

Questions

Q1.

Blood clotting is a process that is affected by genes.

Some people are at an increased risk of a condition called deep vein thrombosis (DVT). Blood clots form in the veins of people with DVT.

There are two alleles in a population, a wild type allele and G20210A.

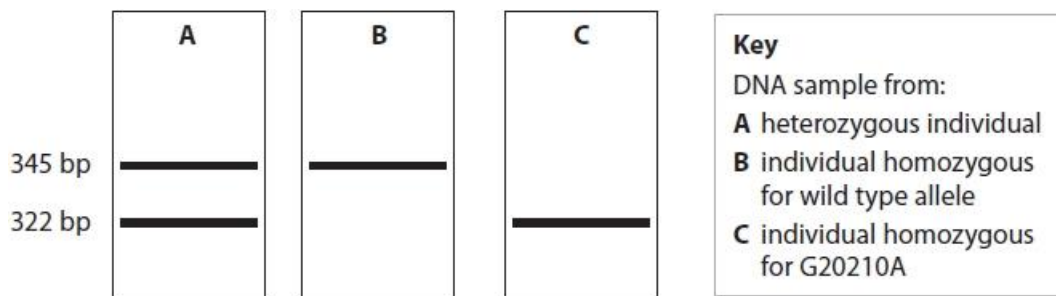
Individuals with a family history of DVT may be offered a genetic test for the G20210A allele.

In this test, a sequence of 345 base pairs (bp) from this gene is amplified using the polymerase chain reaction (PCR).

A specific restriction enzyme is then added to the amplified DNA.

The DNA fragments produced are then separated using gel electrophoresis.

The diagram shows the results of gel electrophoresis for three individuals, A, B and C.



(i) Explain the role of DNA primers in the production of the amplified 345bp sequence.

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(ii) Explain why the amplified DNA fragments for the G20210A allele and the wild type allele are different.

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(iii) Devise an investigation to determine the optimum number of cycles for the polymerase chain reaction used to amplify the DNA for this test.

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(Total for question = 9 marks)

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Q2.

The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.



The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

	Husks alone		Husks with added cow dung	
Days composting	0	90	0	90
Organic carbon (%)	54.50	41.70	48.10	35.40
Nitrogen (%)	1.84	2.31	2.76	3.19

Comment on the effect of adding cow dung to composting coffee husks.

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(Total for question = 3 marks)

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Q3.

Body farms use the bodies of pigs to study the changes in insect species on a body after death.

(i) Describe how this study could be carried out.

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(ii) Explain how the results of this study could be used to help to establish the time of death of a human.

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(Total for question = 6 marks)

Q4.

Describe how DNA profiling could be carried out to show that these snakes are different species.

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(Total for question = 4 marks)

Q5.

Describe the changes that occur inside a body in the first week after death.

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(Total for question = 3 marks)

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Q6.

One method of estimating the time of death is to determine the age of blowfly maggots on a dead body.

Microorganisms are also found on a dead body.

Describe the role of decomposers, such as microorganisms, in the carbon cycle.

