson's index of diversity (D): $D = 1 - \left(\sum \left(\frac{n}{N} \right)^2 \right)$

Which of the following statements is/are correct?

- 1 The species richness of woodland and wetland are the same.
 - 2 The wetland area has the greater Simpson's index of diversity.
 - 3 In the formula for D shown above, $\sum \left(\frac{n}{N} \right)^2$ is always less than or equal to 1.
- A 1, 2 and 3 are correct
B only 1 and 2 are correct
C only 2 and 3 are correct
D only 1 is correct

Your answer

[1]

- 10 The genetic diversity of monkey populations in a forest ecosystem was studied. The data for one population are shown in the table below.

Total genes studied	Genes with one allele	Genes with two alleles	Genes with more than two alleles
49	33	5	11

Which of the options, A to D, is the proportion of polymorphic genes in the monkey population?

- A 0.11
B 0.33
C 0.67
D 0.78

Your answer

[1]

- 11 Here are three statements about the evolution of language:

- 1 Sequencing the genome of extinct human ancestors helps to indicate the origins of language.
- 2 The evolution of language will have been influenced by reproductive (mating) preferences.
- 3 The 'gossip' hypothesis relies on trust between animals for the acceptance of unfamiliar sounds.

Which of the statements is/are correct?

- A 1, 2 and 3 are correct
B Only 1 and 2 are correct
C Only 2 and 3 are correct
D Only 1 is correct

Your answer

[1]

12 *Miscanthus* and reed canary grass are crops that are reported to promote species diversity.

A field trial was carried out to determine which crop promotes the greater diversity of bird species:

- two fields (**M** and **R**) were sampled
- *Miscanthus* was grown in field **M**
- reed canary grass was grown in field **R**
- the number of each bird species (n) was recorded for both fields
- the Simpson's Index of Diversity was calculated for both fields.

(i) Explain what is meant by the term species diversity.

----- [2]

(ii) State **two** variables that should have been controlled to ensure a **valid** comparison between fields **M** and **R**.

1

2

----- [2]

13

- extract DNA from tissue, e.g. skin or hair
- amplify a length of DNA, known as a barcode, using the polymerase chain reaction (PCR)
- read the base sequence of the DNA.

The strip below represents a length of extracted DNA before PCR. Lines 1 to 4 represent primers.

Key:

white = same DNA sequence in all species

black = variable DNA sequence between species



Which of the options, A to D, gives the pair of primers that could be used to amplify DNA from all species?

- A** 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

Your answer

5

[1]

14(a) The Succulent Karoo is a biome in southern Africa, which:

- has high levels of biodiversity
- is an arid area receiving very little rainfall per year
- has maximum summer temperatures of 40 °C and winter minima of >4 °C.

Fig. 5.1 shows the results of an experiment conducted on a plant species from the Succulent Karoo. It shows the stomatal conductance of the leaves of the plants over a 24-hour period under conditions as found in the Succulent Karoo. Stomatal conductance is a measure of the rate of movement of carbon dioxide (CO₂) entering, or water vapour exiting a leaf.

