A Use the words and formulae below to complete the word and symbol equations for photosynthesis.

\[
\begin{align*}
\text{C}_6\text{H}_{12}\text{O}_6 & \quad \text{oxygen} & \quad \text{light} & \quad \text{CO}_2 & \quad \text{water} \\
\text{carbon dioxide} + & \quad \text{glucose} + & \quad 6 & \quad 6\text{H}_2\text{O} + & \quad 6\text{O}_2 \\
6 & \quad + & \quad 6\text{H}_2\text{O} & \quad + & \quad 6\text{O}_2
\end{align*}
\]

B A student carried out an experiment using the equipment shown opposite.

She placed pondweed in some water and shone a lamp on it. She observed bubbles collecting in the test tube.

She placed a glowing splint into the test tube and it relit.

a Underline the section of text that is evidence that a plant makes a gas during photosynthesis.

b Circle the section of text that is evidence that the gas is oxygen.

C The leaves of a plant are adapted to carry out photosynthesis.

Draw a line to match each adaptation to its function.

<table>
<thead>
<tr>
<th>Adaptation of leaf</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>broad shape</td>
<td>to allow carbon dioxide to enter the leaf and oxygen to leave</td>
</tr>
<tr>
<td>thin</td>
<td>to bring water to the cells</td>
</tr>
<tr>
<td>stomata</td>
<td>big surface area for light to fall on</td>
</tr>
<tr>
<td>veins</td>
<td>allow carbon dioxide to get to cells and oxygen to leave, by diffusion</td>
</tr>
<tr>
<td>air spaces</td>
<td>diffusion distances for gases are short</td>
</tr>
</tbody>
</table>

What you need to remember

Photosynthesis is an \underline{\text{\textbf{chemical}}} \underline{\text{\textbf{reaction}}} \underline{\text{\textbf{that}} \underline{\text{\textbf{takes}} \underline{\text{\textbf{place}} \underline{\text{\textbf{in}} \underline{\text{\textbf{the}} \underline{\text{\textbf{cells}}} \underline{\text{\textbf{in}}} \underline{\text{\textbf{the}} \underline{\text{\textbf{plant}} \underline{\text{\textbf{leaves}}}}}} \underline{\text{\textbf{by}} \underline{\text{\textbf{chloroplast}}} \underline{\text{\textbf{by}} \underline{\text{\textbf{convert}} \underline{\text{\textbf{carbon}} \underline{\text{\textbf{dioxide}} \underline{\text{\textbf{and}} \underline{\text{\textbf{water}}} \underline{\text{\textbf{into}} \underline{\text{\textbf{sugar}} \underline{\text{\textbf{(glucose)}}}}}} \underline{\text{\textbf{.}}}}}} \underline{\text{\textbf{A}} \underline{\text{\textbf{green}} \underline{\text{\textbf{substance}} \underline{\text{\textbf{called}} \underline{\text{\textbf{chlorophyll}}} \underline{\text{\textbf{captures}} \underline{\text{\textbf{the}} \underline{\text{\textbf{light}}}}}} \underline{\text{\textbf{.}}}}}} \underline{\text{\textbf{Photosynthesis}} \underline{\text{\textbf{can}} \underline{\text{\textbf{be}} \underline{\text{\textbf{summarised}} \underline{\text{\textbf{as}} \underline{\text{\textbf{follows}} \underline{\text{\textbf{}}}}}} \underline{\text{\textbf{that}} \underline{\text{\textbf{carbon}} \underline{\text{\textbf{dioxide}} \underline{\text{\textbf{and}} \underline{\text{\textbf{water}} \underline{\text{\textbf{into}} \underline{\text{\textbf{sugar}} \underline{\text{\textbf{(glucose)}}}}}}} \underline{\text{\textbf{.}}}}}} \underline{\text{\textbf{Leaves}} \underline{\text{\textbf{are}} \underline{\text{\textbf{well}} \underline{\text{\textbf{adapted}} \underline{\text{\textbf{to}} \underline{\text{\textbf{allow}} \underline{\text{\textbf{the}} \underline{\text{\textbf{maximum}} \underline{\text{\textbf{amount}} \underline{\text{\textbf{of}} \underline{\text{\textbf{photosynthesis}} \underline{\text{\textbf{to}} \underline{\text{\textbf{take}} \underline{\text{\textbf{place}}}}}}}}} \underline{\text{\textbf{.}}}}}}
A  You can investigate the effect of light intensity on the rate of photosynthesis.

