1.4 Bioenergetics: 1-hour Pack

AQA 8461 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Chlorophyll is important for capturing light.

(a) State the role of chlorophyll in photosynthesis. **(1)**

(Total for Question 1 is 1 mark)

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2 A green plant's cells carry out both photosynthesis and respiration throughout each 24-hour period.

(a) Explain why, in bright sunlight, a green plant releases oxygen into the environment overall, even though its cells are also respiring. **(2)**

(b) At a certain light intensity, a leaf's rate of photosynthesis is exactly equal to its rate of respiration. (i) Name this point. (ii) Describe the net exchange of oxygen and carbon dioxide between the leaf and the environment at this point. **(3)**

(c) Explain why, at night, there is a net release of carbon dioxide from a green plant. **(2)**

(Total for Question 2 is 7 marks)

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3 Photosynthesis can also be represented using a balanced chemical symbol equation.

(a) Write the balanced symbol equation for photosynthesis. **(2)**

(b) Name the organelle in a plant cell where photosynthesis takes place. **(1)**

(Total for Question 3 is 3 marks)

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4 Several environmental factors can affect the rate of photosynthesis in a plant.

(a) Define the term 'limiting factor'. **(1)**

(b) State three environmental factors that can limit the rate of photosynthesis. **(3)**

(c) Which of these three factors is most likely to be limiting the rate of photosynthesis at night? **(1)**

(Total for Question 4 is 5 marks)

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5 A student measured the rate of photosynthesis of a plant at increasing light intensities, keeping temperature and carbon dioxide concentration constant. The results are shown below.

Light intensity (arbitrary units): 0, 10, 20, 30, 40, 50, 60
Rate of photosynthesis (mm^3 of O_2 per minute): 0, 4, 8, 11, 12, 12, 12

Light intensity (arbitrary units)	Rate of photosynthesis (mm^3 of O_2 per minute)
0	0
10	4
20	8
30	11
40	12
50	12
60	12

(a) Describe the relationship between light intensity and rate of photosynthesis shown between 0 and 30 arbitrary units. **(2)**

(b) Explain why the rate of photosynthesis does not increase further between 40 and 60 arbitrary units. **(2)**

(c) Suggest one change the student could make to their investigation to determine which other factor is limiting the rate above 40 units. **(2)**

(Total for Question 5 is 6 marks)

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6 Glucose produced during photosynthesis can be used by the plant in several ways.

(a) Complete the sentences below. **(4)**

(i) Some glucose molecules are joined together and stored as an insoluble carbohydrate called _____.
(ii) Some glucose is converted into _____, used to strengthen plant cell walls.
(iii) Glucose combines with nitrate ions, absorbed from the soil, to produce _____, which are used to build proteins.
(iv) Glucose combines with other substances to form _____, used for storage in seeds and in cell membranes.

(b) Explain why plants need to absorb nitrate ions from the soil in order to make amino acids from glucose. **(2)**

(Total for Question 6 is 6 marks)

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7 During vigorous exercise, muscle cells may not receive enough oxygen and so respire anaerobically.

(a) Complete the word equation for anaerobic respiration in muscle cells: glucose -> _____ **(1)**

(b) State one difference between the reactants needed for aerobic and anaerobic respiration. **(1)**

(c) Explain why anaerobic respiration releases much less energy per glucose molecule than aerobic respiration. **(2)**

(d) Define the term 'oxygen debt'. **(2)**

(Total for Question 7 is 6 marks)

8 Yeast is a single-celled fungus that can respire anaerobically in a process called fermentation.

(a) Complete the word equation for anaerobic respiration in yeast: glucose -> _____ + _____ **(2)**

(b) State two industries that make use of anaerobic respiration in yeast. **(2)**

(c) State one difference between the products of anaerobic respiration in yeast and in human muscle cells. **(1)**

(Total for Question 8 is 5 marks)

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9 A student recorded bubbles of oxygen produced by pondweed at different light intensities. The data are: light intensity 20 -> 4 bubbles per minute; 40 -> 8; 60 -> 12; 80 -> 16.

(a) Estimate the number of bubbles per minute at light intensity 50 by interpolation. Show a short calculation. **(2)**

(Total for Question 9 is 2 marks)

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10 Aerobic respiration releases energy that cells use for many metabolic reactions.

