

IGCSE BIOLOGY 0610 — PAPER 4

Extended Theory · Practice Paper — ANSWERS

Time allowed: 1 hour 15 minutes | Total marks: 80 | Calculator allowed

Name: _____ Class: _____ Date: _____

Original questions by TutorZone. Not a Cambridge past paper or mark scheme.

Questions

Question 1 — Cell structure and cell transport (12 marks)

Part	Question	Marks
(a)	Name the part of a cell that controls the movement of substances into and out of the cell.	1
(b)	A photomicrograph of a cell structure has an image length of 45 mm. The actual length of the structure is 0.05 mm. Calculate the magnification. Show your working.	2
(c)	Two cubes of plant tissue have sides of 2.0 mm and 4.0 mm. Calculate the surface area to volume ratio of each cube and explain which cube diffuses oxygen in faster.	3
(d)	Explain how a root hair cell is adapted for absorbing water and mineral ions.	3
(e)	Define diffusion and state one way in which it differs from active transport.	3

Question 2 — Enzymes and human nutrition (14 marks)

Part	Question	Marks
(a)	Define the term enzyme and describe the lock and key model of enzyme action.	3
(b)	In an experiment, 36 cm ³ of oxygen was collected in 45 s from the breakdown of hydrogen peroxide by catalase. Calculate the mean rate of reaction in cm ³ per second.	2
(c)	Catalase works fastest at pH 7. Explain the shape of the curve at pH 2.	3
(c2)	A meal contains 60 g carbohydrate, 25 g protein and 20 g fat. Using 17 kJ g ⁻¹ for carbohydrate and protein, and 38 kJ g ⁻¹ for fat, calculate the energy content of the meal in kJ.	3
(d)	Explain why a 15-year-old needs a higher proportion of protein in the diet than a 45-year-old office worker.	3

Question 3 — Gas exchange and respiration (14 marks)

Part	Question	Marks
(a)	Describe three features of an alveolus that make gas exchange efficient.	3
(b)	A student takes 15 breaths per minute with a tidal volume of 0.50 dm^3 . Calculate the pulmonary ventilation rate in dm^3 per minute.	2
(c)	The stroke volume of an athlete is 70 cm^3 and the heart rate is 72 beats per minute. Calculate the cardiac output in dm^3 per minute.	3
(d)	Compare aerobic respiration with anaerobic respiration in a human muscle cell.	4
(e)	Explain why the breathing rate increases during vigorous exercise.	2

Question 4 — Transport in humans and flowering plants (14 marks)

Part	Question	Marks
(a)	Name the type of blood vessel that carries blood away from the heart and state one way it differs from a vein.	2
(b)	A shoot with a leafy stem had a mass of 84.6 g. After 3 hours in a moving air stream its mass was 72.0 g. Calculate the total mass lost and the mean rate of water loss in g per hour.	3
(c)	Explain how an increase in temperature and an increase in wind speed each affect the rate of transpiration.	4
(d)	Explain what translocation is and state the role of the phloem in a plant.	3
(e)	State two functions of blood plasma.	2

Question 5 — Coordination and homeostasis (14 marks)

Part	Question	Marks
(a)	Put the parts of a reflex arc in the correct order: motor neurone, receptor, relay neurone, effector, sensory neurone.	3
(b)	A person's blood glucose concentration rose from 5.5 mmol dm^{-3} to 7.8 mmol dm^{-3} after a meal. Calculate the increase and the percentage increase.	2
(c)	Explain how insulin reduces blood glucose concentration.	4
(d)	Describe negative feedback, using the control of body temperature as an example.	3

(e)	State two effects on the body of producing too little ADH.	2
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Question 6 — Ecology and inheritance (12 marks)

Part	Question	Marks
(a)	A food chain has energy values of 45 000 kJ at the producer level, 4 500 kJ at the primary consumer level and 450 kJ at the secondary consumer level. Calculate the percentage of the producer's energy transferred to the secondary consumer.	3
(b)	Give two reasons why energy is lost between trophic levels.	2
(c)	40 woodlice were caught, marked and released. Later, 50 woodlice were caught and 8 of them were marked. Estimate the size of the population.	2
(d)	Two heterozygous black mice are crossed ($Bb \times Bb$), where B is black and b is brown. State the expected ratio of phenotypes and the probability that one offspring is brown.	3
(e)	State one difference between continuous and discontinuous variation, giving one example of each.	2

Answers and marking scheme

Question 1 — Cell structure and cell transport (12 marks)

