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

Paper 5 Planning, Analysis and Evaluation **October/November 2018**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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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**1** Transpiration in plants can be investigated using a potometer, which measures water uptake by plants. Fig. 1.1 shows a potometer that was used by a student.

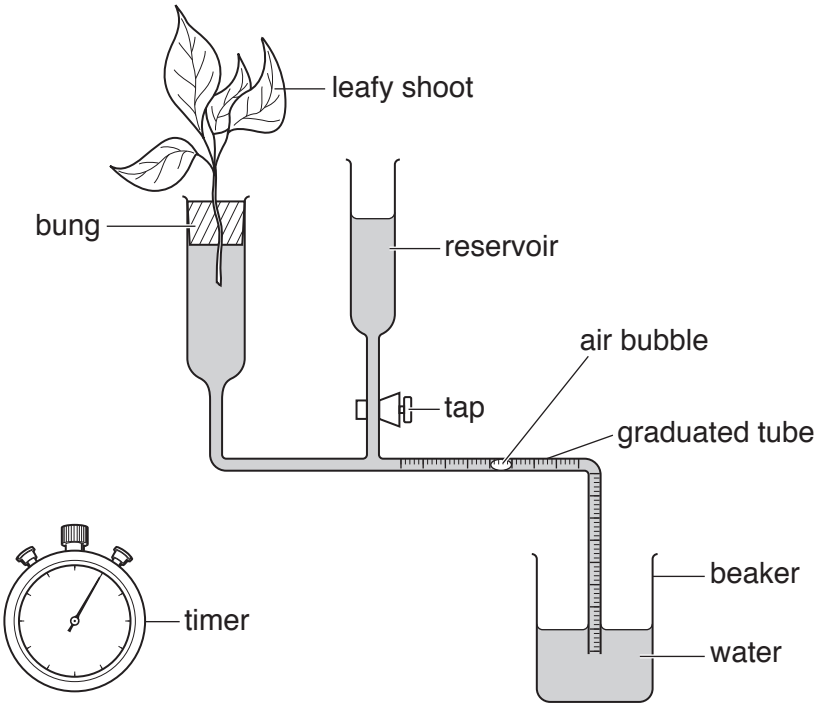



**Fig. 1.1**

As water is lost by the leaves through transpiration, the air bubble moves along the graduated tube.

The student used this apparatus to investigate the effect of light intensity on the rate of transpiration in plants.

**(a) (i)** State the independent variable **and** the dependent variable in this investigation.

*independent* .....

*dependent* .....

[2]

**(ii)** List **three** variables that should be controlled in this investigation **and** describe how the student could standardise **two** of these variables.

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.....[3]

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**(b)** Describe how the student could set up and use the potometer shown in Fig. 1.1 to investigate the rate of transpiration at different light intensities.

Your method should be set out in a logical way and be detailed enough to let another person follow it.

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**(c)** The student carried out further experiments, using the same apparatus, to investigate the effect of two different environmental carbon dioxide concentrations on the rate of transpiration. These experiments were carried out at a high light intensity and at a low light intensity.

The leafy shoots used in the experiments were taken from the same plant and each shoot had five leaves.

The student calculated the percentage reduction in the transpiration rate from 50 ppm to 730 ppm of carbon dioxide at low light intensities.

The results are shown in Table 1.1.

**Table 1.1**

| concentration of carbon dioxide / ppm | light intensity | transpiration rate / g $dm^{-3}$ $hr^{-1}$ | percentage reduction in transpiration rate from 50 ppm to 730 ppm of carbon dioxide |
|---|---|---|---|
| 50 | low | 1.28 | 36.7 |
| 730 | low | 0.81 | |
| 50 | high | 3.03 | |
| 730 | high | 2.12 | |

ppm = parts per million

**(i)** Complete Table 1.1 by calculating the percentage reduction in transpiration rate from 50 ppm to 730 ppm of carbon dioxide at the **high light intensity**.

Show your working.

[2]

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**(ii)** The student concluded that, as carbon dioxide concentration increased, the transpiration rate in plants decreased at all light intensities.

Explain why this conclusion may **not** be valid.

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.....[2]

[Total: 15]

**2** Resistance to antibiotics within a population of bacteria is due to selection pressure. This can be linked to the use of antibiotics by patients.

A study was carried out into the link between antibiotic use and the presence of resistant *Escherichia coli (E. coli*) populations in human communities.

- Over 30 000 patients were involved in the study.
- Only patients attending large medical clinics took part in the study.
- The number of prescriptions issued by each clinic was used as an estimate of antibiotic use.
- Urine from patients attending the clinics was used as a possible source of antibiotic resistant *E. coli*.
- Antibiotic resistance of *E. coli* in the urine samples was measured using the disc diffusion method.

The disc diffusion method measures sensitivity of bacteria to an antibiotic. A bacterial population with low sensitivity to an antibiotic is resistant to that antibiotic.