Draw a line from each variable in the investigation to its type.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature of water</td>
<td>independent variable</td>
</tr>
<tr>
<td>distance from light to plant</td>
<td>independent variable</td>
</tr>
<tr>
<td>type of plant</td>
<td>independent variable</td>
</tr>
<tr>
<td>volume of oxygen produced after 5 minutes</td>
<td>dependent variable</td>
</tr>
<tr>
<td>temperature of room</td>
<td>control variable</td>
</tr>
<tr>
<td>concentration of carbon dioxide in the water</td>
<td>control variable</td>
</tr>
</tbody>
</table>

B  Which of the graphs below correctly shows the results obtained from this investigation?

Tick the correct box.

X  

U  

V  

C  In certain conditions, the amount of photosynthesis a plant can carry out is limited. This is due to **limiting factors**.

Which of these are limiting factors for photosynthesis?

Tick the correct boxes.

W  concentration of minerals in the soil  

X  carbon dioxide concentration  

Y  temperature  

Z  amount of starch in leaves  

**What you need to remember**

The rate of photosynthesis may be affected by ____________ intensity, temperature, concentration of ____________, ____________, and chlorophyll levels in the leaf. These are known as ____________ factors because at times any one or several of these things can be in short supply and limit the rate.

For most plants the ____________ the light, the faster the rate of photosynthesis. As temperature rises, the rate of photosynthesis ____________ up to a certain temperature. After this, ____________ are denatured and the rate falls. Increasing the concentration of carbon dioxide will ____________ the rate of photosynthesis.
B8.3 How plants use glucose

A  You can test leaves for the presence of starch. The sentences below describe the stages in the method.

1. Boil the leaf in ethanol to... ...test for starch.
2. Rinse the leaf in hot water to... ...remove the green colour.
3. Add iodine to the leaf to... ...soften the leaf.

B  A student tested some plant parts for the presence of different food molecules.

Their results are shown below.

<table>
<thead>
<tr>
<th>What was tested</th>
<th>Added iodine</th>
<th>Added to ethanol</th>
<th>Heated with Benedict’s solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>tuber (potato)</td>
<td>went black</td>
<td>stayed clear</td>
<td>went orange</td>
</tr>
<tr>
<td>seed (sunflower)</td>
<td>went black</td>
<td>went cloudy</td>
<td>stayed blue</td>
</tr>
<tr>
<td>fruit (apple)</td>
<td>stayed orange</td>
<td>stayed clear</td>
<td>went red</td>
</tr>
</tbody>
</table>

Which plant part(s) contains:

a  sugars?

b  starch?

c  lipids?

C  Circle true or false for the following statements.

a  Plants carry out respiration 24 hours a day.  true/false

b  Glucose is stored as starch because starch is soluble in water.  true/false

c  Plants use glucose to make cellulose.  true/false

d  Some plants can get nitrates from digesting animals.  true/false

e  Only animals contain lipids (fats).  true/false

What you need to remember

Plant and algal cells use the glucose produced during photosynthesis for _______________ to transfer energy. They also convert the glucose into insoluble _______________ for storage, and use it to produce fats or oils for storage, _______________ to strengthen cell walls, and amino acids. Plants and algal cells also need _______________ ions absorbed from the soil or water to make amino acids. The amino acids are joined together to make _______________.
A student carried out an investigation into how a limiting factor affects the rate of photosynthesis. The equipment they used is shown in Figure 1.

This is the method they used:
1. Place the pondweed 20 cm away from the lamp.
2. Leave the pondweed for 5 minutes.
3. Measure the pH of the water in the test tube.
4. Change the water in the test tube and repeat.
5. Repeat steps 1–5, moving the test tube away from the lamp by 20 cm each time.

01.1 Which limiting factor is the student investigating? Tick one box. [1 mark]

- W light intensity
- X carbon dioxide concentration
- Y temperature
- Z pH of water

01.2 Use Figure 1 to explain how the student is controlling the temperature of the pondweed. [1 mark]

01.3 Their results are shown in Table 1.

<table>
<thead>
<tr>
<th>Distance of lamp from pondweed in cm</th>
<th>pH of water around pondweed after 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>20</td>
<td>8.5</td>
</tr>
<tr>
<td>40</td>
<td>8.2</td>
</tr>
<tr>
<td>60</td>
<td>7.7</td>
</tr>
<tr>
<td>80</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Calculate the missing value in Table 1. [2 marks]

01.4 If carbon dioxide is removed from water, the pH of the water becomes more alkaline (pH > 7).
State what happened to the pH of the water after 5 minutes when the lamp was 20 cm away from the pondweed. [1 mark]

HINT Remember that ‘>’ means ‘more than’.

