1.6 Organisms Respond to Changes in their Environments: 30-minute Pack

AQA 7402 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In a classic experiment, the tips of oat coleoptiles (seedling shoots) were removed and placed upside-down on blocks of agar jelly, allowing auxin (indoleacetic acid, IAA) produced by the tips to diffuse into the agar. Each agar block (now containing auxin) was then placed off-centre on top of a separate decapitated coleoptile stump, touching only one side of the cut surface. The stumps were left in the dark and their growth was monitored.

(a) Predict, with a reason, the direction in which a coleoptile stump would bend as it grew. **(3)**

(b) In an intact coleoptile exposed to unilateral (one-sided) light, explain how light brings about lateral (side-to-side) redistribution of auxin, and how this causes the shoot to curve towards the light (positive phototropism). **(4)**

(c) The coleoptile in the intact plant curved through 35 degrees over a period of 90 minutes. Calculate the mean rate of curvature, in degrees per hour. **(2)**

(d) Suggest two improvements to the experimental procedure that would increase confidence in a conclusion drawn from a single curvature measurement like this. **(2)**

(Total for Question 1 is 11 marks)

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2 A resting neurone maintains a potential difference of about -70 mV across its axon membrane (inside negative relative to outside).

(a) Explain how the sodium-potassium pump and ion channels in the axon membrane maintain this resting potential. **(5)**

(b) State the term used to describe the state of the axon membrane when it is at its resting potential and not currently transmitting an impulse. **(1)**

(Total for Question 2 is 6 marks)

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3 Blood glucose concentration is regulated by negative feedback involving the hormones insulin and glucagon, secreted by the islets of Langerhans in the pancreas.

(a) Describe how a rise in blood glucose concentration, following a meal, is detected and the sequence of events that returns it to normal. **(4)**

(b) Describe the second messenger role of cyclic AMP (cAMP) in glucagon action on liver cells. **(3)**

(c) Explain why insulin and glucagon secretion form an example of negative feedback control. **(2)**

(Total for Question 3 is 9 marks)

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Mark scheme · 1.6 Organisms Respond to Changes in their Environments: 30-minute Pack

Question 1

(a) the stump bends away from the side where the agar block is placed (i.e. curves towards the side with no auxin block) **B1**

(a) the side of the stump in contact with the agar block receives a higher concentration of auxin **B1**

(a) auxin stimulates cell elongation, so this side elongates more than the opposite side, causing unequal growth and curvature away from the block (oe) **B1**

(a) Answer: The stump curves away from the side with the agar block, because that side receives more auxin and its cells elongate more than those on the opposite side, so unequal growth causes the stem to bend towards the side without the block.

(b) auxin (IAA) is produced in the tip of the shoot **B1**

(b) when the shoot is illuminated from one side, auxin is transported laterally towards the shaded side of the tip **B1**

(b) this results in a higher concentration of auxin on the shaded side than on the illuminated side, and auxin then moves down the shoot from the tip **B1**

(b) auxin stimulates cell elongation in the region just behind the tip; because the shaded side has more auxin it elongates more than the illuminated side, causing the shoot to bend/curve towards the light **B1**

(b) Answer: Auxin made in the tip is moved to the shaded side when light comes from one direction, giving a higher auxin concentration there; since auxin promotes cell elongation, the shaded side grows faster than the illuminated side, bending the shoot towards the light.

(c) correct method: 35/90 x 60 (or equivalent unit conversion) **M1**

(c) 23.3 degrees per hour (awrt 23) **A1**

(c) Answer: 23.3 degrees per hour

(d) repeat the experiment using several different coleoptiles (of the same age/species) and calculate a mean curvature, to reduce the effect of natural variation between individual plants (oe) **B1**

(d) include a control coleoptile with a plain agar block (containing no auxin) placed off-centre, to confirm that curvature is caused specifically by auxin and not by the presence of the agar block, gravity or handling of the stump (oe) **B1**

(d) Answer: Repeat with several coleoptiles and calculate a mean, and include a control using a plain (auxin-free) agar block to confirm the curvature is due to auxin rather than the block itself or another factor.

Question 2

(a) the sodium-potassium pump actively transports (using ATP) 3 sodium ions out of the axon for every 2 potassium ions moved into the axon **B1**

(a) this creates a concentration gradient with a higher concentration of sodium ions outside the axon and a higher concentration of potassium ions inside the axon **B1**

(a) the membrane has (some) potassium ion channels open at rest, making it more permeable to potassium ions than to sodium ions **B1**

(a) potassium ions diffuse back out of the axon down their concentration gradient through these channels (facilitated diffusion), while few sodium ions can re-enter as most sodium channels are closed **B1**

(a) the resulting net loss of positive charge from inside the axon makes the inside of the membrane negatively charged relative to the outside, maintaining the resting potential of about -70 mV **B1**

(a) Answer: The sodium-potassium pump actively moves 3 Na^+ out for every 2 K^+ in, using ATP, creating concentration gradients; because the membrane is more permeable to K^+ (via open potassium channels) than to Na^+, K^+ diffuses back out, leaving the inside relatively negative and maintaining the resting potential of about -70 mV.

(b) polarised (accept 'resting state') **B1**

(b) Answer: Polarised

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Question 3

(a) β cells in the islets of Langerhans detect the rise in blood glucose concentration directly oe **B1**

(a) β cells secrete (more) insulin into the blood oe **B1**

(a) insulin binds to specific receptors on muscle cells, causing more glucose transporters (GLUT4) to move to the cell-surface membrane, increasing glucose uptake into these cells oe **B1**

(a) insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the liver/muscle, and increases the rate of glucose use in respiration, lowering blood glucose concentration back towards normal oe **B1**

(a) Answer: Beta cells detect rising blood glucose and secrete insulin, which binds to receptors on liver and muscle cells, increasing glucose uptake and stimulating glycogenesis and glucose use in respiration, lowering blood glucose back to normal.

(b) glucagon binds to a specific receptor on the cell-surface membrane of a liver cell (glucagon cannot cross the membrane as it is a protein hormone) oe **B1**

(b) this activates an enzyme (adenylate cyclase) inside the cell, which converts ATP into cyclic AMP (cAMP) oe **B1**

(b) cAMP acts as a second messenger, activating a cascade of enzymes (e.g. activating enzymes that break down glycogen to glucose, glycogenolysis) inside the cell oe **B1**

(b) Answer: Glucagon binds a surface receptor, activating adenylate cyclase to produce cAMP inside the cell, which acts as a second messenger to activate enzymes that break down glycogen to glucose.

(c) a rise in blood glucose triggers insulin release, which lowers blood glucose; a fall in blood glucose triggers glucagon release, which raises blood glucose - in each case the response counteracts/reverses the original change oe **B1**

(c) this keeps blood glucose concentration fluctuating within a narrow range around a set point, rather than continuing to rise or fall oe **B1**

(c) Answer: Each hormone's effect counteracts the change that triggered its release (insulin lowers a rise, glucagon raises a fall), keeping blood glucose within a narrow range - the defining feature of negative feedback.

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