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*4293322347*

**BIOLOGY** **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2012**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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Write in dark blue or black ink.
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Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **both** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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For Examiner's Use

**1** A student investigated the effect of different growth media on the germination and growth of pollen.

The growth media tested are shown in Table 1.1.

**Table 1.1**

| component | concentration of components in each growth medium | | |
|---|---|---|---|
| | medium **A** | medium **B** | medium **C** |
| sucrose solution / % | 10 | 10 | 10 |
| boric acid / mg dm$^{-3}$ | 0 | 100 | 100 |
| calcium nitrate / mg dm$^{-3}$ | 0 | 300 | 300 |
| magnesium sulfate / mg dm$^{-3}$ | 0 | 0 | 200 |
| potassium nitrate / mg dm$^{-3}$ | 0 | 0 | 100 |

Fig. 1.1 shows the apparatus used by the student in this investigation.

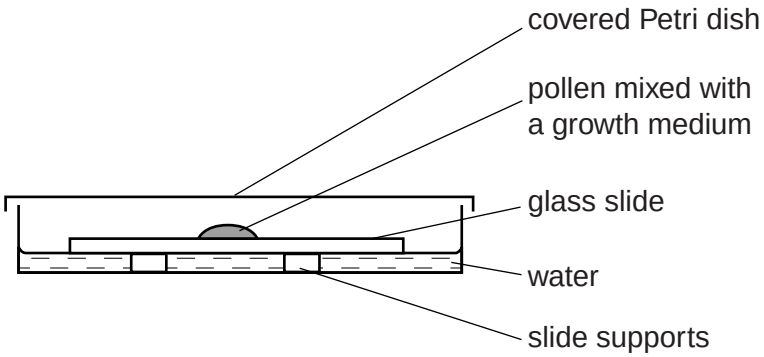



**Fig. 1.1**

The student carried out the following procedure when investigating each growth medium, **A**, **B** and **C**:

- pollen from a mature anther of a flower was removed with a paint brush
- the pollen was mixed with two drops of the growth medium on a slide
- the slide was placed in the Petri dish as shown in Fig. 1.1
- the apparatus was kept at room temperature
- every 10 minutes the slide was removed and the pollen observed using a light microscope
- the percentage of the pollen germinated was estimated
- the lengths of the 10 longest pollen tubes in a field of view were measured
- the mean pollen tube length was calculated.

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The results of the three investigations are shown in Table 1.2.

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**Table 1.2**

| | mean length of ten longest pollen tubes / μm | | | | | | |
|---|---|---|---|---|---|---|---|
| **time / min** | **10** | **20** | **30** | **40** | **50** | **60** | **70** |
| medium **A** | 23.9 | 48.5 | 72.4 | 97.6 | 128.2 | 156.0 | 180.0 |
| medium **B** | 27.6 | 58.4 | 89.9 | 121.7 | 154.8 | 186.8 | 219. 2 |
| medium **C** | 38.2 | 76.1 | 112.6 | 150.6 | 188.5 | 226.5 | 264.7 |
| | **percentage germination** | | | | | | |
| medium **A** | 5 | 18 | 26 | 38 | 51 | 55 | 57 |
| medium **B** | 8 | 12 | 22 | 31 | 46 | 52 | 61 |
| medium **C** | 3 | 8 | 18 | 28 | 36 | 48 | 56 |

**(a)** Identify the independent variable and the **two** dependent variables.

*independent* .....

*dependent* .....

.....[2]

**(b)** **(i)** Describe how the student could have measured the length of the pollen tubes using a microscope.

.....

.....

.....

.....

.....

.....[3]

**(ii)** Suggest why the percentage germination was calculated.

.....

.....[1]

*For Examiner's Use*

**(c)** The student carried out *t*-tests on the results to compare the lengths of the pollen tubes when grown in different media.

To carry out a *t*-test the number in the sample must be counted. It is also necessary to carry out two calculations from the data.

**(i)** State the **two** calculations that must be carried out in order to complete a *t*-test.

.....

.....[1]

**(ii)** State why the student decided to use 18 degrees of freedom in each of the *t*-test calculations.

.....