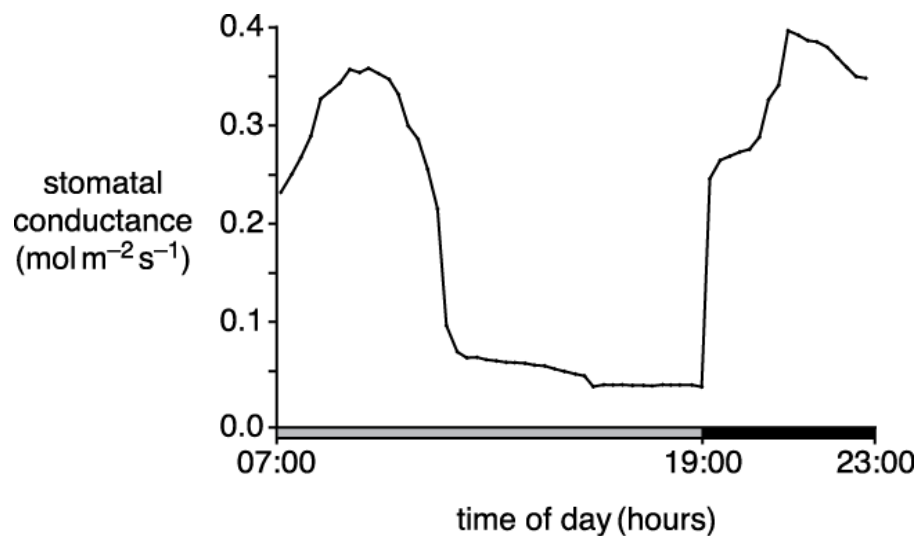


Fig. 5.1

*Using your own knowledge and the patterns shown in Fig. 5.1, explain how the plant species has an evolutionary advantage for living in the Succulent Karoo.

[6]

(b) An ecologist collected data on the number of species found in a biome. Table 5.1 shows some of these data.

Species	n	n / N
A	2	0.13
B	6	0.40
C	2	0.13
D	2	0.13
E	3	0.20

Table 5.1

- (i) Using the data in Table 5.1 and the formula for Simpson's diversity index, given below, calculate the biodiversity of this sample.

$$D = 1 - \left(\sum \left(\frac{n}{N} \right)^2 \right)$$

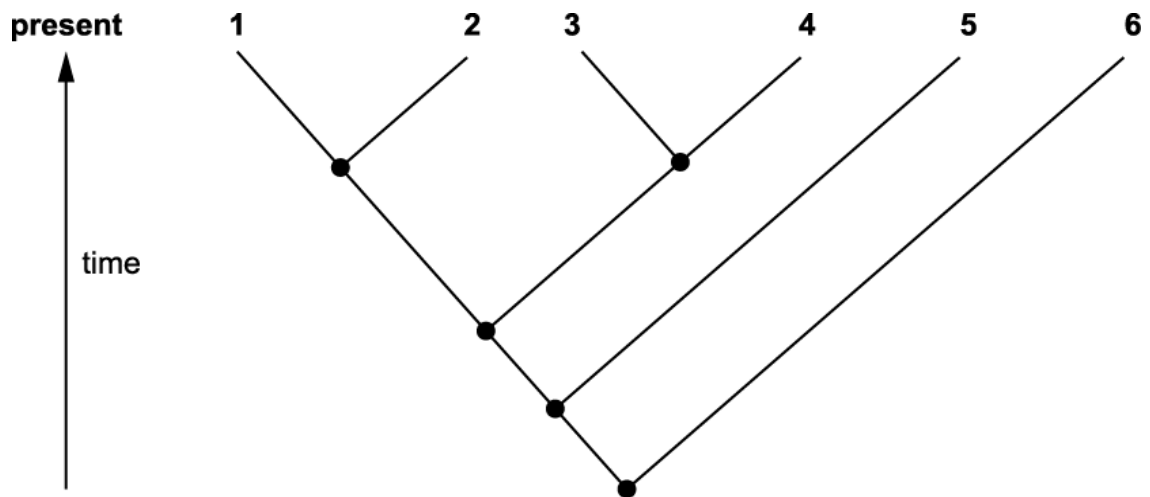
Answer _____ [2]

- (ii) Another survey in a different biome gave a Simpson's diversity index which was half that of the Succulent Karoo.

What does this suggest about the species distribution in this biome compared to the Succulent Karoo?

[2]

15 A phylogenetic tree is shown below. Six species are labelled 1 to 6.



Which of the options, A to D, is a statement that is **not** true of this phylogenetic tree?

- A Branching of the tree is due to random mutations and selection pressures.
- B In genetic terms, species 2, 3 and 4 are equally close to species 1.
- C Species 2 and 5 evolved at different times.
- D The tree could have been constructed using fossil records or DNA evidence.

Your answer

[1]

16(a) The hominids are a family containing four genera with extant species.

Table 7 shows the four genera included in the hominid family. There are seven extant species in the hominid family.

Genus	<i>Pongo</i>	<i>Gorilla</i>	<i>Pan</i>	<i>Homo</i>
Number of extant species	2	2		

Table 7

- (i) State the number of extant species in the genus *Pan*.