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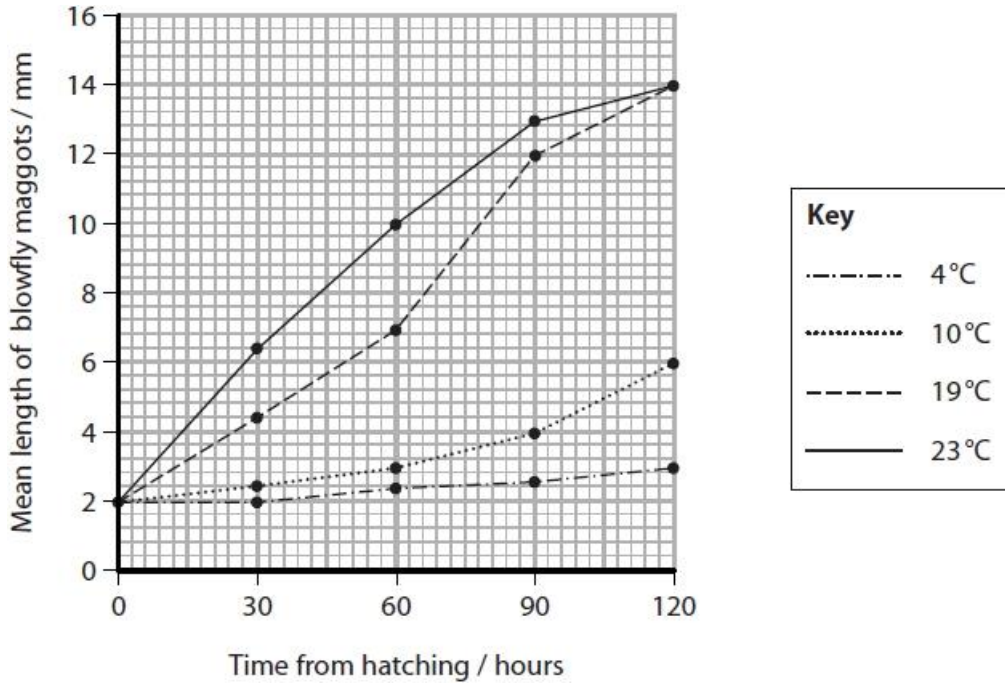
(Total for question = 2 marks)

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Q7.

One method of estimating the time of death is to determine the age of blowfly maggots on a dead body.

The effect of environmental temperature on the growth of blowfly maggots is shown in the graph.



(i) Blowfly maggots found on a dead body had lengths between 3 and 8 mm. The body had been at a constant environmental temperature of 19 °C since death.

Determine the maximum time since these maggots hatched.

(1)

..... hours

(ii) Determine the fastest rate of growth of a blowfly maggot at a temperature of 19 °C.

Give your answer to 2 significant figures.

(2)

..... mm hour⁻¹

(iii) Explain the effect of temperature on the rate of growth of blowfly maggots.

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(Total for question = 6 marks)

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Q8.

Skulls can be used as evidence for human evolution.

The only type of human present today is the modern human. In the past, another type of human, called Neanderthal, occupied the same geographical area.

The photograph shows the skulls of both types of human.



Modern human skull

Neanderthal skull

© hairyuseummatt/DrMikeBaxter

Genetic studies now show that these two types of human have interbred.

Only small quantities of DNA can be extracted from the remains of Neanderthal humans.

The quantity of extracted DNA is amplified using

- A** DNA profiling
- B** polymerase chain reaction
- C** RNA profiling
- D** translation chain reaction

(1)

(Total for question = 1 mark)

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Q9.

Skulls can be used as evidence for human evolution.

The only type of human present today is the modern human. In the past, another type of human, called Neanderthal, occupied the same geographical area.

The photograph shows the skulls of both types of human.



Modern human skull

Neanderthal skull

© hairyuseummatt/DrMikeBaxter

Genetic studies now show that these two types of human have interbred.

Devise a procedure, using electrophoresis, to compare the amplified DNA from these two types of human.

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(Total for question = 4 marks)

Q10.

A deer was found dead on National Trust land. Some people thought that the wounds that led to the deer's death could have been caused by a big cat such as a black panther.



The DNA produced by PCR was analysed to find out if a black panther was involved.

Explain how gel electrophoresis could be used to find out if this DNA came from a black panther.

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(Total for question = 5 marks)

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Q11.

The extent of decomposition is important in helping to determine the time of death of a mammal.

Body farms are outdoor laboratories where experiments take place to investigate the changes that take place after death in a range of conditions. Body farms use the bodies of pigs or donated human bodies.

The effects of factors such as temperature, moisture and position of the body on the rate of decomposition can be studied.

Explain the effect of ambient temperature on the rate of decomposition.

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(Total for question = 3 marks)

Q12.

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 .

Farmers use fertilisers to increase the growth of crops such as wheat.

