0 3 . 1 In fruit flies, the genes for body colour and wing length are linked. Explain what this means.

[1 mark]

A scientist investigated linkage between the genes for body colour and wing length. He carried out crosses between fruit flies with grey bodies and long wings and fruit flies with black bodies and short wings.

Figure 2 shows his crosses and the results.

- **G** represents the dominant allele for grey body and **g** represents the recessive allele for black body.
- **N** represents the dominant allele for long wings and **n** represents the recessive allele for short wings.

Figure 2

Phenotype of parents	grey body, long wings	×	black body, short wings
Genotype of parents	**GGNN**		**ggnn**
Genotype of offspring	**GgNn**		
Phenotype of offspring	all grey body, long wings		

These offspring were crossed with flies homozygous for black body and short wings.

The scientist's results are shown in **Figure 3**.

Figure 3

GgNn crossed with **ggnn**

	Grey body, long wings	**Black body, short wings**	**Grey body, short wings**	**Black body, long wings**
Number of offspring	975	963	186	194

0 3 . 2 Use your knowledge of gene linkage to explain these results.

[4 marks]

[Extra space]

0 3 . 3 If these genes were **not** linked, what ratio of phenotypes would the scientist have expected to obtain in the offspring?

[1 mark]

0 3 . 4 Which statistical test could the scientist use to determine whether his observed results were significantly different from the expected results?

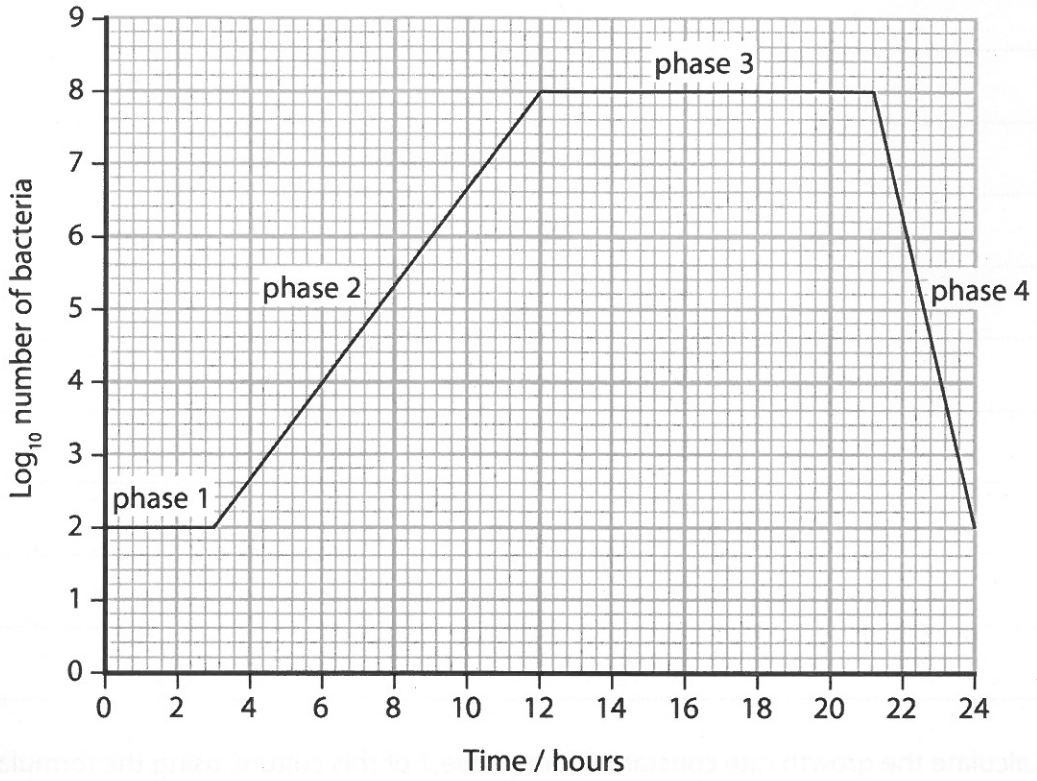
Give the reason for your choice of statistical test.

