HIGHER

B2H Organisation: Higher Tier Practice

AQA 8461 · Calculator allowed · about 100 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The digestive system includes specialised tissues and organs. Match each structure with its main function.

(a) State which number matches function A. **(1)**

- ☐ 1
- ☐ 2
- ☐ 3

(b) State which number matches function B. **(1)**

- ☐ 1
- ☐ 2
- ☐ 3

(c) State which number matches function C. **(1)**

- ☐ 1
- ☐ 2
- ☐ 3

(Total for Question 1 is 3 marks)

2 Enzymes are biological catalysts. A student investigates how temperature affects the rate at which an amylase solution breaks down starch in a test-tube experiment. They measure the time taken for the starch to disappear (indicated by iodine) at different temperatures. Results: 10 degrees C - 180 s, 20 degrees C - 75 s, 30 degrees C - 30 s, 40 degrees C - 32 s, 50 degrees C - 300 s.

(a) Calculate the approximate rate of reaction at 30 degrees C in terms of 1/time (s^{-1}). Give your answer to 3 significant figures. **(2)**

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(b) Explain why the rate at 40 degrees C is almost the same as at 30 degrees C, but the rate at 50 degrees C is much slower. **(2)**

(Total for Question 2 is 4 marks)

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3 The surface area to volume ratio affects heat loss and diffusion rates in organisms. Calculate the surface area to volume ratio for a cube-shaped cell with side 0.02 mm. Give your answer in mm^{-1} to 2 significant figures.

(a) Calculate the surface area of the cube in mm^2. **(1)**

.....

(b) Calculate the volume of the cube in mm^3. **(1)**

.....

(c) Calculate the surface area to volume ratio in mm^{-1} and give to 2 significant figures. **(2)**

.....

(Total for Question 3 is 4 marks)

4 Blood is transported in arteries, veins and capillaries which have different structural features.

(a) Give one structural feature of an artery. **(1)**

(b) Explain how the feature you gave helps the artery to do its job. **(2)**

(Total for Question 4 is 3 marks)

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5 The human heart contains valves that ensure one-way flow. A patient has a leaky valve causing backflow and reduced cardiac output. Explain how a leaky valve could reduce the amount of oxygenated blood reaching tissues.

(a) Explain the physiological sequence by which a leaky valve reduces oxygen delivery to tissues. **(4)**

(Total for Question 5 is 4 marks)

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6 Plants transport water in xylem and sugars in phloem. State one difference between xylem and phloem structure, and explain how this difference relates to their functions.

(a) State one structural difference between xylem and phloem. **(1)**

(b) Explain how this structural difference helps xylem and phloem carry out their functions. **(2)**

(Total for Question 6 is 3 marks)

7 A student measures transpiration by attaching a potometer to a leafy shoot and records the volume of water taken up over 30 minutes at two different room humidities. Data: Humidity 40% - water uptake 12.0 cm^3 in 30 min. Humidity 80% - water uptake 4.8 cm^3 in 30 min.

(a) Calculate the transpiration rate at 40% humidity in cm^3 per minute. Give your answer to 2 significant figures. **(1)**

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(b) Calculate the transpiration rate at 80% humidity in cm^3 per minute. Give your answer to 2 significant figures. **(1)**

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(c) Calculate the percentage decrease in rate when humidity increases from 40% to 80%. Give your answer to 2 significant figures. **(2)**

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(Total for Question 7 is 4 marks)

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8 Pathogens enter the body and may be destroyed by the immune system. Describe two differences between the action of phagocytes and the action of antibodies.

(a) Give one difference. **(1)**

(b) Give a second difference. **(2)**

(Total for Question 8 is 3 marks)

9 A student measures the concentration of glucose in an unknown solution using a colorimeter and a calibration curve. Their calibration curve gives absorbance 0.10 for 1.0 g/dm^3 glucose and 0.30 for 3.0 g/dm^3 glucose, showing a straight line through the origin. The unknown has absorbance 0.185.

(a) Determine the gradient of the calibration line (absorbance per g/dm^3). **(1)**

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(b) Use the gradient to calculate the concentration of glucose in the unknown (g/dm^3). **(2)**

.....