-----[1]

- (ii) The hominid family shares many features with the hylobatid family. Which taxonomic class and order contain both the hominid and hylobatid families?

class -----

order -----

[2]

- (b) In 2008, a fossilised human bone was discovered. The bone was dated to a time when both *Homo neanderthalensis* and *Homo sapiens* were known to have been living in the same area as the fossil.

Mitochondrial DNA was isolated from the fossil and compared with mitochondrial DNA from *Homo neanderthalensis* and *Homo sapiens*.

- (i) Suggest why mitochondrial DNA may be easier to obtain from fossil material than nuclear DNA.

-----[1]

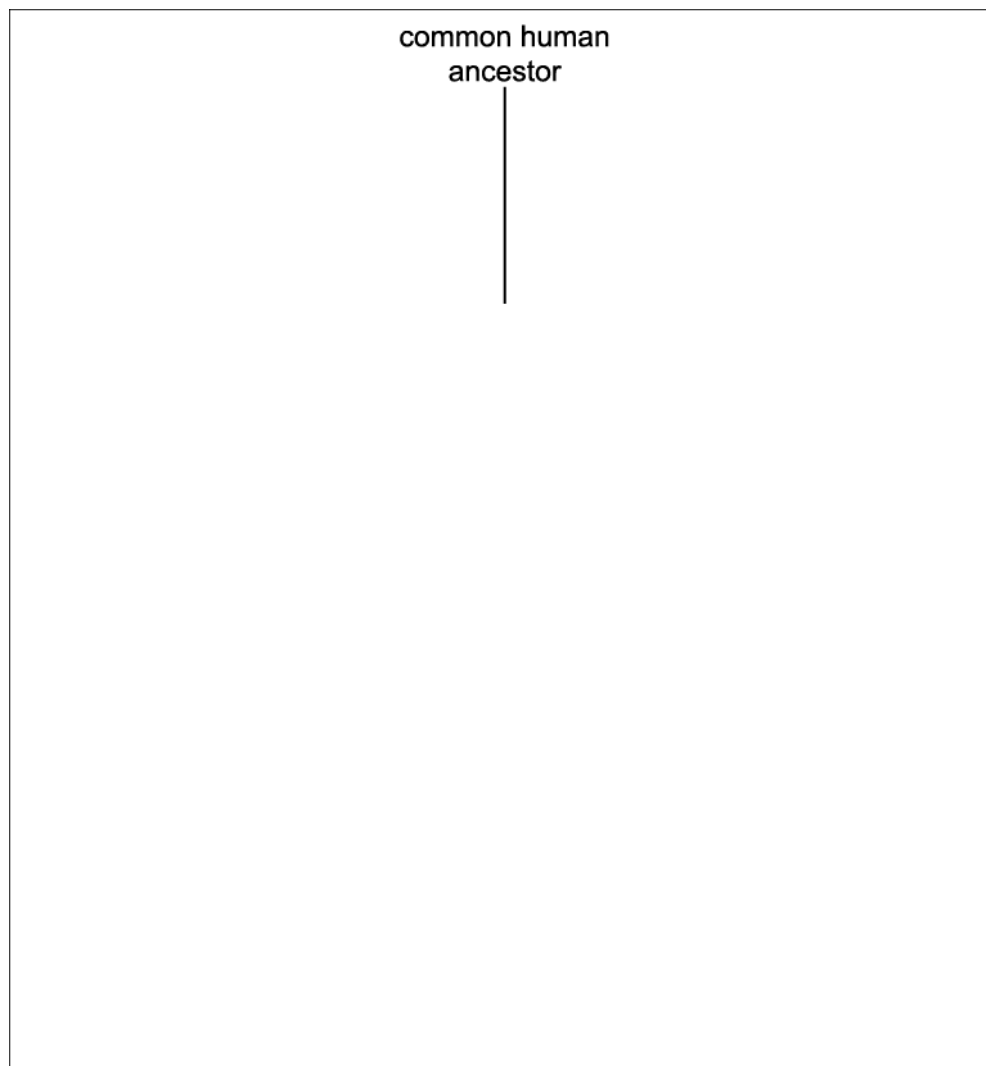
- (ii) Name one gene present in mitochondrial DNA.

