1. Plants which are adapted to living in water are known as hydrophytes.

Two adaptations found in hydrophytes are the absence of a waxy cuticle on leaves and the absence of xylem tissue throughout the plant.

Suggest the advantage to plants living in water of:

The absence of a waxy cuticle _____

_____

_____

The absence of xylem tissue _____

_____

_____

[2]

2. DNA sequencing is a technique that may be used to show the evolutionary relationships of organisms.

Fig. 25.2 shows some of the evolutionary relationships of *Arabidopsis thaliana* in the form of a phylogenetic tree.

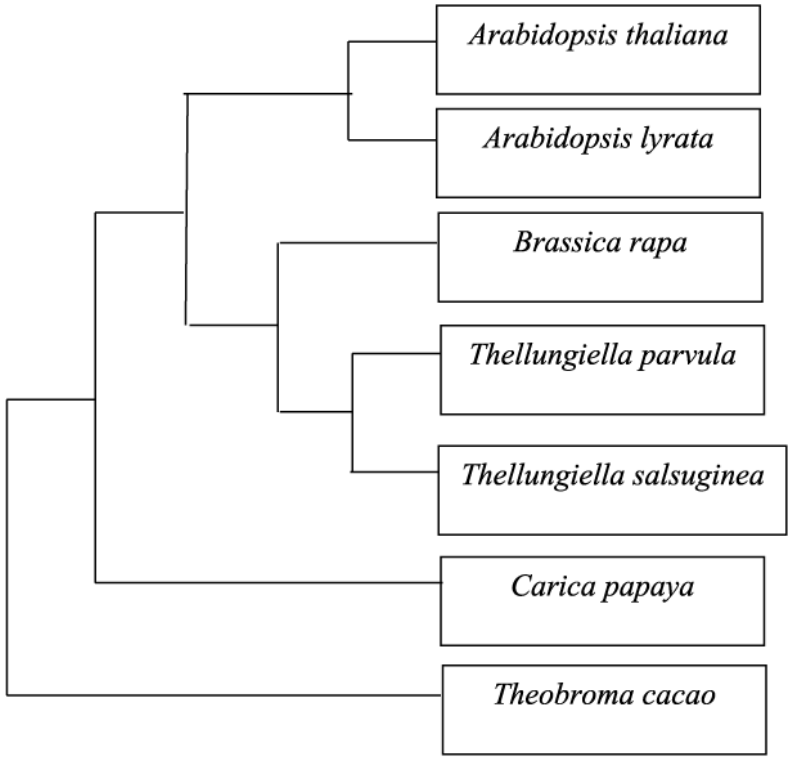


Fig. 25.2

(i) Which species is most closely related to *Arabidopsis thaliana*?

---------- [1]

(ii) Which species is most distantly related to *Arabidopsis thaliana*?

---------- [1]

(iii) How many genera are there in this phylogenetic tree?

---------- [1]

3(a). Scientists studying human evolution have shown that both *Homo neanderthalensis* and *Homo sapiens* were 'hunter-gatherers'. Both evolved behaviours in response to the changing environment. *Homo sapiens* made the transition to producing food.

(i) What evidence might suggest that both species hunted food?

---

[2]

(ii) Suggest how **one** environmental factor may have caused a change in the behaviour of both species.

---

[2]

(iii) Suggest two advantages to *Homo sapiens* of producing food rather than hunting or gathering.

---

[2]

(b). The hyoid bone is a horseshoe-shaped structure found in the neck. It supports the root of the tongue and is needed for speech. Hyoid bones from *Homo neanderthalensis* were discovered in 1989.

Why is the discovery of the hyoid bone **not** conclusive evidence of the ability of *Homo neanderthalensis* to speak?

---

[2]

4. Peanut and cumin are the common names for two different plant species.

The taxonomic classification of these species is shown in the table below.

The taxa are arranged hierarchically.

Complete the table by inserting the correct missing words.

Taxon	Organism	
	Peanut	**Cumin**
_____	Plantae	Plantae
Phylum	Angiosperms	Angiosperms
_____	Eudicots	Eudicots
_____	Fabales	Apiales
_____	Fabaceae	Apiaceae
Genus	_____	_____
_____	*Arachis hypogaea*	*Cuminum cyminum*

[3]

5. 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]

6.

(i) DNA barcoding is a method of classifying different plant species based on their genes.
Some of the genes used in DNA barcoding are found inside the nucleus of the cell.

Where else in a plant cell can genes be found for DNA barcoding?

---

[1]

(ii) State **one** advantage and **one** disadvantage of using DNA barcoding to classify plant species.