.....[1]

The student carried out a number of *t*-tests to find out if, after 70 minutes, the difference in mean pollen tube length is significant:

1. between medium **A** and medium **B** ***t* = 2.50**
2. between medium **A** and medium **C** ***t* = 3.56**
3. between medium **B** and medium **C** ***t* = 1.94**

Table 1.3 shows the critical values for the *t*-test.

**Table 1.3**

| **degrees of freedom** | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **probability 0.05** | 2.23 | 2.18 | 2.14 | 2.12 | 2.10 | 2.09 | 2.07 | 2.06 | 2.06 | 2.05 | 2.04 | 2.02 | 2.01 | 2.00 |
| **probability 0.01** | 3.17 | 3.06 | 2.98 | 2.92 | 2.88 | 2.85 | 2.82 | 2.80 | 2.78 | 2.76 | 2.75 | 2.70 | 2.68 | 2.66 |

**(iii)** State what conclusions can be drawn about the significance of the differences in mean lengths from the three values of ***t*** given above.

.....

.....

.....

.....

.....

.....[3]

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**(d)** From the results in Table 1.2 and the *t*-tests the student concluded that:

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- calcium has no effect on the germination of pollen grains but increases the growth rate of pollen tubes
- sucrose is needed for pollen tube germination but has no effect on the growth rate of the pollen tube.

**(i)** With reference to Table 1.2 state the evidence that supports these conclusions and the evidence that does **not** support these conclusions.

*evidence that supports these conclusions* .....

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*evidence that does **not** support these conclusions* .....

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.....[4]

**(ii)** Outline a further investigation that the student might carry out to provide more support for the conclusions about the role of sucrose in the germination of pollen and in the growth of pollen tubes.

.....

.....

.....

.....[2]

**(iii)** Predict the results of this investigation if the student's conclusion about the effects of sucrose is correct.

.....

.....

.....[2]

[Total: 19]

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**2** In mammals, digested food is absorbed by active transport and diffusion. In an investigation into the absorption of sugars a short piece of intestine was turned inside out, so that the absorptive surface was on the outside. The ends of the intestine were tied to form a bag containing oxygenated buffer solution.

The apparatus used is shown in Fig. 2.1.

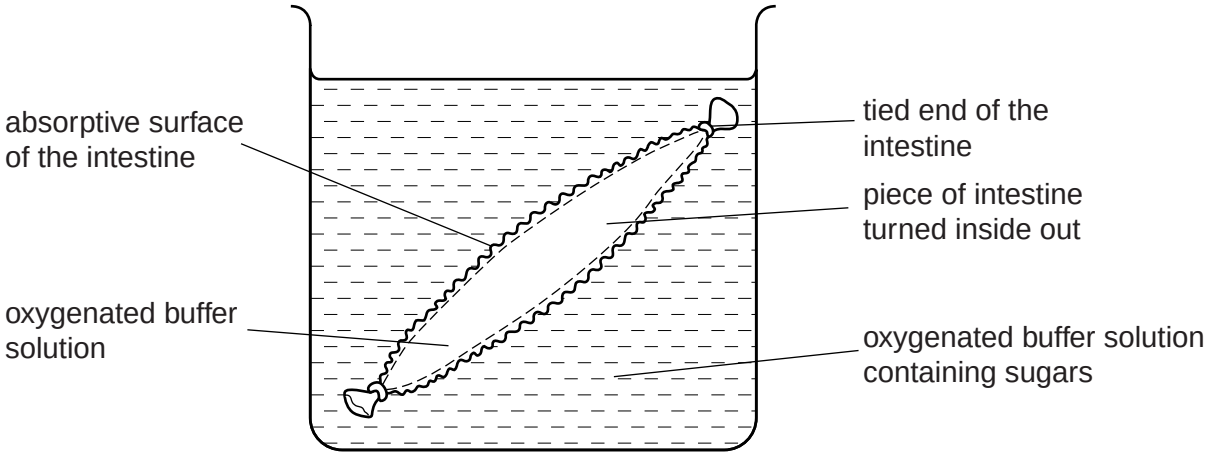



**Fig. 2.1**

**(a) (i)** Outline a method that could have been used to oxygenate the buffer solution.

.....