-----[1]

(c) Analysis of the mitochondrial DNA results showed that the fossil belonged to a different human species. Members of this species are currently referred to as Denisovans.

(i) The mitochondrial DNA from the *H. neanderthalensis* and *H. sapiens* was found to be more closely related to each other than to the DNA from the Denisovan fossil.

In the box below, draw a phylogenetic diagram showing this relationship between these three human species and their common human ancestor.



[1]

(ii) Give one reason why analysis of the nuclear DNA from the three human species might show a different relationship.

17 A research team planned to compare the genetic diversity of the populations of three towns.

An overview of their methodology is provided below.

- Genetic analysis will be conducted on 20 people from town A, 50 people from town B and 155 people from town C.
- 100 gene loci will be analysed.

What additional information would need to be considered to improve this methodology?

[3]

- 18 People travelling to high altitudes can develop altitude sickness because they produce more haemoglobin than normal, which results in thick, viscous blood.

Many people in Tibet live more than 4 000 m above sea level, but they do not develop altitude sickness.

Tibetan people have a variant of the EPAS1 gene that causes them to maintain relatively low haemoglobin levels in their blood.

- (i) Describe how the Tibetan variant of the EPAS1 gene has become common in Tibetan populations.

[4]

- (ii) What type of adaptation is represented by the maintenance of low haemoglobin levels in Tibetan people?

[1]

- (iii) State and explain **one** problem that a Tibetan person with the EPAS1 gene variant might experience.

[2]

- (iv) Suggest a practical technique that could be used to compare the relative number of erythrocytes in a Tibetan population with that of another population **and** state what this technique would show.

[2]

19 A population of nitrogen-fixing bacteria was isolated from a root nodule of the leguminous plant, *Pisum sativum*.

The bacteria were then cultured *in vitro* and viewed using an electron microscope.

The resulting photomicrograph is shown in Fig. 34.1.



Magnification 32 000x

Fig. 34.1

(i) Name the **genus** of nitrogen-fixing bacteria seen in Fig. 34.1.

-----[1]

(ii) Calculate the **actual** width of the bacterium labelled X. Show your working.

Answer = ----- μm [2]

20 The Abert's squirrel, *Sciurus aberti*, and the Kaibab squirrel, *Sciurus aberti kaibabensis*, are two biological species that live in the mountainous Grand Canyon region of North America.

(i) What is meant by the term biological species?

[2]

(ii) Complete Table 32.1 below to show the full biological classification of *S. aberti*.

Domain	-----
Kingdom	Animalia
-----	Chordata
Class	Mammalia
Order	Rodentia
Family	Sciuridae
Genus	<i>Sciurus</i>
Species	<i>S. aberti</i>

Table 32.1

[2]

21 Organisms can be classified into taxa by analysing and comparing some of their molecules.

The molecules below are all involved in respiration.

Which would be the most appropriate molecule to study in order to classify organisms into taxa?

- A ATP synthase
- B Acetyl coenzyme A
- C NAD
- D FAD

Your answer

[1]

The lava cactus, *Brachycereus nesioticus*, is found only in the Galapagos Islands. It speciated rapidly from a very few individuals of a parent species, perhaps only two. These individuals were carried on currents from the mainland of South America.

There is a gene that enables the mainland *Brachycereus* species to obtain water from damp mists in the atmosphere:

- let Q be the normal allele, allowing the cactus to obtain water from damp mists
- let q be a rare recessive allele that, when homozygous, could allow the cactus to obtain water from salty sea spray.

(i) Consider a cross between two heterozygous individuals.

What is the **theoretical** percentage of the offspring from these two individuals that would be able to obtain water from sea spray?

Use the space below for any working.

Answer = _____ % [1]

(ii) *B. nesioticus* colonises bare rock at the edge of the Galapagos Islands.

Explain how individuals homozygous for the q allele would soon come to dominate the gene pool.

