Materials
For this paper you must have:
- Ruler
- Pencil, Rubber, Protractor and Compass
- Scientific calculator, which you are expected to use when appropriate

Instructions
- Answer all questions
- Answer questions in the space provided
- All working must be shown
- Do all rough work in this book. Cross out any rough work you don't want to be marked

Information
- The marks for the questions are shown in brackets
Figure 1 shows one type of white blood cell.

(a) What is structure A?

Tick one box.

- Cell membrane
- Cell wall
- Cytoplasm
- Nucleus
(b) White blood cells help to defend the body against pathogens.

How do the white blood cells do this?

Tick **three** boxes.

- Clone pathogens
- Engulf pathogens
- Produce antibiotics
- Produce antibodies
- Produce antitoxins
- Produce toxins
Measles is a serious disease. A person can die from measles.

**Figure 2** shows the number of cases of measles in England and Wales between 2012 and 2015

(c) Use **Figure 2** to calculate the decrease in the number of cases of measles between 2012 and 2015

___________________________________________________________________

___________________________________________________________________

Answer = ______________________ cases  

(2)

(d) Suggest one reason for the decrease in the number of cases of measles between 2012 and 2015

___________________________________________________________________

___________________________________________________________________

(1)
(e) Antibiotics cannot be used to treat measles.

Suggest why.

___________________________________________________________________
___________________________________________________________________

(f) Gonorrhoea is a disease caused by a bacterium.

Gonorrhoea can be treated with antibiotics.

Give one other way to control the spread of gonorrhoea.

___________________________________________________________________
___________________________________________________________________

A scientist investigated how effective different antibiotics were at killing gonorrhoea bacteria.

This is the method used.

1. Grow gonorrhoea bacteria on agar in a Petri dish.
2. Place one paper disc soaked in water onto the agar.
3. Place four other paper discs, each soaked in a different antibiotic, A, B, C, and D, onto the agar.
4. Use the same sized paper discs and the same concentration of each antibiotic.
5. Incubate the Petri dish for 3 days.

Figure 3 shows the scientist’s results.

A clear area around the disc means the antibiotic has killed the bacteria.

Figure 3

![Figure 3 diagram]

Paper disc soaked in water
Bacteria killed
Bacteria growing
(g) Give one control variable the scientist used.

___________________________________________________________________
___________________________________________________________________

(h) Suggest why one disc was soaked in water.

___________________________________________________________________
___________________________________________________________________

(i) Which antibiotic in Figure 3 would be the best to treat gonorrhoea?

Give a reason for your answer.

Antibiotic ___________________________________________________________
Reason ____________________________________________________________
___________________________________________________________________

(Total 13 marks)

Exercise can improve health.

A student measured her breathing rate at rest, when walking and when jogging.

Figure 1 shows her results.

![Figure 1](image.png)
(a) Compare the breathing rates when doing the three different activities.  
Use values from Figure 1 in your answer.

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(b) Explain why the breathing rate changes when doing different activities.

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___________________________________________________________________  
___________________________________________________________________  
___________________________________________________________________  

Figure 2 shows the heart in the circulatory system.
Coronary heart disease (CHD) is a non-communicable disease.

CHD is caused when fatty material builds up in the coronary arteries.

(a) Explain what a non-communicable disease is.

(b) The heart is a double pump. Describe what this means. Use Figure 2 to help you.

(c) The wall of the left ventricle is much thicker than the wall of the right ventricle. Suggest one reason for this.

(d) People are encouraged to exercise after recovering from a heart attack. Suggest one reason why.

(Total 10 marks)
The diagram below shows a coronary artery of someone with CHD.

(b) Explain how CHD can cause a heart attack.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________

(c) Explain how lifestyle and medical risk factors increase the chance of developing CHD.

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___________________________________________________________________

(3)

(6)
(Total 11 marks)
(a) Name hole A in the leaf surface.
___________________________________________________________________ (1)

(b) Name cell B.
___________________________________________________________________ (1)

(c) Cell B can lose or gain water.

Complete the sentences.

Choose answers from the box.

<table>
<thead>
<tr>
<th>active transport</th>
<th>condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>osmosis</td>
<td>photosynthesis</td>
</tr>
</tbody>
</table>

Cell B can gain water by _______________________________.

Water vapour can escape from the leaf through hole A
by _______________________________. (2)
(d) Which factors increase the rate of water loss from hole A?

Tick two boxes.

- Increasing acidity
- Increasing nitrogen concentration
- Increasing oxygen concentration
- Increasing temperature
- Increasing wind speed

(2)

(e) Give one reason why the movement of water in a plant is important.

___________________________________________________________________
___________________________________________________________________

(1)

(f) The African Baobab tree has no leaves for up to 9 months of the year.

Suggest how this helps the tree to survive in an area where there is not much rain.