.....

.....

.....

.....[2]

**(ii)** Identify **one** important variable, other than those shown in Fig. 2.1, that should be standardised in this investigation.

.....[1]

**(b)** Substances which are absorbed by the intestine collect in the centre of the bag. Samples from the contents of the bag can be removed for analysis.

The absorption of glucose was investigated using untreated pieces of intestine and pieces of intestine that had been treated with a respiratory inhibitor. The investigation was then repeated using fructose.

Table 2.1 shows the results of this investigation.

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**Table 2.1**

*For Examiner's Use*

| sugar | relative rate of absorption by the intestine | |
|---|---|---|
| | without respiratory inhibitor | with respiratory inhibitor |
| glucose | 95 | 30 |
| fructose | 30 | 31 |

**(i)** Outline a procedure by which the rate of absorption of glucose could be determined.

.....

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.....

.....[3]

**(ii)** Suggest how the relative rate of absorption of the sugars is calculated.

.....

.....

.....

.....[2]

**(c)** State the conclusions that can be drawn about the absorption of sugars from this investigation.

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.....

.....

.....[3]

[Total: 11]

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*0028818786*

**BIOLOGY** **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2012**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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**1** Hybridisation is used by plant breeders to develop new varieties of crop and garden plants. A student investigated the ability of one species of grass, species **A**, to hybridise with two other species of grass, **B** and **C** by studying the chromosomes of the hybrids.

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The diploid number of chromosomes for each species was:

- species **A** 12
- species **B** 20
- species **C** 14

The main steps in the procedure used by the student are described below.

1. The undeveloped anthers of species **A** were removed from 40 immature flowers.
2. Each of the flowers (still attached to the plant) was placed inside a separate plastic bag.
3. When the flowers of species **A** were mature, pollen from species **B** was transferred onto the stigmas of 20 flowers of species **A**.
4. Step 3 was repeated, transferring pollen from species **C** to the stigmas of the other 20 flowers of species **A**.
5. Each of the flowers of species **A** was then replaced inside its plastic bag.
6. All the fruits formed by species **A** were collected and the embryo plants were removed.
7. The number of chromosomes in the cells of the embryo plants was counted.

**(a) (i)** Identify the independent and dependent variables in this investigation.

*independent variable* .....

*dependent variable* .....[2]

**(ii)** State the variable being controlled by the use of plastic bags.

.....

.....[1]

**(b) (i)** Suggest a method by which the student could have obtained and transferred the pollen from species **B** to species **A**.

.....

.....[1]

**(ii)** Identify **one** potential safety issue with the experimental method you have described.
State a suitable precaution.

.....

.....[1]

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**(c)** The fruits of the grass species used by the student are similar in structure to maize fruits.

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In steps 6 and 7 the student collected the fruits formed by species **A** in order to count the chromosomes in the cells of the embryos.

Suggest a procedure by which the student could:

- obtain cells of the embryo plant in which chromosomes would be present
- make the chromosomes visible so that they could be counted.

Outline the main stages of this procedure.

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.....[5]

**(d)** Table 1.1 shows the results that the student obtained from the investigation.

**Table 1.1**

| **number of chromosomes in the embryo plants** | |
|---|---|
| hybrid of species **A** and species **B** | hybrid of species **A** and species **C** |
| 16 | 26 |

Explain the results of the student's investigation as shown in Table 1.1.

.....

.....

.....

.....

.....

.....

.....[3]

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**(e)** In a second investigation, the student repeated the procedure to hybridise the grasses.

- The fruits were collected and 50 of each hybrid were planted.
- The number of fruits that germinated was counted.
- Pollen was collected from the flowers of the hybrid grass plants that grew from the fruits.
- The chromosomes were counted in a random sample of 30 pollen grains from each hybrid.

Table 1.2 shows the results of this investigation.