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	chance event occurs ✓ (causing) <u>significant</u> reduction in , population / number of individuals , in Tonle Sap Lake area ✓ surviving crocodile population have fewer alleles than original population ✓ decrease in genetic diversity ✓	3 max(A O2.1)	
		ii	habitat destruction ✓ over-hunting / over-poaching ✓ disease ✓ toxic chemicals in the lake ✓ loss of prey species ✓ named natural disaster ✓	1 max	ALLOW description Must be relevant to the lake e.g. drought IGNORE flooding
	b	i	(farm 1) 20% ✓ (farm 2) 35% ✓	2(AO2.6)	(28/35) × = 80% monomorphic (26/40) × = 65% monomorphic
		ii	Farm 2 would be most suitable ✓ Farm 2 has greater genetic diversity ✓ Farm 1 has more individuals in the population so more options for breeding pairs ✓	2 max(A O2.5)	ALLOW ECF from Q34di
			Total	8	
2			B	1(AO2.2)	
			Total	1	
3			C	1(AO1.1)	
			Total	1	
4			C	1(AO2.1)	
			Total	1	
5	a		steep / AW, decrease from 1950 to 1955 and gradual / AW, increase to 1990 ✓ use of two pieces of correct data from graph e.g. 85% in 1950 / 35% in 1955 / 60% in 1990 ✓	2(AO2.1)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	(surviving rabbits produce) memory (T / B) cells ✓ <u>alleles</u> for resistance (to MYXV) would be selected for ✓ (so the) <u>allele frequency</u> increases (in the population) ✓	max 2(AO2.2)(AO2.2)(AO2.2)	ALLOW advantageous allele(s) passed on
		ii	(vaccination involves) giving pathogen antigens ✓ (formation of) memory (T / B) cells ✓ exposure to pathogen leads to secondary immune response ✓ (which) destroys / kills, pathogen before it can cause, disease / death ✓	max 3(AO1.2)(AO1.2)(AO1.2)	ALLOW any correct example of vaccine, e.g. live-attenuated, subunit vaccines, pathogen fragments ALLOW rapid production of antibodies
		iii	vaccinated hosts can still transmit virus ✓ (so) unvaccinated, birds / flocks, could become infected ✓ OR (high) mutation rate leads to antigen variability ✓ so antibodies produced by vaccination no longer specific ✓	2(AO2.5)(AO2.5)(AO2.5)(AO2.5)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	<i>for</i> susceptible birds would die before they could infect other birds ✓ resistant birds (are more likely to) encourage evolution of more virulent pathogens ✓ <i>against</i> (but) evolution of virulence may not matter for resistant birds ✓ hypervirulent pathogens could threaten, non-resistant / non-GMO, flocks ✓ ethical issues if industrial practices threaten organic producers ✓ susceptible birds may also be susceptible to, related / similar, pathogens	max 4(AO3.2)(AO3.2)(AO3.2)(AO3.2)(AO3.2)	ALLOW other unambiguous term for birds throughout
			Total	13	