[2 marks]

8 A broth culture for growing bacteria was set up.

Dilution plating was used to determine the number of live bacteria in the culture over a period of 24 hours.

The graph below shows the number of live bacteria in the culture during this 24-hour period.



(a) Which is the correct order of the phases 1 to 4 shown on the graph?

(1)

- ☒ **A** lag, log, death, stationary
- ☒ **B** lag, log, stationary, death
- ☒ **C** log, lag, death, stationary
- ☒ **D** log, lag, stationary, death

*(b) Evaluate the use of dilution plating and optical methods for determining the number of bacterial cells in a culture.

(6)

(c) Calculate the growth rate constant (k) for phase 2 of this culture, using the formula:

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(4)

Answer .....

(Total for Question 8 = 11 marks)

32 The control of growth in plants is achieved by plant hormones. Plant hormones can be produced in the locations where they have their effects or they can be transported from the regions where they are synthesised to the regions where they have their effects.

(a) Suggest how the plant hormone gibberellic acid (gibberellin) is transported in plants.

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.....**[1]**

An experiment was carried out into the role of plant hormones in germination. The experiment was carried out on winter barley seeds.

Four sterile starch agar plates were prepared containing the following solutions:
Plate 1 – distilled water
Plate 2 – gibberellic acid (GA) solution
Plate 3 – abscisic acid (ABA) solution
Plate 4 – GA and ABA solution

Winter barley grains were soaked for 24 hours and then cut in half as shown in **Fig. 32.1**.

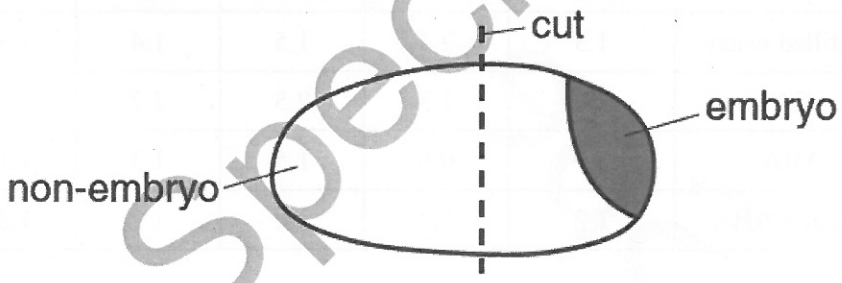

Fig. 32.1

Four non-embryo halves were placed cut side down onto each of the agar plates.

The plates were incubated at 20°C.

After incubation, iodine solution was added to each plate. The appearance of a plate after adding iodine solution is shown in **Fig. 32.2**.

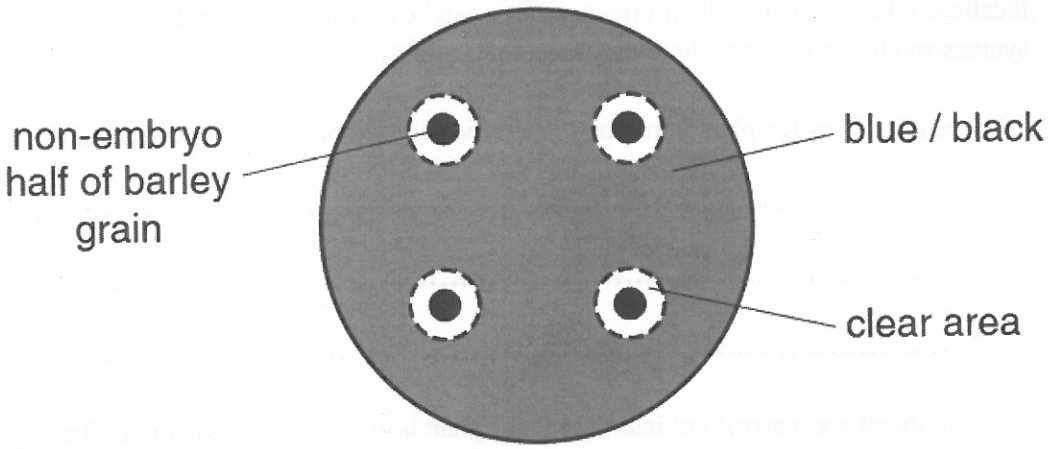

Fig. 32.2

The maximum diameter of the clear area surrounding each halved seed was recorded.

