1.4 Bioenergetics: Test Pack

AQA 8461 · Calculator allowed · about 50 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Plants make food by photosynthesis.

(a) Define the term photosynthesis. **(1)**

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(Total for Question 1 is 1 mark)

2 Photosynthesis makes substances that help plants grow.

(a) State two products of photosynthesis. **(2)**

(Total for Question 2 is 2 marks)

3 Write a simple word equation for photosynthesis.

(a) Write the word equation for photosynthesis. **(2)**

.....

(Total for Question 3 is 2 marks)

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4 During vigorous exercise, several changes occur in the human body to supply the muscles with more energy. Explain how heart rate, breathing rate and breathing depth change during exercise, and describe how the body repays an oxygen debt after exercise has finished.

(Total for Question 4 is 6 marks)

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5 Answer each multiple-choice question by selecting the correct letter.

(a) Which organelle is the main site of aerobic respiration in a cell? **(1)**

- ☐ A) Nucleus
- ☐ B) Mitochondria
- ☐ C) Chloroplast
- ☐ D) Ribosome

(b) Which gas is released by plant cells as a product of photosynthesis? **(1)**

- ☐ A) Carbon dioxide
- ☐ B) Nitrogen
- ☐ C) Oxygen
- ☐ D) Hydrogen

(c) Photosynthesis is best described as: **(1)**

- ☐ A) An exothermic reaction
- ☐ B) An endothermic reaction
- ☐ C) A type of anaerobic respiration
- ☐ D) A type of aerobic respiration

(d) Which two products are formed during anaerobic respiration in yeast? **(1)**

- ☐ A) Lactic acid only
- ☐ B) Oxygen and water
- ☐ C) Ethanol and carbon dioxide
- ☐ D) Glucose and oxygen

(Total for Question 5 is 4 marks)

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6 Using the equation relative light intensity = 1 / distance^2, calculate the percentage increase in relative light intensity when a lamp is moved from 40 cm to 25 cm away from a plant. Give your answer to 3 significant figures.

(Total for Question 6 is 4 marks)

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7 Aerobic respiration is the main process used by cells to release energy from glucose.

(a) Complete the word equation for aerobic respiration: glucose + oxygen -> _____ + _____ **(2)**

(b) Write the balanced symbol equation for aerobic respiration. **(2)**

(c) Name the cell organelle where most of the reactions of aerobic respiration take place. **(1)**

(Total for Question 7 is 5 marks)

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8 A plant absorbs 30 J of light energy and stores 9 J as chemical energy in glucose during photosynthesis.

(a) Calculate the efficiency of the plant at storing light energy as chemical energy. **(2)**
Show your working and give the answer as a percentage.

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(Total for Question 8 is 2 marks)

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9 Complete the table below to compare aerobic and anaerobic respiration in human muscle cells. Each lettered blank is worth one mark.

Feature	Aerobic respiration	Anaerobic respiration (muscle cells)
Oxygen required?	(a) _____	No
Waste product(s)	carbon dioxide and water	(b) _____
Relative amount of energy released per glucose molecule	(c) _____	relatively small amount
Is glucose completely broken down?	(d) _____	No
Rate at which energy can be released	(e) _____	faster, but cannot be sustained for long

(Total for Question 9 is 5 marks)

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10 A student measures the rate of oxygen uptake by isolated plant mitochondria at two different oxygen concentrations. The data are given below.

Oxygen concentration in the assay solution / micromol per litre: 5, 20, 50, 100
Rate of O_2 uptake / nmol O_2 per min per mg protein: 12, 45, 85, 92

Use the table to answer the questions.

(a) Describe how the rate of oxygen uptake changes as oxygen concentration increases from 5 to 100 micromol per litre. **(2)**

(b) Suggest one biological explanation for the plateau seen between 50 and 100 micromol per litre. **(2)**

(Total for Question 10 is 4 marks)

11 Plants combine glucose from photosynthesis with nitrate ions absorbed from the soil to build larger molecules needed for growth.

(a) Name the type of molecule formed directly from glucose and nitrate ions, and state what these molecules are then used to build. **(2)**

(b) State why a plant needs a supply of nitrate ions from the soil for this process. **(1)**

(Total for Question 11 is 3 marks)

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Mark scheme · 1.4 Bioenergetics: Test Pack

Question 1

(a) the process by which plants use light energy to make glucose from carbon dioxide and water, oe **B1**

(a) Answer: The process by which plants use light energy to make glucose from carbon dioxide and water.