In the disc diffusion method a Petri dish is filled with nutrient agar and urine samples containing *E. coli* are spread evenly across the agar.

Discs containing different antibiotics are placed on top of the agar. A lid is put on the Petri dish and the plate is incubated overnight.

Fig. 2.1 shows an example of a Petri dish from the study after incubation.

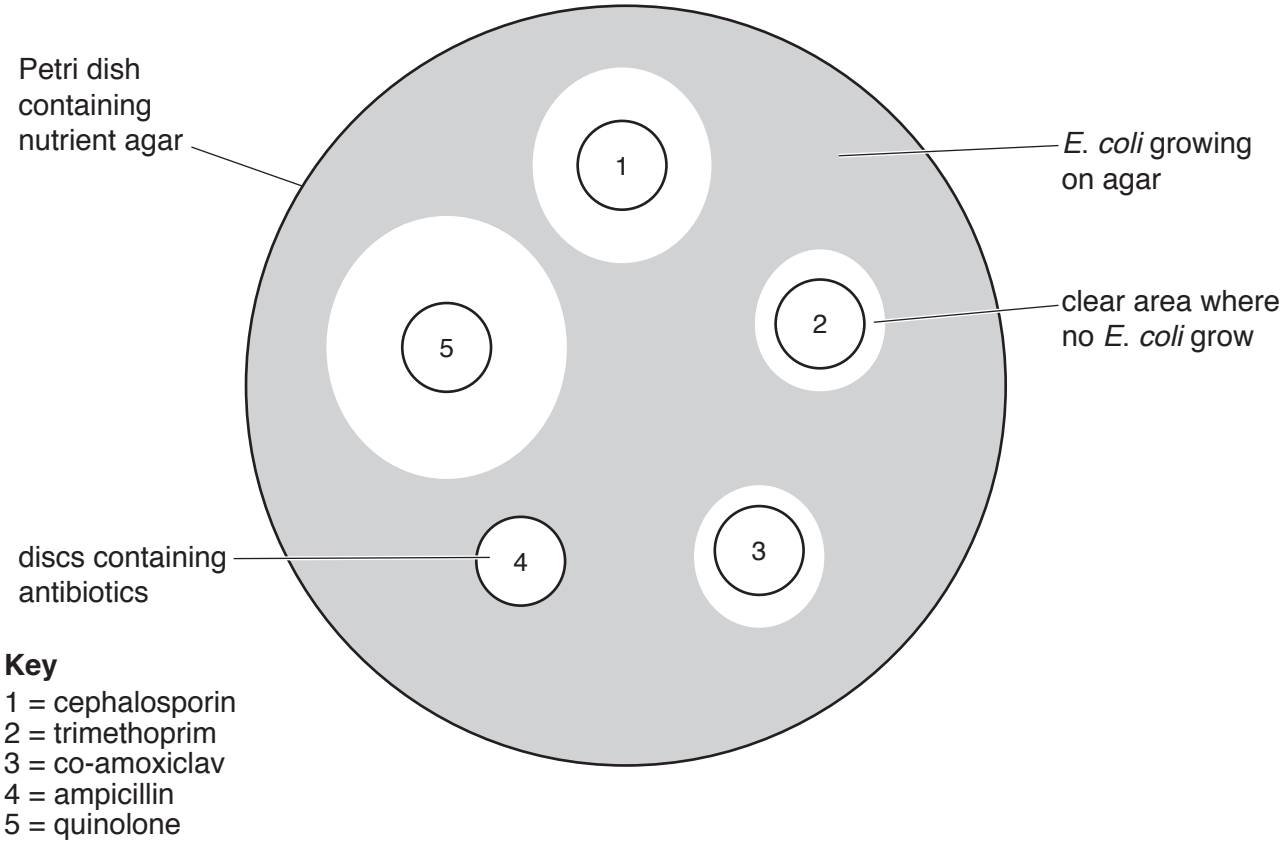



**Fig. 2.1**

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**(a) (i)** Suggest two variables that need to be standardised when using the disc diffusion method in this study.

1 .....

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[2]

**(ii)** Describe how you would determine the sensitivity of *E. coli* to each antibiotic.

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.....[2]

**(b)** Table 2.1 shows the results of this investigation.

**Table 2.1**

| antibiotic | antibiotic use / prescriptions per thousand patients per year | | percentage *E. coli* resistance | |
|---|---|---|---|---|
| | mean ($\overline{x}$) | standard deviation ($s$) | mean ($\overline{x}$) | standard deviation ($s$) |
| cephalosporin | 107.0 | 83.0 | 6.5 | 3.5 |
| trimethoprim | 62.6 | 25.6 | 26.3 | 5.8 |
| co-amoxiclav | 75.5 | 43.9 | 8.4 | 5.7 |
| ampicillin | 351.9 | 171.1 | 53.2 | 7.2 |
| quinolone | 33.6 | 18.3 | 2.2 | 1.9 |

**(i)** Comment on the standard deviations for **antibiotic use** as shown in Table 2.1.

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.....[2]

**(ii)** Suggest two reasons why the number of prescriptions issued for antibiotics may **not** give an accurate measure of antibiotic use by patients.

