

Respiration

Mark Scheme



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1. Respiration is the process that releases energy from glucose, making it available for the diverse functions of living cells. Answer the following questions. Circle the letter of the correct answer for each.

- a) Yeast is placed inside a container full of a glucose solution with no air.

Which word equation summarises the process that takes place inside the container?

A – is the only correct answer.	1 mark
	Total: 1 mark

- b) Which row describes anaerobic respiration?

D – is the only correct answer.	1 mark
	Total: 1 mark

- c) What role does anaerobic respiration perform in bread-making?

D – is the only correct answer.	1 mark
	Total: 1 mark

- d) Which organelle is the site of aerobic respiration within cells?

C – is the only correct answer.	1 mark
	Total: 1 mark

- e) Which of the following is a product of **aerobic** respiration in animal cells?

C – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 5 marks)

2. A student investigated how different amounts of glucose influence anaerobic respiration in yeast.

a) This method was repeated for each concentration of glucose.

Describe how to set up a control for this investigation.

A description to include two of the following:	
Set up identical apparatus / experiment / measuring cylinder but without glucose / use water instead of glucose solution.	1 mark
Include yeast.	1 mark
Include washing-up liquid	1 mark
Keep other conditions the same / measure after the same time.	1 mark
	Total: 2 marks

b) Give the word and balanced symbol equation for **aerobic** respiration.

Glucose + oxygen → carbon dioxide + water	2 marks
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	2 marks
	Total: 4 marks

c) State how the scientist could improve this investigation to increase the rate of the reaction.

A statement to include two of the following:	
Increase the temperature.	1 mark
Towards optimum / named temperature range approx. 30-40 °C.	1 mark
Increase the amount / concentration of yeast.	1 mark
Ensure anaerobic conditions more effectively e.g. layer of oil.	1 mark
	Total: 2 marks

d) The student thought one of the results was anomalous. Explain which of these results is anomalous.

An explanation to include the following:	
Identifies the result at 15 % glucose / 3 mm foam as anomalous,	1 mark
Explains why it is anomalous, e.g. it does not fit the (general) pattern / trend.	1 mark
	Total: 2 marks

e) With this anomalous result in mind, calculate the mean height of foam after 3 minutes.

$12 + 13 + 11 + 12$	1 mark
Divides sum of valid results by the correct number of valid results $48 \div 4$	1 mark
$= 12$	1 mark
	Total: 3 marks

f) Provide an explanation for why the foam reached its maximum height when the glucose concentration was 30 %.

An explanation to include the following:	
At lower concentrations, glucose is the limiting factor for the rate of respiration / foam production.	1 mark
At 30% (or high concentrations), glucose is no longer the limiting factor / is in excess.	1 mark
Therefore another factor is limiting the rate, such as enzyme / yeast concentration OR enzyme active sites are saturated (with glucose).	1 mark
	Total: 3 marks

(Total for Question 2 is 16 marks)

3. Dead plants and animals contain complex organic molecules.

a) Name the process carried out by decomposers that releases energy from these complex organic molecules.

<u>Aerobic respiration</u>	2 marks
	Total: 2 marks

b) Describe **two** ways in which the respiration of decomposers is important for the recycling of nutrients within an ecosystem.

Award up to 2 marks for each distinct way described:	
Way 1: <u>Carbon Cycling</u> Respiration releases carbon dioxide / CO ₂ . Carbon dioxide / CO ₂ is used by plants / producers for photosynthesis.	
Way 2: <u>Energy for Decomposition / Mineral Release.</u> - Respiration releases energy / provides ATP. - This energy is used (by decomposers) for the breakdown / decomposition of (complex) organic molecules / dead organisms / waste products OR used for synthesis of enzymes (involved in breakdown). - The breakdown (powered by respiration) releases mineral ions / nutrients (e.g., nitrates, phosphates, magnesium ions) into the soil / environment. - These mineral ions / nutrients can then be absorbed / taken up by plants (for growth).	
	Total: 4 marks

c) Explain why decomposers respire both aerobically and anaerobically, depending on the conditions in their environment.

An explanation to include the following:	
When oxygen is present / available / in aerobic conditions, they respire aerobically because this releases more energy / is more efficient.	1 mark
When oxygen is absent / limited / in anaerobic conditions, they respire anaerobically which still releases (some) energy / ATP for survival.	1 mark
This ability (to use both / switch modes) allows them to survive / function / decompose organic matter in environments where oxygen levels vary / fluctuate / may be low.	1 mark
	1 mark
	Total: 3 marks

d) Give **one** example of an environmental condition that would favour anaerobic respiration in decomposers.