Part	Answer	Marking points	Marks
(a)	Cell surface membrane (plasma membrane).	1 mark for cell surface membrane / plasma membrane.	1
(b)	Magnification = $45 / 0.05 = \times 900$.	1 mark for correct working (image size $\div$ actual size). 1 mark for answer $\times 900$ (accept 900).	2
(c)	Small cube: surface area 24 mm^2 , volume 8 mm^3 , ratio 3.0. Large cube: surface area 96 mm^2 , volume 64 mm^3 , ratio 1.5. The 2.0 mm cube has the larger surface area to volume ratio, so oxygen diffuses in faster.	1 mark for 3.0 (small cube ratio). 1 mark for 1.5 (large cube ratio). 1 mark for linking the larger ratio to faster diffusion.	3
(d)	Long, thin extension gives a large surface area for absorption; many mitochondria release energy for active transport of ions; the cell surface membrane is partially permeable.	1 mark large surface area / long hair extension. 1 mark many mitochondria / energy release. 1 mark active transport of mineral ions.	3
(e)	Diffusion is the net movement of particles from a region of higher concentration to a region of lower concentration, down a concentration gradient, without energy from respiration. Active transport moves particles against the gradient and requires energy from ATP.	1 mark movement from high to low concentration. 1 mark down a concentration gradient / passive. 1 mark active transport needs energy (ATP) and can move against the gradient.	3

Question 2 — Enzymes and human nutrition (14 marks)

Part	Answer	Marking points	Marks
(a)	Enzymes are biological catalysts made of protein that speed up reactions. The substrate binds to the active site, which is complementary in shape,	1 mark protein biological catalyst.	3

	forming an enzyme-substrate complex; the products are then released and the enzyme is unchanged.	1 mark substrate fits complementary active site. 1 mark enzyme-substrate complex / enzyme unchanged after reaction.	
(b)	Rate = $36 / 45 = 0.8 \text{ cm}^3 \text{ s}^{-1}$.	1 mark $36 \div 45$. 1 mark 0.8 (accept 0.80) with unit $\text{cm}^3 \text{ s}^{-1}$.	2
(c)	At pH 2 the acidic conditions change the shape of the active site (denaturation); the substrate no longer fits the active site, so very little or no enzyme-substrate complex forms and the rate is close to zero. The change is not reversible at that pH.	1 mark low pH changes active site shape. 1 mark substrate cannot fit / no enzyme-substrate complex. 1 mark rate very low or zero / denatured.	3
(c2)	Carbohydrate $60 \times 17 = 1020 \text{ kJ}$; protein $25 \times 17 = 425 \text{ kJ}$; fat $20 \times 38 = 760 \text{ kJ}$. Total = 2205 kJ.	1 mark 1020 kJ and 425 kJ. 1 mark 760 kJ. 1 mark total 2205 kJ.	3
(d)	A teenager is still growing, so protein is needed for growth and repair of tissues and for making new cells and enzymes. Growth has largely stopped in a 45-year-old, so protein is needed mainly for repair.	1 mark growth / making new cells. 1 mark growth and repair of tissues. 1 mark comparison with the adult who only needs repair.	3

Question 3 — Gas exchange and respiration (14 marks)

Part	Answer	Marking points	Marks
(a)	Large total surface area; walls one cell thick (short diffusion distance); good blood supply maintains a steep concentration gradient; thin film of moisture allows gases to dissolve.	1 mark large surface area. 1 mark wall one cell thick / short diffusion distance. 1 mark good blood supply / steep concentration gradient.	3
(b)	$15 \times 0.50 = 7.5 \text{ dm}^3 \text{ min}^{-1}$.	1 mark 15×0.50 . 1 mark 7.5 with unit $\text{dm}^3 \text{ min}^{-1}$.	2

(c)	Cardiac output = $72 \times 70 = 5040 \text{ cm}^3 \text{ min}^{-1} = 5.04 \text{ dm}^3 \text{ min}^{-1}$.	1 mark 72×70 . 1 mark $5040 \text{ cm}^3 \text{ min}^{-1}$. 1 mark conversion to $5.04 \text{ dm}^3 \text{ min}^{-1}$.	3
(d)	Aerobic respiration uses oxygen, releases a large amount of energy, and produces carbon dioxide and water. Anaerobic respiration occurs without oxygen, releases much less energy, produces lactic acid in muscle cells, and only happens for a short time during vigorous exercise. Both start with glucose breakdown.	1 mark aerobic uses oxygen. 1 mark anaerobic without oxygen / lactic acid. 1 mark aerobic releases much more energy. 1 mark products: carbon dioxide and water for aerobic.	4
(e)	Muscles respire faster and need more oxygen while producing more carbon dioxide, so the breathing rate increases to take in oxygen and to remove the extra carbon dioxide.	1 mark more carbon dioxide produced. 1 mark more oxygen needed / faster removal of carbon dioxide.	2

