Materials
For this paper you must have:
• a ruler
• a scientific calculator.

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions in the spaces provided.
• Do all rough work in this book. Cross through any work you do not want to be marked.
• In all calculations, show clearly how you work out your answer.

Information
• The maximum mark for this paper is 100.
• The marks for questions are shown in brackets.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.
In respiration, glucose is broken down.

What is the chemical formula for glucose? 

Tick **one** box.

- $\text{C}_6\text{H}_6\text{O}_6$
- $\text{C}_3\text{H}_6\text{O}_3$
- $\text{C}_6\text{H}_{12}\text{O}_6$
- $\text{C}_6\text{H}_{10}\text{O}_6$

**Figure 1** shows the apparatus a student used to investigate aerobic respiration.

**Figure 1**

Air in $\rightarrow$ Lime water $\rightarrow$ Woodlice $\rightarrow$ Lime water $\rightarrow$ To pump

Lime water goes cloudy when carbon dioxide is added to it.
01.2 After 10 minutes the limewater in flask B was cloudy, but the limewater in flask A remained colourless.

Explain why.

[2 marks]

01.3 Flask A acts as a control in this investigation.

What is the purpose of a control?

[1 mark]

01.4 The student repeated the investigation with no woodlice.

Describe what you would see in flask A and flask B after 10 minutes.

[2 marks]

Flask A

Flask B

Question 1 continues on the next page
Anaerobic respiration is another form of respiration in living organisms.

What is produced during anaerobic respiration in humans?

Tick one box.

- Carbon dioxide
- Carbon dioxide and lactic acid
- Lactic acid
- Oxygen and water

Complete the equation for anaerobic respiration in yeast.

\[
glucose \rightarrow \text{carbon dioxide} + \text{[missing product]}
\]
**Figure 2** shows part of a root from a cress plant.

**Figure 2**

![Image of root hair](image)

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**02.1** What type of microscope was used to create the image in **Figure 2**?

[1 mark]

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**02.2** The magnification of the cress root in **Figure 2** is ×200.

There are 1000 micrometres (µm) in a millimetre (mm).

Calculate the real length of the root hair, X.

Give your answer in micrometres (µm).

[2 marks]

---

Real length \( X = \) \( \mu \text{m} \)

**Question 2 continues on the next page**
Root hair cells take up water from the soil.

Explain one way in which the root hair cell is adapted to this function. [2 marks]

Table 1 shows the water uptake by a plant’s roots on two different days.

Table 1

<table>
<thead>
<tr>
<th>Mean water uptake in cm³ per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold day</td>
</tr>
<tr>
<td>Hot day</td>
</tr>
</tbody>
</table>

Explain why the mean rate of water uptake is higher on a hot day than on a cold day. [3 marks]
The concentration of mineral ions in the soil is lower than in root hair cells.

Root hair cells take up mineral ions from the soil.

Root hair cells contain mitochondria.

Explain why root hair cells contain mitochondria.

[4 marks]
There are no questions printed on this page
Rose black spot is a disease of roses.

What type of microorganism causes rose black spot? [1 mark]

Tick one box.

A bacterium

A fungus

A protist

A virus

Explain how different types of organism defend themselves against microorganisms. [6 marks]

Question 3 continues on the next page
A student tried to grow some bacteria in the laboratory.

Figure 3 shows some of the apparatus used.

This is the method used.

1. Remove the lid of the Petri dish.
2. Remove the lid of the bottle containing the bacteria.
3. Use the inoculating loop to remove some of the bacteria from the bottle.
4. Spread the bacteria over the agar using the inoculating loop.
5. Put the lid back on the Petri dish.
6. Put the Petri dish into an incubator at 25 °C for 24 hours.
Steps 1–5 could cause the sample of the bacteria to be contaminated.

Give three improvements to the method to prevent contamination.

[3 marks]

1. 

2. 

3. 

Why did the student grow the bacteria at 25 °C rather than at 40 °C?

Tick one box.

So the bacteria grew more quickly

So the bacteria grew more slowly

To prevent the growth of a harmful pathogen

To save money

Turn over for the next question
There are no questions printed on this page
Stem cells can be used to treat some diseases.

**Question 4.1** What is a stem cell? [2 marks]

**Figure 4** shows a malignant tumour in the trachea of a patient.

**Figure 4**

Give one way a malignant tumour differs from a benign tumour. [1 mark]

Question 4 continues on the next page
Scientists can treat the patient’s tumour by replacing the trachea with a plastic trachea.

