Questions

Q1.

* The photograph shows a tawny owl. These owls live in areas close to the Arctic Circle.

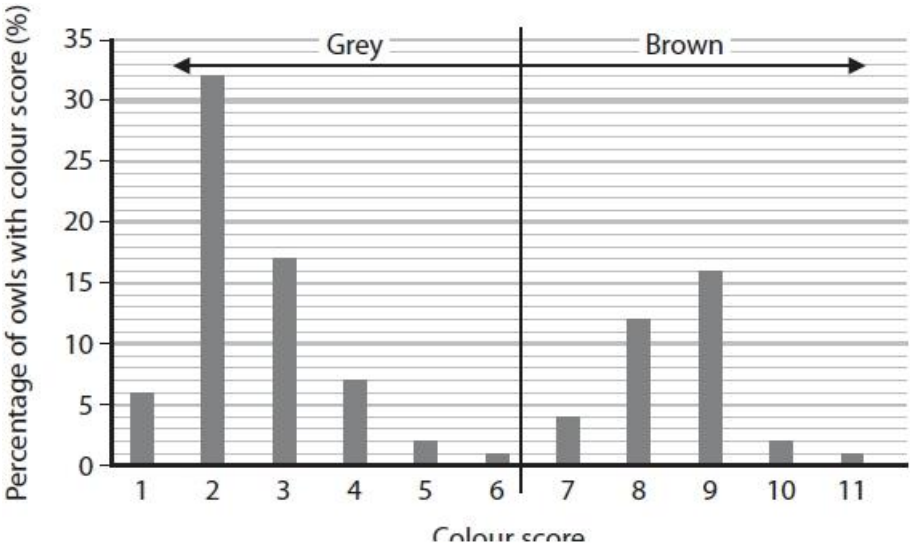
(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

Scientists investigated the feather colours of a population of tawny owls. Feather colours of the owls were scored on a scale of 1 to 11, according to how grey or brown they were.

Grey feathered owls were given a score between 6 and 1, with 1 being the most grey.

Brown feathered owls were given a score between 7 and 11, with 11 being the most brown.

The graph shows the percentages of owls in the population with each of the colour scores.



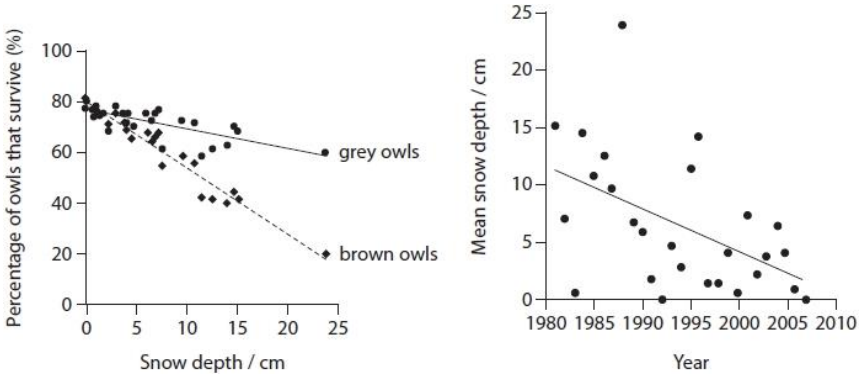
The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

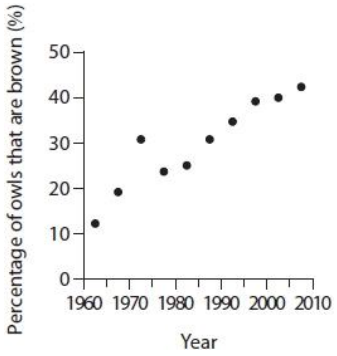
The percentage survival rates of both colours of owl were measured when there were different depths of snow.

The mean depth of snow was recorded each year between 1980 and 2007.

The percentage of owls that were coloured brown between 1960 and 2007 was also recorded.

The graphs show the results.





The scientists concluded that increased greenhouse gases from human activity are resulting in an increase in the frequency of the brown allele.

Analyse the data to evaluate this conclusion.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q2.

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

(Source: ©Imogen Warren / Shutterstock)

The males are known for building and decorating a bower to attract females.

This is made of two parallel walls of sticks and is used as a courtship arena during the breeding season.

The male decorates the bower with bright blue coloured objects that it collects. Blue clothes pegs, drinking straws and bottle tops are among the favourite items.

Away from human habitation, bright blue parrot feathers, flowers and snail shells make up the majority of the decorations.

(i) Describe how courtship ensures that bowerbirds mate successfully.

(2)

.....

.....

.....

.....

.....

.....

(ii) Explain how this bower building behaviour has evolved by natural selection.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(iii) Devise an investigation to determine the effect of changing the colour of the objects used to decorate the bower on its attractiveness to female bowerbirds.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 10 marks)

Q3.

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.

Explain why most of the plants in areas where bulbs are collected in high numbers have greyish-brown leaves and flowers.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q4.

Natural selection can lead to adaptations in organisms.

Compare and contrast allopatric and sympatric speciation.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q5.

Cholera is a disease caused by a bacterial infection that affects the absorption of water in the small intestine.

There is a high frequency of mutated CFTR alleles in some human populations.

In an experiment, three groups of genetically modified mice were infected with cholera bacteria.

The relative volume of water in their faeces was measured.

The results are shown in the table.