___________________________________________________________________
___________________________________________________________________

(1)
(g) The photograph above is a photograph taken through a microscope. The image is magnified 800 times. One of the cells in the image has a width of 12 mm.

Calculate the real width of this cell in micrometres.

Complete the following steps.

Use the equation to work out the real width of the cell in millimetres.

\[
\text{real width of object} = \frac{\text{width of image}}{\text{magnification}}
\]

Real width of cell = ____________________ millimetres

Convert the real width of the cell from millimetres to micrometres.

1 millimetre = 1000 micrometres.

Real width of cell = ____________________ millimetres

(Total 11 marks)

The concentration of glucose in the blood is controlled by homeostasis.

(a) Give one other example of an internal condition controlled by homeostasis.

___________________________________________________________________
___________________________________________________________________

(1)
The graph below shows the change in glucose concentration in the blood of a person with Type 1 diabetes.

(b) Calculate the increase in blood glucose concentration between 1 pm and 2 pm.

___________________________________________________________________
___________________________________________________________________

Increase in blood glucose = _________________ mmol/dm$^3$

(1)

(c) Suggest at what time the person ate lunch.

Use the graph above.

___________________________________________________________________

(1)

(d) Name the hormone the person injected that caused the blood glucose concentration to decrease.

___________________________________________________________________

(1)
(e) Explain the decrease in blood glucose concentration after the hormone was injected.

Use all the words in the box in your explanation.

<table>
<thead>
<tr>
<th>blood</th>
<th>cells</th>
<th>glucose</th>
<th>glycogen</th>
</tr>
</thead>
</table>

___________________________________________________________________
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(2)

(f) Normal blood glucose concentration is approximately 4 mmol/dm$^3$

What could be the reason for the blood glucose concentration falling below normal at 4 pm?

Tick one box.

- The food contained too much glucose
- The person ate another meal
- The person injected too much hormone
- The person fell asleep

(1)

(g) Explain what would happen to the blood glucose concentration if the person went for a run at 6 pm.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
Look at the graph above.

Suggest **one** way that the graph would be different for a person who does not have diabetes.

___________________________________________________________________

___________________________________________________________________

(Total 10 marks)

The diagram below shows a sweet potato plant.

The sweet potatoes grow underground and can be cooked and eaten.

The table below shows some of the nutrients in cooked sweet potato.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Mass in grams per 100 grams of cooked sweet potato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>73.83</td>
</tr>
<tr>
<td>Protein</td>
<td>2.01</td>
</tr>
<tr>
<td>Fat</td>
<td>0.15</td>
</tr>
<tr>
<td>Total carbohydrate of which sugars</td>
<td>20.71</td>
</tr>
<tr>
<td></td>
<td>6.55</td>
</tr>
<tr>
<td>Fibre</td>
<td>3.30</td>
</tr>
</tbody>
</table>
(a) After cooked sweet potato is digested, sugars (including glucose) pass into the blood.

Give two other soluble molecules that would pass into the blood after cooked sweet potato is digested.

1. _________________________________________________________________
2. _________________________________________________________________

(b) Calculate the mass of sugars in 180 g of cooked sweet potato.

Use the information from the table above.

___________________________________________________________________
___________________________________________________________________

Mass of sugars = _____________________ g

(c) The sweet potatoes found underground contain starch.

Explain how starch in the sweet potato is produced from carbon dioxide in the air.

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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 9 marks)
Some students tested a red cabbage leaf for starch.

This is the method used.

1. Boil the leaf in ethanol.
2. Rinse the leaf in water.
3. Add the reagent to test the leaf for starch.

(a) Give **one** safety precaution the students should take in this test.

___________________________________________________________________
___________________________________________________________________


(b) Which reagent is used to test the boiled leaf for starch?

Tick **one** box.

- Benedict's solution
- Biuret solution
- Iodine solution
- Sodium chloride solution

(1)
(c) What colour will be seen if the test for starch is positive?

Tick one box.

Blue-black
Pale pink
Orange
Red

(1)

The students then used paper chromatography to investigate the coloured pigments in a red cabbage leaf.

(d) Complete the sentences.

Choose answers from the box.

| distil | evaporate | filter | mobile | separate | solid |

Chromatography can be used to ___________________________ mixtures.

In paper chromatography, the paper is part of the stationary phase.

The solvent is called the ___________________________ phase.

(2)

Table 1 shows the students’ results.

The distance each pigment moved was measured from the start line.

<table>
<thead>
<tr>
<th>Distance moved in mm</th>
<th>R_f value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow-green pigment</td>
<td>17</td>
</tr>
<tr>
<td>Yellow pigment</td>
<td>46</td>
</tr>
<tr>
<td>Orange pigment</td>
<td>100</td>
</tr>
</tbody>
</table>
The $R_f$ value is calculated using the equation:

$$R_f = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent}}$$

(e) The solvent moved 110 mm from the start line.