1 .....

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[2]

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**(c)** The number of prescriptions issued for antibiotics varied considerably between clinics.

The researchers wanted to find out whether there was a correlation between the number of prescriptions for each of the five antibiotics issued by a clinic and the percentage of urine samples containing resistant *E. coli*.

Spearman's rank correlation test was used for this analysis.

The results of this analysis are shown in Table 2.2.

**Table 2.2**

| antibiotic | Spearman's rank correlation coefficient ($r_s$) |
|---|---|
| cephalosporin | 0.30 |
| trimethoprim | 0.62 |
| co-amoxiclav | 0.23 |
| ampicillin | 0.71 |
| quinolone | 0.44 |

Table 2.3 shows the critical values for $r_s$ at five levels of significance for the data collected in this study.

**Table 2.3**

| level of significance ($p$) | 0.20 | 0.10 | 0.05 | 0.02 | 0.01 |
|---|---|---|---|---|---|
| critical value of $r_s$ | 0.240 | 0.306 | 0.362 | 0.425 | 0.467 |

**(i)** Suggest why the Spearman's rank correlation test was used in this study.

.....

.....[1]

**(ii)** State a null hypothesis for the Spearman's rank correlation test for this study.

.....

.....[1]

**(iii)** Using Table 2.2 and Table 2.3, identify which antibiotics showed a statistically significant correlation between the number of prescriptions and the presence of resistant strains of *E. coli* in urine samples. Give a reason for your answer.

*antibiotics* .....

*reason* .....

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[2]

**(d)** The percentage of patients with ampicillin-resistant *E. coli* infections varies with age and gender, as shown in Fig. 2.2.

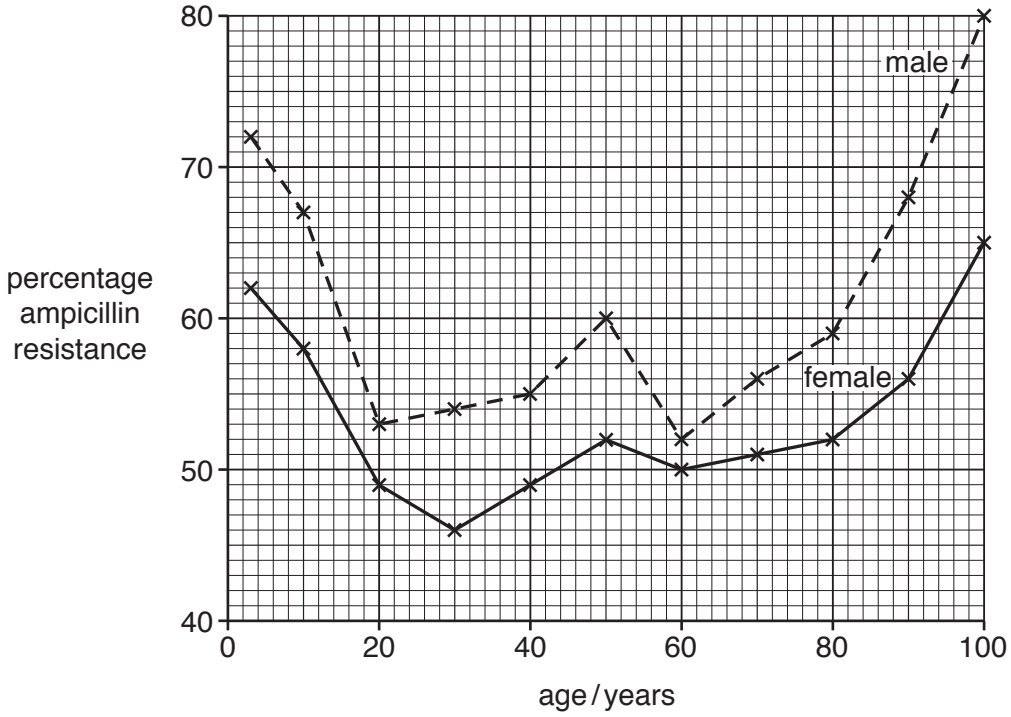



**Fig. 2.2**

Describe **and** explain the trends shown by these data.

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[Total: 15]

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*6124186229*

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

Paper 5 Planning, Analysis and Evaluation **October/November 2018**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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**1** Fig. 1.1 shows apparatus that can be used to measure the loss of water vapour from leaves.