(a) Name the organelle in which most of the reactions of aerobic respiration take place. **(1)**

(b) Explain what is meant by the term 'metabolism' and give one example of a reaction, other than respiration itself, that is part of metabolism in living organisms. **(2)**

(Total for Question 10 is 3 marks)

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11 Explain how a farmer could increase the rate of photosynthesis in a greenhouse to increase crop yield. In your answer include at least three different changes the farmer could make, how each change increases the rate of photosynthesis, and one reason why a farmer might not use a particular change.

(Total for Question 11 is 6 marks)

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Mark scheme · 1.4 Bioenergetics: 1-hour Pack

Question 1

(a) absorbs light energy (to drive photosynthesis) cao **B1**

(a) Answer: Absorbs light energy for photosynthesis.

Question 2

(a) in bright light, the rate of photosynthesis is greater than the rate of respiration, oe **M1**

(a) so more oxygen is produced by photosynthesis than is used up by respiration, and the excess oxygen diffuses out of the leaf, oe **A1**

(a) Answer: In bright light, photosynthesis occurs faster than respiration, so more oxygen is produced than is used up, and the excess diffuses out of the leaf.

(b) (i) compensation point **B1**

(b) (ii) there is no net uptake or release of oxygen, oe **B1**

(b) (ii) there is no net uptake or release of carbon dioxide, because all the gas produced by one process is used up by the other, oe **B1**

(b) Answer: (i) Compensation point (ii) There is no net exchange of oxygen or carbon dioxide with the environment, since all of the gas produced by one process is used up by the other within the leaf.

(c) at night there is no light, so photosynthesis cannot occur and only respiration takes place, oe **M1**

(c) carbon dioxide produced by respiration is no longer used up by photosynthesis, so it diffuses out of the plant as a net release, oe **A1**

(c) Answer: At night, with no light, photosynthesis stops but respiration continues, so the carbon dioxide it produces is no longer used up internally and diffuses out of the plant.

Question 3

(a) correct formulae used: CO_2, H_2O, $C_6H_{12}O_6$, O_2 **M1**

(a) $6CO_2 + 6H_2O$ --[light energy]--> $C_6H_{12}O_6 + 6O_2$, correctly balanced, cao **A1**

(a) Answer: $6CO_2 + 6H_2O$ --[light energy]--> $C_6H_{12}O_6 + 6O_2$

(b) chloroplast **B1**

(b) Answer: Chloroplast

Question 4

(a) a factor that, when in short supply, restricts/slows the rate of a reaction even though other factors are available in excess, oe **B1**

(a) Answer: A limiting factor is any factor in short supply that restricts the rate of a process, even when other factors needed are plentiful.

(b) light intensity **B1**

(b) carbon dioxide concentration **B1**

(b) temperature **B1**

(b) Answer: Light intensity; carbon dioxide concentration; temperature.

(c) light intensity, oe **B1**

(c) Answer: Light intensity

Question 5

(a) as light intensity increases, the rate of photosynthesis increases, oe **B1**

(a) the increase is roughly steady/proportional over this range, oe **B1**

(a) Answer: As light intensity increases from 0 to 30 units, the rate of photosynthesis increases at a roughly steady rate.

(b) light intensity is no longer the limiting factor, oe **M1**

(b) another factor, such as carbon dioxide concentration or temperature, has become limiting, so increasing light further has no effect, oe **A1**

(b) Answer: Light is no longer limiting the rate; another factor (carbon dioxide concentration or temperature) has become the limiting factor, so further increases in light intensity have no effect.

(c) increase the carbon dioxide concentration (e.g. add more sodium hydrogencarbonate) and repeat, oe; allow increasing temperature instead **B1**

(c) if the rate then increases above 12 mm^3/min, this confirms that factor was limiting, oe **B1**

(c) Answer: Repeat the investigation with a higher carbon dioxide concentration; if the rate then increases beyond 12 mm^3/min, carbon dioxide concentration was the limiting factor.