(i) Fertilisers contain phosphate ion compounds.

Plants need phosphate in order to synthesise

(1)

- A both cellulose and phospholipids
- B both phospholipids and polysaccharides
- C both polynucleotides and phospholipids
- D both polynucleotides and polysaccharides

(ii) After the grain is harvested, farmers plough the stems (straw) from wheat plants into the soil.

This improves the quality of the soil. These stems contain polysaccharides.
Explain how microorganisms in the soil break down the stems.

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(Total for question = 4 marks)

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Q13.

A deer was found dead on National Trust land. Some people thought that the wounds that led to the deer's death could have been caused by a big cat such as a black panther.



Samples of DNA from the wounds of this deer were collected.

Investigators used the polymerase chain reaction (PCR) to increase the quantity of DNA in the samples.

(i) Describe how one PCR cycle would increase the quantity of DNA present.

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(ii) One PCR cycle takes two minutes.

Show that the quantity of DNA would have been amplified over one million times after 40 minutes.

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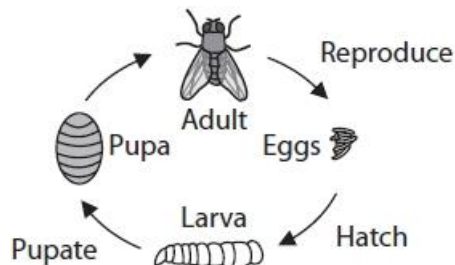
(Total for question = 5 marks)

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Q14.

Blowflies are found in many parts of the world, including Africa.

The diagram shows the life cycle of one species of blowfly (species A) found in Africa.



An investigation was carried out to find the temperature at which 50% of the larvae of this species survive. This investigation was repeated for a further six species of African blowfly larvae, B to G. All other variables were kept constant.

In another investigation, the temperature of sand that the larvae selected when ready to pupate was recorded.

A student used the data from these investigations to find out if there is a statistically significant correlation between the two sets of temperatures.

To do so, a Spearman's rank correlation coefficient can be calculated.

(i) Complete the table to rank all the data and to calculate d and d^2 for species E to G.

(3)

Blowfly species	Mean temperature at which 50% of larvae survive / °C	Rank for mean temperature for 50% larvae survival	Mean temperature of sand selected / °C	Rank for mean temperature of sand selected	Difference in rank (d)	Difference in rank squared (d^2)
A	49.0	5	26.1	7	-2	4
B	47.5	2	23.2	3	-1	1
C	48.5	3	24.7	6	-3	9
D	42.9	1	16.6	1	0	0
E	48.8		23.6			
F	50.1		24.2			
G	49.2		23.1			

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(ii) Calculate the Spearman's rank correlation coefficient (r_s) using the equation:

(3)

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

where $\sum d^2 = 34$ and n is the number of blowfly species.

Answer

(iii) The table shows critical values for r_s .

n	Probability		
	0.10	0.05	0.01
5	0.900	1.000	1.000
6	0.829	0.886	1.000
7	0.714	0.786	0.929
8	0.643	0.738	0.881
9	0.600	0.683	0.833

Deduce whether the data showed a statistically significant correlation.

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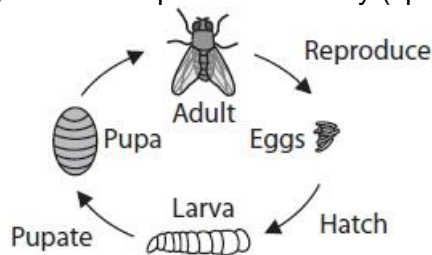
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(Total for question = 8 marks)

Q15.

Blowflies are found in many parts of the world, including Africa. The diagram shows the life cycle of one species of blowfly (species A) found in Africa.



An investigation was carried out to find the temperature at which 50% of the larvae of this species survive. This investigation was repeated for a further six species of African blowfly larvae, B to G. All other variables were kept constant.

