Q1.

DCMU is a herbicide that can disrupt one of the carrier proteins in the electron transport chain of chloroplasts.

A student carried out an investigation to study the effect of DCMU concentration on the Hill reaction.

The student ground up some spinach leaves in an isolation mixture containing sucrose solution at a concentration of 0.4 mol dm^{-3}. The mixture was filtered and then spun in a centrifuge. The chloroplasts were extracted.

These chloroplasts were divided equally into eight different tubes containing a solution of distilled water, DCPIP and a buffer.

A small volume of DCMU was added to each tube and the time taken for the blue DCPIP to decolourise was recorded.

(b) The time taken for the DCPIP to decolourise was converted to a rate of colour change. The results are shown in the table.

Concentration of DCMU / $\mu mol\ dm^{-3}$	Rate of colour change / $\times 10^{-4}\ s^{-1}$
0	23.5
1	12.5
2	6.3
3	4.2
4	3.2
5	2.6
6	2.2
7	2.3

(i) Analyse the data to deduce a null hypothesis for this investigation.

(1)

_____

_____

_____

(ii) The student started to analyse the data using a statistical test, called the Spearman's rank correlation coefficient (r_s), to see if there was a correlation.

Complete the table by filling in the empty boxes.

(1)

Concentration of DCMU / mol dm^{-3}	Concentration ranked (R_1)	Rate of colour change / 10^{-4} s^{-1}	Rate ranked (R_2)	Difference in ranks d (R_1–R_2)	Difference squared d^2
0	1	23.5	8		
1	2	12.5	7	5	25
2	3	6.3	6	3	9
3	4	4.2	5	1	1
4	5	3.2	4	1	1
5	6	2.6	3	3	9
6	7	2.2	1	6	36
7	8	2.3	2	6	36

(iii) Calculate r_s by using the equation.

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

Where $\Sigma(d^2)$ is the sum of all the values for d^2 and n is the number of pairs of data.

(3)

r_s = ...

(iv) The table shows some of the critical values for the Spearman's rank correlation coefficient.

Number of pairs of data (n)	p value			
	0.10	**0.05**	**0.02**	**0.01**
6	0.829	0.866	0.943	1.000
8	0.643	0.786	0.833	0.881
10	0.564	0.648	0.746	0.794
12	0.506	0.591	0.712	0.777
14	0.456	0.544	0.645	0.715
16	0.425	0.506	0.601	0.665
18	0.399	0.475	0.564	0.625

Explain the outcome of the statistical test.

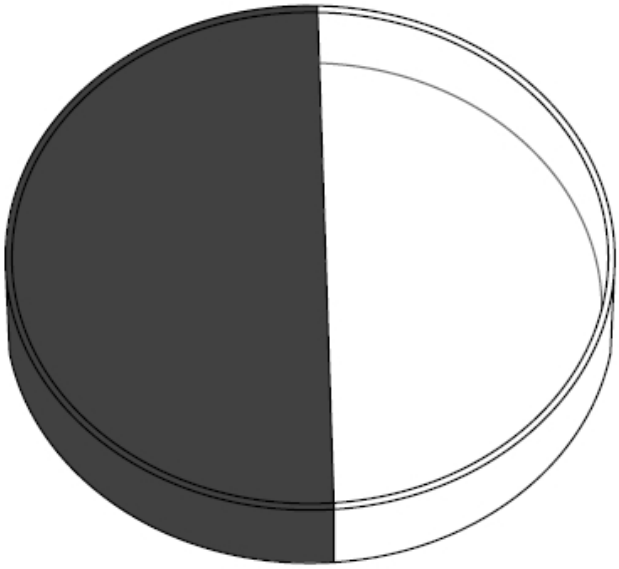
(3)

(Total for question = 8 marks)

Q2.

Blowfly larvae can be used by a forensic scientist to help determine the time of death of a body.

The diagram shows a Petri dish used by a student to investigate whether young and old blowfly larvae show a preference for light or dark conditions.



In the first trial, the left side was dark and the right side was light.

Five blowfly larvae were added to each side of the chamber.

After five minutes, the number of larvae on each side of the Petri dish was recorded.