**Table 1.2**

| **number of fruits that germinated** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| hybrids from the crosses between **A** and **B** | | | | | hybrids from the crosses between **A** and **C** | | | | |
| 35 | | | | | 46 | | | | |
| **number of chromosomes in the pollen grains** | | | | | | | | | |
| 6 | 6 | 8 | 7 | 10 | 13 | 13 | 13 | 13 | 13 |
| 16 | 8 | 16 | 9 | 0 | 13 | 13 | 13 | 13 | 13 |
| 8 | 8 | 16 | 6 | 6 | 13 | 13 | 13 | 13 | 13 |
| 6 | 10 | 8 | 16 | 9 | 13 | 13 | 13 | 13 | 13 |
| 13 | 12 | 16 | 8 | 6 | 13 | 13 | 13 | 13 | 13 |
| 8 | 8 | 16 | 6 | 10 | 13 | 13 | 13 | 13 | 13 |

**(i)** The student also counted the number of chromosomes in the female gametes of each hybrid.

Predict the number of chromosomes you would expect the student to find in the female gametes of each hybrid.

hybrid from the cross **A** × **B** .....

hybrid from the cross **A** × **C** ..... [1]

The student concluded that hybrids from the cross of **A** × **C** could be bred successfully but hybrids from the cross of **A** × **B** could not be bred successfully.

**(ii)** State the evidence in Table 1.2 that supports this conclusion.

.....

.....

.....

..... [2]

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**(f)** The student carried out a further investigation to find out if the difference in the germination of the two hybrid grasses was significant. The student counted the number of fruits that germinated from eleven samples of 50 fruits of each hybrid.

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The student collated all the data in order to calculate the mean, mode and median of the fruit germination of both hybrids.

Table 1.3 shows the data.

**Table 1.3**

| **sample number** | **number of fruits germinated** | |
|---|---|---|
| | hybrid **A** × **B** | hybrid **A** × **C** |
| 1 | 30 | 41 |
| 2 | 31 | 42 |
| 3 | 32 | 44 |
| 4 | 32 | 45 |
| 5 | 34 | 45 |
| 6 | 34 | 46 |
| 7 | 34 | 47 |
| 8 | 35 | 48 |
| 9 | 36 | 48 |
| 10 | 38 | 49 |
| 11 | 37 | 48 |
| **mean** | 34 | |
| **mode** | 34 | |
| **median** | 34 | |

The student recorded the calculations for the hybrid from the cross of **A** × **B** in Table 1. 3.

**(i)** Complete Table 1.3 by writing in the values of the mean, mode and median for the hybrid from the cross of **A** × **C**. [2]

**(ii)** State a reason why the student used the *t*-test to find out if the difference in germination of the two hybrids was significant.

.....

.....[1]

**(iii)** State a null hypothesis for this test.

.....

.....[1]

**(iv)** State why the student used 20 degrees of freedom for this test.

.....

.....[1]

[Total: 21]

**2** The effect of temperature on the permeability of cell membranes was investigated using discs of a plant tissue. When discs of this plant tissue were placed in water, chloride ions were released from the cell vacuoles.

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Discs of this plant tissue were placed in tubes of deionised water in water baths at different temperatures for 30 minutes as shown in Fig. 2.1.

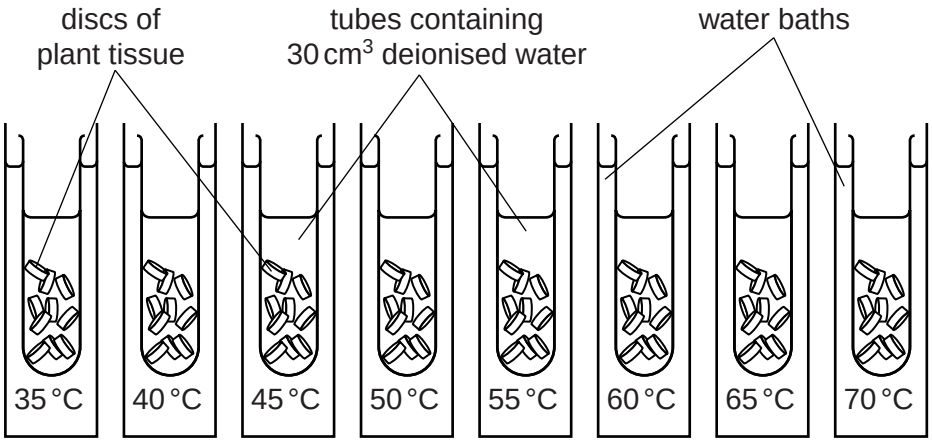



**Fig. 2.1**

The concentration of chloride ions in the water around the plant tissue was measured using an ion-sensitive electrode.