Group	Relative volume of water in faeces
Mice with two normal CFTR alleles	1.0
Mice with one normal and one mutated CFTR allele	0.5
Mice with two mutated CFTR alleles	0.1

Use the information in the table to explain why the mutated CFTR allele has a high frequency in some human populations.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

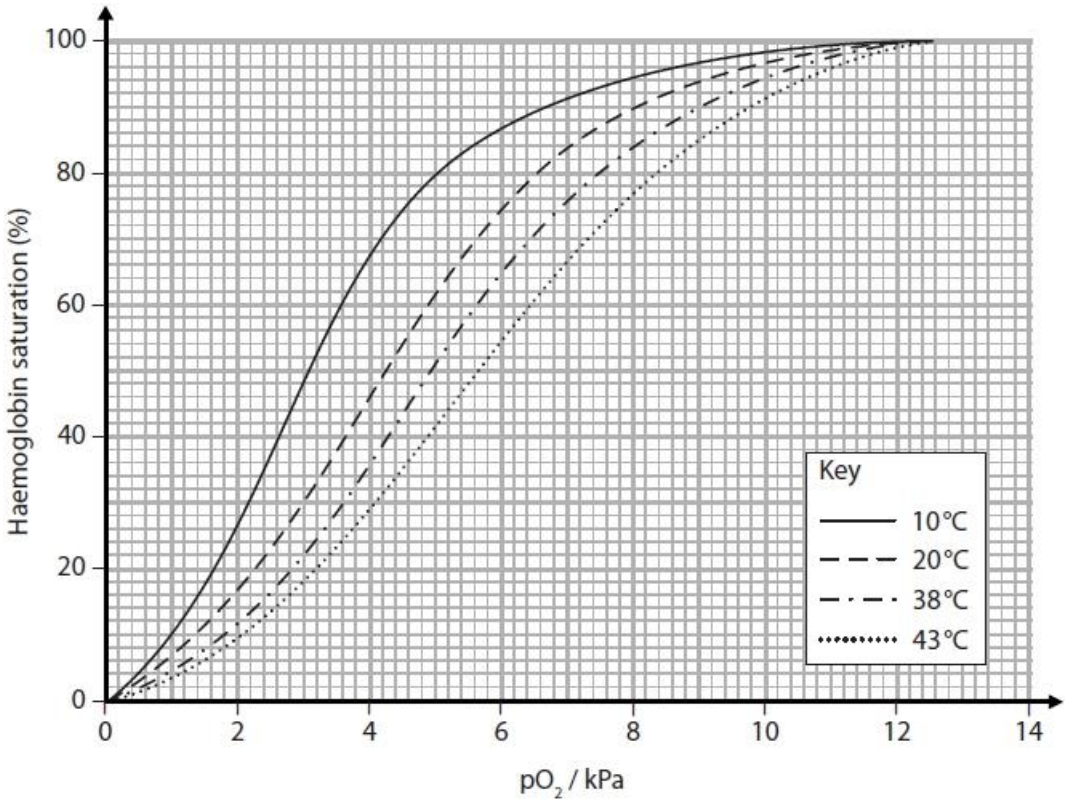
.....

(Total for question = 3 marks)

Q6.

Scientists also investigated the effect of temperature on the percentage saturation of haemoglobin with oxygen, using blood from an Asian elephant.

The oxygen dissociation curves are shown in the graph.



(i) In the alveolar capillaries, the partial pressure of oxygen is 12 kPa at a temperature of 38 °C and haemoglobin is fully saturated with oxygen.

In active muscle tissue, the partial pressure of oxygen is 2 kPa at a temperature of 43 °C. Use the graph to determine the percentage saturation of haemoglobin in active muscle tissue.

(1)

Answer ..... %

(ii) When 1g of haemoglobin is fully saturated it carries 1.3 cm^3 of oxygen.

Calculate the volume of oxygen released by 1 g of haemoglobin to this active muscle tissue.
Show your working.

(2)

Answer .....

(iii) Scientists extracted the genes for mammoth haemoglobin and used them to produce mammoth haemoglobin.

The oxygen dissociation curve for mammoth haemoglobin at 38 °C was found to be the same as for the Asian elephant at 38 °C.
Lowering the temperature did not shift the oxygen dissociation curve.
Explain how these observations show that this haemoglobin enabled mammoths to be adapted for life in cold Arctic regions.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q7.

Natural selection can lead to adaptations in organisms.

(i) Which of the following is an example of a behavioural adaptation?

(1)

- ☒ **A** courtship display in sticklebacks
- ☒ **B** litter size in pigs
- ☒ **C** number of *Drosophila* eggs that hatch
- ☒ **D** pollen production in sycamore trees

(ii) Which of the following is an example of anatomical adaptation?

(1)

- ☒ **A** an alarm call by a song thrush
- ☒ **B** dominance behaviour in dairy cattle
- ☒ **C** limb structure in primates
- ☒ **D** water potential in root hair cells

(iii) Which of the following is an example of physiological adaptation?

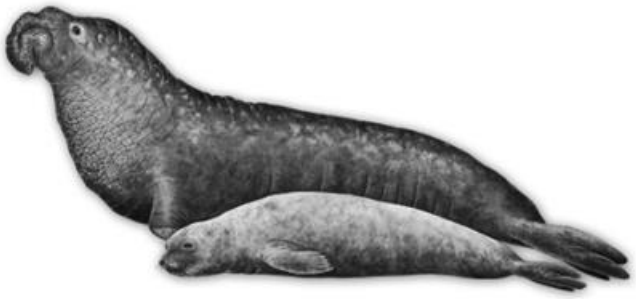
(1)

- ☒ **A** increased number of stomata on leaf upper surface in a water lily
- ☒ **B** production of venom by a snake
- ☒ **C** reduction of leaves to spines in a cactus
- ☒ **D** salmon swimming upstream to mate

(Total for question = 3 marks)

Q8.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

Species	Maximum time holding breath / min	Maximum diving depth / m	Mass of animal / kg
bottlenose dolphin	5	20	200
harbour seal	17	19	24
Weddell seal	82	400	400
Northern elephant seal	119	437	400

Species	Volume of oxygen in body / $cm^3\ kg^{-1}$	Concentration of haemoglobin in blood / $g\ dm^{-3}$	Total blood volume / $cm^3\ kg^{-1}$	Percentage of stored oxygen in different body tissues		
				lungs	blood	muscle
bottlenose dolphin	36	14	71	34	27	39
harbour seal	57	21	132	13	54	33
Weddell seal	87	210	173	5	66	29
Northern elephant seal	97	216	207	4	71	25

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

(3)

Answer .....