In the second trial, the same experiment was repeated but this time the right side was dark and the left side was light.

The table shows the results of the trials.

Trial	Number of young blowfly larvae		Number of old blowfly larvae	
	Left side dark	Right side light	Left side dark	Right side light
1	9	1	2	8
2	2	8	9	1

(a) Give a null hypothesis for this investigation.

(1)

_____

_____

(b) The Chi squared test can be used to determine whether the results of this investigation indicate a significant difference in the distribution of young larvae between the light and the dark side.

(i) Use the formula to calculate the Chi-squared value for young larvae.

(3)

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

Answer .....

(ii) The table below gives some critical values for Chi-squared.

p value			
0.15	0.1	0.05	0.025
2.07	2.71	3.84	5.02

Use your calculated value to determine whether the difference between the observed and expected results is significant.

(1)

_____

_____

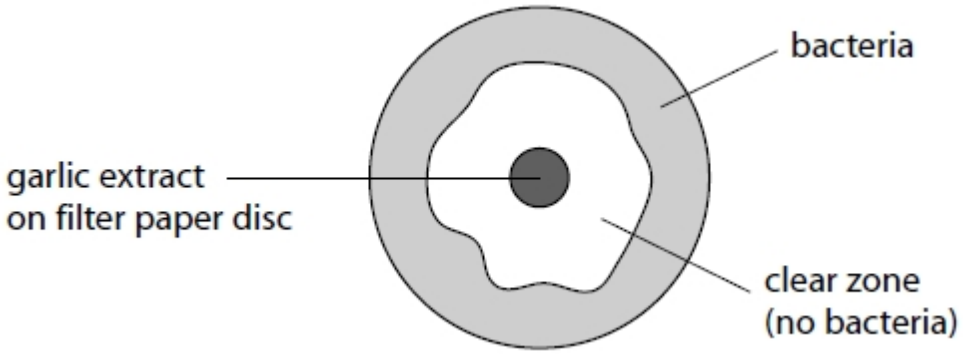
(Total for question = 5 marks)

Q3.

A student carried out an investigation to compare the antibacterial effect of a garlic extract with that of three antibiotics, all at the same concentration.

To obtain the extract, a clove of garlic was cut into lots of small pieces and soaked in 0.1% ethanol for a long time.

The diagram shows the effect of the garlic extract on bacteria growing on an agar plate.



(b) The results of the investigation are shown in the table.

Sample number	Estimated area of clear zone / mm²			
	Antibiotics			Plant extract
	Chloramphenicol	Tetracycline	Streptomycin	Garlic
1	28	16	15	20
2	26	19	13	28
3	29	11	14	18
4	28	21	12	25
5	26	7	14	27
6	29	11	15	26
7	22	8	9	25
8	25	21	14	25
9	29	10	12	29
Mean	27	14	13	25
Standard deviation	2.37	5.54	1.90	3.60

These data were analysed using *t*-tests.
(i) Several statistical tests were available to the student to analyse these data, including the *t*-test, Chi squared and the correlation coefficient.

Explain why the *t*-test was chosen to analyse these data, rather than the other two tests.

(3)

_____

_____

_____

_____

_____

_____

(ii) Calculate the *t* value for the data to compare garlic with chloramphenicol, using the formula:

$$t = \frac{\left|\overline{x}^1 - \overline{x}^2\right|}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

(3)

Answer .....

(iii) The table shows the critical values of t with 16 degrees of freedom.

Significance level (p)	0.20	0.10	0.05	0.01	0.001
Critical value of t	1.34	1.75	2.12	2.92	4.02

Use your value of t to test the validity of a stated null hypothesis.

(4)

(Total for question = 10 marks)

Q4.

A student investigated the effect of salt concentration on the growth of one species of brine shrimp.

The student placed 100 shrimp eggs in a beaker containing 1dm^3 of 3% salt solution. Three days after the eggs hatched, 10 shrimps were collected and their lengths measured. Seven days after hatching, another 10 shrimps were collected and their lengths measured.

The procedure was repeated using a 5% salt solution. All other variables were kept constant.

The results are shown in the table.