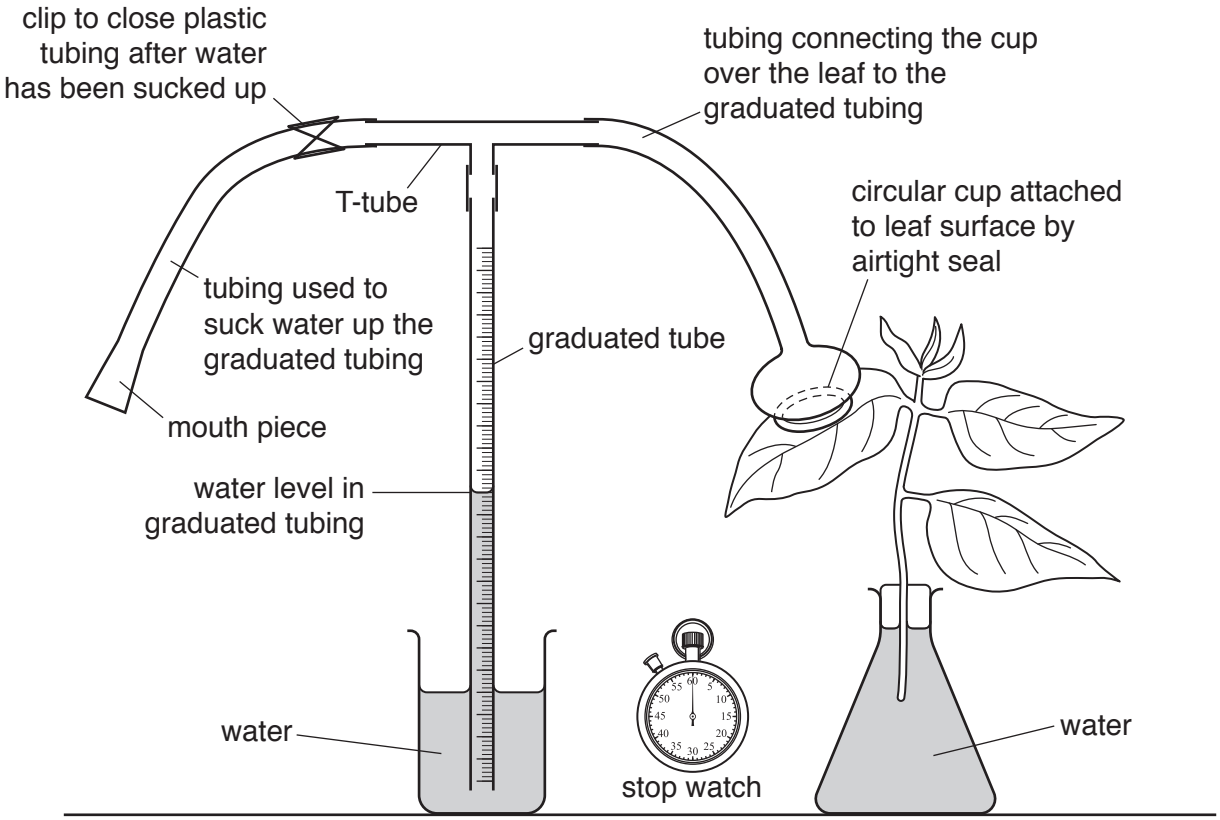



**Fig. 1.1**

The water vapour given out by the area of leaf under the cup increases the pressure inside the tubing, causing the water level in the graduated tube to go down.

Some students used the apparatus in Fig. 1.1 to test the hypothesis:

The loss of water vapour from the lower surface of the leaves of a plant is greater per unit time than the loss of water vapour from the upper surface of the leaves of the same plant.

**(a) (i)** State the independent variable **and** the dependent variable in this investigation.

*independent variable* .....

.....

*dependent variable* .....

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[2]

**(ii)** Describe a method by which the students could use the apparatus shown in Fig. 1.1 to measure loss of water vapour in order to test the hypothesis.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

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**(b)** The hypothesis that the students tested was:

The loss of water vapour from the lower surface of the leaves of a plant is greater per unit time than the loss of water vapour from the upper surface of the leaves of the same plant.

The students decided that, to make a valid comparison, they needed to work out the water loss per unit time per unit area of leaf.

**(i)** Describe how the students obtained the measurement needed to work out the results as **per unit area** of leaf.

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**(ii)** Describe how the students could use this measurement and their results for the loss of water vapour to find out if their results support the hypothesis.

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**(iii)** Sketch a bar chart on Fig. 1.2 to show the results if the hypothesis was supported. You should include the axis labels and the units. [3]



**Fig. 1.2**

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**(c)** The apparatus shown in Fig. 1.1 was used in another series of experiments to measure water vapour loss from the same leaf in different experimental conditions for the same period of time.

Table 1.1 shows the results.