* (ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

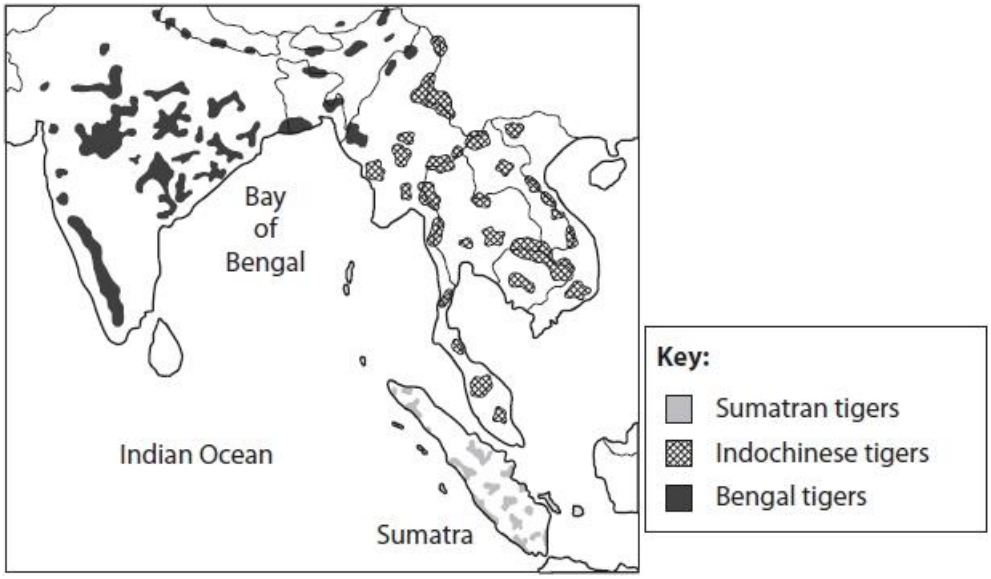
.....

.....

(Total for question = 9 marks)

Q9.

Before the twentieth century, tigers were once widespread across the whole of South and South East Asia. Over the last hundred years, their geographical distribution has been reduced by over 90%. The diagram shows the current distribution of three varieties of tiger.



The development of palm oil plantations in Sumatra has removed areas of forest that provided the natural habitat for these tigers.

Many tigers in Sumatra suffer from inherited disorders.

Explain why planting strips of trees to link the remaining patches of forest would have an effect on the frequency of genetic disorders in these tigers.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q10.

Natural selection can lead to adaptations in organisms.

Explain how evolution can occur through natural selection.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q11.

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

Taxonomy is the branch of biology concerned with classifying organisms.

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

Which of the following contributes to evolution by natural selection?

(1)

- ☐ **A** all organisms have enough resources to survive
- ☐ **B** individuals in the same population show little variation
- ☐ **C** individuals inherit acquired characteristics
- ☐ **D** organisms produce many more offspring than survive

(Total for question = 1 mark)

Q12.

Malaria is caused by *Plasmodium*, a pathogenic microorganism.

Vaccination is one of many methods being used to control malaria.

In a study, the effectiveness of a vaccine for malaria was tested.

The following method was used:

- samples of *Plasmodium* were exposed to radiation and used to make a vaccine
- two groups of people, A and B, were given different doses of the vaccine
- a third group of people, C, was used as a control
- one month after vaccination, all three groups of people were exposed to mosquitoes known to contain live *Plasmodium*
- the number of people in each group with malaria was recorded.

The results are shown in the table.

Group	Treatment with the vaccine	Number of people in each group	Number of people with malaria
A	low dose	17	16
B	high dose	6	0
C	control	12	11

Anti-malarial drugs can be used to protect people from malaria.

These drugs are not always effective because *Plasmodium* develop resistance.

Explain how drug-resistant *Plasmodium* may evolve.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q13.

Changes in the number of chromosomes of lizards can occur, resulting in speciation.

Some lizards are tetraploid (4n) rather than diploid (2n).

Explain how this speciation has arisen.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q14.

The hawthorn fly is found in a part of North America.

The hawthorn fly has separated into two species.

One species is called the apple maggot fly and feeds on apples. The other species is called the hawthorn fly and feeds on hawthorn fruit.

The photographs show these two species.

Apple maggot fly

Hawthorn fly

Explain how these two species have evolved.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q15.

The photograph shows three head lice on human hair.

Source: www.shutterstock.com

Insecticides are used to control the spread of head lice.

However, commonly used insecticides have become less effective at reducing head lice populations.

(i) Explain why these insecticides have become less effective when used to treat head lice.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Explain how the use of insecticides could be changed to make the treatment more effective.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q16.