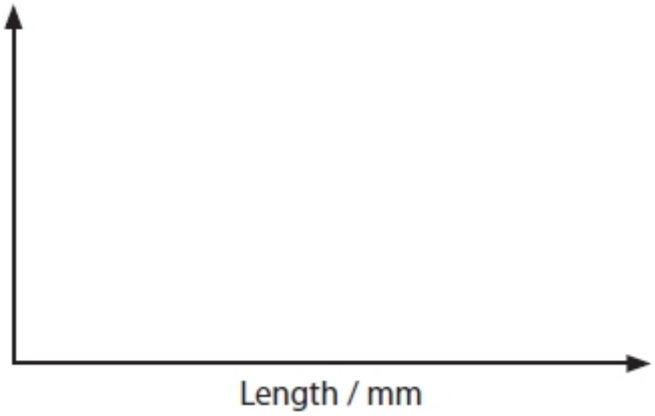
Specimen number	Length of specimen in 3% salt solution / mm		Length of specimen in 5% salt solution / mm	
	3 days after hatching	7 days after hatching	3 days after hatching	7 days after hatching
1	0.75	1.00	0.75	0.98
2	0.78	1.25	0.73	0.95
3	0.66	1.10	0.61	0.93
4	0.73	1.03	0.63	0.83
5	0.85	1.15	0.53	0.98
6	0.78	1.08	0.60	1.08
7	0.90	1.13	0.52	0.95
8	0.90	1.05	0.81	1.03
9	0.80	1.18	0.58	0.88
10	0.85	1.05	0.68	0.88
Mean	0.800	1.102		0.949

The student carried out a statistical test to see if there was a significant difference between the mean lengths of brine shrimps in these two salt solutions. The student used the 7 days after hatching data.

The student selected the *t*-test because the data are normally distributed.

(i) Draw a line on the graph to show a normal distribution for a population of brine shrimp.

(1)



(ii) Complete the table by filling in the missing value for specimen 7 and then calculate the value for Σx_1^2

(1)

Specimen number (n)	3% salt solution		5% salt solution	
	Length of specimen (x_1)	Square of length of specimen (x_1^2)	Length of specimen (x_2)	Square of length of specimen (x_2^2)
1	1.00	1.000	0.98	0.960
2	1.25	1.563	0.95	0.903
3	1.10	1.210	0.93	0.865
4	1.03	1.061	0.83	0.689
5	1.15	1.323	0.98	0.960
6	1.08	1.166	1.08	1.166
7	1.13	.....	0.95	0.903
8	1.05	1.103	1.03	1.061
9	1.18	1.392	0.88	0.774
10	1.05	1.103	0.88	0.774
Sum (Σ)	$\Sigma x_1 = 11.020$	$\Sigma x_1^2 =$	$\Sigma x_2 = 9.490$	$\Sigma x_2^2 = 9.055$
Mean	$\bar{x}_1 = 1.102$		$\bar{x}_2 = 0.949$	

(iii) The variances are used in the calculation of a *t*-value.

The variance for the 3% salt solution $S_1^2 = 0.0059$.

Calculate the variance for the 5% salt solution (S_2^2) using the formula

$$S_2^2 = \frac{\Sigma x_2^2 - \frac{(\Sigma x_2)^2}{n}}{n-1}$$

n = the number of specimens

(2)

S_2^2 .....

(iv) Calculate the *t*-value using the formula.

Give your answer to an appropriate number of significant figures.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(3)

t = ...

(v) The calculated *t*-value is greater than the critical value at $p = 0.05$.

Describe what this result indicates about the effect of salt concentration on the length of brine shrimp.

(2)

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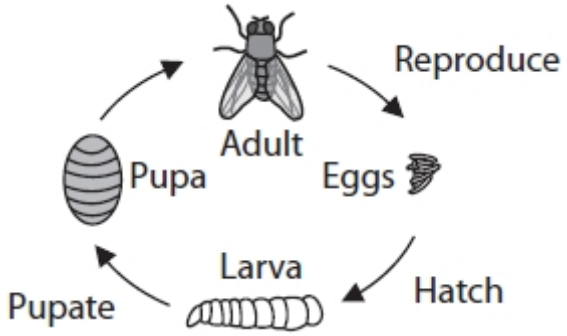
(Total for question = 9 marks)

Q5.