**Table 1.1**

| experimental condition | distance moved by water column /cm per unit time | | | | |
|---|---|---|---|---|---|
| | trial 1 | trial 2 | trial 3 | trial 4 | trial 5 |
| high light intensity | 7.3 | 7.5 | 7.8 | 6.2 | 7.0 |
| no light | 0.0 | 0.0 | 1.5 | 0.2 | 0.0 |
| high temperature | 4.4 | 2.8 | 3.2 | 4.8 | 3.1 |
| strong air current | 1.5 | 2.4 | 1.1 | 0.9 | 1.0 |

**(i)** **On Table 1.1**, draw circles around **two** of the values that may be anomalous. [2]

**(ii)** The aperture of stomata affects the loss of water vapour.

State **one** conclusion that can be made about the effect of experimental conditions on the aperture of stomata in this plant.

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.....[1]

[Total: 19]

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**[Turn over**

**2** Antibiotic resistance of pathogenic bacteria is a worldwide cause for concern. Investigations into the use of antibiotics and their effects use an international unit of measurement, called the defined daily dose (DDD).

The DDD represents the assumed average dose for a drug per day being used to treat a specific disease in adults.

A study investigated the antibiotic resistance of *Streptococcus pneumoniae*. The study was carried out in some European countries and the percentage of *S. pneumoniae* resistant to the antibiotics penicillin and macrolide was determined.

The results are shown in Table 2.1.

**Table 2.1**

| country | DDD per 1000 people per day | | percentage of resistant *S. pneumoniae* | |
|---|---|---|---|---|
| | penicillin | macrolide | penicillin | macrolide |
| Netherlands | 9 | 1 | 1 | 5 |
| Denmark | 11 | 2 | 2 | 2 |
| Sweden | 13 | 1 | 4 | 3 |
| Germany | 14 | 2 | 7 | 9 |
| UK | 14 | 3 | 11 | 19 |
| Austria | 18 | 4 | 12 | 11 |
| Italy | 24 | 5 | 13 | 29 |
| Portugal | 29 | 4 | 29 | 9 |
| France | 37 | 6 | 43 | 53 |
| Spain | 33 | 6 | 50 | 36 |

**(a) (i)** State **two** conclusions that can be made about the quantity of these antibiotics used and the percentage of *S. pneumoniae* resistant to these two types of antibiotic.

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[2]

**(ii)** Calculate the ratio of penicillin use between Spain and the Netherlands.

ratio .....[1]

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**(b)** To find the strength of the relationship between antibiotic use and the percentage resistance in *S. pneumoniae*, a linear correlation test was used. The probability for each value was found using the critical values from a probability table.

**(i)** State **two** reasons why this statistical test is suitable for these data.

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**(ii)** The results of the test are shown in Table 2.2.

**Table 2.2**

| type of antibiotic | Pearson's linear correlation coefficient ($r$) | level of significance ($p$) |
|---|---|---|
| penicillin | 0.95 | < 0.01 |
| macrolide | 0.86 | < 0.01 |

State what the values in Table 2.2 indicate about the relationship between antibiotic use and antibiotic resistance in *S. pneumoniae*.

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**(c)** The disc diffusion method is used to test the effectiveness of different concentrations of antibiotics. Fig. 2.1 shows the results of a disc diffusion test.

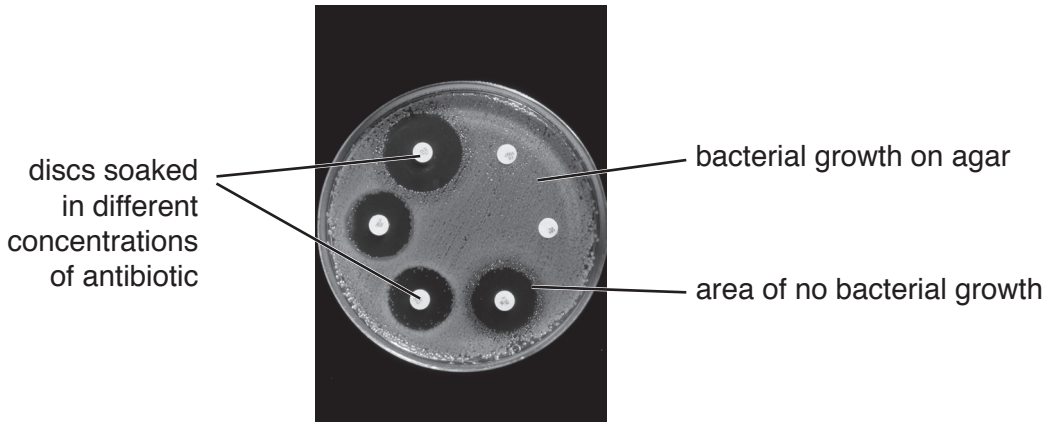



**Fig. 2.1**

Starting with a stock solution of an antibiotic, outline how you would make a serial dilution to produce a range of concentrations of the antibiotic.

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**(d)** The disc diffusion test is also used to test for antibiotic resistance. The test may take about five days to complete.

*Escherichia coli* is a common bacterium in the human intestines that can develop antibiotic resistance and transmit it to other bacteria. It is present in faeces and can also be present in waste water that is discharged into rivers.