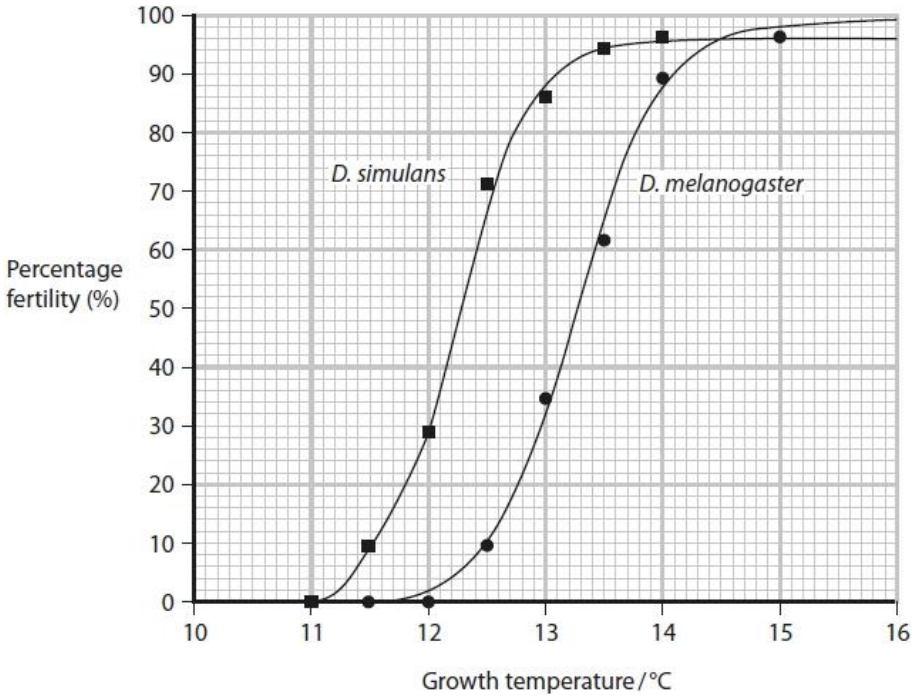
The photograph shows a fruit fly, *Drosophila*.

(Source: © Roblan/Shutterstock)

Species of *Drosophila* live in a range of habitats in different parts of the world.

The geographic distribution of these species ranges from regions with low temperatures to regions with high temperatures.

The graph shows the effect of temperature on the percentage fertility of male flies of two species of *Drosophila*, *D. simulans* and *D. melanogaster*.



The effect of low temperature on fertility is often compared using the temperature that results in 50% fertility.

Determine the difference in these temperatures for the two species.

(1)

Temperature difference .....

(Total for question = 1 mark)

Q17.

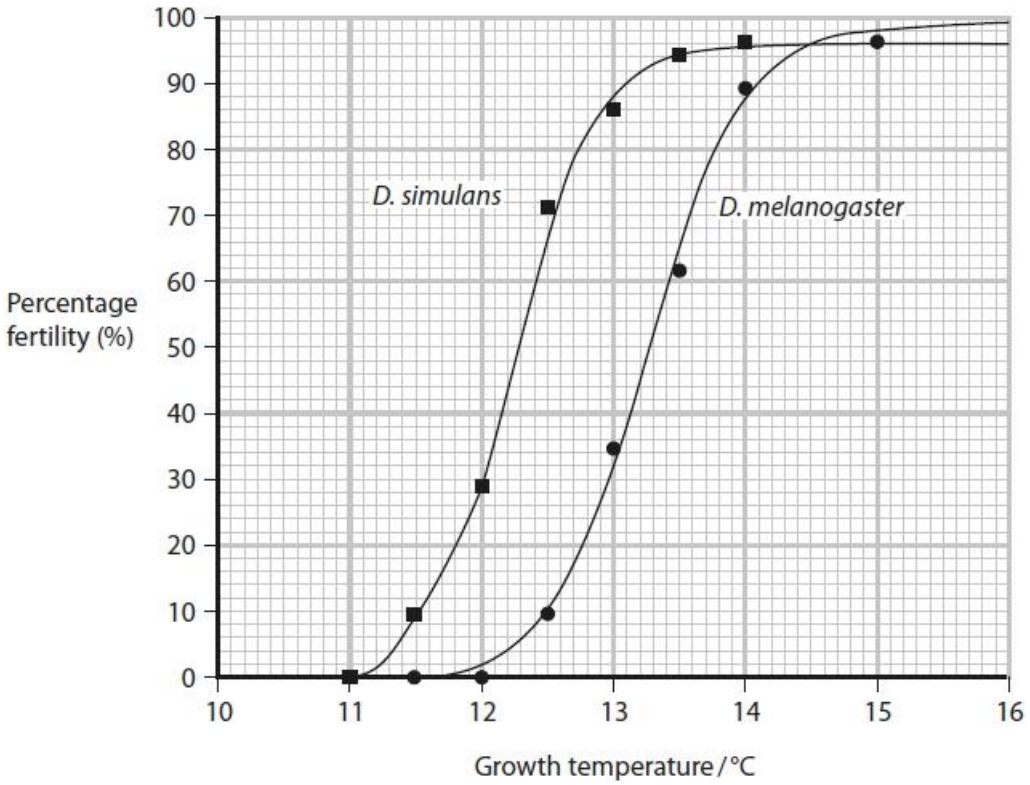
The photograph shows a fruit fly, *Drosophila*.

(Source: © Roblan/Shutterstock)

Species of *Drosophila* live in a range of habitats in different parts of the world.

The geographic distribution of these species ranges from regions with low temperatures to regions with high temperatures.

The graph shows the effect of temperature on the percentage fertility of male flies of two species of *Drosophila*, *D. simulans* and *D. melanogaster*.



Scientists also collected data from the two species about the effect of both high and low temperature on the viability of eggs and fertility of male flies.

An egg is viable if it develops into an adult.

The table shows the effects of temperature on the viability of eggs and fertility of males, for the two species of *Drosophila*.

Species	Lowest temperature / °C		Highest temperature / °C	
	at which eggs are viable	at which males are fertile	at which eggs are viable	at which males are fertile
D. melanogaster	10	12	32	30
D. simulans	10	11	31	28

(i) Give the relationship between temperature and the viability of eggs and fertility of males.