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			

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

(3)

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

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

Answer .....

(iii) The table shows critical values for r_s.

	Probability		
n	**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.

(2)

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_____

(Total for question = 8 marks)

Q6.

Scientists measured the mean amino acid concentration in white wines made from grapes grown organically and white wines made from grapes that were not grown organically.

(a) The scientists used a statistical test to determine whether there was a significant difference in the amino acid concentration in the two types of white wine. They obtained a value for P of 0.04.

Name the statistical test the scientists used and give a reason for your answer.

Was the difference significant? Give a reason for your answer.

Name of statistical test _____

Reason for choice _____

_____

_____

Explanation of test result _____

_____

_____

_____

_____

_____

(3)
(Total 3 marks)

Q7.

Detritivorous insects feed on the dead remains of plants. Some students estimated the numbers of detritivorous insects at two different sites in an ecosystem. They also obtained data about the net primary production of the sites to see if this influenced the numbers of insects present. Net primary production is a measure of plant biomass formed per year. The results are shown in the table.

Site	Number of insects per m^2	Net primary production / g m^{-2} y^{-1}
A	316	1440
B	90	550

(a) The students used the chi-squared (χ^2) test to test the hypothesis that there was no significant difference between the numbers of insects per square metre at sites **A** and **B**. The value they obtained was 125.8. They checked this value in χ^2 tables.

(i) How many degrees of freedom should they check against?

_____

(1)

(ii) What level of probability is normally used to judge whether a difference is statistically significant?

_____

(1)

(iii) The value of χ^2 for the 0.001 level of probability for this number of degrees of freedom is 10.8. What does the value obtained by the students suggest about the difference in numbers of the insects per square metre between the two sites?

Explain your answer.

_____

_____

_____

_____

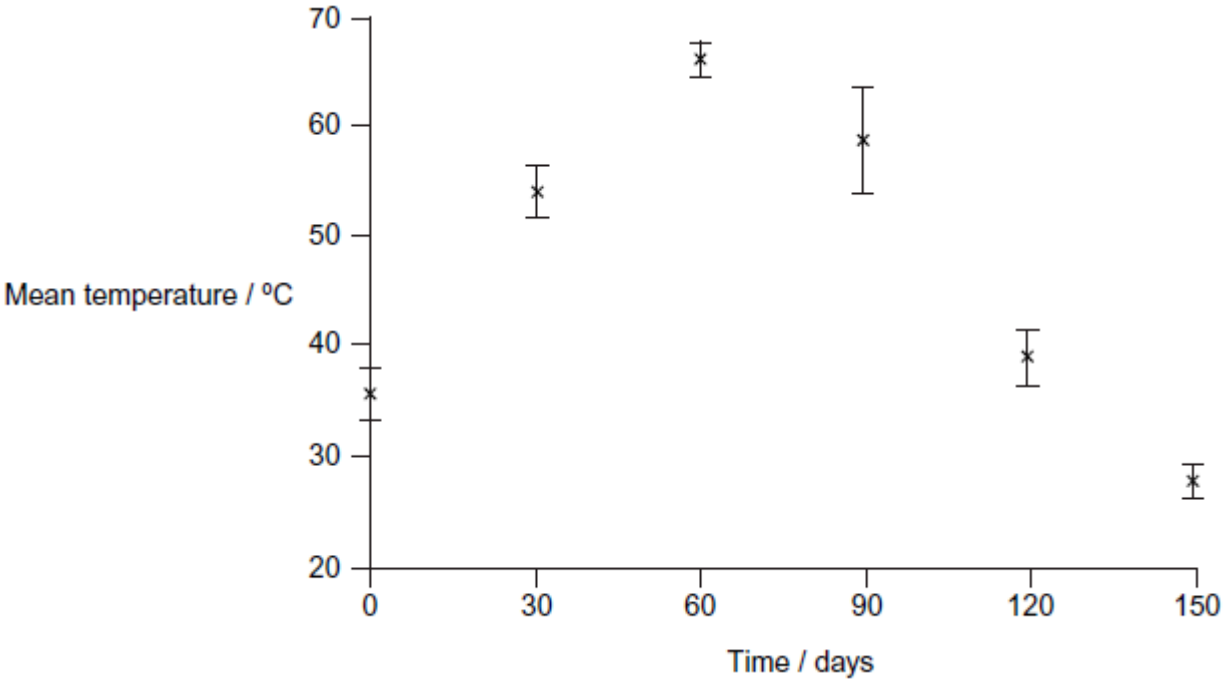
(2)

