AB6D Organisms Respond to Changes in their Environments: Depth and Exam Drill

Total Marks

AQA 7402 · Calculator allowed · about 140 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 This question tests core vocabulary used to describe homeostatic control.

(a) Define homeostasis. **(1)**

(b) State what is meant by negative feedback. **(1)**

(c) State the general term for a cell or structure that detects a stimulus/change in a homeostatic system. **(1)**

(d) State the term for a structure that brings about a response to restore the normal level of a factor, e.g. a gland or a muscle. **(1)**

(Total for Question 1 is 4 marks)

2 This question tests key facts about blood glucose regulation and the kidney. For each part, identify the correct option.

(a) Which cells in the islets of Langerhans secrete insulin? **(1)**

- ☐ A) Alpha cells
- ☐ B) Beta cells
- ☐ C) Δ cells
- ☐ D) Acinar cells

(b) Which structure in the nephron is responsible for ultrafiltration of the blood? **(1)**

- ☐ A) The glomerulus and Bowman's capsule
- ☐ B) The loop of Henle
- ☐ C) The distal convoluted tubule
- ☐ D) The collecting duct

(c) Where is antidiuretic hormone (ADH) produced and released from? **(1)**

- ☐ A) Produced and released by the pancreas
- ☐ B) Produced in the hypothalamus, released from the posterior pituitary gland
- ☐ C) Produced and released by the adrenal cortex
- ☐ D) Produced in the liver, released by the kidney

(d) Which hormone raises blood glucose concentration by stimulating the breakdown of glycogen in the liver? **(1)**

- ☐ A) Insulin
- ☐ B) Glucagon
- ☐ C) Adrenaline
- ☐ D) Both B and C

(Total for Question 2 is 4 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)

4 In type 1 diabetes, the β cells of the islets of Langerhans are destroyed by an autoimmune response, so little or no insulin is produced. A patient with untreated type 1 diabetes has a fasting blood glucose concentration of 11.8 mmol/dm3 (normal fasting range is approximately 4.0-5.9 mmol/dm3).

(a) Explain why a person with untreated type 1 diabetes has a persistently high blood glucose concentration. **(2)**

(b) Calculate the percentage by which this patient's fasting blood glucose concentration (11.8 mmol/dm3) exceeds the upper limit of the normal fasting range (5.9 mmol/dm3). **(2)**

(c) When blood glucose concentration exceeds the kidney's reabsorption capacity (the renal threshold, approximately 10 mmol/dm3), glucose appears in the urine. Explain, in terms of the proximal convoluted tubule, why glucose is normally completely reabsorbed from the filtrate but appears in the urine of this patient. **(3)**

(d) Explain why untreated type 1 diabetes also causes excessive urine production (polyuria). **(1)**

(Total for Question 4 is 8 marks)

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5 Antidiuretic hormone (ADH) regulates the water potential of the blood by altering the permeability of the collecting duct to water. A dehydrated volunteer's plasma ADH concentration and urine concentration were monitored over several hours.

Time (hours)	Plasma ADH (arbitrary units)	Urine concentration (mosmol/kg)
0	2.0	300
2	5.5	620
4	8.0	900
6	4.0	550

(a) Explain how a fall in the water potential of the blood plasma (as in dehydration) leads to increased secretion of ADH. **(3)**

(b) Explain how increased ADH concentration causes the collecting duct to produce more concentrated urine. **(3)**

(c) Using the data, calculate the percentage increase in urine concentration between 0 and 4 hours. **(2)**

(d) Suggest why both plasma ADH concentration and urine concentration fall between 4 and 6 hours. **(1)**

(Total for Question 5 is 9 marks)

6 Thermoregulation in mammals is controlled by the thermoregulatory centre in the hypothalamus, which coordinates responses to both a rise and a fall in core body temperature.