The plastic trachea has a layer of the patient’s own stem cells covering it.

**Figure 5** shows the procedure.

**Figure 5**

**Step 1**
A plastic trachea is made

**Step 2**
Stem cells from the patient’s bone marrow are placed on the surface of the plastic trachea

**Step 3**
The plastic trachea is placed in a liquid medium to allow the stem cells to grow and divide for 48 hours

**Step 4**
The new trachea is transplanted into the patient
04.3 In Step 3 the cells are left for 48 hours to divide.

Name the type of cell division in Step 3.  

[1 mark]

04.4 In Step 3 the cells are given oxygen and water.

Name two other substances the cells need so they can grow and divide.  

[2 marks]

1  

2  

04.5 Give two advantages of using the stem cell trachea compared with a trachea from a dead human donor.  

[2 marks]

1  

2  

04.6 Sometimes the stem cell trachea is not strong enough.

Doctors can put a stent into the trachea.

Suggest how a stent in the trachea helps to keep the patient alive.  

[2 marks]

Question 4 continues on the next page
Stem cells can also be obtained from human embryos.

Evaluate the use of stem cells from a patient’s own bone marrow instead of stem cells from an embryo.

Give a conclusion to your answer. [6 marks]

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

SPECIMEN MATERIAL
A student carried out an investigation using leaf epidermis.

This is the method used.

1. Peel the lower epidermis from the underside of a leaf.
2. Cut the epidermis into six equal sized pieces.
3. Place each piece of lower epidermis into a different Petri dish.
4. Add 5 cm$^3$ of salt solution to the six Petri dishes. Each Petri dish should have a different concentration of salt solution.
5. After 1 hour, view each piece of epidermis under a microscope at ×400 magnification.
6. Count and record the total number of stomata present and the number of open stomata that can be seen in one field of view.

The student’s results are shown in Table 2.

<table>
<thead>
<tr>
<th>Concentration of salt solution in mol / dm$^3$</th>
<th>Number of stomata in field of view</th>
<th>Number of open stomata in field of view</th>
<th>Percentage (%) of open stomata in field of view</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>7</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>0.1</td>
<td>8</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>0.2</td>
<td>7</td>
<td>6</td>
<td>X</td>
</tr>
<tr>
<td>0.3</td>
<td>9</td>
<td>6</td>
<td>67</td>
</tr>
<tr>
<td>0.4</td>
<td>10</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>0.5</td>
<td>9</td>
<td>2</td>
<td>22</td>
</tr>
</tbody>
</table>

Calculation

Calculate value X in Table 2.

\[
X = \frac{\text{Number of open stomata}}{\text{Number of stomata}} \times 100
\]
Give one conclusion from the results in Table 2.  

[1 mark]

How could the student find out what concentration of salt solution would result in half of the stomata being open?  

[1 mark]

The student measured the real diameter of the field of view to be 0.375 mm.  
Calculate the number of open stomata per mm$^2$ of leaf for the epidermis placed in 0.4 mol/dm$^3$ salt solution.  
Use information from Table 2.  
Take $\pi$ to be 3.14  

[3 marks]

Number of open stomata = _______________ per mm$^2$
Figure 6 shows two guard cells surrounding a closed stoma and two guard cells surrounding an open stoma.

Figure 6

When light intensity is high potassium ions are moved into the guard cells.

Describe how the movement of potassium ions into the guard cells causes the stoma to open.

[4 marks]
A virus called RSV causes severe respiratory disease.

Suggest two precautions that a person with RSV could take to reduce the spread of the virus to other people.

[2 marks]

1. 

2. 

One treatment for RSV uses monoclonal antibodies which can be injected into the patient.

Scientists can produce monoclonal antibodies using mice.

The first step is to inject the virus into a mouse.

Describe the remaining steps in the procedure to produce monoclonal antibodies.

[3 marks]

Question 6 continues on the next page
Describe how injecting a monoclonal antibody for RSV helps to treat a patient suffering with the disease. [2 marks]

A trial was carried out to assess the effectiveness of using monoclonal antibodies to treat patients with RSV.

Some patients were given a placebo.

Why were some patients given a placebo? [1 mark]
A number of patients had to be admitted to hospital as they became so ill with RSV.

The results are shown in Table 3.