(b) The organic material in household waste can be used to make compost for use as a fertiliser.

Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 1 shows the results they obtained. The vertical bars show standard deviations.

Figure 1



Explain the advantage of showing the data using standard deviations rather than ranges.

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_____

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_____

(2)

(Total 6 marks)

Q8.

(a) In mice, two genes affecting coat colour are on different chromosomes.
One gene controls whether there is any black pigment in the hairs. The dominant allele of this gene, **B**, results in black fur. The recessive allele, **b**, results in white fur. The second gene controls banding of the fur. The dominant allele, **A**, causes a yellow band to develop on each hair. The resulting coat colour is called agouti. The recessive allele, **a**, results in hairs with no bands on them. This gene has no effect on mice with white fur; white mice do not develop bands, even if they have the **A** allele.

Breeders performed many crosses in which agouti mice were crossed with white mice, homozygous for both genes. They expected agouti, black and white mice in the offspring in a 1 : 1 : 2 ratio.

(i) The actual numbers of offspring with each phenotype were

Agouti	34
Black	35
White	51

The X^2 test can be used to test the hypothesis that there is no significant difference between these results and the expected 1 : 1 : 2 ratio. Complete the table to calculate the value of X^2 for these results.

Colour of offspring	**Observed (O)**	**Expected (E)**	**(O - E)**	**$(O - E)^2$**	$\frac{(O-E)^2}{E}$
Agouti	34				
Black	35				
White	51				
			$\Sigma \frac{(O-E)^2}{E}$ =		

(2)

(ii) The table shows values for X^2 at different levels of probability and for different degrees of freedom.

Degrees of freedom	Probability, p				
	0.2	**0.1**	**0.05**	**0.02**	**0.01**
1	1.64	2.71	3.84	5.41	6.64
2	3.22	4.61	5.99	7.82	9.21
3	4.64	6.25	7.82	9.84	11.35
4	5.99	7.78	9.49	11.67	13.28
5	7.29	9.24	11.07	13.39	15.09

What should the breeders conclude about the significance of their results? Explain your answer.

_____

_____

_____

_____

_____

_____

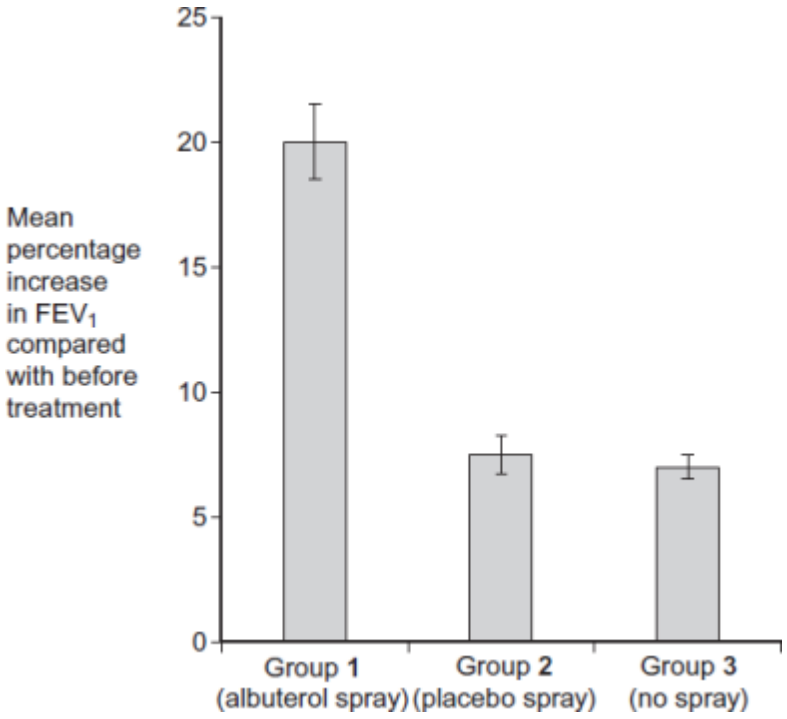
(3)
(Total 5 marks)

Q9.