In another investigation, the temperature of sand that the larvae selected when ready to pupate was recorded.

A number of observations were made about a dead rhinoceros:

- adults of all seven species of blowfly (A to G) were observed near the rhinoceros
- large numbers of living larvae of species F were present inside the rhinoceros
- mean temperature in this group of larvae was $49 \pm 1.1 \text{ }^\circ\text{C}$
- mean temperature of the air surrounding the rhinoceros was $33 \pm 3.0 \text{ }^\circ\text{C}$.

(i) Determine how the mean temperature of $49 \text{ }^\circ\text{C}$ was found.

(2)

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(ii) It was observed that all the living larvae in the rhinoceros belonged to species F.

The metabolic activity of the larvae of species F increases the temperature within the dead rhinoceros.

Explain the advantages for this species of blowfly of increasing the temperature within the dead rhinoceros.

(3)

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(Total for question = 5 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(i)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> primers have a specific base sequence (1) bind to complementary bases (at either end) of the DNA to be amplified (1) therefore, provide a site for the DNA polymerase to bind (1) 	<p>IGNORE contain complementary bases</p> <p>ALLOW primers attach to the start of the STR sequence</p> <p>ALLOW anneal for bind</p> <p>ALLOW allowing DNA polymerase to create a complementary strand</p>	(2)
Question number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> the base sequences of the alleles are different (1) the restriction enzyme {recognises / cuts} at a specific {site / DNA base sequence} (1) that is only present in the G20210A allele (1) therefore, a shorter fragment is produced for the G20210A allele (1) 	<p>ALLOW they have different numbers of base pairs e.g. wild type 345bp and the G20210A has 322bp</p>	(3)

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Question number	Answer	Additional guidance	Mark
(iii)	<p>An answer that makes reference to four of the following:</p> <ul style="list-style-type: none"> • identify an appropriate reagent to be provided (in excess) (1) • identify appropriate conditions (to control) (1) • change the number of cycles (1) • use gel electrophoresis (to determine quantity of DNA produced) (1) • choose the smallest number of cycles that produces an observable band (1) 	<p>e.g. DNA, polymerase, primers, mononucleotides</p> <p>e.g. temperatures used are 95, 55 and 70°C / duration of steps in cycle</p> <p>ALLOW a description of gel electrophoresis</p> <p>ALLOW choose the number of cycles giving the {thickest / clearest} band</p>	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • at the start of composting the percentage of organic carbon is less and the percentage of nitrogen is more when cow dung is added (1) • adding cow dung does not change the decrease in organic carbon (1) • adding cow dung causes {a slight / no change} to the increase in nitrogen (1) • adding cow dung has no significant effect on composting (of coffee husks) (1) 	<p>e.g. 12.8% and 12.7%</p> <p>e.g. 0.43% compared with 0.47%</p>	3

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Q3.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> • standardisation of pigs studied (1) • named {environmental condition / abiotic factor} controlled (1) • record the presence of different species (of insects) (1) • at regular intervals of time (1) 	<p>e.g. same {size / breed / mass / type / age /sex}</p> <p>ALLOW example of an abiotic factor being monitored such as temperature</p> <p>e.g. every 24 hours, every day, hourly, weekly</p>	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> • record which {insects / species} are present (on the human) (1) • compare with results from investigation (on pigs) to determine time of death (1) • take into account which stages of the lifecycle are present (1) • (when using stage of succession to determine time of death) environmental variables need to be taken into account (1) 		(3)

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Q4.

Question Number	Answer	Additional guidance	Mark
	<p>A description that makes reference to four of the following:</p> <ul style="list-style-type: none"> DNA obtained from the two types of grass snake (1) { PCR / restriction enzymes } used to produce fragments of DNA (1) gel electrophoresis used to analyse the DNA samples (1) (gel electrophoresis) used to separate the fragments of DNA (1) more differences in the pattern of bands produced would indicate that the snakes are different species (1) 	<p>ALLOW produce different length sections of DNA or target regions of DNA</p> <p>ALLOW description of gel electrophoresis e.g. use of agarose gel and electric current</p> <p>ALLOW similar patterns in the bands would indicate they are the same species</p>	(4)

Q5.