(1)

.....

.....

.....

*(ii) Another group of scientists recorded the courtship song of male *D. melanogaster* and male *D. simulans*.

The male flies vibrate their wings producing a courtship song to attract females.
The courtship song is produced in pulses.
The interval between pulses and the duration of each pulse are shown in the table.

Species	Mean interval between pulses / ms	Duration of pulse / s
D. melanogaster	34.1	1.6
D. simulans	48.9	3.4

Discuss how the data provides evidence for the geographical distribution and type of speciation of the two species of *Drosophila*.
Use the data from tables for temperature and for courtship song.

(6)

(Total for question = 7 marks)

Q18.

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)

.....

.....

.....

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

(1)

.....

.....

.....

(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)

Q19.

Natural selection can lead to adaptations in organisms.

Natural selection can lead to speciation.

(i) Which information about a new organism would to lead to it being classified as a new species?

(1)

- ☒ **A** anatomical differences
- ☒ **B** behavioural differences
- ☒ **C** genetic differences
- ☒ **D** inability to produce fertile offspring with similar species

(ii) Give one method that a scientist might use to inform the scientific community about the discovery of a new species.

(1)

.....

.....

.....

(Total for question = 2 marks)

Q20.

Macroalgae and microalgae are photosynthetic organisms.

Seaweeds are macroalgae that live attached to rock in coastal areas.

Some seaweeds are green, some are brown and some are red.

The colour of seaweeds depends on the photosynthetic pigments contained in their cells.

Green seaweeds contain chlorophyll, brown seaweeds contain chlorophyll and fucoxanthin and red seaweeds contain chlorophyll and phycoerythrin.

(i) Explain why these seaweeds have different absorption spectra and action spectra.

(3)

.....

.....

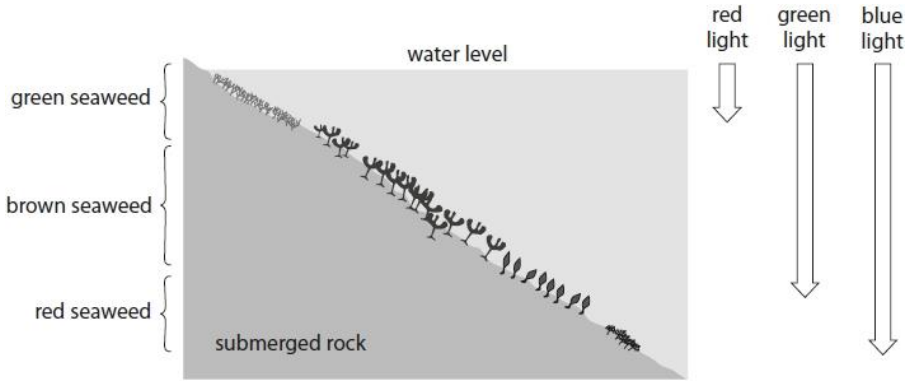
.....

.....

.....

.....

(ii) The diagram shows the position that these seaweeds occupy on submerged rock and the depth to which different wavelengths of light penetrate into the water.



Explain why the seaweeds occupy different positions on the submerged rock.

(3)

.....

.....

.....

.....

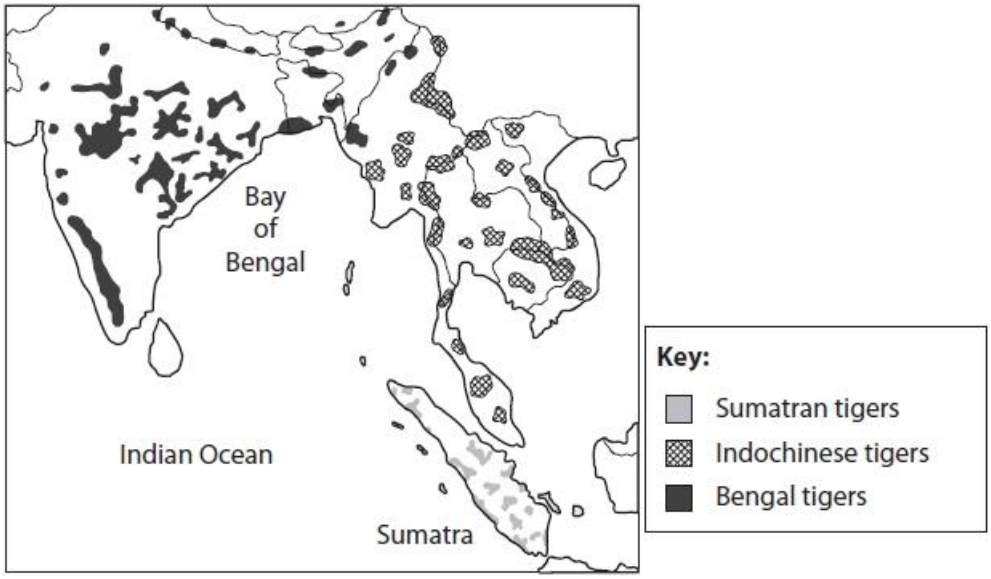
.....

.....

(Total for question = 6 marks)

Q21.

Before the twentieth century, tigers were once widespread across the whole of South and South East Asia. Over the last hundred years, their geographical distribution has been reduced by over 90%. The diagram shows the current distribution of three varieties of tiger.



Use the map to explain how the different varieties of tiger may eventually become separate species.

(4)

.....

.....

.....

.....

.....