The 'placebo effect' describes the improvement in patients' symptoms due to psychological effects. Scientists investigated the placebo effect in patients with asthma. They divided a large number of asthma patients into three groups, **1**, **2** and **3**.

- Group 1 inhaled a spray containing albuterol every day. Albuterol is a drug used to treat asthma.
- Group 2 inhaled a placebo spray every day. This was identical to the spray given to group 1 but it did not contain albuterol.
- Group 3 did not receive any spray treatment.

The scientists measured the forced expiratory volume (FEV_1) of each patient at regular intervals. The forced expiratory volume (FEV_1) is the volume of air forced out of the lungs in the first second when breathing out. The scientists recorded each patient's FEV_1 before treatment started and after 60 days of treatment. They then calculated the mean increase in FEV_1 for each group. Their results are shown in the graph. The bars show the standard deviation.



(a) What do the standard deviation bars suggest about the difference in the mean increase in FEV_1 between Group **1** and the other groups? Explain your answer.

_____

_____

_____

_____

_____

(2)

(b) What do the data suggest about the 'placebo effect' in this investigation? Explain your answer.

_____

_____

_____

_____

_____

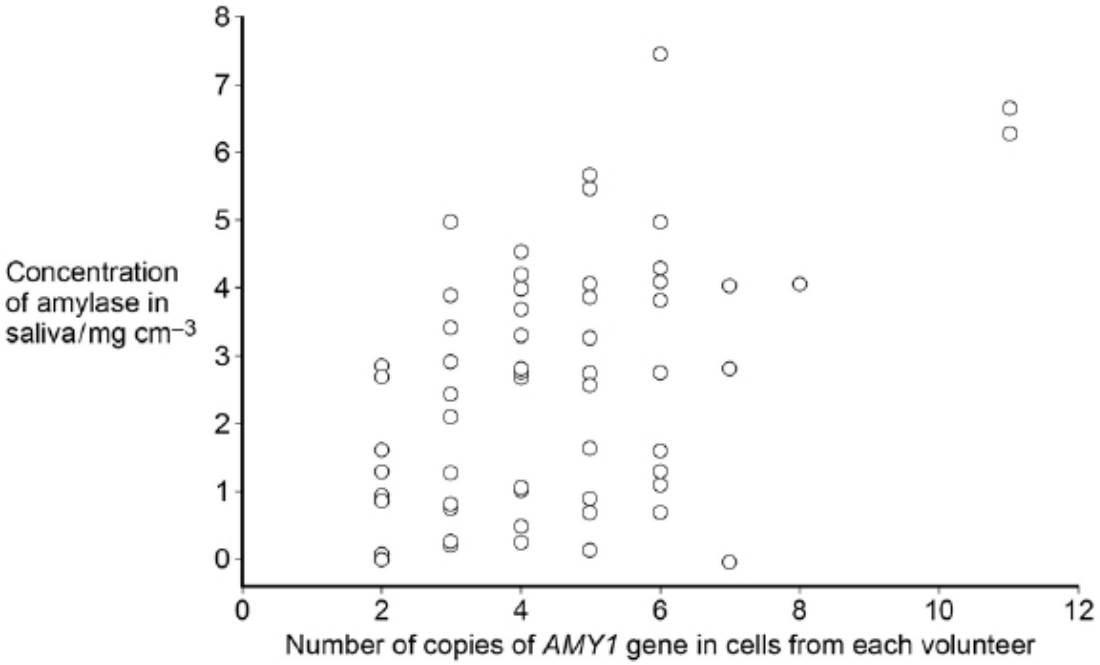
(2)
(Total 4 marks)

Q10.