Advantage

Disadvantage

---

[2]

7. This question is based on the case study '**SOWING THE SEEDS OF HEALTH**' **(Case Study 2)**.

In the case study, Jamie and Mr Rose discuss Kew Gardens. Kew Gardens is home to the Millennium Seed Bank.

(i) State why seed banks, such as the one at Kew Gardens, are examples of *ex situ* conservation.

---

[1]

(ii) Many of the seeds stored in seed banks are given a DNA barcode.

Suggest what is meant by a DNA barcode **and** how a DNA barcode could be used to identify plants with potential medicinal properties.

---

[3]

8. The Galapagos Islands is an ecosystem of exceptional biological interest.

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.

_____

_____

_____

_____

_____

_____

_____

[4]

9(a).

Homo habilis is a species of hominid that lived in central Africa between 2.8 and 1.5 million years ago.

Since the discovery of *Homo habilis* fossils in central Africa during the 1950s, scientists have debated whether this species should have been placed in the genus *Australopithecus.*

Discuss the usefulness of different types of evidence when classifying species such as *Homo habilis.*

[6]

(b). *Homo habilis* is a species of hominid that lived in central Africa between 2.8 and 1.5 million years ago.

Fig. 3.1 shows tools used by *Homo habilis* and Homo *neanderthalensis*.

Tools used by *Homo habilis*

Fig. 3.1(a)

Tools used by *Homo neanderthalensis*

Fig. 3.1(b)

Explain how different tools, such as those shown in Fig. 3.1, can provide evidence of hominid evolution.

---[2]

(c). Primate species are known to use physical grooming to maintain social groups. Studying this behaviour in primates has enabled scientists to hypothesise about how it developed into 'vocal grooming' and the evolution of language in hominids.

Table 3 shows results from a predictive model of how much time must be spent physically grooming for hominid species to maintain the size of their social groups.

Species	Size of social group (number of individuals per group)	Time that must be spent physically grooming to maintain group size (% of each day)
Australopithecus sp.	65	18
Homo habilis	90	25
Homo erectus	110	30
Homo neanderthalensis	120	35
Homo sapiens	150	40

Table 3

In extant primates, the maximum time that could be spent physically grooming has been recorded at 20%. This was observed in *Theropithecus gelada*, a species of baboon.

Discuss how this information and the predictive data in Table 3 support the idea for the development of 'vocal grooming' and evolution of language in hominids.

[3]

10. *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]

11(a)

. Certain geographical regions of the Earth have high species diversity including large numbers of species that are unique to these regions. Such species are called endemic species.

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

---

[2]

(ii) Some geographical regions are threatened with habitat loss and have been prioritised for conservation. Such regions are known as biodiversity hotspots.

To be identified as a biodiversity hotspot a region must:

- have at least 0.5% of the Earth's 300 000 plant species as endemic species;
- have lost at least 70% of its original habitat.

Table 21 shows some data about two geographical regions, Madagascar and New Zealand.

Geographical region	Original habitat (km^2)	Remaining habitat (km^2)	Number of endemic plant species
Madagascar	594 150	59 038	9704
New Zealand	270 500	59 400	1865

Table 21

Analyse the data in Table 21 **and** compare these geographical regions as potential biodiversity hotspots.

---

[4]

(b). The rosy periwinkle, *Catharanthus roseus*, is one of the plant species found in Madagascar where it has evolved adaptations to survive in the hot and humid climate.

Describe the adaptations that plants such as *C. roseus* could have evolved to survive in a hot and humid climate?

[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			*idea that* water can diffuse directly into the leaves (1) *idea that* stems / AW, more flexible / can move with the currents / less likely to be broken by water movement (1)	2	IGNORE references to 'not needing' a cuticle as the question asks for the advantages IGNORE references to 'not needing' xylem as the question asks for the advantages
			Total	**2**	
2		i	*Arabidopsis lyrata* (1)	1	
		ii	*Theobroma cacao* (1)	1	
		iii	5 (1)	1	
			Total	**3**	
3	a	i	evidence of tools (1) evidence of tool marks on fossilised animal bones (1)	2	
		ii	factor e.g. climate change (1) link e.g. could cause migration (1)	2	Answer should link factor to description
		iii	**Any 2 from:** settlements (1) could farm animals and plants (1) *idea that* humans could control breeding of animals (1) increase food availability (1)	2	
	b		*idea that* position of hyoid bone may not be determined from fossils (1) *idea that* further evidence would be needed e.g. tongue position (1)	2	
			Total	**8**	

Question			Answer/Indicative content	Marks	Guidance
4				3	Both genera correct = 1 mark Arachis and Cuminum must be spelled correctly and have initial capital letter 5 taxon terms correct = 2 marks 3 taxon terms correct = 1 mark
			Total	3	

	Peanut	*Cumin*
Kingdom		
Class		
Order		
Family		
	Arachis	Cuminum
Species		

(1)