Environmental agencies test samples of waste water for antibiotic resistant bacteria. This can be done with the disc diffusion method. A new test was developed to allow estimates of antibiotic-resistant *E. coli* to be obtained within 24 hours.

Suggest **two** criteria that environmental agencies could apply when assessing the new test to see whether it is suitable.

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[Total: 11]

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*9973451659*

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

Paper 5 Planning, Analysis and Evaluation **October/November 2018**

**1 hour 15 minutes**

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**1** Transpiration in plants can be investigated using a potometer, which measures water uptake by plants. Fig. 1.1 shows a potometer that was used by a student.

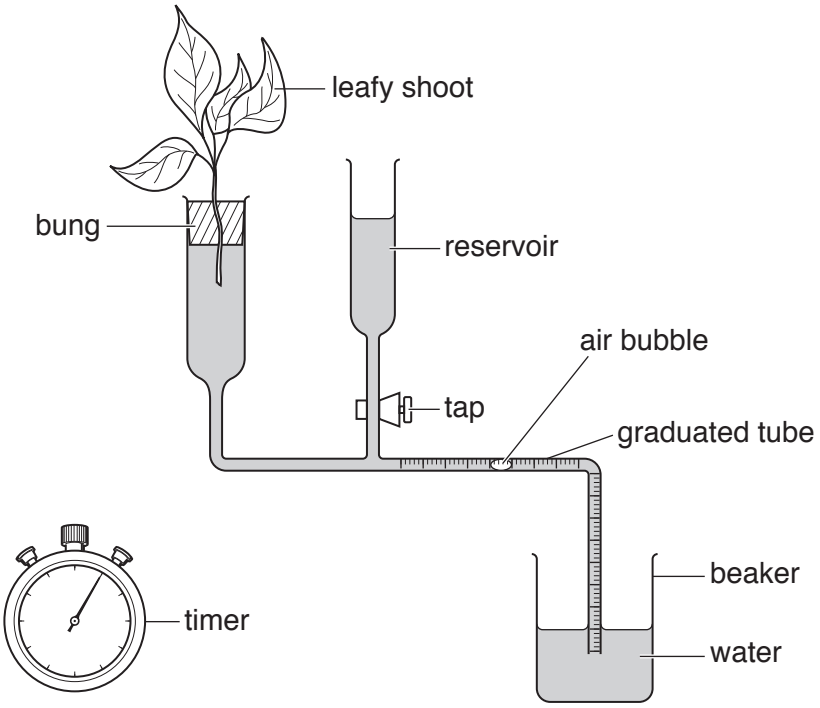



**Fig. 1.1**

As water is lost by the leaves through transpiration, the air bubble moves along the graduated tube.

The student used this apparatus to investigate the effect of light intensity on the rate of transpiration in plants.

**(a) (i)** State the independent variable **and** the dependent variable in this investigation.

*independent* .....

*dependent* .....

[2]

**(ii)** List **three** variables that should be controlled in this investigation **and** describe how the student could standardise **two** of these variables.

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.....[3]

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**(b)** Describe how the student could set up and use the potometer shown in Fig. 1.1 to investigate the rate of transpiration at different light intensities.

Your method should be set out in a logical way and be detailed enough to let another person follow it.

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**(c)** The student carried out further experiments, using the same apparatus, to investigate the effect of two different environmental carbon dioxide concentrations on the rate of transpiration. These experiments were carried out at a high light intensity and at a low light intensity.

The leafy shoots used in the experiments were taken from the same plant and each shoot had five leaves.

The student calculated the percentage reduction in the transpiration rate from 50 ppm to 730 ppm of carbon dioxide at low light intensities.

The results are shown in Table 1.1.

**Table 1.1**

| concentration of carbon dioxide / ppm | light intensity | transpiration rate / g $dm^{-3}$ $hr^{-1}$ | percentage reduction in transpiration rate from 50 ppm to 730 ppm of carbon dioxide |
|---|---|---|---|
| 50 | low | 1.28 | 36.7 |
| 730 | low | 0.81 | |
| 50 | high | 3.03 | |
| 730 | high | 2.12 | |

ppm = parts per million

**(i)** Complete Table 1.1 by calculating the percentage reduction in transpiration rate from 50 ppm to 730 ppm of carbon dioxide at the **high light intensity**.

Show your working.

[2]

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**(ii)** The student concluded that, as carbon dioxide concentration increased, the transpiration rate in plants decreased at all light intensities.

Explain why this conclusion may **not** be valid.

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.....[2]

[Total: 15]

**2** Resistance to antibiotics within a population of bacteria is due to selection pressure. This can be linked to the use of antibiotics by patients.

A study was carried out into the link between antibiotic use and the presence of resistant *Escherichia coli (E. coli*) populations in human communities.