The results are shown in **Table 32.1**.

Agar plate		Maximum diameter of the clear area surrounding halved seed (cm)					
		Halved seed 1	Halved seed 2	Halved seed 3	Halved seed 4	Mean	Standard deviation
1	Distilled water	1.5	2.4	1.5	1.4	1.7	0.47
2	GA	2.0	1.3	2.5	2.2	2.0	
3	ABA	0.9	0.8	1.5	1.3	1.1	0.32
4	GA and ABA	1.2	1.2	1.0	1.2	1.2	0.10

Table 32.1

(b) Using the information in **Table 32.1**, calculate the standard deviation (s) for the data from plate **2** (GA).

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

standard deviation = ... **[2]**

(c)* Evaluate the role of GA and ABA in the control of germination as shown by the results of the experiment in Fig 32.2 and Table 32.1.

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..... **[6]**

(d) The seeds used in the experiment were a variety of winter barley.

Suggest one treatment that would need to be carried out on the germinated seedlings in order to ensure a grain harvest from the matured plants.

Explain your suggestion.

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..... **[2]**

23 Different models can be used to investigate factors that affect the rate of diffusion of molecules into and out of cells.

Beetroot cells are a useful model for investigating the effect on diffusion rates of changes to plasma membranes. These cells contain the pigment betalain and the diffusion of betalain out of the cells can be measured using a colorimeter.

Fig. 23.1 is a simplified diagram of an intact beetroot cell.

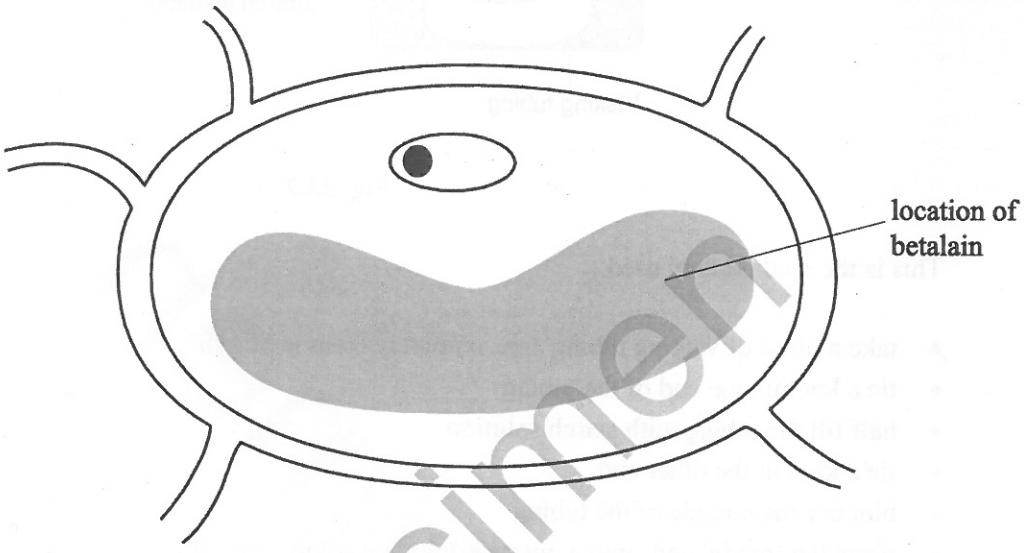

Fig. 23.1

(a) Describe the diffusion of betalain out of a beetroot cell under normal conditions.

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..... **[3]**

(b) Alternatively, a model cell can be made using visking tubing. A group of students investigated the effect of temperature on the rate of diffusion using visking tubing as a model cell as shown in **Fig. 23.2**.