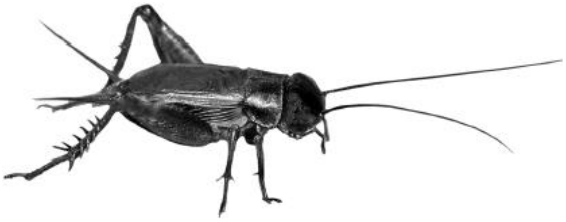
.....

.....

.....

(Total for question = 4 marks)

Q22.
The photograph shows a species of insect, *Gryllus pennsylvannicus*.



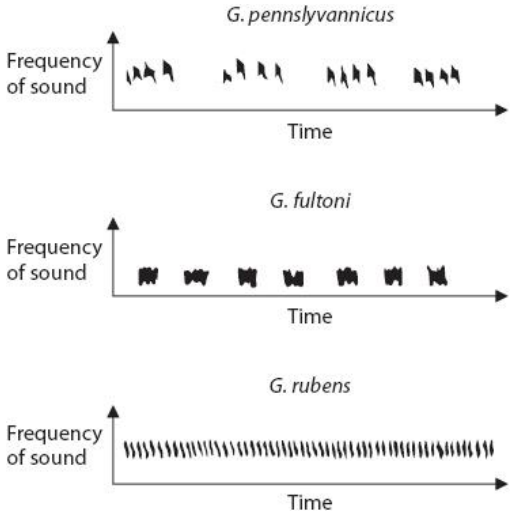
Scientists used to think that *G. pennslyvannicus* and two other species, *G. fultoni* and *G. rubens*, belonged to the same species.

The insects live in North Carolina in the USA.

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

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

The diagram shows the sonogram for each species.



Explain how the insects evolved from a common ancestor into three distinct species.

(4)

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q23.

There are currently only three surviving species of elephant:

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

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

(2)

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

(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • with increasing snow depth, there is higher survival of grey owls / fewer brown owls survive / more grey owls D • snow depth has decreased over time D • the percentage of brown owls has increased over time / percentage of grey owls has decreased D For • with less snow, more ground is visible / uncovered / more twigs and trees visible E • with less snow, grey owls more obvious (to predators / prey) / less camouflaged E • with less snow, natural selection would favour brown owls / more brown (advantageous) alleles passed on / fewer grey alleles passed on / brown owls outcompete grey owls E • enhanced greenhouse effect due to carbon dioxide emissions reflecting radiation back / absorbing radiation (causing melting) E Against • no direct measure of greenhouse gas / temperature / fossil fuel emissions A • graphs show correlations not causal links A • data for owl survival with snow depth is scattered / gaps in data / weak correlation A • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A • other factors (named factors) could be affecting the owl population A • reduced snow may not be due to greenhouse gas release A
	• data for owl survival with snow depth is scattered / gaps in data / weak correlation A • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A • other factors (named factors) could be affecting the owl population A • reduced snow may not be due to greenhouse gas release A

Level 0	Marks	No awardable content
Level 1	1-2 (1-3)	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made . **1 mark : any 1 from D, E, A** **2 marks : any 2 from D, E, A**
Level 2	3-4 (4-6)	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. **D and, E OR A** **3 marks : at least 3 points. Any combination of D, plus E, or A** **4 marks : at least 4 points. Any combination of D, plus E, or A**
Level 3	5-6 (7-9)	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. **D, E, AND A** **5 marks : at least 5 points. Must have combination of D, E, and A** **6 marks : at least 6 points. Must have combination of D, E, and A**

Q2.

Question Number	Answer	Mark
(i)	An description that makes reference to the following points : • enables female to judge fitness of male bird (1) • ensures that correct sex / female is courted / mated (1) • ensures that the correct species is courted / mated (1)	**exp (2)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation makes reference to **four** of the following: • (variation in) bower building caused by mutation (1) • males / birds that build (larger bower) attract (more) females / birds that build (more colourful) bower attract (more) females (1) • so more likely to mate / reproduce (1) • therefore pass on alleles / genes (to offspring) (1) • females who mate with successful bower birds more likely to produce offspring (1)	allow produce offspring	**EXP (4)**

Question Number	Answer	Additional guidance	Mark
(iii)	An answer that makes reference to **four** of the following: • change the colour of feathers or objects (1) • control size / shape / location of bower / size or shape of objects / time of day / season (1) • control presence / absence of male / use same male / use model male bird (1) • count how many female birds visit bower (1) • in stated time (1) • repeat in different areas / repeat with different females (1)	allow idea of females choosing from selection of bowers	**EXP (4)**

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that includes four of the following:		
	• collection acts as a selection pressure (1)	Accept collection of plants results in natural selection	
	• (random) mutation (in gene) for pigment / colour (1)	Accept genetic variation for colour exists (in population)	
	• greyish brown plants are less likely to be {collected / found} as harder to see (1)	Accept greyish brown plants {better camouflaged / blend in} so not picked piece together Accept converse	
	• more likely to reproduce, passing on new **allele** (1)	Accept more likely to pass on allele to offspring Accept converse	
	• **allele** frequency increases (1)	Accept allele increases in gene pool Accept converse	**Exp (4)**

Q4.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: Similarities • reproductive isolation (1) • one original population / from existing species / have a common ancestor (1) • absence of gene flow / genetic differences accumulate (1) Differences • allopatric requires geographic isolation / sympatric in same geographic area (1) • sympatric caused by different food / behavioural / anatomical / physiological / seasonal / temporal isolation (1) • sympatric results from ploidy (1)	**ACCEPT** no longer mate **ACCEPT** barriers to mating **ACCEPT** example e.g. river **ACCEPT** example e.g. apple maggot fly	**(4)**

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • (mice / humans with) mutated alleles lose less water / more mutant alleles reduces water loss (1) • therefore survive cholera / infection (1) • pass on {allele / mutant genes} (1)	ACCEPT converse statement	(3)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct reading from graph	= 10(%)	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • correct subtraction of percentages • correct calculation of volume	Example of Calculation ECF from part (i) 100% - 10 % = 90% 1.3 – 0.13 = 1.17 (90 ÷ 100) x 1.3 = 1.2 **cm^3** ALLOW 1.17 **cm^3** no units or incorrect units gains ONE mark only correct response with no working gains full marks	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • affinity of haemoglobin for oxygen does not change (1) • therefore oxygen is still released (1) • therefore heat is still produced by respiration (1)	ALLOW the converse ACCEPT haemoglobin does not bind to oxygen tightly when cold / haemoglobin binds to oxygen more weakly (than elephants) when cold	(3)

Q7.