01.5 Explain why this happened. [2 marks]

01.6 Write a conclusion to explain the trend in the results. [3 marks]

HINT Your conclusion should describe the pattern (trend) in the results and explain why there is this trend. Make sure it contains three separate points (one for each mark).
<table>
<thead>
<tr>
<th>Task</th>
<th>Student Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can list the raw materials and energy source for photosynthesis.</td>
<td>8.1</td>
</tr>
<tr>
<td>I can describe photosynthesis as an endothermic reaction.</td>
<td>8.1</td>
</tr>
<tr>
<td>I can write the equations that summarise photosynthesis.</td>
<td>8.1</td>
</tr>
<tr>
<td>I can list the factors that limit the rate of photosynthesis in plants.</td>
<td>8.2</td>
</tr>
<tr>
<td>I can describe how plants use the glucose they make.</td>
<td>8.3</td>
</tr>
<tr>
<td>I can name the extra materials that plant cells need to produce proteins.</td>
<td>8.3</td>
</tr>
<tr>
<td>I can describe some practical tests for starch, sugars, and proteins.</td>
<td>8.3</td>
</tr>
</tbody>
</table>
B9.1 Aerobic respiration

A  Aerobic respiration is a reaction that takes place in all living cells.

Draw a line from each substance to show if it is a reactant or a product of respiration.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Reactant</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oxygen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glucose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B  Many of the stages of aerobic respiration take place in one part of the cell.

On the diagram of an animal cell below, label this part with its name.

C  The energy transferred during respiration supplies all the energy needed for living processes in the cells.

Describe why the following cells need energy.

a  a muscle cell

b  a plant root hair cell

What you need to remember

Aerobic respiration is an _____________ reaction that takes place in all living cells. It can be summarised as:

\[ \text{glucose} + \text{[reactant]} \rightarrow \text{[product]} + \text{water} \ (\text{+ energy transferred to the environment}) \]

Most stages take place in the _____________ of the cells. The _____________ transferred is needed for living processes. Some organisms, such as humans, need it for keeping warm.
B9.2 The response to exercise

A Circle the correct bold words to complete the description of what happens when you exercise.

When you exercise your muscles start contracting slower/faster.

Your heart rate decreases/increases and the arteries supplying blood to your muscles dilate/constrict. This increases the flow of deoxygenated/oxygenated blood to the muscles.

Your breathing rate decreases/increases and you breathe more shallowly/deeply. This increases the amount of oxygen/carbon dioxide in the blood. It also allows oxygen/carbon dioxide to be removed more quickly from the blood.

B Name the carbohydrate used to store glucose in the muscles.

Tick the correct box.

W starch
X insulin
Y glucagon
Z glycogen

C Four Year 10 students measured their pulse rates at rest. They then ran on a treadmill at a speed of 8 km/h for 5 minutes and measured their pulse rates during the run. The results are shown below.

<table>
<thead>
<tr>
<th>Student</th>
<th>Pulse rate in beats per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At rest</td>
</tr>
<tr>
<td>Jasmine</td>
<td>80</td>
</tr>
<tr>
<td>Louise</td>
<td>72</td>
</tr>
<tr>
<td>Brandon</td>
<td>84</td>
</tr>
<tr>
<td>Ruby</td>
<td>65</td>
</tr>
</tbody>
</table>

Write the correct words in the gaps.

During exercise the pulse rates of all the students ________________.

Louise’s pulse rate went up by ________________ beats per minute.

_______________ was the fittest person.

Her heart volume was probably the ________________.

What you need to remember

When you exercise your ________________ help you move around. They need energy to contract.

During exercise the human body responds to the increased demand for energy. Body responses to exercise include:

- increases in the ________________ rate, the breathing rate, and the breath volume
- ________________ stores in the muscles are converted to glucose for respiration
- the flow of oxygenated ________________ to the muscles increases.

These responses act to increase the rate of supply of glucose and ________________ to the muscles.

They also increase the rate of removal of ________________, ________________ from the muscles.
B9.3 Anaerobic respiration

A Which of the following word equations correctly shows anaerobic respiration in animal cells?

Tick the correct box.

W glucose → lactic acid + carbon dioxide  
X glucose → lactic acid  
Y glucose → carbon dioxide + water  
Z glucose → carbon dioxide + ethanol

B Tick the boxes to compare aerobic and anaerobic respiration in animal cells.