The saliva of most humans contains α-amylase. The gene encoding α-amylase is called *AMY1*; it is located on chromosome 1.

As a result of mutation, humans might have more than one copy of the *AMY1* gene on one, or both, of their copies of chromosome 1. A team of scientists investigated whether the number of copies of the *AMY1* gene was associated with the concentration of α-amylase in the saliva of 58 human volunteers.

The graph shows their results. Each circle represents one volunteer.



(a) What was the range in the number of copies of the *AMY1* gene?

_____

(1)

(b) The scientists found the mean number of copies of gene *AMY1* was 4.4 genes per person.

Four values of the standard deviation of this mean are given below.
Estimate which of the four values for the standard deviation is most likely for this mean.
Indicate your choice by placing a tick in the appropriate box.

Use evidence from the graph to justify your answer.

☐ ± 0.002 ☐ ± 0.02 ☐ ± 0.20 ☐ ± 2.00

Justification_____

_____

_____

_____

(2)

(c) The scientists calculated a correlation coefficient, R, from their data.
They found R = 0.50, with P <0.0001

Explain the meaning of the result of their calculations.

_____

_____

_____

_____

_____

_____

_____

_____

(3)
(Total 6 marks)

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	There is no correlation between the concentration of DCMU and the rate of DCPIP colour change		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	7 and 49		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(iii)	• Correct calculation of numerator (1) • Correct calculation of denominator (1) • Correct calculation of correlation coefficient (1)	Example of calculation: $(\Sigma d^2 = 996) \div (n(n^2-1) = 504)$ $= (-) 0.976$ Allow all marks for correct answer with no working	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(iv)	An explanation that makes reference to the following: • Selection of appropriate critical value from the table (1) • calculated value is greater (than critical value) (1) • Can reject the null hypothesis / correlation is significant (1)	0.786 , 0.833 , 0.881	**(3)**

Q2.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	larvae show no significant preference for light over dark side (1)	Allow vice versa Must have NO in hypothesis.	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	calculation of expected frequency 10 and 10 (1) $(O-E)^2/E$ for both light and dark sides $49 \div 10 = 4.9$ (1) sum = 9.8 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	An answer that makes reference to the following: • higher than 3.84 therefore Chi square value as high as 9.8 arise by chance alone less than 1 in 20 / 0.05 therefore there is a significant difference (1)	allow ECF for incorrect value of Chi allow converse if calculated of Chi is lower than 3.84	**(1)**

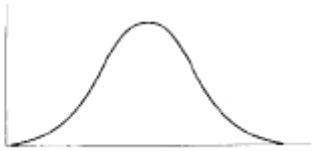
Q3.

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: • the *t*-test assess the significance of the difference between the means of the two treatments (1) • Chi squared not appropriate because there are no expected values (1) • correlation coefficient not appropriate because the independent variable is discontinuous / not continuous (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	$2.37^2 \div 9 = 0.62$ and $3.60^2 \div 9 = 1.44$ (1) $\sqrt{(0.62 + 1.44)} = 1.44$ (1) $(27 - 25) \div 1.44 = t = 1.39$ (1)	Correct answer gains full marks	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to the following: • there is no significant difference between the clear area caused by garlic compared with that caused by chloramphenicol (1) • $p > 0.05$ (1) • difference due to chance (1) • therefore accept null hypothesis (1)	Allow marking points for the calculated value of *t* from the candidate	**(4)**

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	• (symmetrical) bell-shaped curve drawn **(1)**		**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• specimen 7 = 1.277 **AND** $\Sigma x_1^2 = 12.198$ **(1)**		**(1)**

Question Number	Answer	Additional Guidance	Mark
(iii)	• Top line of formula correctly calculated **(1)** • correct answer to two significance figures **(1)**	<u>Example of calculation</u> 9.055 – 9.006 = 0.0054 / 0.00544 / 5.4×10^{-3}	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iv)	• top line of formula correctly calculated **(1)** • bottom line of formula correctly calculated **(1)** • correct answer to between three and five significant figures **(1)**	<u>Example of calculation</u> 0.153 0.0336 (0R 0.0337 if 0.00544 used) = 4.55 (OR 4.54 if 0.00544 used) ALLOW answer between 4.5510 and 4.5540 Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
(v)	An explanation that makes reference to the following: • there was a significant difference between {the 3% and the 5% salt solution / groups} **(1)** • at the 5% significance level **(1)**	IGNORE significant correlation / significant relationship ALLOW 95% probability there is a difference e.g. '5% chance that the difference is due to chance' or with 95% certainty' IGNORE p = 0.05	**(2)**