**(a) (i)** State how three different variables have been standardised in this investigation.

1. .....

.....

2. .....

.....

3. .....

.....[3]

**(ii)** Suggest how the reliability of the results could be improved.

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.....

.....[2]

**(b)** The results of this investigation are shown in Fig. 2.2.

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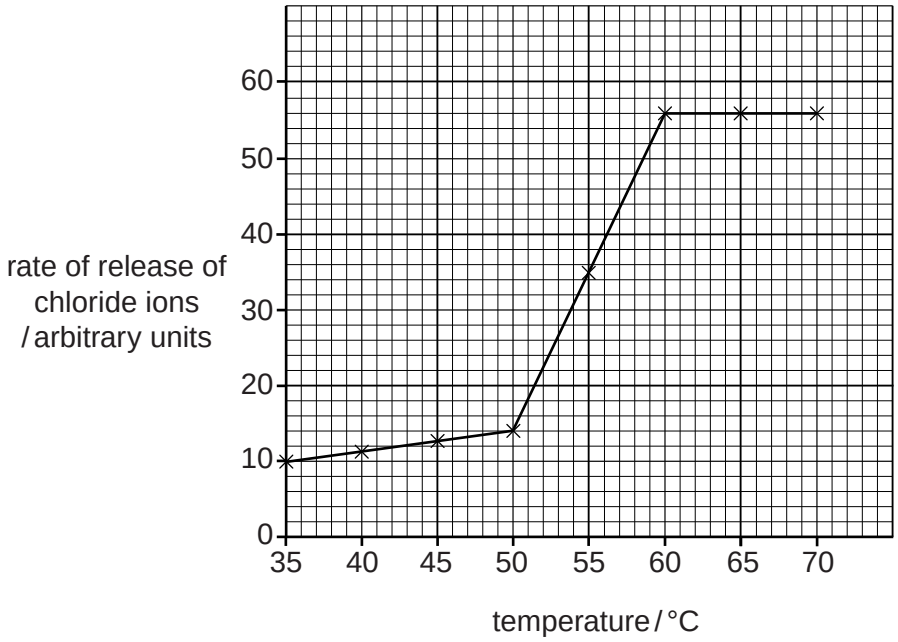



**Fig. 2.2**

**(i)** State how the rate of release of chloride ions is calculated for each temperature.

.....[1]

**(ii)** Calculate the relative increase in the rate of release of chloride ions between 50 °C and 60 °C.
Show your working.

.....[2]

**(c)** The investigation was repeated, but a solution of 70% ethanol was added to each tube instead of deionised water.

Predict the effect of using ethanol on the rate of release of chloride ions from the discs in all the tubes.

.....

.....[1]

[Total: 9]

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*3023010287*

**BIOLOGY** **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2012**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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For Examiner's Use

**1** A student investigated the effect of different growth media on the germination and growth of pollen.

The growth media tested are shown in Table 1.1.

**Table 1.1**

| component | concentration of components in each growth medium | | |
|---|---|---|---|
| | medium **A** | medium **B** | medium **C** |
| sucrose solution / % | 10 | 10 | 10 |
| boric acid / mg dm$^{-3}$ | 0 | 100 | 100 |
| calcium nitrate / mg dm$^{-3}$ | 0 | 300 | 300 |
| magnesium sulfate / mg dm$^{-3}$ | 0 | 0 | 200 |
| potassium nitrate / mg dm$^{-3}$ | 0 | 0 | 100 |

Fig. 1.1 shows the apparatus used by the student in this investigation.