(a) State the two types of receptor, and their locations, that provide the thermoregulatory centre with information about temperature. **(2)**

(b) Explain how vasodilation of arterioles supplying the skin capillaries helps to lower body temperature when core temperature rises above normal. **(3)**

(c) Explain how shivering helps to raise body temperature when core temperature falls below normal. **(2)**

(d) Explain why thermoregulation is described as an example of negative feedback control involving effectors that can produce opposite responses (antagonistic effectors). **(1)**

(Total for Question 6 is 8 marks)

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7 The kidneys filter blood at the glomerulus to produce filtrate, and then reabsorb most of the filtered water and solutes as it passes along the nephron. In a healthy adult, the glomerular filtration rate (GFR) is approximately 125 cm3 of filtrate produced per minute, but typical urine output is only about 1.0 cm3 per minute.

(a) Calculate the volume of filtrate produced by the kidneys in 24 hours, in dm3, to 3 significant figures. **(2)**

(b) Given that typical urine output is 1.0 cm3 per minute, calculate the percentage of the filtrate that is reabsorbed back into the blood as it passes along the nephron. **(3)**

(c) Explain why almost all of the glucose and amino acids in the filtrate are reabsorbed in the proximal convoluted tubule, but urea is only partially reabsorbed. **(3)**

(Total for Question 7 is 8 marks)

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8 The loop of Henle creates a concentration gradient of sodium and chloride ions in the medulla of the kidney, which is essential for producing concentrated urine. This is known as the countercurrent multiplier mechanism.

(a) Explain how the ascending limb of the loop of Henle, which is impermeable to water, contributes to establishing a high concentration of sodium and chloride ions in the medulla. **(3)**

(b) Explain how this ion concentration gradient in the medulla enables the collecting duct to reabsorb water and produce concentrated urine, when ADH is present. **(2)**

(c) A desert-adapted rodent has unusually long loops of Henle that extend deep into the medulla, compared with an aquatic mammal such as a beaver, which has short loops of Henle. Suggest why this difference in loop length is an adaptation to each animal's habitat. **(2)**

(Total for Question 8 is 7 marks)

9 Evaluate the effectiveness of negative feedback control in maintaining a stable internal environment, using blood glucose regulation and thermoregulation as examples, and discuss circumstances in which this control can fail or be overwhelmed.

(Total for Question 9 is 6 marks)

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10 Skeletal muscle contraction is explained by the sliding filament theory, in which actin and myosin filaments slide past one another within each sarcomere, shortening the muscle fibre.

(a) Describe the role of calcium ions and troponin in initiating muscle contraction once an action potential reaches a muscle fibre. **(3)**

(b) Explain the role of ATP in both the power stroke of the myosin head and in muscle relaxation. **(3)**

(c) An electron micrograph of a relaxed sarcomere shows the whole sarcomere (Z line to Z line) is 2.6 micrometres long, and the (constant) A band is 1.5 micrometres long. During contraction the sarcomere shortens to 2.0 micrometres. Assuming the A band stays the same length, calculate the percentage decrease in the length of the I band during this contraction. (I band length = sarcomere length - A band length.) **(3)**

(Total for Question 10 is 9 marks)

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11 This final question draws together ideas about nervous and hormonal coordination in maintaining homeostasis in response to changing conditions.

(a) Compare nervous and hormonal (endocrine) communication in terms of the speed of response and the duration of effect, explaining why each is suited to a different type of homeostatic control. **(3)**

(b) During a sudden stressful event, adrenaline is released from the adrenal medulla under direct nervous stimulation via the sympathetic nervous system, producing effects (e.g. increased heart rate, raised blood glucose) within seconds. Explain why this rapid nervous stimulation of a hormone-secreting gland is advantageous for a 'fight or flight' response, compared with the normal (slower) hormonal feedback loop involving blood glucose concentration alone. **(3)**

(c) Both adrenaline and glucagon raise blood glucose concentration via the same second messenger, cAMP, acting on liver cells, yet they are released in response to different stimuli. Suggest one advantage to an organism of having two different hormones capable of producing the same overall effect on blood glucose. **(3)**