An example to include one of the following:	
Lack/ absence / low levels / shortage of oxygen.	1 mark
Allow: waterlogged soil / bog / marsh	
	Total: 1 mark

(Total for Question 3 is 10 marks)

4. During intense exercise in animals and in the absence of oxygen in yeast, anaerobic respiration occurs.

a) State **one** similarity and **one** difference in the overall process of anaerobic respiration in animal muscle cells and yeast cells.

Similarity any one from:	
- Does not use / require oxygen. - Starts with glucose. - Releases (relatively) small amount of energy / ATP - Occurs in cytoplasm. - Involves incomplete breakdown of glucose.	1 mark
Difference any one from:	
- Different products formed. - Animal (muscle) produces lactic acid whereas yeast produces ethanol / alcohol (+ carbon dioxide). - Yeast produces carbon dioxide / CO₂ / gas whereas animal (muscle) does not.	1 mark
	Total: 2 marks

b) Write the **balanced** chemical equation for anaerobic respiration in yeast cells.

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$	3 marks
	Total: 3 marks

c) Calculate the percentage change in the rate of carbon dioxide production between the first 4 minutes and the last 4 minutes of the experiment. Show all working.

Calculation of initial rate (first 4 mins) = 3 cm ³ /min.	
Final rate (last 4 mins) = 2.5 cm ³ /min	1 mark
Calculation for second mark: [(final rate - initial rate) ÷ initial rate] × 100	
[(2.5 - 3) ÷ 3] × 100 = (-)16.6... (%)	1 mark
	Total: 2 marks

d) Explain why the products of anaerobic respiration in animal muscle cells can lead to muscle fatigue.

An example to include two of the following:	
Anaerobic respiration <u>produces lactic acid</u> .	1 mark
(Build-up of lactic acid causes) pH to fall / muscles become acidic / acidity increases OR (Lactic acid build-up) inhibits / denatures / affects / stops enzymes working.	1 mark
	Total: 2 marks

(Total for Question 4 is 9 marks)

5. All living organisms respire.

a) What is the balanced chemical equation for aerobic respiration?

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	3 marks
Marking points: 1 mark for correct reactants. 1 mark for correct products. 1 mark for correct balancing.	
	Total: 3 marks

b) Name the sub-cellular structures where aerobic respiration takes place.

Mitochondria.	1 mark
	Total: 1 mark

Energy is released during aerobic respiration from the oxidation of glucose.

c) Give **two** uses of the energy released in respiration.

Any two from:	
- For muscle contraction / movement. - To maintain body temperature / keep warm. Allow thermoregulation. - For active transport. - For synthesis (of larger molecules / named molecule e.g. protein) / building molecules / growth / repair / making new cells / cell division.	
	Total: 2 marks

d) Describe **two** differences between aerobic and anaerobic respiration in humans.

Your answer should not refer to oxygen.

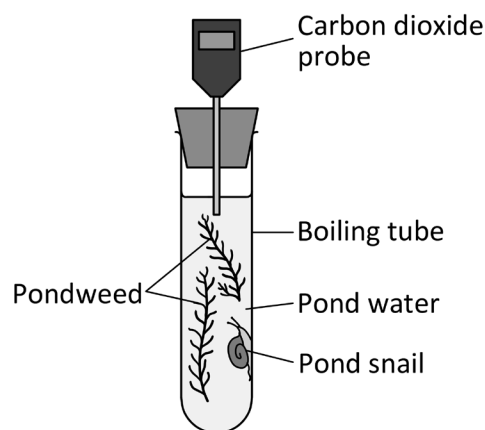
A description to include the following:	
Any two differences from: - Aerobic releases a (much) larger amount of energy / ATP (per glucose molecule) whereas anaerobic releases a (much) smaller amount of energy / ATP. (Glucose is) completely / fully broken down in aerobic respiration whereas (glucose is) incompletely / partially broken down in anaerobic respiration. - Aerobic respiration produces carbon dioxide and water whereas anaerobic respiration produces lactic acid (in humans/muscles). - Aerobic respiration occurs (mainly) in mitochondria whereas anaerobic respiration occurs in the cytoplasm.	
	Total: 2 marks

e) What are the **two** products of anaerobic respiration in plant cells?

A description to include the following:	
Ethanol. Accept: C ₂ H ₅ OH	1 mark
Carbon dioxide. Accept: CO ₂	1 mark
	Total: 2 marks

An ecologist investigated respiration and photosynthesis that occurs in a pond. The ecologist used a small section of pond weed and a pond snail in their investigation.