Some rows apply to both types of respiration.

<table>
<thead>
<tr>
<th>Glucose is a reactant.</th>
<th>✓ if true for aerobic respiration</th>
<th>✓ if true for anaerobic respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen is a reactant.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon dioxide is produced.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy is transferred to the environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cells can carry it out continuously.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C Plants and microorganisms also carry out anaerobic respiration. These reactions can be useful for us.

Circle true or false for each statement.

a  Anaerobic respiration in yeast is known as fermentation. true/false
b  The production of ethanol during bread-making makes the bread rise. true/false
c  Bacteria that produce lactic acid are used to make yoghurt. true/false
d  During the brewing process, yeast produces carbon dioxide. true/false

What you need to remember

Anaerobic respiration is respiration without ________________ . When this takes place in animal cells, glucose is incompletely broken down to form ________________ acid. Because of this, anaerobic respiration transfers ________________ energy than aerobic respiration.

When you exercise hard, your blood might not be able to supply the muscles with enough ________________ so they use anaerobic respiration. The acid produced makes muscles tired.

Anaerobic respiration in ________________ cells and some microorganisms, such as yeast, results in the production of ________________ and carbon dioxide.
B9.4 Metabolism and the liver

A Which is the correct definition of metabolism?

Tick the correct box.

W the sum of all the chemical reactions in your body    □
X how fast you transfer energy during respiration    □
Y how easily you lose weight    □
Z the amount of energy transferred from your body    □

B Draw a line to match each word or symbol equation to the metabolic reaction it represents.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Metabolic reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 )</td>
<td>photosynthesis</td>
</tr>
<tr>
<td>sucrose → glucose + fructose</td>
<td>breakdown of molecules</td>
</tr>
<tr>
<td>( 6H_2O + 6CO_2 \rightarrow C_6H_{12}O_6 + 6O_2 )</td>
<td>respiration</td>
</tr>
<tr>
<td>amino acids → protein</td>
<td>formation of molecules</td>
</tr>
</tbody>
</table>

C Circle each correct word to describe a metabolic reaction.

The breakdown of excess proteins in the kidney to form glucose in the liver to form urea and glucose in the protein.

What you need to remember

Metabolism is the sum of all the ____________ in the body. The energy transferred by ____________ in cells is used by the organism for the enzyme-controlled processes that synthesise new molecules or break molecules down.

Metabolism includes:

● the conversion of ____________ to starch, glycogen, and cellulose
● the formation of lipid molecules
● the use of glucose and nitrate ions to form ____________ acids, which are used to synthesise proteins
● the breakdown of excess proteins to form ____________, which takes place in the ____________.
01 Yeast is a single-celled fungus. It carries out anaerobic respiration.

01.1 Complete the word equation for this reaction. [1 mark]

\[ \text{glucose} \rightarrow \text{product} + \text{carbon dioxide} \]

**HINT** Remember, energy is released during respiration but this is not a product, so it not included in the equation.

01.2 Give one reason why this reaction is useful to humans. [1 mark]

01.3 Animals, such as humans, also carry out anaerobic respiration.

01.3.1 Give one way in which anaerobic respiration in animals and fungi is the same. [1 mark]

01.3.2 Give one way in which anaerobic respiration in animals and fungi is different. [1 mark]

02 A student was asked to carry out an investigation into the anaerobic respiration of yeast.

**Figure 1** shows the equipment he was told to use.

The volume of carbon dioxide produced is measured using the syringe.

![Figure 1](image.png)

02.1 Explain how the student could use the equipment in **Figure 1** to investigate how changing the temperature affects the rate of anaerobic respiration in yeast. [4 marks]

**HINT** A water bath can be used to change the temperature of the flask.

02.2 The student plotted his results as a line graph, as shown in **Figure 2**.

![Figure 2](image.png)

Describe what the graph shows about how temperature affects the rate of anaerobic respiration in yeast. [3 marks]

**HINT** To get the full marks, make sure you describe three different trends in the graph. Include numbers and units, such as: ‘between a temperature of ... and ..., the rate ...’.
I can write the equations that summarise aerobic respiration. 9.1
I can explain why cellular respiration is important. 9.1
I can describe how my body responds to the increased demands for energy during exercise. 9.2
I can explain why less energy is transferred by anaerobic respiration than by aerobic respiration. 9.3
I can describe how anaerobic respiration can take place in lots of different organisms, including plants, bacteria, and fungi. 9.3
I can define metabolism. 9.4