(Total for Question 11 is 9 marks)

Mark scheme · AB6D Organisms Respond to Changes in their Environments: Depth and Exam Drill

Question 1

- (a) **B1** the maintenance of a stable/constant internal environment, within set limits, despite external changes oe
- **(a) Answer: The maintenance of a stable internal environment within set limits despite external changes.**
- (b) **B1** a mechanism in which a change in a factor (from its normal/set level) brings about processes that return the factor back towards its normal level oe
- **(b) Answer: A mechanism in which a deviation from the normal level triggers a response that returns the level back towards normal.**
- (c) **B1** receptor
- **(c) Answer: Receptor.**
- (d) **B1** effector
- **(d) Answer: Effector.**

Question 2

- (a) **B1** B
- **(a) Answer: B**
- (b) **B1** A
- **(b) Answer: A**
- (c) **B1** B
- **(c) Answer: B**
- (d) **B1** D
- **(d) Answer: D**

Question 3

- (a) **B1** β cells in the islets of Langerhans detect the rise in blood glucose concentration directly oe
- (a) **B1** β cells secrete (more) insulin into the blood oe
- (a) **B1** insulin binds to specific receptors on target cells (e.g. liver and muscle cells), causing more glucose channel proteins to move to the cell-surface membrane, increasing glucose uptake into cells oe
- (a) **B1** 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
- **(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) **B1** 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
- (b) **B1** this activates an enzyme (adenylate cyclase) inside the cell, which converts ATP into cyclic AMP (cAMP) oe
- (b) **B1** 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
- **(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) **B1** 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
- (c) **B1** this keeps blood glucose concentration fluctuating within a narrow range around a set point, rather than continuing to rise or fall oe
- **(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.**

Question 4

- (a) **B1** without functioning β cells, little or no insulin is secreted in response to rising blood glucose oe
- (a) **B1** so glucose uptake by cells and conversion of glucose to glycogen are not stimulated, and blood glucose remains high after eating (and between meals) oe
- **(a) Answer: Without insulin, cells cannot increase their glucose uptake or convert glucose to glycogen normally, so blood glucose concentration stays persistently high.**
- (b) **M1** correct substitution: (11.8 - 5.9)/5.9 x 100
- (b) **A1** 100% (exactly double the upper normal limit), cao
- **(b) Answer: 100%**
- (c) **B1** glucose is normally reabsorbed from the filtrate in the proximal convoluted tubule by active co-transport with sodium ions, via specific glucose-sodium co-transporter proteins oe
- (c) **B1** these co-transporter proteins have a limited/finite number, giving a maximum rate at which glucose can be reabsorbed oe
- (c) **B1** when blood (and therefore filtrate) glucose concentration is very high, as in this patient, the amount of glucose filtered exceeds this maximum reabsorption capacity, so the excess glucose remains in the filtrate and is excreted in the urine oe
- **(c) Answer: Glucose is normally reabsorbed by a limited number of co-transporter proteins in the proximal convoluted tubule; when filtrate glucose concentration is very high, as in this patient, this reabsorption capacity is exceeded and the excess glucose passes into the urine.**
- (d) **B1** glucose remaining in the filtrate lowers the water potential of the filtrate, so less water is reabsorbed by osmosis from the nephron into the blood, increasing the volume of urine produced oe
- **(d) Answer: Glucose left in the filtrate lowers its water potential, so less water is reabsorbed by osmosis, increasing urine volume.**