Mark Scheme

Question			Answer/Indicative content				Marks	Guidance																
6	a		<table><tr><td>Adaptation</td><td>Behavioural</td><td>Physiological</td><td>Anatomical</td></tr><tr><td>Stomata open only at night</td><td>✓</td><td></td><td></td></tr><tr><td>Stem becomes more rounded with fewer folds when water is available</td><td></td><td>✓</td><td></td></tr><tr><td>Stomata are located in sunken pits</td><td></td><td></td><td>✓</td></tr></table>				Adaptation	Behavioural	Physiological	Anatomical	Stomata open only at night	✓			Stem becomes more rounded with fewer folds when water is available		✓		Stomata are located in sunken pits			✓	3	
			Adaptation	Behavioural	Physiological	Anatomical																		
			Stomata open only at night	✓																				
			Stem becomes more rounded with fewer folds when water is available		✓																			
			Stomata are located in sunken pits			✓																		
	b	i	Control (group), for /to allow, comparison ✓				1 AO 3.1																	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
ii	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. <i>In summary:</i> Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in <i>italics</i>): ◦ award the higher mark where the Communication Statement has been met. ◦ award the lower mark where aspects of the Communication Statement have been missed. • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i> Level 3 (5–6 marks) Balanced, detailed evaluation with both supporting and undermining statements using information from Fig. 2.2a and Fig. 2.2b/c <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Evaluation with both supporting and undermining statements using information from Fig. 2.2a and Fig. 2.2b/c <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i>	6 AO3.2 AO3.3	Indicative scientific points may include (not exhaustive): ALLOW ORA to shade species throughout <i>Supporting statements:</i> • chloroplast from <i>M.o</i> (2.2a) shows more similar ultrastructure to <i>M. g</i> chloroplast in sun conditions (2.2b) • chloroplast from <i>M.o</i> (2.2a) and chloroplast from <i>M.g</i> in sun conditions have similar sized grana / thylakoid stacks (2.2b) • chloroplast from <i>M.o</i> (2.2a) and chloroplast from <i>M.g</i> in sun conditions (2.2b) have similar numbers of grana • chloroplast from <i>M.o</i> (2.2a) and chloroplast from <i>M.g</i> in sun conditions (2.2b) have similar numbers of thylakoids per granum • chloroplast from <i>M.o</i> (2.2a) don't need as many thylakoids / grana for light capture as they are in high light intensity • fewer thylakoids in both chloroplasts from <i>M.o</i> (2.2a) and chloroplasts from <i>M.g</i> in sun conditions (2.2b) than chloroplast from <i>M.g</i> in shade conditions (2.2c) <i>Undermining statements:</i> • only have one drawing of a chloroplast from each micrograph • student's drawings may be inaccurate • chloroplasts / leaves from extinct species may have been damaged • images / electron micrographs may have been poor quality • methods of obtaining the leaf samples may have been different • more data required to draw this conclusion • there (maybe) different numbers of chloroplasts in different species • there (maybe) different numbers of leaves in different species

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 1 (1–2 marks) Limited evaluation with basic descriptive statements that may not include reference to Fig. 2.2a and Fig. 2.2b/c <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks <i>No response or no response worthy of credit.</i>		
			Total	10	
7	a	i	5 ✓	1 AO1.2	
		ii	we share a common ancestor with <i>Pan paniscus</i> more recently than with <i>Gorilla gorilla</i> ✓	1 AO1.2	ACCEPT 5 million years ago compared with over 7 million years ago
	b		deoxyribose (nucleotide) ✓ ribose nucleotide ✓ amino acid ✓	3 AO1.2	
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		any 1 from: scientific, journals / papers / reports ✓ scientific, conferences / meetings ✓	max 1 AO1.1	ALLOW peer review
	b		honesty / trust, required for communication between mother and offspring in mother tongue theory ✓ in mother tongue theory, trust not required on population level ✓ gossip and grooming theory does not require trust (to accept new sounds) ✓	3 AO3.1	
	c		any 2 from: hand gestures could help clarify meaning of new words / sounds ✓ verbal communication required to explain how to carry out activities with hands ✓ such as, tool making / use of tools / hunting / other examples ✓ bipedalism led to complex manual activities that required language to share ✓ eye contact/facial expression help clarify meaning ✓	max 2 AO2.1	verbal communication to explain how to use of tools = 2 marks
	d		(genetic) variation ✓ pressure ✓ natural selection ✓	3 AO1.2	ALLOW diversity
			Total	9	
9			A	1 AO2.4	
			Total	1	
10			B	1	
			Total	1	
11			B	1	<u>Examiner's Comments</u> Many candidates selected option A or C for this question. However, statement 3 here relates to the mother tongues theory of language evolution.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12		i	number of species in habitat / species richness ✓ relative abundance of each species / species evenness ✓	2	Examiner's Comments (a)(i) There are two elements to species diversity and most candidates only referred to species richness, completely omitting reference to species evenness. Candidates were often imprecise in their definitions of species richness. There were many unclear statements using terms such as amount, type and range of species (e.g. the number of types of species) as well as some more significant inaccuracies such as the number of species in a <u>population</u> . Candidates should be encouraged to keep their definitions clear and use simple language.
		ii	any 2 from: equal size of, field / sampled area ✓ same soil, quality / type / hydration ✓ same season for observations ✓ same time of day for observations ✓ same method of sampling ✓ same climate ✓ same time period for observations ✓	max 2	Examiner's Comments (a)(ii) asked candidates to identify variables that could be controlled in this field based investigation. Although there were many good responses, candidates do need to remember to apply their knowledge to the question being asked. A few candidates listed variables that were completely inappropriate for a trial recording species of bird e.g. use the same size quadrat, control the number of predators.
			Total	4	
13			A ✓	1	Examiner's Comments Candidates scored highly on this question, most correctly identifying the pair of primers that could be used to amplify DNA from all species.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a		<i>Summary of instructions to markers:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a ‘best-fit’ approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> • <i>award the higher mark where the Communication Statement has been met.</i> • <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i>		