Question Number	Answer	Mark
(i)	**The only correct answer is A** ***B*** *is not correct because litter size is not a behavioural adaptation* ***C*** *is not correct because number of eggs is not a behavioural adaptation* ***D*** *is not correct because pollen production is not a behavioural adaptation*	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is C** ***A*** *is not correct because an alarm call is not an anatomical adaptation* ***B*** *is not correct because dominance behaviour is not an anatomical adaptation* ***D*** *is not correct because water potential is not an anatomical adaptation*	**(1)**

Question Number	Answer	Mark
(iii)	**The only correct answer is B** ***A*** *is not correct because number of stomata is not a physiological adaptation* ***C*** *is not correct because reduction of leaves is not a physiological adaptation* ***D*** *is not correct because swimming upstream is not a physiological adaptation*	**(1)**

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	• total blood volume in one seal (1)	Example of calculation: 400 x 207 = 82800 cm^3 **Accept** calculation of total haemoglobin per cm^3 kg^{-1} blood: 207 × 216 = 44712 **Accept** calculation of concentration of haemoglobin in one seal: 216 × 400 = 86400	
	• conversion of g dm^{-3} to g cm^{-3} (1)	216 ÷ 1000 = 0.216 g cm^{-3}	
	• total mass of haemoglobin (concentration of haemoglobin x volume of blood in a seal) (1)	0.216 x 82800 = 17885 g Correct answer with no working gains full marks **Accept** for two marks a correct answer with no units / wrong units **Accept** for three marks: 17884.8 g / 17880 g / 17890 g / 17900/ 18000 g / 17.8848 kg / 17.885 kg / 17.89 kg / 17.9 kg / 18 kg	(3)

Question Number	Indicative content
(ii) *	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. <u>A: Depth and diving</u>: • positive correlation between maximum depth and maximum time holding breath • weak positive correlation between mass of animal and depth • weak correlation between maximum time holding breath and mass of mammal • because diving deeper requires larger oxygen storage as can't breathe underwater • aerobic respiration requires oxygen to release energy <u>B: Blood and muscle:</u> • positive correlation between volume of oxygen in body and maximum depth • positive correlation between concentration of haemoglobin in blood and maximum depth • no correlation between oxygen stored in muscle and maximum depth • all the mammals must possess myoglobin acting as an oxygen store in muscle • bottlenose dolphin and harbour seal have more oxygen stored in lungs / Weddell seal and Northern elephant seal have less oxygen stored in lungs • oxygen stored in lungs results in more buoyancy so deeper diving mammals have less stored in lungs • combined effect of high blood volume and haemoglobin concentration results in very high blood oxygen storage • more oxygen stored in blood so higher haemoglobin concentration and blood volume in animals that dive deeper • all have similar proportions of oxygen stored in muscle <u>Quantitative analysis</u> • Q1: quoting of data to support explanation • Q2: manipulation of data to support explanation, for example, determining total haemoglobin concentrations in mammals.

Level	Marks	
0	0	No awardable content
1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **Level 1: Description of some patterns from at least one of A or B**
2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. The discussion shows some linkages and lines of scientific reasoning with some structure. **Level 2: Description of patterns with explanation from at least one of A or B**
3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **Level 3: Detailed description and explanation of patterns from both A and B with quantitative analysis (Q)**

Q9.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • decrease in genetic disorders (1) And one from: • because of increased gene pool / more alleles / less chance of two harmful alleles (1) • because of reduced inbreeding / more outbreeding (1)	ACCEPT no longer geographically isolated / tigers from different populations breed	**(2)**

Q10.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • genetic variation / mutation (1) • some organisms are better adapted so survive (1) • reproduce / have offspring (1) • therefore {alleles / genes} passed on (1)	**ACCEPT** converse **ACCEPT** converse **ACCEPT** converse	**(3)**

Q11.

Question Number	Answer	Mark
	The only correct answer is D organisms produce many more offspring than survive ***A*** *is not correct because all organisms do not have enough resources to survive* ***B*** *is not correct because individuals in the same population do not show little variation* ***C*** *is not correct because individuals do not inherit acquired characteristics*	**(1)**

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • {random / chance} mutations (1) • produce {proteins / enzymes} that make the drug ineffective (1) • therefore resistant organisms pass on allele (1) • drug is the selection pressure (1)	**DO NOT ACCEPT** if mutation caused by drug **DO NOT ACCEPT** pass on mutation / gene	**(3)**

Q13.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • mutation (1) • unable to {breed / reproduce / mate / produce zygote} (1) • because {gametes} have different numbers of chromosomes (1)	**ACCEPT** non-disjunction / description of nondisjunction	**(2)**

Q14.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • sympatric (speciation) (1) • occupy different niches / competition for food / behavioural change / behavioural / ecological isolation (1) • less {breeding / reproduction / mating} with other fly (1) • reproductive isolation / no gene flow / different selection pressure / evolve separately (1)	**IGNORE** allopatric	**(3)**

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following points: • some head lice are resistant to one insecticide (1) • due to a mutation (1) • these resistant head lice survive and reproduce (1) • pass on {allele / gene} for resistance to offspring (1) • resulting in an increase in allele frequency in population (1)	IGNORE reference to **immune** ALLOW not killed and reproduce not just pass on resistance	**(4)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: • use an insecticide that has not been used before / different insecticide (1) • so no {resistance / selection pressure} (1) • insecticide regularly changed so no resistance develops to any one type (1)	IGNORE immune	(3)

Q16.