Question 5

- (a) **B1** osmoreceptors in the hypothalamus detect the fall in water potential of the blood oe
- (a) **B1** the osmoreceptor cells lose water by osmosis and shrink, stimulating them to fire more frequently/generate more action potentials oe
- (a) **B1** this stimulates neurosecretory cells in the hypothalamus to release more ADH from the posterior pituitary gland into the blood oe
- **(a) Answer: Osmoreceptors in the hypothalamus lose water and shrink when blood water potential falls, stimulating neurosecretory cells to release more ADH from the posterior pituitary.**
- (b) **B1** ADH binds to receptors on the cell-surface membrane of collecting duct cells oe
- (b) **B1** this causes vesicles containing aquaporins (water channel proteins) to fuse with the cell-surface membrane, increasing the number of aquaporins present oe
- (b) **B1** this increases the permeability of the collecting duct to water, so more water is reabsorbed by osmosis (into the blood, down the gradient created by the medulla), producing a smaller volume of more concentrated urine oe
- **(b) Answer: ADH causes more aquaporins to be inserted into the collecting duct cell membrane, increasing its permeability to water so more water is reabsorbed by osmosis, giving a smaller volume of more concentrated urine.**
- (c) **M1** correct substitution: (900 - 300)/300 x 100
- (c) **A1** 200% cao
- **(c) Answer: 200%**
- (d) **B1** the volunteer is likely to have drunk water (or the negative feedback response has restored blood water potential towards normal), reducing the stimulus for ADH release, so less ADH is secreted and less water is reabsorbed, producing more dilute urine oe
- **(d) Answer: The volunteer probably drank water, raising blood water potential back towards normal, reducing the stimulus for ADH release and allowing more dilute urine to be produced.**

Question 6

- (a) **B1** thermoreceptors in the skin, which detect the temperature of the external environment/skin surface oe
- (a) **B1** thermoreceptors within the hypothalamus itself, which detect the temperature of the blood flowing through it (core body temperature) oe
- **(a) Answer: Thermoreceptors in the skin (detecting external/skin temperature) and thermoreceptors in the hypothalamus itself (detecting core blood temperature).**
- (b) **B1** arterioles supplying the skin capillary network dilate (widen), allowing more blood to flow close to the skin surface, into the capillary network oe
- (b) **B1** this increases the flow of warm blood near the body surface oe
- (b) **B1** increasing the transfer of heat from the blood to the environment (by radiation/convection/conduction), cooling the blood and lowering body temperature oe
- **(b) Answer: Vasodilation lets more warm blood flow through capillaries near the skin surface, increasing heat loss to the environment by radiation and convection, cooling the blood and lowering body temperature.**
- (c) **B1** shivering involves rapid, involuntary contraction and relaxation of skeletal muscles oe
- (c) **B1** these contractions require respiration, which releases heat as a by-product, warming the body oe
- **(c) Answer: Shivering causes rapid involuntary muscle contractions; the increased respiration this requires releases heat as a by-product, warming the body.**
- (d) **B1** a rise in temperature triggers heat-losing responses (e.g. vasodilation, sweating) while a fall in temperature triggers heat-generating/conserving responses (e.g. shivering, vasoconstriction) - each response counteracts the original deviation, and the two sets of effectors act in opposite directions to keep temperature within a narrow range oe
- **(d) Answer: Rising temperature triggers heat-losing responses and falling temperature triggers heat-generating responses; these opposite (antagonistic) effector actions each counteract the original change, keeping body temperature within a narrow range around the set point.**

Question 7

- (a) **M1** 125 x 60 x 24 = 180000 cm3
- (a) **A1** 180 dm3, cao
- **(a) Answer: 180 dm3**
- (b) **M1** reabsorbed per minute = 125 - 1.0 = 124 cm3
- (b) **M1** percentage reabsorbed = 124/125 x 100
- (b) **A1** 99.2%, awrt
- **(b) Answer: 99.2%**
- (c) **B1** glucose and amino acids are actively/selectively reabsorbed by specific co-transporter proteins in the proximal convoluted tubule wall, which the cell has in sufficient number to reabsorb essentially all of the useful solute present under normal conditions oe
- (c) **B1** urea is a waste product with no specific reabsorption mechanism/no specific transporter protein oe
- (c) **B1** urea only re-enters the blood by diffusion down its concentration gradient (as water reabsorption concentrates it in the tubule), so only some of it is reabsorbed, and most passes out in the urine oe
- **(c) Answer: Glucose and amino acids are actively reabsorbed via specific co-transporters, so almost all is recovered; urea has no specific transporter and only diffuses back passively, so only part of it is reabsorbed and most remains in the urine.**