- Over 30 000 patients were involved in the study.
- Only patients attending large medical clinics took part in the study.
- The number of prescriptions issued by each clinic was used as an estimate of antibiotic use.
- Urine from patients attending the clinics was used as a possible source of antibiotic resistant *E. coli*.
- Antibiotic resistance of *E. coli* in the urine samples was measured using the disc diffusion method.

The disc diffusion method measures sensitivity of bacteria to an antibiotic. A bacterial population with low sensitivity to an antibiotic is resistant to that antibiotic.

In the disc diffusion method a Petri dish is filled with nutrient agar and urine samples containing *E. coli* are spread evenly across the agar.

Discs containing different antibiotics are placed on top of the agar. A lid is put on the Petri dish and the plate is incubated overnight.

Fig. 2.1 shows an example of a Petri dish from the study after incubation.

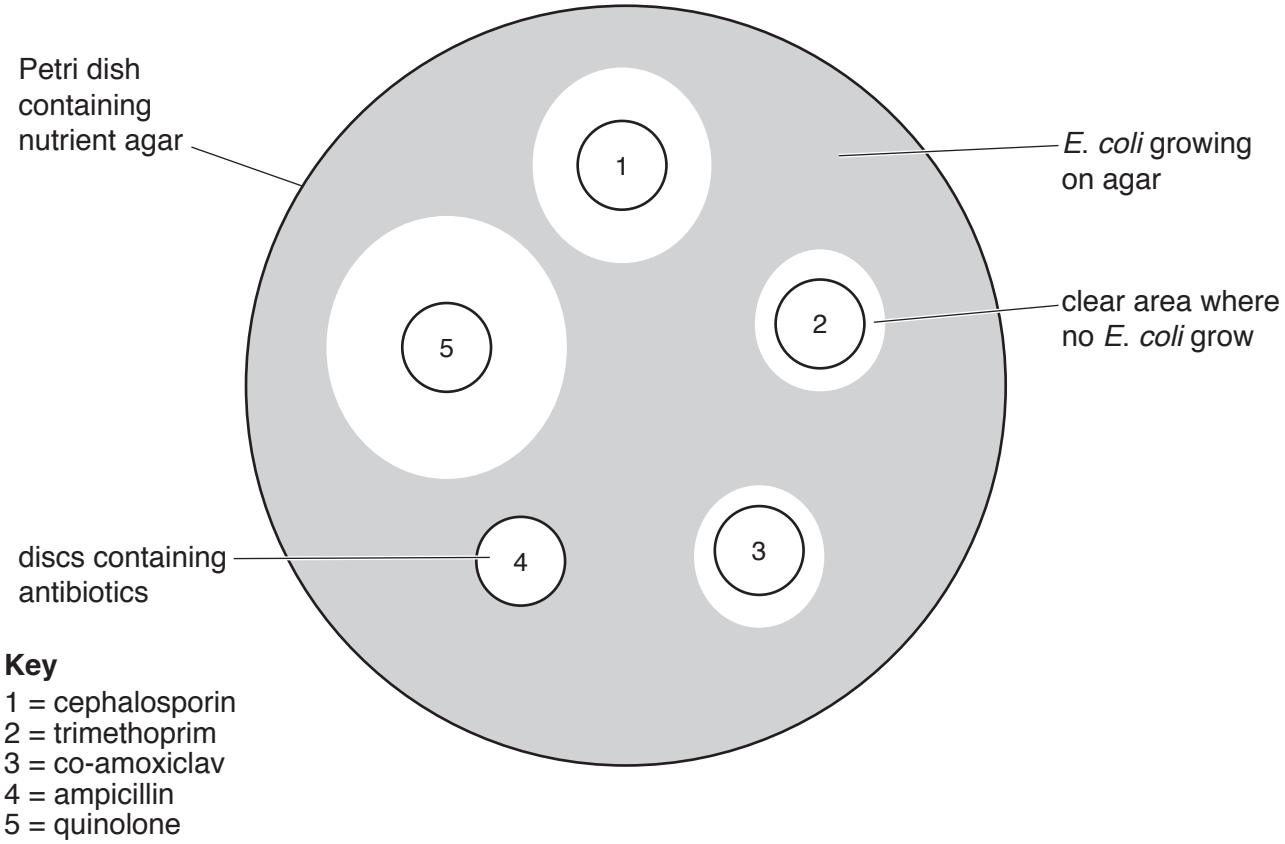



**Fig. 2.1**

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**(a) (i)** Suggest two variables that need to be standardised when using the disc diffusion method in this study.

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2 .....