Question 4 — Transport in humans and flowering plants (14 marks)

Part	Answer	Marking points	Marks
(a)	Artery. It has a thick, elastic muscular wall and a narrow lumen; veins have thin walls and valves.	1 mark artery. 1 mark thicker muscular wall / narrow lumen / no valves in artery.	2
(b)	Mass lost = $84.6 - 72.0 = 12.6 \text{ g}$. Mean rate = $12.6 / 3 = 4.2 \text{ g h}^{-1}$.	1 mark correct subtraction 12.6 g . 1 mark $12.6 \div 3$. 1 mark 4.2 g h^{-1} .	3
(c)	Higher temperature gives water molecules more kinetic energy, so they evaporate faster from the leaf surface and diffuse out faster. Higher wind speed removes water vapour from around the leaf, keeping the concentration gradient steep so diffusion continues quickly.	1 mark heat gives particles more kinetic energy. 1 mark faster evaporation / diffusion out of leaf. 1 mark wind removes humid air. 1 mark steeper	4

		concentration gradient / faster diffusion.	
(d)	Translocation is the movement of sucrose and amino acids from sources such as leaves to sinks such as roots, fruits and growing tips, through the phloem. The phloem is a tube of living cells with sieve plates.	1 mark movement of sucrose / amino acids. 1 mark from source (leaf) to sink (root, fruit, bud). 1 mark phloem as the transport tissue with sieve plates.	3
(e)	Transports carbon dioxide to the lungs; carries dissolved nutrients such as glucose and amino acids, hormones, urea and heat around the body.	1 mark transport of carbon dioxide. 1 mark transport of glucose / amino acids / hormones / urea / heat.	2

Question 5 — Coordination and homeostasis (14 marks)

Part	Answer	Marking points	Marks
(a)	Receptor → sensory neurone → relay neurone → motor neurone → effector.	1 mark receptor first. 1 mark sensory, relay, motor in order. 1 mark effector last.	3
(b)	Increase = $7.8 - 5.5 = 2.3 \text{ mmol dm}^{-3}$. Percentage increase = $2.3 / 5.5 \times 100 = 41.8 \%$.	1 mark 2.3 mmol dm^{-3} . 1 mark 41.8% (accept $41.8\text{--}42 \%$).	2
(c)	Insulin is secreted by the pancreas when blood glucose is too high. It causes liver and muscle cells to take up glucose, converts glucose to glycogen in the liver, and increases the rate of respiration of glucose.	1 mark secreted by the pancreas. 1 mark cells take up glucose from blood. 1 mark glucose converted to glycogen in the liver. 1 mark increased respiration of glucose.	4
(d)	A change in temperature is detected by the hypothalamus and effectors respond to reverse the change: sweating and vasodilation cool the body, while shivering and vasoconstriction warm it. Once the temperature returns to normal the response stops.	1 mark detection by hypothalamus / receptor. 1 mark effector response reverses the	3

		change. 1 mark response stops when normal value is restored.	
(e)	The kidneys reabsorb less water, so large volumes of dilute urine are produced and the person feels very thirsty; dehydration follows.	1 mark large volume of dilute urine. 1 mark thirst / dehydration.	2

Question 6 — Ecology and inheritance (12 marks)

Part	Answer	Marking points	Marks
(a)	$450 / 45\,000 = 0.010$, so 1.0 % of the energy is transferred.	1 mark $450 \div 45\,000$. 1 mark 0.01 / 1 % (accept 1). 1 mark unit as a percentage.	3
(b)	Energy is lost as heat during respiration and in uneaten parts (bones, fur, roots) and undigested material in egested faeces.	1 mark loss as heat from respiration. 1 mark uneaten / undigested material, excretion.	2
(c)	Population = $(40 \times 50) / 8 = 250$. Assumes random mixing and no births, deaths, immigration or emigration.	1 mark correct substitution $(40 \times 50) / 8$. 1 mark 250.	2
(d)	Offspring are 1 BB : 2 Bb : 1 bb, so the phenotype ratio is 3 black : 1 brown. The probability that one offspring is brown is 0.25 (1 in 4).	1 mark 3 black : 1 brown. 1 mark 0.25 / 1 in 4 / 25 %. 1 mark BB, Bb, bb genotypes listed.	3
(e)	Continuous variation shows a range of values with no distinct groups (for example human height); discontinuous variation places individuals into distinct categories (for example blood group or ability to roll the tongue).	1 mark continuous gives a range / no distinct categories, with a valid example. 1 mark discontinuous gives distinct categories, with a valid example.	2

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