<table>
<thead>
<tr>
<th>Treatment received by patient</th>
<th>% of patients within each group admitted to hospital with RSV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: Monoclonal antibody for RSV</td>
<td>4.8</td>
</tr>
<tr>
<td>Group B: Placebo</td>
<td>10.4</td>
</tr>
</tbody>
</table>

The trial involved 1,500 patients.
- Half of the patients (group A) were given the monoclonal antibodies.
- Half of the patients (group B) were given the placebo.

Calculate the total number of patients admitted to hospital with RSV during the trial.

[2 marks]

Total number of patients admitted to hospital =

Evaluate how well the data in Table 3 supports the conclusion:

‘monoclonal antibodies are more effective at treating RSV than a placebo’.

[2 marks]
The heart pumps blood to the lungs and to the cells of the body.

Name the blood vessel that transports blood from the body to the right atrium. [1 mark]

The aorta transports blood from the heart to the body.

In a person at rest:
- blood travels at a mean speed of 10 cm/s in the aorta
- blood travels at a mean speed of 0.5 mm/s in the capillaries
- the speed of blood decreases at a rate of 0.4 cm/s² as blood travels from the aorta to the capillaries.

Calculate the time it takes for blood to travel from the aorta to the capillaries. Assume that the speed of blood decreases at a constant rate.

Use the equation:

\[
\text{rate of decrease in speed} = \frac{\text{change in speed}}{\text{time}}
\]

[4 marks]

Give your answer to 2 significant figures.

Time = ________________ s
07.3 Describe the route taken by oxygenated blood from the lungs to the body cells. [4 marks]

Question 7 continues on the next page
The digestive system and the breathing system both contain specialised exchange surfaces.

- In the digestive system, digested food is absorbed into the blood stream in structures called villi.
- In the breathing system, gases are absorbed into the blood stream in the alveoli.

**Figure 7** shows the structure of villi and alveoli.
Explain how the villi and the alveoli are adapted to absorb molecules into the bloodstream. [6 marks]
Amylase is an enzyme found in the human body.

Amylase breaks down starch into sugars.

Where is amylase produced in the human body?

Tick one box.

- Liver and pancreas
- Liver and stomach
- Salivary glands and pancreas
- Salivary glands and stomach

Enzymes speed up chemical reactions.

Explain how amylase breaks down starch.

[3 marks]
One sugar in the body is glucose.

Glucose is used for respiration.

Give **one** other use for glucose in the body. [1 mark]
A student investigated the effect of temperature on the activity of human amylase.

This is the method used.

1. Put 2 cm$^3$ of 1% starch solution into a boiling tube.
2. Put 2 cm$^3$ of amylase solution into a second boiling tube.
3. Put both boiling tubes into a water bath at 20 °C.
4. After 5 minutes, mix the amylase and the starch together in one boiling tube.
5. After 30 seconds, add a drop of the starch and amylase mixture to a drop of iodine solution in one well of a spotting tile.
6. Repeat step 5 until the iodine solution no longer changes colour.
7. Repeat steps 1–6 at 40 °C and at 60 °C and at 80 °C

Why did the student leave the starch and amylase solutions in the water bath for 5 minutes in step 3?

[1 mark]
The temperature of the human body is 37 °C.

**Figure 8** shows the results of the investigation at 20 °C and at 80 °C.

Complete **Figure 8** to show the results you would expect at 40 °C and at 60 °C.

You should write a tick or a cross in each well of the spotting tile.

**Figure 8**

<table>
<thead>
<tr>
<th>Key</th>
<th>20 °C</th>
<th>40 °C</th>
<th>60 °C</th>
<th>80 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Starch present</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>✗ Starch not present</td>
<td>✗</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are different ways to investigate the breakdown of starch by amylase.

One other method is to measure the concentration of starch present in the solution every 30 seconds.

Why is this method better than the method the student used?

**[2 marks]**
A colorimeter can be used to measure the concentration of starch present in the solution every 30 seconds.

A colorimeter measures the amount of light that **cannot** pass through a solution. This is known as absorbance.

**Figure 9** shows a graph of absorbance against concentration of starch.

![Graph](image)
The absorbance of the solution at 40 °C was 0.56 arbitrary units after 30 seconds.

What was the concentration of starch in this solution? [1 mark]

Concentration of starch = %

The concentration of starch in the solution at 20 °C after 1 minute is different from the concentration at 40 °C after 1 minute.

Explain why. [2 marks]

Predict the absorbance for the solution at 80 °C after 30 seconds.

Give a reason for your answer. [3 marks]

Absorbance = arbitrary units

Reason
There are no questions printed on this page