Question Number	Answer	Additional guidance	Mark
	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> (body) temperature falls (1) rigor mortis / stiffening of the muscles (1) autolysis / break down of cells by enzymes in the body (1) putrefaction / discolouration / bloating (1) 	<p>ALLOW algor mortis</p> <p>ALLOW breakdown of tissues by enzymes</p> <p>ALLOW accumulation of gases</p>	(3)

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Q6.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that makes reference to two of the following:</p> <ul style="list-style-type: none"> decomposers break down organic material (from the dead body) (decomposers) respire releasing carbon dioxide (into the atmosphere) 	<p>ALLOW organic molecules / named organic molecule / organic compounds</p> <p>ALLOW respiration takes place</p> <p>ALLOW methane in context of anaerobic respiration</p>	(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> 66 	ALLOW 67	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> correct values taken from the graph correct rate calculated from figures used from graph 	<p><u>Example of calculation</u></p> <p>$(12 - 6.8) \div (90 - 60) =$ or $5.2 \div 30 =$</p> <p>ALLOW 5.0, 5.1 or 5.2</p> <p>0.17 (mm hour⁻¹)</p> <p>(0.1667 or 0.167 – one mark only)</p> <p>Correct answer without working gains full marks</p>	(2)

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Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> temperature affects {enzymes / metabolism / reactions} an increase in temperature increases kinetic energy producing more (frequent) collisions between enzyme and substrate (molecules) (1) 	<p>ALLOW protein synthesis / cell division</p> <p>ALLOW converse statement for temperature decrease</p> <p>ALLOW more (frequent) formation enzyme-substrate complexes</p>	(3)

Q8.

Question Number	Answer	Mark
	<p>The only correct answer is B polymerase chain reaction</p> <p><i>A is not correct because it is not profiling</i></p> <p><i>C is not correct because it is not RNA</i></p> <p><i>D is not correct because it is not translation</i></p>	(1)

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Q9.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to four of the following</p> <ul style="list-style-type: none"> • restriction { enzymes / endonucleases } used to cut DNA (from modern humans and Neanderthals) into fragments (1) • DNA samples are loaded onto (agarose) gel (1) • {electric current is passed through / potential difference is applied across} the gel (1) • markers are added to visualise the bands (1) • the position of the bands produced can be compared (1) 	<p>ALLOW use of fluorescent dyes</p>	(4)

Q10.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to five of the following:</p> <ul style="list-style-type: none"> • detail of loading of electrophoresis tank (1) • { current / potential difference } applied across the gel (1) • use { gene probe / DNA stain } (1) • use of { STRs / DNA } of black panther (1) • compare { bands / DNA profiles } (1) • a match would indicate that (DNA from) a black panther was present (1) 	<p>e.g. use of agarose gel, use of a buffer, sample placed in wells</p> <p>ALLOW voltage</p> <p>e.g. fluorescent dye, methylene blue, iodine or ethidium bromide</p> <p>ALLOW reference to Southern blot technique</p> <p>ALLOW compare lines</p>	(5)

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Q11.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to the following</p> <ul style="list-style-type: none"> • an increase in temperature will increase the rate of { decomposition / decay } (1) • (an increase in temperature) increases enzyme activity (1) • an increase in temperature increases growth rate of {bacteria / fungi / decomposers} (1) 	<p>ALLOW converse for all points for the effects of a decrease in temperature</p> <p>ALLOW high temperatures may denature enzymes and decrease rate of decomposition</p> <p>ALLOW increases rate of multiplication</p>	(3)

Q12.