Question 2

(a) glucose **B1**

(a) oxygen **B1**

(a) Answer: Glucose and oxygen.

Question 3

(a) gives reactants and products in the correct order with light energy present **M1**

(a) carbon dioxide + water -> glucose + oxygen cao **A1**

(a) Answer: carbon dioxide + water -> glucose + oxygen

Question 4

Level 1 Simple, isolated statements are made, e.g. heart rate or breathing rate increases during exercise, with little or no reasoning or reference to oxygen debt. **1-2**

Level 2 Describes changes to heart rate and/or breathing rate/depth with some reasoning about increased oxygen or glucose delivery, and gives a partial description of the oxygen debt or its repayment. **3-4**

Level 3 Gives a clear, well-linked explanation of increases in heart rate, breathing rate and breathing depth in terms of delivering more oxygen and glucose and removing carbon dioxide faster, together with a correct, detailed explanation of how the oxygen debt is repaid after exercise. **5-6**

Indicative content:

- Heart rate increases during exercise to deliver oxygen and glucose to the muscles more quickly
- Increased heart rate also removes carbon dioxide and lactic acid from the muscles more quickly
- Breathing rate and breathing depth both increase during exercise
- This increases the volume of air (and therefore oxygen) taken into the lungs each minute, and removes carbon dioxide faster
- If the muscles cannot get enough oxygen during vigorous exercise, they respire anaerobically and produce lactic acid
- This creates an oxygen debt: the amount of extra oxygen needed after exercise to break down the accumulated lactic acid
- After exercise, heart rate and breathing rate/depth remain higher than resting levels
- This supplies the extra oxygen needed to oxidise the lactic acid to carbon dioxide and water (or convert it back to glucose in the liver), repaying the oxygen debt

Question 5

(a) B (mitochondria) **B1**

(a) Answer: B

(b) C (oxygen) **B1**

(b) Answer: C

(c) B (endothermic) **B1**

(c) Answer: B

(d) C (ethanol and carbon dioxide) **B1**

(d) Answer: C

Question 6

intensity at 40 cm calculated: $1/40^2 = 1/1600 = 0.000625$ **M1**

intensity at 25 cm calculated: $1/25^2 = 1/625 = 0.0016$ **M1**

percentage increase calculated: (0.0016 - 0.000625) / 0.000625 x 100 **dM1**

156%, awrt, cao **A1**

Answer: 156% increase

Question 7

(a) carbon dioxide **B1**

(a) water **B1**

(a) Answer: carbon dioxide + water

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

(b) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$, correctly balanced, cao **A1**

(b) Answer: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

(c) mitochondria (mitochondrion) **B1**

(c) Answer: Mitochondria

Question 8

(a) substitutes into efficiency = (useful energy out / total energy in) x 100, i.e. (9 / 30) x 100 **M1**

(a) 30% cao **A1**

(a) Answer: 30%

Question 9

(a) Yes **B1**

(b) lactic acid **B1**

(c) relatively large amount, oe **B1**

(d) Yes **B1**

(e) slower, but can be sustained for a much longer time, oe **B1**

Answer: (a) Yes (b) lactic acid (c) relatively large amount (d) Yes (e) slower, but sustainable for longer

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Question 10

(a) rate increases as oxygen concentration increases, with larger increases at low concentrations (5 to 50) and approaching a plateau by 100 micromol per litre, oe **B1**

(a) recognises that from 50 to 100 there is little increase indicating a limiting factor, oe **B1**

(a) Answer: The rate increases with oxygen concentration, steeply from 5 to 50 micromol per litre then leveling off so that from 50 to 100 there is little further increase, indicating a plateau.

(b) mitochondrial enzymes or electron transport chain become saturated so oxygen is no longer limiting, oe **B1**

(b) other factors such as ADP availability, substrate or temperature limit the rate, oe **B1**

(b) Answer: Possible explanation: components of the electron transport chain or enzymes are saturated so oxygen is no longer limiting; another factor such as ADP or substrate availability limits the rate.

Question 11

(a) amino acids are formed from glucose and nitrate ions cao **B1**

(a) amino acids are joined together to build proteins, oe **B1**

(a) Answer: Glucose and nitrate ions are combined to form amino acids, which are then used to build proteins.

(b) nitrate ions provide the nitrogen needed to make amino acids/proteins, which glucose alone cannot supply, oe **B1**

(b) Answer: Nitrate ions supply the nitrogen needed to make amino acids and proteins, which glucose alone does not contain.

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