(1) (1)

Question			Answer/Indicative content	Marks	Guidance
5		i	selection pressure, (is) high altitude / risk of altitude sickness *idea of* individuals with, mutated gene / allele / Tibetan variant, will survive better at high altitude / have selective advantage *idea that* allele frequency for Tibetan EPAS1 increases over many generations natural selection	4	
		ii	physiological	1	ALLOW biochemical
		iii	Any 2 from: *idea of* 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	

Question			Answer/Indicative content	Marks	Guidance
6		i	chloroplast / plastids / mitochondria ✓	1	Examiner's Comments A lot of candidates were not reading the question again in (i) and suggested a tissue or part of plant instead of a cellular structure. Those that did put cellular structures quite frequently put ribosome or nucleolus. The candidates that achieved marks often got an advantage but very few candidates got a disadvantage, with many just putting expensive without qualification.
		ii	Advantages accurate method of classification or quick to conduct or can be done at any stage of development or similarities can be seen between species easily ✓ Disadvantages recently diverged species are often too similar or expensive, qualified ✓	2	e.g. expensive to train laboratory technicians / expensive equipment
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
7		i	*idea of* (conserving plants) outside their (natural) environment / habitat;	1	Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, AO2 and AO3 skills. Most candidates gained this mark, but a minority confused it with the idea that the species was extinct.
		ii	*Barcode* Short piece / (base) sequence / length of, DNA; from a specific, position / locus, on a chromosome; *Use* *idea of* comparing / matching / similar to, DNA (sequence) / barcode of a known medicinal plant; *idea that* similar sequence / barcode indicate related species / related species more likely to have similar medicinal compounds;	3	IGNORE gene and chromosome throughout ACCEPT rbcl, matK, trnH-psbA (plastid genomic regions) ITS (nuclear gene region) Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, AO2 and AO3 skills. Candidates found this question challenging. Candidates who understood the concept scored well but some confused it with mapping the genome of the plant. They did not clearly express the idea of comparing the barcode of the plant with known medical properties with others, and barcode similarities showing the possibility of the test plant having similar medicinal properties.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
8		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.

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 *Brachycereus* 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	

Question			Answer/Indicative content	Marks	Guidance
9	a		*Summary of instructions to markers:* *Read through the whole answer.(Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using '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 italics):* ◦ *award the higher mark where the Communication Statement has been met.* ◦ *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** Level 3 (5–6 marks) Provides **comprehensive** description of types of evidence useful to classify species **and** why other evidence can't be used for species such as *H.habilis.* A comprehensive / clear description of useful evidence with advantages and disadvantages can be awarded Level 3 without reference to evidence that can't be used for classifying *H.habilis*. Likewise a comprehensive description of non-useful evidence with regards to *H.habilis* can be awarded Level 3. *There is 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 continuous narrative* Level 2 (3–4 marks)	6	Indicative scientific points may include *Types of evidence useful in classifying species* Fossil records Carbon dating Morphology Anatomy Physical features *Evidence not useful* Embryo development Biochemical molecules .g. DNA / amino acids Behaviour Immunology Fossil records may be incomplete Examiner's Comments In the level of response question, **(b)**, candidates often described every method they could think of without considering whether it would be useful. For example, DNA is useful but rarely found in fossils. Candidates need lot more practice in this type of question. They need to read the question carefully and think about what is being asked. These questions are not just about using their knowledge but constructing logical and relevant answer that usually has more than one part or angle to consider. Very few candidates described why certain types of evidence would not be useful.

Question			Answer/Indicative content	Marks	Guidance
			Provides a basic description of types of evidence useful to classify *H.habilis* **and** limited reasons why other evidence can't be used. *There is line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** Description of types of evidence **or** limited description offered to support evidence that can't be used to classify *H.habilis.* *There is an attempt at a logical structure with line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.		
	b		For H. neanderthalensis tools are specialised ✓ tools require greater dexterity to make ✓ idea that(shows) increased use of hands ✓ idea that(shows) increased use of tools ✓ idea that (shows) more complex thought processes ✓	**Max 2**	**ALLOW ORA** for H. habilis **ALLOW** tools are sharper **ALLOW** requires greater skill to make **Examiner' Comments** Candidates often gave a description of the tool in **Q3(c)**, achieving one mark, but they less often made the link to greater cognitive, or dextral, ability.