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[2]

**(ii)** Describe how you would determine the sensitivity of *E. coli* to each antibiotic.

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.....[2]

**(b)** Table 2.1 shows the results of this investigation.

**Table 2.1**

| antibiotic | antibiotic use / prescriptions per thousand patients per year | | percentage *E. coli* resistance | |
|---|---|---|---|---|
| | mean ($\overline{x}$) | standard deviation ($s$) | mean ($\overline{x}$) | standard deviation ($s$) |
| cephalosporin | 107.0 | 83.0 | 6.5 | 3.5 |
| trimethoprim | 62.6 | 25.6 | 26.3 | 5.8 |
| co-amoxiclav | 75.5 | 43.9 | 8.4 | 5.7 |
| ampicillin | 351.9 | 171.1 | 53.2 | 7.2 |
| quinolone | 33.6 | 18.3 | 2.2 | 1.9 |

**(i)** Comment on the standard deviations for **antibiotic use** as shown in Table 2.1.

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.....[2]

**(ii)** Suggest two reasons why the number of prescriptions issued for antibiotics may **not** give an accurate measure of antibiotic use by patients.

1 .....

.....

2 .....

.....

[2]

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**(c)** The number of prescriptions issued for antibiotics varied considerably between clinics.

The researchers wanted to find out whether there was a correlation between the number of prescriptions for each of the five antibiotics issued by a clinic and the percentage of urine samples containing resistant *E. coli*.

Spearman's rank correlation test was used for this analysis.

The results of this analysis are shown in Table 2.2.

**Table 2.2**

| antibiotic | Spearman's rank correlation coefficient ($r_s$) |
|---|---|
| cephalosporin | 0.30 |
| trimethoprim | 0.62 |
| co-amoxiclav | 0.23 |
| ampicillin | 0.71 |
| quinolone | 0.44 |

Table 2.3 shows the critical values for $r_s$ at five levels of significance for the data collected in this study.

**Table 2.3**

| level of significance ($p$) | 0.20 | 0.10 | 0.05 | 0.02 | 0.01 |
|---|---|---|---|---|---|
| critical value of $r_s$ | 0.240 | 0.306 | 0.362 | 0.425 | 0.467 |

**(i)** Suggest why the Spearman's rank correlation test was used in this study.

.....

.....[1]

**(ii)** State a null hypothesis for the Spearman's rank correlation test for this study.

.....

.....[1]

**(iii)** Using Table 2.2 and Table 2.3, identify which antibiotics showed a statistically significant correlation between the number of prescriptions and the presence of resistant strains of *E. coli* in urine samples. Give a reason for your answer.

*antibiotics* .....

*reason* .....

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[2]

**(d)** The percentage of patients with ampicillin-resistant *E. coli* infections varies with age and gender, as shown in Fig. 2.2.

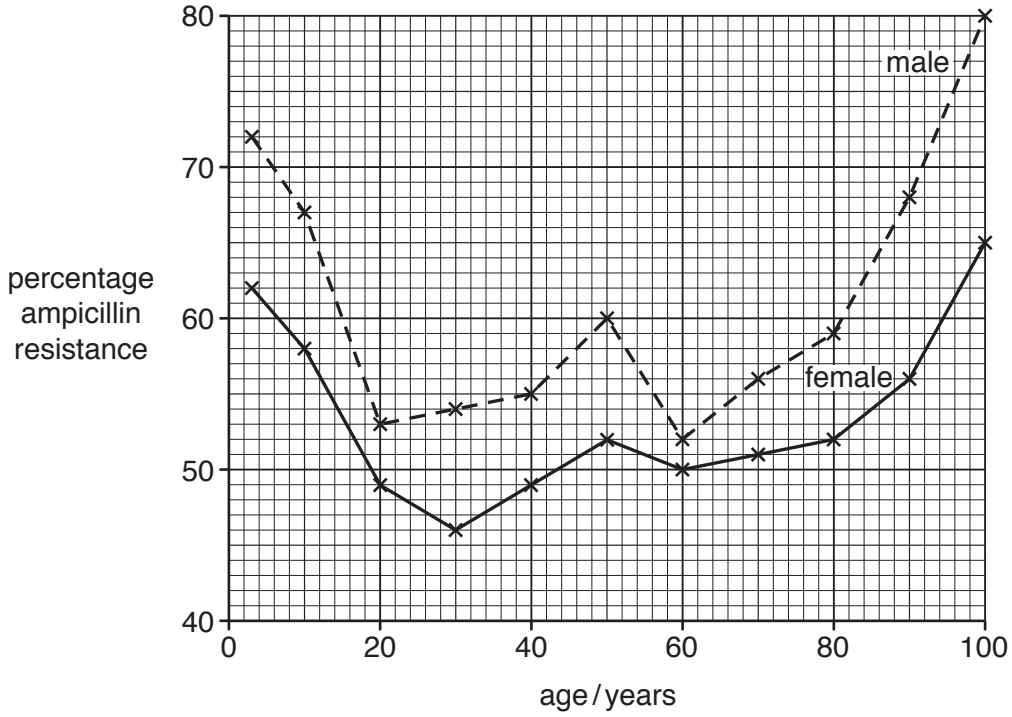



**Fig. 2.2**

Describe **and** explain the trends shown by these data.

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[Total: 15]

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