(c) State one source of experimental error in this method and give one improvement. **(1)**

(Total for Question 9 is 4 marks)

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10 Osmosis can be demonstrated using potato cylinders placed in sugar solutions. A student places equal-mass potato cylinders in three solutions for 60 minutes: pure water, 0.5 mol/dm^3 sucrose, 1.0 mol/dm^3 sucrose. After 60 minutes the percentage change in mass is: pure water +12.0%, 0.5 mol/dm^3 +2.5%, 1.0 mol/dm^3 -9.6%.

(a) Explain why the potato in 1.0 mol/dm^3 sucrose lost mass. **(1)**

(b) Estimate the sucrose concentration at which there is no net change in mass (the approximate isotonic point) using the data above. Explain your reasoning. **(2)**

(Total for Question 10 is 3 marks)

11 A person has mass 68 kg and height 1.70 m. Calculate their body mass index (BMI) and state the BMI category using NHS adult ranges: underweight < 18.5, healthy 18.5-24.9, overweight 25.0-29.9, obese ≥ 30.0.

(a) Calculate the BMI to 1 decimal place. Use BMI = mass / (height^2). **(2)**

.....

(b) State the BMI category for this person. **(2)**

(Total for Question 11 is 4 marks)

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12 During respiration cells use glucose and oxygen to release energy. Write a balanced symbol equation for aerobic respiration using glucose and oxygen to make carbon dioxide and water.

(a) Write the balanced symbol equation. **(4)**

(Total for Question 12 is 4 marks)

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13 A patient sample shows raised white blood cell count and increased C-reactive protein (CRP). Explain what this indicates about the patient's condition and suggest two further tests that could help identify the cause.

(a) Explain what raised WBC and raised CRP suggest about the patient's condition. **(2)**

(b) Suggest two further tests to identify the cause and give a brief reason for each. **(1)**

(Total for Question 13 is 3 marks)

14 In a standard resting adult, cardiac output is about 5.0 litres per minute and heart rate is 70 beats per minute. Calculate the stroke volume in cm^3 per beat. Remember 1 litre = 1000 cm^3.

(a) Calculate the stroke volume in cm^3 per beat. Show working and give answer to 3 significant figures. **(4)**

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(Total for Question 14 is 4 marks)

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15 Explain how the structure and organisation of specialised cells, tissues and organs in the human small intestine enable efficient absorption of the products of digestion. In your answer, you should describe features at the cellular and tissue level and link structure to function.

(Total for Question 15 is 6 marks)

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16 A bacteria culture shows resistance to an antibiotic after a mutation spreads in the population. Explain, using natural selection, how antibiotic resistance can become common in a bacterial population. Include the role of selection pressure and inheritance in your answer.

(a) Explain how antibiotic use leads to increased frequency of resistant bacteria. **(3)**

(Total for Question 16 is 3 marks)

Mark scheme · B2H Organisation: Higher Tier Practice

Question 1

- (a) **B1** 3 (pancreas) cao
- **(a) Answer: 3**
- (b) **B1** 2 (stomach) cao
- **(b) Answer: 2**
- (c) **B1** 1 (small intestine) cao
- **(c) Answer: 1**

Question 2

- (a) **M1** substitutes: rate = 1 / time = 1 / 30 s
- (a) **A1** 0.0333 s^{-1} (3 s.f.) cao
- **(a) Answer: 0.0333 s^{-1}**
- (b) **B1** 40 degrees C: enzyme activity near optimum so rate similar to 30 degrees C or slightly higher, oe
- (b) **B1** 50 degrees C: enzyme denaturation reduces active sites so rate much slower, oe
- **(b) Answer: At 40 degrees C the enzyme is still close to its optimum so activity and rate remain similar to 30 degrees C. At 50 degrees C the enzyme denatures so its active site is lost and the rate falls greatly.**

Question 3

- (a) **B1** surface area = 6 x $side^2$ = 6 x $(0.02)^2$ = 6 x 0.0004 = 0.0024 mm^2 cao
- **(a) Answer: 0.0024 mm^2**
- (b) **B1** volume = $side^3$ = $(0.02)^3$ = 0.000008 mm^3 = 8.0 x 10^{-6} mm^3 cao
- **(b) Answer: 8.0 x 10^{-6} mm^3**
- (c) **M1** substitutes: SA:V = 0.0024 / 0.000008
- (c) **A1** 300 mm^{-1} (2 s.f.) cao
- **(c) Answer: 3.0 x 10^2 mm^{-1}**