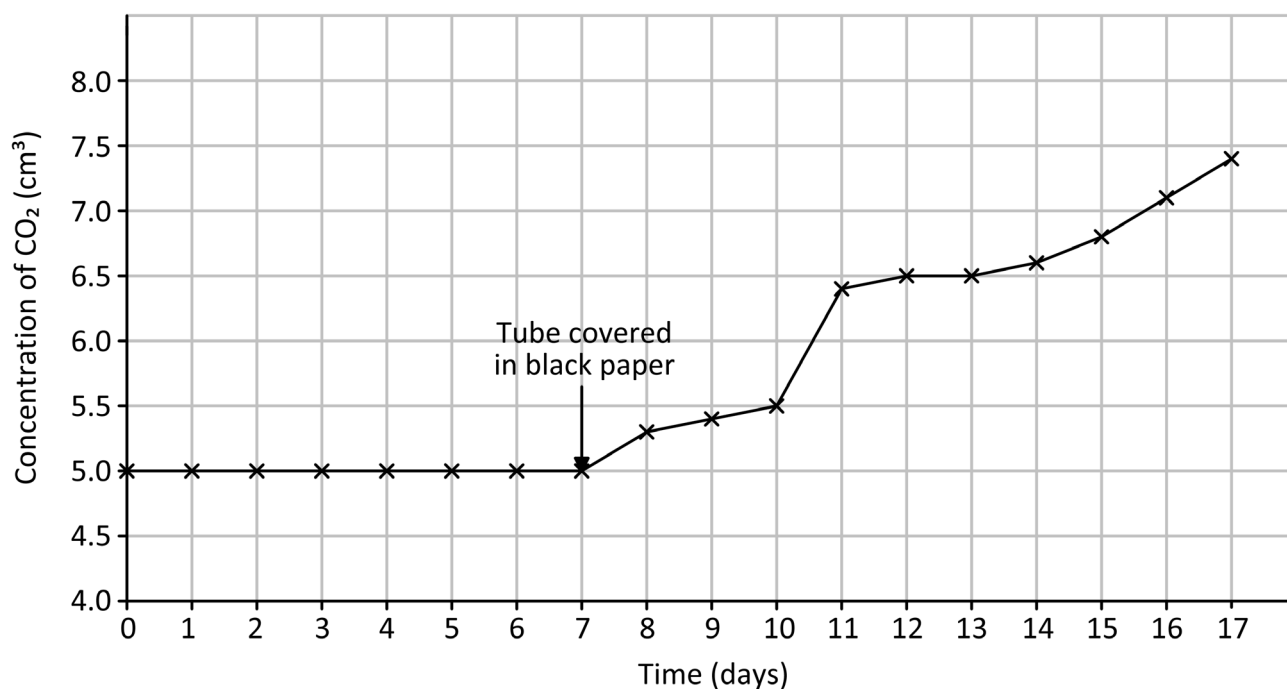
The figure below shows the apparatus used by ecologist.



The experimental apparatus was maintained in a well-lit environment for a period of seven days. During this interval, carbon dioxide concentration was continuously recorded using a data logger.

After this initial seven day period, the boiling tube was entirely encased in black paper, and the data logger continued to monitor carbon dioxide levels.

The graph below shows the concentration of carbon dioxide inside the boiling tube over 15 days.



- f) Explain why the concentration of carbon dioxide in the tube did not change between day 0 and day 7.

An explanation to include the following:	
Rate of carbon dioxide uptake / use by photosynthesis by pondweed is equal to the rate of carbon dioxide production / release by respiration by pondweed and snail.	1 mark
Must mention both processes (photosynthesis using CO ₂ and respiration producing CO ₂) for the first mark, implicitly or explicitly linking them to the balance.	
The rate of photosynthesis is equal / the same as the rate of respiration	1 mark
Total: 2 marks	

- g) Explain the increase in the concentration of carbon dioxide concentration between day 7 and day 10.

An explanation to include the following:	
Tube covered so no light / light is blocked. So pondweed cannot photosynthesise / photosynthesis stops / rate of photosynthesis decreases (significantly).	1 mark
But pondweed and snail continue to respire / respiration occurs.	1 mark
Accept 'respiration carries on'. Must convey that respiration is still happening.	
	Total: 2 marks

- h) On day 11 of the investigation the pond snail being used died. The pond snail was left in the tube.
Explain the increase in the concentration of carbon dioxide in the tube after day 11.