Question 6

(a) (i) starch **B1**

(a) (ii) cellulose **B1**

(a) (iii) amino acids **B1**

(a) (iv) lipids (fats and oils) **B1**

(a) Answer: (i) starch (ii) cellulose (iii) amino acids (iv) lipids

(b) amino acids/proteins contain nitrogen, but glucose contains only carbon, hydrogen and oxygen, oe **M1**

(b) nitrate ions provide the nitrogen needed to make amino acids, oe **A1**

(b) Answer: Glucose only contains carbon, hydrogen and oxygen, but amino acids also contain nitrogen; nitrate ions absorbed from the soil supply this nitrogen.

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Question 7

(a) lactic acid **B1**

(a) Answer: lactic acid

(b) anaerobic respiration does not use/need oxygen, whereas aerobic respiration does, oe **B1**

(b) Answer: Anaerobic respiration does not require oxygen, but aerobic respiration does.

(c) glucose is only partially broken down into lactic acid, rather than being fully broken down, oe **M1**

(c) so less of the chemical energy stored in glucose is released/transferred, oe **A1**

(c) Answer: Glucose is only partially broken down (into lactic acid) rather than fully broken down into carbon dioxide and water, so much less energy is released.

(d) the extra oxygen needed by the body after exercise to break down/oxidise the lactic acid that has built up in the muscles, oe **B1**

(d) this repays the shortfall in oxygen supply that occurred during vigorous exercise, oe **B1**

(d) Answer: Oxygen debt is the extra oxygen the body needs after exercise to break down the lactic acid that built up in the muscles, repaying the oxygen shortfall from exercise.

Question 8

(a) ethanol **B1**

(a) carbon dioxide **B1**

(a) Answer: ethanol + carbon dioxide

(b) brewing (production of alcoholic drinks) **B1**

(b) baking (bread making) **B1**

(b) Answer: Brewing and baking.

(c) yeast produces ethanol and carbon dioxide, whereas muscle cells produce only lactic acid (no carbon dioxide), oe **B1**

(c) Answer: Yeast produces ethanol and carbon dioxide; muscle cells produce only lactic acid.

Question 9

(a) uses linear relation: between 40 and 60 intensity the bubbles go from 8 to 12 so slope = (12-8)/(60-40) = 4/20 = 0.2 bubbles per intensity unit **M1**

(a) gives 10 bubbles per minute cao **A1**

(a) Answer: 10 bubbles per minute

Question 10

(a) mitochondria / mitochondrion cao **B1**

(a) Answer: Mitochondria

(b) metabolism is the sum of all the reactions in a cell or the body, oe **B1**

(b) any one example: conversion of glucose to glycogen (or starch, or cellulose); formation of lipids from glycerol and fatty acids; formation of amino acids from glucose and nitrate ions; breakdown of excess protein to form urea for excretion, oe **B1**

(b) Answer: Metabolism is the sum of all the reactions in a cell or the body; for example, glucose can be converted to glycogen for storage.

Question 11

Level 3 Detailed explanation. Offers at least three valid methods, links each method to how it increases rate of photosynthesis, and gives a valid reason why a method might not be used; explanations are clear and linked to biology terms such as light intensity, carbon dioxide concentration, temperature and limiting factor. **5-6**

Level 2 Partial explanation. Describes two or three methods with correct but limited explanation of how they increase photosynthesis and may include one valid limitation or drawback. **3-4**

Level 1 Basic statements. Mentions one or two relevant methods with little or no explanation of how they increase photosynthesis and no real evaluation of drawbacks. **1-2**

Indicative content:

- Increase light intensity using artificial lamps so more light energy is available to drive photosynthesis; increases rate when light is limiting.
- Enrich carbon dioxide concentration in the greenhouse so more CO_2 is available as a raw material for photosynthesis; increases rate until another factor is limiting.
- Raise temperature to the plant's optimum so enzymes involved in photosynthesis work faster; be careful as too high temperature denatures enzymes so there is a limit.
- Ensure adequate water supply so stomata remain open and water is available as a raw material for photosynthesis; without water photosynthesis stops.
- Use pest and disease control to keep leaves healthy so photosynthetic surface area is not reduced.
- Possible drawbacks: cost of electric lighting or CO_2 enrichment; risk of increased disease at higher humidity or temperature; environmental or safety concerns with CO_2 use.

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