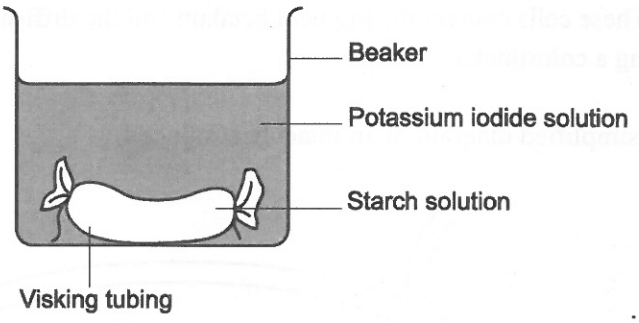


Fig. 23.2

This is the method they used:

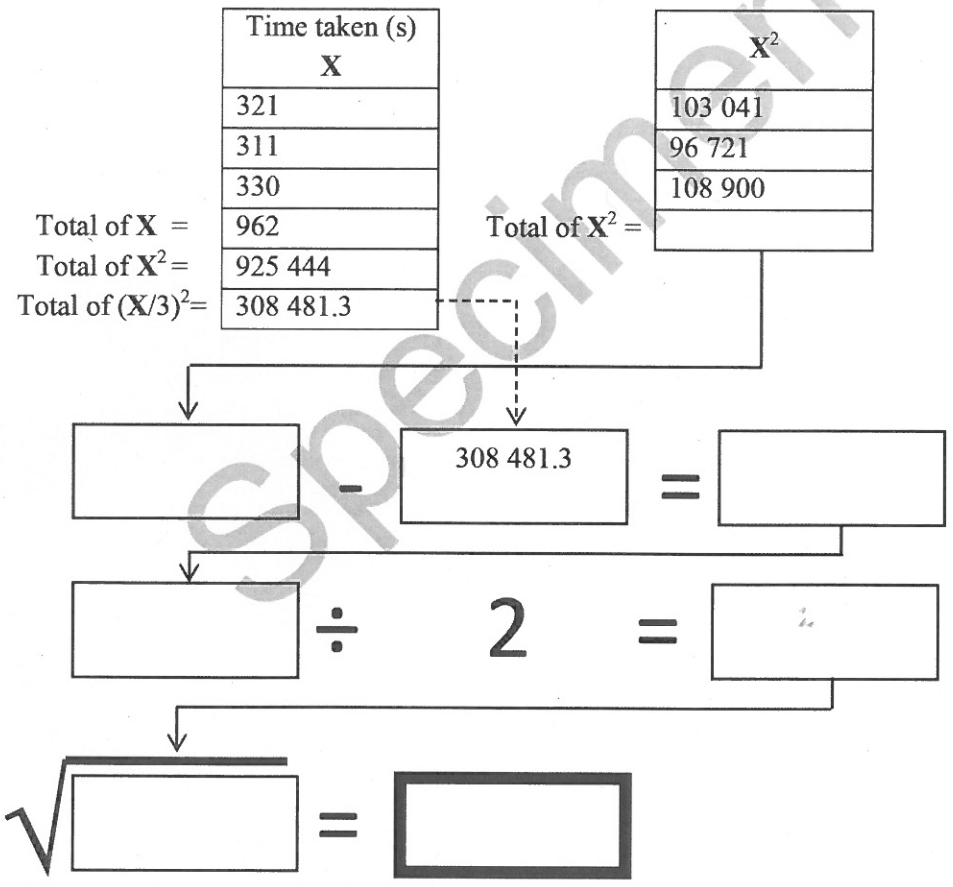
- take a piece of visking tubing approximately 6 cm in length
- tie a knot in one end of the tubing
- half fill the tubing with starch solution
- tie a knot in the other end
- blot dry the outside of the tubing
- place the 'model cell' into a potassium iodide solution at 20°C
- time how long it takes for potassium iodide to diffuse into the model cell and turn it blue-black in colour
- complete the procedure a total of three times and calculate a mean
- repeat the experiment at temperatures of 25 °C, 30 °C, 35 °C and 40 °C.

Table 23.1 shows their results.

Temperature (°C)	Time taken to turn blue-black in colour (s)				Standard deviation
	Repeat 1	Repeat 2	Repeat 3	Mean	
20	545	522	498	521.7	23.50
25	477	451	446	458.0	16.64
30	421	427	448	432.0	14.18
35	378	361	358	365.7	10.79
40	321	311	330	320.7	

Table 23.1

Complete the flowchart below to calculate the standard deviation at 40 °C **and** comment on the precision of results over the temperature range tested.



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..... **[4]**