Question Number	Answer	Mark
(i)	<p>The only correct answer is C – polynucleotides and phospholipids</p> <p><i>A is incorrect because phosphate is not in cellulose</i></p> <p><i>B is incorrect because polysaccharides do not contain phosphate</i></p> <p><i>D is incorrect because phosphate is not in polysaccharides</i></p>	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to three of the following</p> <ul style="list-style-type: none"> • the stems contain starch or cellulose(1) • enzymes are { secreted / released } by the microorganisms (1) • which break down the glycosidic bonds(1) • which releases glucose that is used by the microorganisms in respiration (1) 	<p>ALLOW lignin</p> <p>ALLOW enzymes from microorganisms digest(starch/ cellulose)</p>	(3)

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Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> • heat to 90-98°C { to break hydrogen bonds between (DNA) strands / separate the strands of DNA} (1) • { joining of primers / annealing } at 50- 75°C (1) • { elongating / extension / addition of nucleotides } / DNA polymerase involved in formation of phosphodiester bonds (1) • to double the quantity (of the DNA) (1) 	<p>ALLOW heating to 90-98°C to break hydrogen bonds or to unzip DNA or to denature the DNA</p> <p>ALLOW 'binding/aligning' for joining</p> <p>ALLOW description of production of complementary strands of DNA ALLOW taq polymerase</p> <p>ALLOW replication for doubling</p>	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> • calculation correct • correct answer provided (1) 	<p><u>Example of calculation</u></p> <p>2^{20}</p> <p>1 048 576 (> 1 000 000) or 1.05×10^6</p> <p>Correct answer without working scores full marks</p>	(2)

Q14.

Question Number	Answer	Additional Guidance	Mark																					
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • correct ranking for both columns (1) • correct difference in rank (1) • correct difference squared (1) 	<table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td>E</td> <td>48.8</td> <td>4</td> <td>23.6</td> <td>4</td> <td>0</td> <td>0</td> </tr> <tr> <td>F</td> <td>50.1</td> <td>7</td> <td>24.2</td> <td>5</td> <td>2</td> <td>4</td> </tr> <tr> <td>G</td> <td>49.2</td> <td>6</td> <td>23.1</td> <td>2</td> <td>4</td> <td>16</td> </tr> </tbody> </table> <p>-2 and -4 are incorrect differences in rank</p>	E	48.8	4	23.6	4	0	0	F	50.1	7	24.2	5	2	4	G	49.2	6	23.1	2	4	16	(3)
E	48.8	4	23.6	4	0	0																		
F	50.1	7	24.2	5	2	4																		
G	49.2	6	23.1	2	4	16																		

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Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> • numerator (top line of formula) correctly calculated (1) • denominator (bottom line of formula) correctly calculated (1) • correct answer (1) 	<p>Example of calculation</p> <p>6 x 34 or 204</p> <p>7 x 48 or 336</p> <p>0.3929 / 0.393 / 0.39 Correct answer with no working scores full marks</p>	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • no (significant) correlation (1) • as the calculated figure is less than { 0.786 / the critical value for p= 0.05 } (1) 	<p>ALLOW not statistically significant</p> <p>ECF - ALLOW significant correlation if the value calculated for 3a_{ii} is greater than { cv for 0.05 / 0.786 }</p> <p>ALLOW 5% FOR 0.05</p> <p>ECF- ALLOW calculated value is greater than the cv if the value calculated for 3a_{ii} is greater than 0.786</p>	(2)

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • measure temperature from { several readings / random positions } (within the group of larvae) (1) • description of how mean calculated (1) 	<p>ALLOW stated number of measurements</p> <p>e.g. readings summated and answer divided by number of readings taken</p> <p>ALLOW 'average' for mean</p>	(2)

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Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • increases enzyme activity for (larvae / species F) (1) • high temperature { kills / denatures enzymes of } other species (1) • (high temperature) increases food availability by { reducing competition from other species / increasing rate of decomposition of rhino } (1) 	<p>ALLOW description of increase in activity including maximizes rate of growth/digestion, shorter lifecycle IGNORE ref to metabolic activity unqualified</p> <p>ALLOW outcompetes other {species / larvae} for food</p>	(3)