Question 4

- (a) **B1** thick muscular wall or elastic fibres or small lumen
- **(a) Answer: Thick muscular wall with elastic fibres.**
- (b) **B1** muscular wall allows constriction and control of blood flow or elastic fibres allow stretching and recoil maintaining high pressure
- (b) **B1** this helps maintain high pressure to carry blood quickly away from the heart, oe
- **(b) Answer: The thick muscular wall and elastic fibres allow arteries to stretch and recoil and alter diameter. This maintains high pressure and helps pump blood quickly away from the heart to tissues.**

Question 5

- (a) **M1** states backflow across the valve reduces forward stroke volume or cardiac output
- (a) **M1** links reduced cardiac output to less blood being pumped into systemic circulation per beat
- (a) **A1** states this leads to reduced oxygen delivery to tissues
- (a) **A1** may mention compensatory increase in heart rate or hypertrophy as a consequence or inefficient oxygen supply, oe
- **(a) Answer: A leaky valve allows backflow so less blood is ejected forward each beat, reducing stroke volume and cardiac output. Reduced cardiac output means less oxygenated blood enters the systemic circulation per minute, so tissues receive less oxygen. The heart may compensate by increasing rate or hypertrophy but tissue oxygen delivery is still reduced.**

Question 6

- (a) **B1** xylem vessels are dead and lignified; phloem has living sieve tube elements and companion cells
- **(a) Answer: Xylem vessels are dead and have lignified walls; phloem has living sieve tube elements with companion cells.**
- (b) **B1** xylem being dead and lignified provides a continuous hollow tube that can withstand tension and transport water under tension
- (b) **B1** living phloem cells and companion cells allow active transport of sugars and controlled loading and unloading
- **(b) Answer: Dead, lignified xylem vessels form strong hollow tubes that resist collapse and allow water to be pulled up under tension. Phloem has living cells and companion cells so sugars can be actively loaded and unloaded and transported in solution.**

Question 7

- (a) **B1** 12.0 / 30 = 0.40 cm^3 per minute (2 s.f. = 0.40) cao
- **(a) Answer: 0.40 cm^3 per minute**
- (b) **B1** 4.8 / 30 = 0.16 cm^3 per minute (2 s.f. = 0.16) cao
- **(b) Answer: 0.16 cm^3 per minute**
- (c) **M1** calculates change and divides by original: (0.40 - 0.16) / 0.40
- (c) **A1** 60% decrease (2 s.f.) cao
- **(c) Answer: 60 %**

Question 8

- (a) **B1** phagocytes engulf and digest pathogens; antibodies mark pathogens or neutralise toxins
- **(a) Answer: Phagocytes engulf and digest pathogens; antibodies bind to pathogens or toxins to mark or neutralise them.**
- (b) **B1** phagocytes are cells carrying out non-specific defence; antibodies are specific and produced by B cells in response to antigens
- (b) **B1** antibodies can provide memory/immunity via specific recognition, phagocytes do not provide antigen-specific memory
- **(b) Answer: Phagocytes provide non-specific defence by ingesting many types of pathogen. Antibodies are specific to particular antigens, produced by B cells and are part of long-term immunity.**

Question 9

- (a) **B1** gradient = (0.30 - 0.10) / (3.0 - 1.0) = 0.20 / 2.0 = 0.10 absorbance per (g/dm^3)
- **(a) Answer: 0.10 absorbance per g/dm^3**
- (b) **M1** uses absorbance = gradient x concentration so conc = absorbance / gradient = 0.185 / 0.10
- (b) **A1** 1.85 g/dm^3 (3 s.f.) cao
- **(b) Answer: 1.85 g/dm^3**
- (c) **B1** error: inconsistent cuvette orientation or stray light or poor blanking; improvement: ensure consistent cuvette orientation, use a cuvette holder and blank the colourimeter, repeat measurements and average
- **(c) Answer: Error: inconsistent cuvette orientation or stray light. Improvement: keep cuvette orientation consistent, use a cuvette holder and blank the colorimeter; repeat readings and average.**