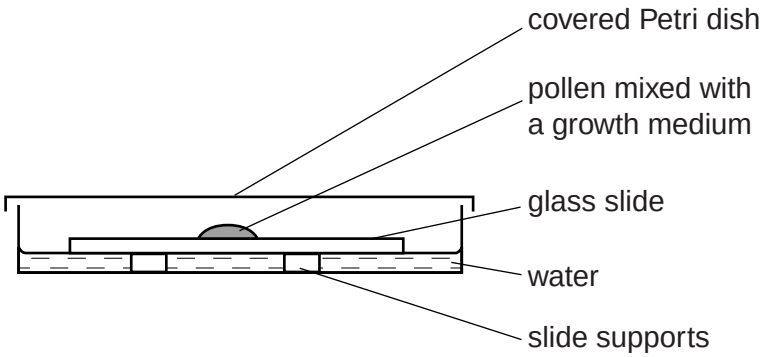



**Fig. 1.1**

The student carried out the following procedure when investigating each growth medium, **A**, **B** and **C**:

- pollen from a mature anther of a flower was removed with a paint brush
- the pollen was mixed with two drops of the growth medium on a slide
- the slide was placed in the Petri dish as shown in Fig. 1.1
- the apparatus was kept at room temperature
- every 10 minutes the slide was removed and the pollen observed using a light microscope
- the percentage of the pollen germinated was estimated
- the lengths of the 10 longest pollen tubes in a field of view were measured
- the mean pollen tube length was calculated.

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The results of the three investigations are shown in Table 1.2.

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**Table 1.2**

| | mean length of ten longest pollen tubes / μm | | | | | | |
|---|---|---|---|---|---|---|---|
| **time / min** | **10** | **20** | **30** | **40** | **50** | **60** | **70** |
| medium **A** | 23.9 | 48.5 | 72.4 | 97.6 | 128.2 | 156.0 | 180.0 |
| medium **B** | 27.6 | 58.4 | 89.9 | 121.7 | 154.8 | 186.8 | 219. 2 |
| medium **C** | 38.2 | 76.1 | 112.6 | 150.6 | 188.5 | 226.5 | 264.7 |
| | **percentage germination** | | | | | | |
| medium **A** | 5 | 18 | 26 | 38 | 51 | 55 | 57 |
| medium **B** | 8 | 12 | 22 | 31 | 46 | 52 | 61 |
| medium **C** | 3 | 8 | 18 | 28 | 36 | 48 | 56 |

**(a)** Identify the independent variable and the **two** dependent variables.

*independent* .....

*dependent* .....

.....[2]

**(b)** **(i)** Describe how the student could have measured the length of the pollen tubes using a microscope.

.....

.....

.....

.....

.....

.....[3]

**(ii)** Suggest why the percentage germination was calculated.

.....

.....[1]

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**(c)** The student carried out *t*-tests on the results to compare the lengths of the pollen tubes when grown in different media.

To carry out a *t*-test the number in the sample must be counted. It is also necessary to carry out two calculations from the data.

**(i)** State the **two** calculations that must be carried out in order to complete a *t*-test.

.....

.....[1]

**(ii)** State why the student decided to use 18 degrees of freedom in each of the *t*-test calculations.

.....

.....[1]

The student carried out a number of *t*-tests to find out if, after 70 minutes, the difference in mean pollen tube length is significant:

1. between medium **A** and medium **B** ***t* = 2.50**
2. between medium **A** and medium **C** ***t* = 3.56**
3. between medium **B** and medium **C** ***t* = 1.94**

Table 1.3 shows the critical values for the *t*-test.

**Table 1.3**

| **degrees of freedom** | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **probability 0.05** | 2.23 | 2.18 | 2.14 | 2.12 | 2.10 | 2.09 | 2.07 | 2.06 | 2.06 | 2.05 | 2.04 | 2.02 | 2.01 | 2.00 |
| **probability 0.01** | 3.17 | 3.06 | 2.98 | 2.92 | 2.88 | 2.85 | 2.82 | 2.80 | 2.78 | 2.76 | 2.75 | 2.70 | 2.68 | 2.66 |

**(iii)** State what conclusions can be drawn about the significance of the differences in mean lengths from the three values of ***t*** given above.

.....

.....

.....

.....

.....

.....[3]

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**(d)** From the results in Table 1.2 and the *t*-tests the student concluded that:

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- calcium has no effect on the germination of pollen grains but increases the growth rate of pollen tubes
- sucrose is needed for pollen tube germination but has no effect on the growth rate of the pollen tube.