Question			Answer/Indicative content	Marks	Guidance
	c		*idea that* based on the data only Australopithecus sp. / early hominids could spend time required to maintain the group size OR *idea that* species (other than *Australopithecus*) would have to spend too much time grooming to maintain group size ✓ *idea that* species (other than *Australopithecus*) would not have enough time for other activities such as hunting to maintain group size ✓ idea that increased level of , vocal grooming / language, needed to maintain group size ✓ comparative figures including units to support ✓	Max 3	Examiner' Comments Data was often not quoted in **Q3(d)** and very few made the link to the fact that there would be less time available to hunt. Very few stated that Australopithecus probably didn' vocalise. Most candidates simply described the data.
			Total	11	

Question			Answer/Indicative content	Marks	Guidance
10		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 population. 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	

Question			Answer/Indicative content	Marks	Guidance
11	a	i	*It is a measure of:* species richness / number of species in a habitat ✓ species evenness / relative abundance of individuals in each species ✓	2	**ALLOW** number of species in an (given) area **ALLOW** AW but must have the idea that it is the number of organisms of each species in the area Examiner's Comments A few excellent responses were seen where candidates had given both 'species evenness' and 'species richness' and were credited with two marks. The majority of candidates were able to gain one mark, usually for describing species richness as *the number of **species** that live in a particular location*.
		ii	1 Madagascar has lost 90% of (original) habitat **AND** New Zealand has lost 78% of (original) habitat ✓ 2 Madagascar has 3% (of Earth's endemic) plants **AND** New Zealand has 0.6% (of Earth's endemic) plants ✓ 3 both have more than 0.5% endemic species and have lost more than 70 % of their habitat ✓ 4 (therefore) both could be identified as biodiversity hotspots ✓ 5 New Zealand has less habitat loss and fewer (of Earth's total endemic) plants than Madagascar ✓	4 max	**ALLOW** ORA e.g. only 10% for Madagascar and 22% for New Zealand of habitat remaining **ALLOW** 1 mark for **either** MP1 **or** 2 if only data for one region has been analysed e.g. Madagascar has lost 90% of (original) habitat **AND** Madagascar has 3% (of Earth's) endemic plants **ALLOW** ECF if calculations in MPs 1 or 2 incorrect **ALLOW** ECF if calculations in MPs 1 or 2 incorrect **ALLOW** ORA Examiner's Comments This question required candidates to analyse data provided by performing simple calculations which would then enable them to compare two geographical regions. Some weaker responses did not analyse the data fully and simply repeated

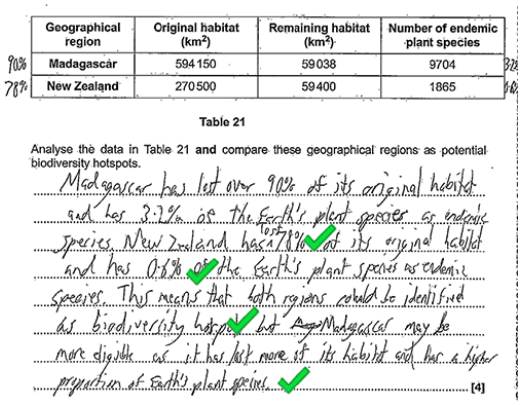
Question	Answer/Indicative content	Marks	Guidance
			information from the table rather than perform any calculations. Exemplar 1  This response identifies a high attaining response where information had been used to the full extent. Percentage calculations for loss of habitat and endemic species have been completed, enabling the candidate to make comparisons and confirm that both regions could be identified as potential biodiversity hotspots.

Table 21

Analyse the data in Table 21 **and** compare these geographical regions as potential biodiversity hotspots.

Madagascar has lost over 90% of its original habitat and has 3.7% of the Earth's plant species as endemic species. New Zealand has lost 78% of its original habitat and has 0.6% of the Earth's plant species as endemic species. This means that both regions could be identified as biodiversity hotspots but Madagascar may be more at risk as it has lost more of its habitat and has a higher proportion of Earth's plant species. [4]

Question			Answer/Indicative content	Marks	Guidance
	b		**description** light-coloured (leaves / hairs / spines) ✓ ***further detail*** for reflecting radiation / to prevent overheating ✓ ***description*** waxy / drip-tip / AW , leaves ✓ ***further detail*** to allow excess water to run off (due to humidity) ✓ AVP ✓✓	2 max	**IGNORE** adaptations relating to shortage of water as it is a **humid** climate Marks can be awarded for: **TWO** descriptions OR **ONE** description and **ONE** further detail linked to correct description **ALLOW** for reflecting heat from sunlight e.g. heat-resistant seeds that remain dormant until conditions are suitable for germination = 2 AVP marks Examiner's Comments Many candidates focussed on hot climates without taking humidity into account. Therefore, many responses referred to adaptations for preventing water loss, such as leaves reduced to 'spines', which did not gain credit in this case. Candidates were credited with one mark for 'waxy leaves' because although it is an adaptation for preventing water loss, it could also be an adaptation to hot and humid climates by enabling water to run off the leaf surfaces.
			Total	8	