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	Level 3 (5-6 marks) There is a comprehensive consideration of regions of the graph which are accurately explained in relation to stomatal aperture size. The adaptive significance of the conductance pattern is discussed in relation to transpiration and photosynthesis. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3-4 marks) There is some consideration of regions of the graph which are correctly linked to stomatal aperture size. A discussion of the adaptive significance of the conductance pattern is attempted and may consider transpiration or photosynthesis. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1-2 marks) Stomata are identified as the structures which will alter conductance values. An attempt is made to link stomatal opening with the correct times of day. There is little consideration of the adaptive significance of the patterns of conductance. <i>The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.</i> 0 marks No response or no response worthy of credit.	6	Indicative scientific points may include Changes in the leaf • stomatal aperture open/wider when conductance is high • stomatal aperture narrower when conductance is low DO NOT ALLOW stomata are closed as no conductance / value is zero • stomata are wider during the morning • stomata narrow from 09:00 • stomata narrowest from 16:00 to 19:00 • gap between guard cells forms stoma(ta) Adaptive significance • stomata open to allow gaseous exchange • gaseous exchange permits aerobic respiration and photosynthesis • wider stomata increase transpiration • stomatal aperture reduced during hottest parts of the day ensuring water loss is minimised • stomatal aperture increased at night when it is cooler but there is no light for photosynthesis • stomata open when evaporation is slower Technical terms • stomata • xerophyte • transpiration • photosynthesis • guard cells

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																								
	b	i	0.7 ✓✓	2	ALLOW 0.75 If answer is incorrect or missing: ALLOW 1 mark for 0.3 OR 0.25 (<i>not subtracting the calculated figure from 1</i>) <table border="1"><thead><tr><th>Species</th><th>n</th><th>n/N</th><th>(n/N)²</th></tr></thead><tbody><tr><td>A</td><td>2</td><td>0.13</td><td>0.0169</td></tr><tr><td>B</td><td>6</td><td>0.40</td><td>0.1600</td></tr><tr><td>C</td><td>2</td><td>0.13</td><td>0.0169</td></tr><tr><td>D</td><td>2</td><td>0.13</td><td>0.0169</td></tr><tr><td>E</td><td>3</td><td>0.20</td><td>0.0400</td></tr></tbody></table> $\Sigma(n/N)^2 = 0.2507$ 1 - 0.2507 = 0.7493	Species	n	n/N	(n/N) ²	A	2	0.13	0.0169	B	6	0.40	0.1600	C	2	0.13	0.0169	D	2	0.13	0.0169	E	3	0.20	0.0400
Species	n	n/N	(n/N) ²																										
A	2	0.13	0.0169																										
B	6	0.40	0.1600																										
C	2	0.13	0.0169																										
D	2	0.13	0.0169																										
E	3	0.20	0.0400																										
		ii	(higher biodiversity) in the Succulent Karoo shows greater species evenness / less dominated by a few species / greater stability ✓ (higher biodiversity) in the Succulent Karoo shows greater species richness / greater number of different species ✓	2	ALLOW ORA throughout																								
			Total	10																									
15			B ✓	1																									
			Total	1																									