Calculate $R_f$ value $X$ in Table 1.

Give your answer to 2 significant figures.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

$R_f$ value $X$ = ______________________ (2)

(f) The known ranges of $R_f$ values of some pigments are shown in Table 2.

<table>
<thead>
<tr>
<th>Pigment</th>
<th>$R_f$ value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotene</td>
<td>0.89 to 0.98</td>
</tr>
<tr>
<td>Chlorophyll a</td>
<td>0.24 to 0.30</td>
</tr>
<tr>
<td>Chlorophyll b</td>
<td>0.20 to 0.26</td>
</tr>
<tr>
<td>Xanthophyll</td>
<td>0.04 to 0.28</td>
</tr>
</tbody>
</table>
The $R_f$ value for the orange pigment in red cabbage leaves is 0.91.

What is this orange pigment most likely to be?

Tick one box.

Carotene

Chlorophyll a

Chlorophyll b

Xanthophyll

In 2017 more than 420 million people worldwide had diabetes.

The table below shows how the percentage of the population with diabetes has changed.

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of population with diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low-income countries</td>
</tr>
<tr>
<td>1986</td>
<td>3.5</td>
</tr>
<tr>
<td>1992</td>
<td>4.4</td>
</tr>
<tr>
<td>1998</td>
<td>5.2</td>
</tr>
<tr>
<td>2004</td>
<td>6.0</td>
</tr>
<tr>
<td>2010</td>
<td>6.9</td>
</tr>
</tbody>
</table>
(a) Use data from the table above to complete the graph in the graph below.

You should:
• plot the data for the low-income countries
• draw a line of best fit for the low-income countries.

The lines for high-income countries and the world have been drawn for you.

(b) Predict the percentage of the world population with diabetes in 2022 if the current pattern were to continue.

You should extend the line of best fit for the world on the graph above.

Percentage = _______________ %

(c) The trend may not continue in the same pattern after 2010.

Suggest one reason why the trend may change.

___________________________________________________________________
___________________________________________________________________

(1)

(2)

(3)
(d) Give two conclusions from the data shown in the graph above.

1. _________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

2. _________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

(2)

(e) The table above shows that the percentage of people with diabetes in the world has changed.

What are two possible reasons for this change?

Tick two boxes.

People are becoming more obese
People are doing more exercise
People are eating less salt
People are eating more sugar
People are smoking less

(2)
(Total 10 marks)
A man with breathing difficulties goes to hospital.
The photographs below show his lung scan and chest X-ray.

(a) What is part A?

Tick one box.

Bronchus
Capillary
Trachea
Vein

(b) Give one advantage of using the lung scan, rather than the chest X-ray, to diagnose problems with the man’s breathing system.

___________________________________________________________________
___________________________________________________________________

(1)
(c) Give **one** advantage of using the **chest X-ray**, rather than the lung scan, to diagnose problems with the man’s breathing system.

___________________________________________________________________
___________________________________________________________________

(d) Aerobic respiration and anaerobic respiration are the two types of cell respiration.

Give **three** differences between aerobic and anaerobic respiration.

1. __________________________________________________________________

2. __________________________________________________________________

3. __________________________________________________________________

___________________________________________________________________

___________________________________________________________________
(e) A health website contains the following advice:

Stop smoking and you will be healthier and live longer.

Explain why stopping smoking will improve a person’s health.

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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(6) (Total 12 marks)
Figure 1 shows an animal cell and a bacterial cell.

(a) Compare the structure of the cells in Figure 1.

Complete the sentences.

Choose the answers from the box.

<table>
<thead>
<tr>
<th>cell membrane</th>
<th>cell wall</th>
<th>chloroplast</th>
</tr>
</thead>
<tbody>
<tr>
<td>cytoplasm</td>
<td>nucleus</td>
<td></td>
</tr>
</tbody>
</table>

Only the animal cell contains a ________________________________.

Only the bacterial cell contains a ________________________________.

(2)

Figure 2 shows a section through a leaf.
(b) The function of palisade cells is to photosynthesise.

Describe one way palisade cells are adapted to carry out their function.

___________________________________________________________________

___________________________________________________________________

(1)

(c) Complete Table 1 to show whether each structure is a tissue, an organ or an organ system.

Tick one box for each structure.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Tissue</th>
<th>Organ</th>
<th>Organ system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xylem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots, stem and leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2)

A student observed palisade cells using a microscope.

The microscope had four objective lenses, each with a different magnification.

(d) Which objective lens should the student use first?

Tick one box.

Give a reason for your answer.

×4 magnification

×10 magnification

×40 magnification

×100 magnification

Reason

___________________________________________________________________

___________________________________________________________________

(2)
The student measured the width of 5 different palisade cells at a total magnification of ×400

(e) Eyepiece lenses are usually ×5 or ×10 magnification.