Question 10

- (a) **B1** water moves out of the potato by osmosis into the more concentrated sucrose solution, causing mass loss
- **(a) Answer: Water moved out of the potato by osmosis into the more concentrated 1.0 mol/dm^3 sucrose solution, so the potato lost mass.**
- (b) **M1** recognises isotonic lies between 0.5 mol/dm^3 (+2.5%) and 1.0 mol/dm^3 (-9.6%) and interpolates
- (b) **A1** gives approx 0.59 to 0.61 mol/dm^3 or 0.60 mol/dm^3 with reasoned interpolation cao
- **(b) Answer: Approximately 0.60 mol/dm^3. This is interpolated between 0.5 mol/dm^3 (small gain) and 1.0 mol/dm^3 (loss), so the isotonic point is closer to 0.6 mol/dm^3.**

Question 11

- (a) **M1** substitutes: BMI = 68 / (1.70^2)
- (a) **A1** 23.5 (1 decimal place) cao
- **(a) Answer: 23.5**
- (b) **B1** healthy (18.5-24.9) cao
- (b) **B1** justification: 23.5 lies between 18.5 and 24.9, oe
- **(b) Answer: Healthy weight (18.5-24.9).**

Question 12

- (a) **M1** partial balancing or correct species order: C6H12O6 + O2 -> CO2 + H2O
- (a) **A1** balanced coefficients: C6H12O6 + 6O2 -> 6CO2 + 6H2O cao
- (a) **A1** states that energy is released (optional supporting statement) oe
- (a) **A1** correct state symbols may be ignored but equation must be balanced
- **(a) Answer: C6H12O6 + 6O2 -> 6CO2 + 6H2O**

Question 13

- (a) **M1** states these are markers of inflammation or infection
- (a) **A1** links to immune response being active, possibly bacterial infection causing acute inflammation, oe
- **(a) Answer: Raised WBC and CRP indicate an active inflammatory response, often due to infection. CRP is an acute-phase protein that rises in inflammation, commonly with bacterial infection.**
- (b) **B1** two sensible tests such as blood culture to identify bacteria; or chest X-ray if respiratory infection suspected; or urine culture for urinary infection; or PCR test for viral pathogen, each with brief reason
- **(b) Answer: Examples: take a blood culture to grow and identify bacteria causing the infection; or perform a chest X-ray if pneumonia is suspected to locate lung infection.**

Question 14

- (a) **M1** converts cardiac output to cm^3: 5.0 L = 5000 cm^3 and divides by heart rate: 5000 / 70
- (a) **A1** 71.428... cm^3
- (a) **A1** gives final to 3 s.f.: 71.4 cm^3 cao
- (a) **B1** units stated cm^3 per beat cao
- **(a) Answer: 71.4 cm^3 per beat**

Question 15

- **Level 3** (5-6): Detailed explanation linking multiple structural features at cell and tissue level to functions that enhance absorption, with clear and accurate use of biological terms.
- **Level 2** (3-4): Reasonable explanation that links some structure to function and includes specific features such as villi or microvilli, with limited detail or minor inaccuracies.
- **Level 1** (1-2): Basic statements about features of the small intestine with limited linking to function; descriptive but not explanatory.
- **Indicative content:**
  - villi increase surface area for absorption; each villus has microvilli on epithelial cells further increasing surface area
  - thin epithelial cell layer (one cell thick) and rich capillary network reduce diffusion distance for amino acids and sugars into blood; lacteals absorb fatty acids and glycerol into lymph
  - many mitochondria in epithelial cells provide ATP for active transport of some molecules
  - tight packing of villi and long intestine increase total surface area and time for absorption
  - presence of enzymes on epithelial cell membranes completes digestion at the site of absorption facilitating uptake
  - peristalsis maintains concentration gradients by moving contents to ensure absorption continues

Question 16

- (a) **M1** mutation produces resistance allele present in some bacteria
- (a) **M1** antibiotic use imposes selection pressure so susceptible bacteria die and resistant ones survive and reproduce
- (a) **A1** over time the resistant allele increases in frequency through inheritance, making resistance common
- **(a) Answer: Random mutation produces occasional resistant bacteria. When antibiotics are used, susceptible bacteria are killed while resistant bacteria survive and reproduce. The resistant trait is inherited by offspring, so over time the frequency of resistant bacteria increases and resistance becomes common.**