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • correct ranking for both columns (1) • correct difference in rank (1) • correct difference squared (1)	<table><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></table> -2 and -4 are incorrect differences in rank	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	• numerator (top line of formula) correctly calculated (1) • denominator (bottom line of formula) correctly calculated (1) • correct answer (1)	Example of calculation 6 x 34 or 204 7 x 48 or 336 0.3929 / 0.393 / 0.39 Correct answer with no working scores full marks	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: • no (significant) correlation (1) • as the calculated figure is less than { 0.786 / the critical value for p= 0.05 } (1)	ALLOW not statistically significant ECF - ALLOW significant correlation if the value calculated for 3aii is greater than { cv for 0.05 / 0.786 } ALLOW 5% FOR 0.05 ECF- ALLOW calculated value is greater than the cv if the value calculated for 3aii is greater than 0.786	(2)

Q6.

(a) Choice: (Student's) *t*-test;
Reason for choice: Looking for differences between two means;
Reason: Allow comparing contrasting two means

Explanation: Difference is significant / not due to chance because the P value is 0.04 / is less than 0.05;
Explanation: Assume 'it' means difference
Explanation: Reject result / data is significant / not due to chance
Explanation: do not accept P value is less than 0.04

3

[3]

Q7.

(a) (i) 1;

1

(ii) (p =) 0.05 / 5%;
(ignore 95%)

1

(iii) value for χ^2 exceeds critical value / 125.8 > 10.8 ;
Results unlikely to be due to chance / have a biological cause;
P < 0.1% / < 5% ;

2 max

(b) 1. SD is spread of data around the mean;
Accept: variation around the mean.
*Accept: range is difference between highest and lowest values/extremes **or** range includes anomalies/outliers.*
2. (SD) reduces effect of anomalies/ outliers;
Reject: (SD) removes anomalies/outliers.
3. (SD) can be used to determine if (difference in results is) significant/not significant/due to chance /not due to chance;
Ignore: reliability/accuracy/validity.

2 max

[6]

Q8.

(a)

(i)

Colour of offspring	*Observed (O)*	*Expected (E)*	*(O-E)*	*$(O-E)^2$*	*$\frac{(O-E)^2}{E}$*
Agouti	34	30	4	16	0.53
Black	35	30	5	25	0.83
White	51	60	9	81	1.35
			$\Sigma \frac{(O-E)^2}{E}$ = **2.71 or 2.72**		

;; 2

(χ^2 correct = 2 marks)
($(O-E)^2$ all correct = 1 mark)

(ii) p = 0.05;
2 degrees of freedom;
Differences due to chance / no significant difference as χ^2 less than / to left of critical value OR Not due to chance / difference is significant as χ^2 greater than to right of critical value;
(as appropriate for candidates χ^2)

3

[5]

Q9.

(a) 1. (Differences) are real / significant / not due to chance;
It = the difference

2. (As) bars / SDs do not overlap;
2. Accept: 'standard errors do not overlap' as told 'standard deviation' in the question stem

2

(b) 1. No / slight (placebo) effect;

2. Group **2** and **3** results are similar / the same / SDs / bars overlap;
*2. Accept: other descriptions of Groups **2** and **3***
*2. Accept: that Groups **2** and **3** are not significantly different*

2

[4]

Q10.

(a) 2 to 11;

1

(b) ± 2.0;

Data show great variation (around mean)
OR
4.4 ± 2 × SD includes most of the values measured.

2

(c) 1. Shows a positive correlation;

2. Their probability of getting this correlation by chance is less than 0.0001;
Allow less than 0.01%

3. Correlation is highly significant.
Reject 'results' are significant / not due to chance

3

[6]