An explanation to include the following:	
Decomposers / microorganisms / bacteria / fungi break down / decompose / decay the (dead) snail / organic matter.	1 mark
Allow: rot instead of decompose.	
These decomposers / microorganisms respire.	1 mark
Must link respiration specifically to the decomposers/microorganisms.	
Respiration by decomposers releases / produces carbon dioxide / CO ₂ .	1 mark
	Total: 3 marks

(Total for Question 5 is 17 marks)

6. Compare and contrast the processes of aerobic and anaerobic respiration in terms of their requirements, products, and the amount of energy released.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple statements about either aerobic or anaerobic respiration, or one basic comparison. May cover only one aspect or contain inaccuracies. Limited use of comparative language.
Level 2	3 - 4	A clear comparison of aerobic and anaerobic respiration, covering at least two of the aspects (requirements, products, energy release) with some accuracy. Some comparative language is used.
Level 3	5 - 6	A detailed and coherent comparison and contrast of both aerobic and anaerobic respiration. Explanations cover all three aspects (requirements, products, energy release) accurately.

Indicative content:	
Requirements: - Aerobic requires oxygen, whereas anaerobic does not require oxygen. Products: - Aerobic produces carbon dioxide and water. - Anaerobic produces lactic acid (in animals / muscle cells). - OR Anaerobic produces ethanol and carbon dioxide (in plant cells / yeast). (Credit comparison e.g., Aerobic produces CO₂ and water, whereas anaerobic produces lactic acid / ethanol + CO₂). Amount of Energy Released: - Aerobic respiration releases a large amount of energy / ATP per glucose molecule. - Anaerobic respiration releases a small / smaller amount of energy / ATP per glucose molecule. (Credit comparison e.g., Aerobic releases much more energy than anaerobic). Completeness of Breakdown: - Aerobic respiration involves the complete breakdown of glucose. - Anaerobic respiration involves the incomplete / partial breakdown of glucose. - Location (Higher level detail): - Aerobic respiration occurs (mainly) in mitochondria (accept cytoplasm for first stage). - Anaerobic respiration occurs in the cytoplasm.	
	Total: 6 marks

(Total for Question 6 is 6 marks)

7. Anaerobic respiration is a process that releases energy from glucose without the involvement of oxygen. This process occurs in both animal and fungal cells, but with different end products.

a) State the location within both an animal muscle cell and a yeast cell where anaerobic respiration takes place.

Cytoplasm.	1 mark
	Total: 1 mark

b) Complete the word equations for anaerobic respiration in:

Animal cell: Glucose → Lactic acid	1 mark
Plant cell: Glucose → Ethanol + carbon dioxide	1 mark
	Total: 2 marks

c) Explain why animal muscle cells respire anaerobically during vigorous exercise.

An explanation to include the following:	
Vigorous exercise causes high energy demand / requires energy rapidly for muscle contraction.	1 mark
Allow muscles working hard / contracting strongly / frequently.	
So, oxygen cannot be supplied (to muscles) fast enough / sufficiently / demand for oxygen exceeds supply.	1 mark
Allow 'not enough oxygen reaches muscles'. Allow blood cannot supply oxygen fast enough.	
	Total: 2 marks

d) Describe **one** consequence of anaerobic respiration in animal muscle cells that can affect their function.

A description to include the following:	
Consequence: Lactic acid builds up / accumulates.	1 mark
Effect on Function: (Leading to) muscle fatigue OR muscles stop contracting (efficiently / properly) OR inhibits enzyme action OR causes pain / cramp	1 mark
Consequence: Oxygen debt is created.	1 mark
Effect on Function: Requires continued elevated breathing/heart rate after exercise (to repay debt / break down lactic acid) - affecting recovery function.	1 mark
	Total: 2 marks

e) Give **one** way in which the anaerobic respiration of yeast is commercially important.

Any one of the following:	
- Production of alcoholic drinks / brewing / making beer / making wine. - Bread making / baking. - Biofuel production.	1 mark
	Total: 1 mark

(Total for Question 7 is 8 marks)

8. This question is about anaerobic respiration.

During vigorous exercise, anaerobic respiration occurs in a person's body.

Identify and explain **two** effects that anaerobic respiration has on a person's physiology during strenuous exercise.

An explanation to include the following:	
Identification: Lactic acid builds up / accumulates in muscles. Allow lactate builds up.	1 mark
Explanation: Causes muscle fatigue OR lowers pH / makes muscles acidic (inhibiting enzymes) OR stops muscles contracting efficiently OR causes pain/cramp.	1 mark
Identification: Oxygen debt is created / incurred.	1 mark
Explanation: Extra oxygen is needed after exercise (to break down lactic acid) OR leads to continued elevated breathing / heart rate after exercise stops.	1 mark
	Total: 4 marks

(Total for Question 8 is 4 marks)