What combination of eyepiece and objective lenses would give a total magnification of ×400?

Eyepiece lens ____________________

Objective lens ____________________

(f) Table 2 shows the student’s results.

<table>
<thead>
<tr>
<th>Cell</th>
<th>Width of cell image in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>

(f) Calculate the mean width of the palisade cell images.

___________________________________________________________________

___________________________________________________________________

Mean width = ____________________ mm

(g) Calculate the real width of a palisade cell.

Use the mean width you calculated in part (f).

Use the equation:

\[
\text{real width} = \frac{\text{image width}}{\text{magnification}}
\]

___________________________________________________________________

___________________________________________________________________

Real width = ____________________ mm
Figure 1 shows the human digestive system.

(a) Which organ in Figure 1 produces acid?

Tick one box.

A  B  C  D  E

(1)

(b) Which organ in Figure 1 produces bile?

Tick one box.

A  B  C  D  E

(1)

(c) Where in Figure 1 are digested foods absorbed into the blood?

Tick one box.

A  B  C  D  E

(1)
Food molecules such as proteins **cannot** be absorbed unless they are digested. Give **one** reason why.

A scientist investigated the effect of pH on the activity of two protease enzymes. **Figure 2** shows the results.

**Figure 2**

![Enzyme Activity vs pH Graph](image)

(e) What is the optimum pH for enzyme Y?

pH ____________________

(1)
(f) Where in the digestive system might the two protease enzymes be produced?

Tick one box.

<table>
<thead>
<tr>
<th>Enzyme X</th>
<th>Enzyme Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td>Stomach</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Mouth</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Pancreas</td>
</tr>
<tr>
<td>Stomach</td>
<td>Small intestine</td>
</tr>
</tbody>
</table>

Figure 3 shows a model of an enzyme molecule.
(g) Which substrate fits the enzyme molecule in **Figure 3**?

Tick **one** box.

- [ ]
- [ ]
- [ ]
- [ ]

(h) The enzyme and substrate diagrams are used as a model for a theory of enzyme action.

What is the name of this theory?

Tick **one** box.

- Evolution
- Lock and key
- Natural selection
- Protein synthesis
(i) Explain why pH affects enzyme activity.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 10 marks)

Figure 1 shows part of the lungs.

Figure 1

Bronchiole (branch of a bronchus)

Blood vessel

Alveoli

(a) Give two ways the lungs are adapted for efficient exchange of gases.

Describe how each adaptation helps to maintain efficient gas exchange.

Adaptation 1 ________________________________________________________
___________________________________________________________________
___________________________________________________________________
Description _________________________________________________________
___________________________________________________________________

Adaptation 2 ________________________________________________________
___________________________________________________________________
___________________________________________________________________
Description _________________________________________________________
___________________________________________________________________

(4)
(b) There are 5.4 million people with asthma in the UK.

What type of disease is asthma?

Tick one box.

- An allergy
- A bacterial infection
- A cancer
- A viral infection

(c) Figure 2 shows cross-sections of bronchioles of two people.

**Figure 2**

Person without asthma

- Relaxed muscle fibres
- Air passage

Person with asthma

- Contracted muscle fibres

Suggest why people with asthma often find it difficult to breathe.

___________________________________________________________________

___________________________________________________________________

(1)
(d) People with asthma often have a reduced lung volume.

**Figure 3** shows the apparatus a student used to measure his lung volume.

![Diagram of measurement apparatus]

This is the method used.

1. Fill the bottle with water.
2. Breathe out through the tube.

The volume of water pushed out of the bottle is equal to his lung volume.

What is the student's lung volume?

\[
\text{Volume} = \underline{\phantom{0000}} \text{dm}^3
\]

(1)

Scientists tested a new drug to treat asthma.

The scientists measured the lung volume of:

- volunteers without asthma
- some volunteers during a mild asthma attack
- other volunteers during a severe asthma attack.

Half the people in each group were given a placebo.

The other half of the people in each group were given the new drug.

The tests were carried out as a double blind trial.

(e) What is a placebo?

____________________________________________________________________

____________________________________________________________________

(1)
(f) Who knows which volunteers in a double blind trial are given the drug and which volunteers are given the placebo?

Tick **one** box.

- The scientists but not the volunteers
- The scientists and the volunteers
- The volunteers but not the scientists
- Neither the volunteers nor the scientists

(g) Suggest why it is a good idea that double blind trials should be used in drug testing?

___________________________________________________________________
___________________________________________________________________

(1)
(h) **Figure 4** shows the results of the drug tests.

![Figure 4](image)

Give **two** conclusions that can be made about the usefulness of the drug.

1. _________________________________________________________________
   ___________________________________________________________________

2. _________________________________________________________________
   ___________________________________________________________________

(2)  
(Total 12 marks)