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16	a	i	2 ✓	1	
		ii	(class) mammal(ia) ✓ (order) primates ✓	2	
	b	i	<i>idea of</i> more copies per cell OR smaller so less likely to fragment ✓	1	
		ii	cytochrome c oxidase ✓	1	
	c	i	diagram to show Denisovan branch from common ancestor before <i>H. sapiens</i> and <i>H. neanderthalensis</i> branched ✓	1	ALLOW <i>sapiens</i> and <i>neanderthalensis</i> in either order DO NOT ALLOW 3 species drawn parallel to each other on the bottom line
		ii	<i>idea that</i> mitochondrial DNA only from female parent OR <i>idea that</i> recombination possible in nuclear DNA / no recombination in mitochondrial DNA OR AVP ✓	1	ALLOW valid alternative suggestions e.g. different mutation rate
			Total	7	
17			Any 2 from: <i>idea that</i> ideally sample sizes from each town should be, the same / more similar <i>idea of</i> avoiding bias / random selection <i>idea of</i> using the same, sampling method / approach, for each town calculation method described or named what gene loci will be analysed	3	e.g. heterozygosity, proportion of polymorphic loci
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18		i	selection pressure, (is) high altitude / risk of altitude sickness <i>idea of</i> individuals with, mutated gene / allele / Tibetan variant, will survive better at high altitude / have selective advantage <i>idea that</i> allele frequency for Tibetan EPAS1 increases over many generations natural selection	4	
		ii	physiological	1	ALLOW biochemical
		iii	Any 2 from: <i>idea of</i> less oxygen able to be transported in their blood (the potential for) less / reduced / AW, respiration partial pressure / concentration, of oxygen is lower at high altitude	2	
		iv	(erythrocyte cell count using) haemocytometer measures / AW, concentration of (red blood) cells OR flow cytometry measures / AW, volume / morphology / concentration, of (red blood) cells	2	ALLOW numbers of / types of protein in / amount of protein in, (red blood) cells
			Total	9	
19		i	<i>Rhizobium</i> (1)	1	ALLOW <i>Sino</i> / <i>Meso</i> / <i>Brady</i> / <i>Azorhizobium</i> ALLOW not italicised DO NOT ALLOW lowercase r
		ii	image size ÷ magnification OR 15,000 ÷ 32,000 (1) 0.47 / 0.5 (1)	2	ALLOW 2 marks for correct answer without working ALLOW 0.469
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20		i	group of organisms that interbreed (to produce fertile offspring) (1) similarity of genetic / physiological / behavioural attributes (1)	2	
		ii	Domain Eukarya / Eukaryota (1) Phylum (1)	2	DO NOT ALLOW eukaryote(s) ALLOW lowercase initial letters
			Total	4	
21			A	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22		i	25 (%);	1	IGNORE working Examiner's Comments The majority of candidates were able to calculate the theoretical percentage of a heterozygous individual being produced in a cross between two heterozygous individuals.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	1. (island edges / cacti) subject to, sea/salt, spray; 2. qq (genotype) confers ability to obtain water from salt spray; 3. (gives) selective advantage; 4. (individuals with qq genotype) survive / reproduce; 5. allele / q, frequency increases; 6. directional selection; 7. geographic, isolation / barrier; 8. (means) no new alleles coming in;	4 max	ACCEPT ORA for mp 2 – 5 IGNORE mist / sea water for mp1 and 2 ACCEPT homozygous recessive / 'they' for qq genotype 2. ACCEPT qq gets water supply from salt spray 2. ACCEPT qq genotype confers tolerance to salt (spray) 3. ACCEPT description e.g. 'they are (at an advantage and are) selected for' 5. DO NOT CREDIT gene frequency increases 5. IGNORE 'qq frequency increases' 6. IGNORE natural selection Examiner's Comments Good responses were able to comprehensibly explain how individuals homozygous for the q allele would come to dominate the gene pool of the <i>Brachycereus</i> species of cactus in the Galapagos Islands. It was essential to refer to the local conditions where the cactus is subjected to salty sea spray. Candidates realising the prevailing conditions, correctly referred to the qq individuals being able to obtain water from the salty spray, giving them a selective advantage and allowing them to survive. A few acceptable alternative arguments were also seen for the other cacti with the Q allele being unable to thrive. A number of responses failed to go as far as explaining that this selective advantage would result in the frequency the q allele rapidly increasing. Rarely was it mentioned that this was directional selection or that the cactus was geographically isolated with no new alleles coming into the population.
			Total	5	