Question Number	Answer	Additional guidance	Mark
	• 13.25 - 12.3 =0.95	allow 0.95 to 1.05	(1)

Q17.

Question Number	Answer	Additional guidance	Mark
(i)	an answer that includes one of • fertility of males and viability in eggs have a similar temperature range • at low and high temperature eggs are not viable and malesare infertile	eggs are viable at same temperature thatmales are fertile	(1)

Question Number	Indicative content
(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relationto the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which isindicated as relevant. Additional content included in the response must be scientific and relevant. **Temp** • viability temperatures are always more extreme than fertility **Obs** • As you can survive but not be able to breed **Conc** Low temp range • *D.melanogaster* cannot survive below 10 °C **and** *D. simulans* cannot survive below 10 °C **Obs** • *D.melanogaster* cannot breed below 12 °C **and** *D. simulans* cannot breed below 11 °C **Obs** High temp • *D.melanogaster* cannot survive above 32 °C **and** *D. simulans* cannot survive above 31 °C **Obs** • *D.melanogaster* cannot breed above 30 °C **and** *D. simulans* cannot breed above 28 °C **Obs** • But very similar temperature ranges *D.melanogaster* 12-30 °C *and D.simulans* 11-28 °C / **Conc** • Therefore expect to find them in similar locations **Conc**

	Courtship song *D.melanogaster* has shorter pulse interval / *D.simulans* has longer pulse interval **obs** *D.melanogaster* has shorter pulse duration / *D.simulans* has longer pulse duration **obs** differences in courtship song unqualified = one **obs** Species differences in courtship song so females only respond to males of correct species **Conc** Therefore behavioural isolation / causes reproductive isolation **Conc** speciation is sympatric **Conc**

Level	Mark	Descriptor
	0	No awardable content
1	1-2	The explanation will contain basic information with some attempt made to link knowledge and understanding tothe given context. ***Gives one observation about temp or courtship =1*** ***Gives one observation and explains one conclusion from temp or courtship or gives two observations fromtemp or courtship = 2***
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of thescientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
		Gives one observation from temp and one from courtship and explains one conclusion=3 ***Gives one observation from temp and one from courtship and gives two conclusions=4***
3	5-6	An explanation is given which is supported throughout by evidence from the analysis, interpretation and/orevaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent andlogically structured. ***Gives two observations from temp and two from courtship and explains all four observations =5*** ***Gives two observations from temperature and two from courtship and explains all four observations andincludes suggests (similar) distributions or ranges or identifies sympatric speciation =6***

Q18.

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

Q19.

Question Number	Answer	Mark
(i)	**The only correct answer is D** ***A*** *is not correct because anatomical differences can exist within species* ***B*** *is not correct because behavioural differences can exist within species* ***C*** *is not correct because genetic differences can exist within species*	**(1)**

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

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • each pigment will absorb different wavelengths (of light) (1) • each pigment will absorb different amounts of light at eachwavelength (1) • action spectrum is different because the seaweeds are absorbingdifferent wavelengths of light (1) • the rate of photosynthesis will therefore be different at each wavelength(1)	**ACCEPT** each pigment will reflect different wavelength (of light) description of which colour light is {reflected / absorbed}	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • green seaweeds found in shallow water as they {cannot absorb thegreen light / can absorb the red light} (1) • {brown / red} seaweeds can absorb {green / blue / other} wavelengths of light so are positioned further down as thesewavelengths can penetrate further (1) • seaweeds positioned so that they can absorb light for {photosynthesis / light-dependent reactions / photolysis} (1) • seaweeds positioned to avoid competition with the other types of seaweed (1)	**ALLOW** plants for seaweeds	(3)

Q21.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: • allopatric speciation (would occur) (1) • because tigers become geographically {isolated / separated} (1) • so that they are reproductively isolated / no longer interbreed (1) • therefore they become genetically different / accumulate different mutations (1) • due to different selection pressures / genetic drift (1)	ACCEPT reduce gene flow / change in allele frequency IGNORE references to not breeding once they have become a new species	(4)

Q22.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following: • there have been mutations (1) • therefore each species has a different mating call (1) • so mating call not recognised / females of one species not attracted to males of another species / (1) • therefore {reproductive isolation / behavioural isolation / no interbreeding / no gene flow} occurs (1) • therefore sympatric speciation (1)	Reject geographic isolation Ignore no mating Reject allopatric	(4)

Q23.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td></td>
<td>Any two correct rows for 1 mark:

<table>
<tr><td>Domain</td><td>Eukarya</td></tr>
<tr><td>Kingdom</td><td>Animalia</td></tr>
<tr><td>Phylum</td><td>Chordata</td></tr>
<tr><td>Class</td><td>Mammalia</td></tr>
<tr><td>Order</td><td>Proboscidea</td></tr>
<tr><td>Family</td><td>Elephantidae</td></tr>
<tr><td>Genus</td><td>Loxodonta</td></tr>
<tr><td>Species</td><td>africana</td></tr>
</table>
</td>
<td>ACCEPT Eukaryote / Eukaryota

Upper case for Loxodonta
Lower case for africana</td>
<td>(2)</td>
</tr>
</table>