**(i)** With reference to Table 1.2 state the evidence that supports these conclusions and the evidence that does **not** support these conclusions.

*evidence that supports these conclusions* .....

.....

.....

.....

.....

.....

*evidence that does **not** support these conclusions* .....

.....

.....

.....

.....

.....[4]

**(ii)** Outline a further investigation that the student might carry out to provide more support for the conclusions about the role of sucrose in the germination of pollen and in the growth of pollen tubes.

.....

.....

.....

.....[2]

**(iii)** Predict the results of this investigation if the student's conclusion about the effects of sucrose is correct.

.....

.....

.....[2]

[Total: 19]

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**2** In mammals, digested food is absorbed by active transport and diffusion. In an investigation into the absorption of sugars a short piece of intestine was turned inside out, so that the absorptive surface was on the outside. The ends of the intestine were tied to form a bag containing oxygenated buffer solution.

The apparatus used is shown in Fig. 2.1.

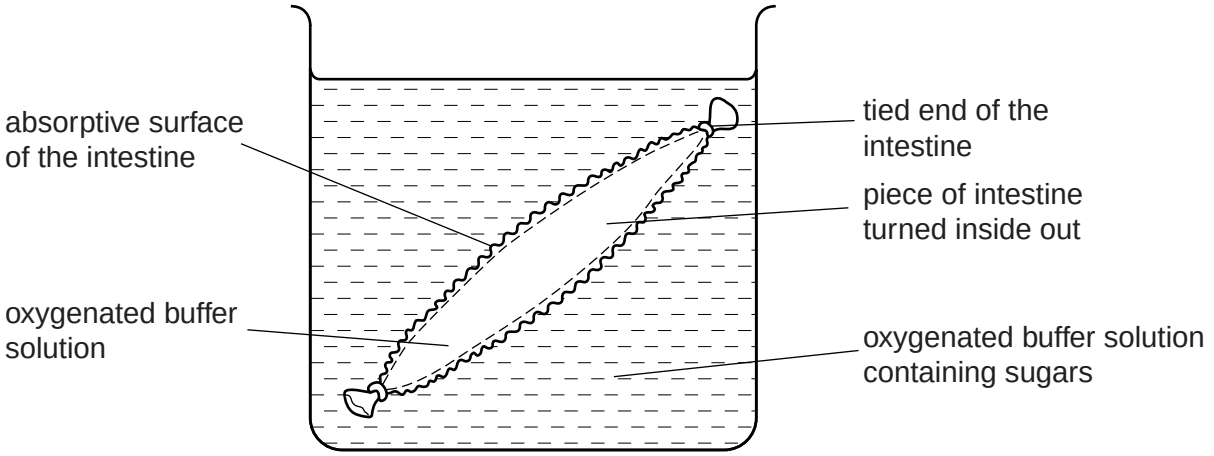



**Fig. 2.1**

**(a) (i)** Outline a method that could have been used to oxygenate the buffer solution.

.....

.....

.....

.....

.....[2]

**(ii)** Identify **one** important variable, other than those shown in Fig. 2.1, that should be standardised in this investigation.

.....[1]

**(b)** Substances which are absorbed by the intestine collect in the centre of the bag. Samples from the contents of the bag can be removed for analysis.

The absorption of glucose was investigated using untreated pieces of intestine and pieces of intestine that had been treated with a respiratory inhibitor. The investigation was then repeated using fructose.

Table 2.1 shows the results of this investigation.

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**Table 2.1**

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| sugar | relative rate of absorption by the intestine | |
|---|---|---|
| | without respiratory inhibitor | with respiratory inhibitor |
| glucose | 95 | 30 |
| fructose | 30 | 31 |

**(i)** Outline a procedure by which the rate of absorption of glucose could be determined.

.....

.....

.....

.....

.....

.....

.....

.....[3]

**(ii)** Suggest how the relative rate of absorption of the sugars is calculated.

.....

.....

.....

.....[2]

**(c)** State the conclusions that can be drawn about the absorption of sugars from this investigation.

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.....[3]

[Total: 11]

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