Question 8

- (a) **B1** sodium and chloride ions are actively transported (pumped) out of the filtrate in the ascending limb, into the surrounding medulla tissue oe
- (a) **B1** because the ascending limb is impermeable to water, water cannot follow the ions out, so this builds up a high concentration of ions in the medulla tissue without diluting it oe
- (a) **B1** because the loop is long and the process happens repeatedly along its length, a large concentration gradient (increasing towards the tip of the loop, deep in the medulla) is built up and maintained oe
- **(a) Answer: Sodium and chloride ions are actively pumped out of the water-impermeable ascending limb into the medulla, building a high, undiluted ion concentration that increases towards the tip of the loop.**
- (b) **B1** the collecting duct passes back down through the medulla, alongside the loop of Henle, and its wall (with ADH present) is permeable to water via aquaporins oe
- (b) **B1** as fluid in the collecting duct passes through regions of increasingly low water potential (high ion concentration) in the medulla, water is progressively reabsorbed by osmosis into the surrounding tissue and blood, concentrating the urine oe
- **(b) Answer: As the collecting duct passes through the medulla, water moves out by osmosis into the increasingly concentrated surrounding tissue, progressively concentrating the fluid inside and producing concentrated urine.**
- (c) **B1** a longer loop of Henle allows a greater/steeper ion concentration gradient to be built up in the medulla, enabling more water to be reabsorbed and much more concentrated urine to be produced, conserving water - an advantage in a desert where water is scarce oe
- (c) **B1** an aquatic mammal has ready access to water, so producing highly concentrated urine (and conserving water) is less important, and a shorter loop (with less energy spent on active transport) is sufficient oe
- **(c) Answer: Long loops build a steeper medullary gradient, allowing the desert rodent to produce very concentrated urine and conserve scarce water; the beaver has abundant water available, so a shorter loop (needing less energy) is sufficient.**

Question 9

- **Level 3** (5-6): A detailed, well-structured evaluation that explains the general principle of negative feedback with correct reference to both blood glucose regulation and thermoregulation, discusses why the system is normally highly effective (rapid detection, antagonistic effectors, hormonal amplification), and gives at least two well-explained circumstances in which control can fail (e.g. type 1 diabetes, extreme environmental temperature, prolonged/severe stimuli), reaching a supported overall judgement.
- **Level 2** (3-4): A reasonably clear evaluation referencing at least one of the two named systems correctly, with some discussion of why the system is normally effective and at least one valid example of when it can fail, but the discussion is not fully developed or one system is not properly addressed.
- **Level 1** (1-2): Limited evaluation; describes negative feedback only in general terms with little or no correct reference to blood glucose or thermoregulation, and little or no discussion of when control can fail.
- **Indicative content:**
  - Negative feedback works by detecting a deviation from a set point and triggering a response that counteracts (reverses) that deviation, returning the factor towards normal.
  - In blood glucose regulation, beta and alpha cells of the pancreas act as both receptors and (via hormone secretion) as the trigger for effector responses in the liver/muscle (insulin/glucagon), providing rapid, hormone-mediated correction.
  - In thermoregulation, the hypothalamus integrates information from skin and internal thermoreceptors and coordinates antagonistic effector responses (e.g. vasodilation/vasoconstriction, sweating/shivering) via the nervous system, allowing very rapid correction.
  - Both systems are normally highly effective because they involve continuous monitoring, rapid detection, and effectors capable of acting in either direction depending on which way the factor has deviated.
  - Control can fail when a receptor or effector itself is damaged or absent, e.g. in type 1 diabetes the beta cells are destroyed, so no insulin can be secreted regardless of how high blood glucose rises, and blood glucose regulation fails.
  - Control can be overwhelmed when the environmental stimulus is too extreme or prolonged for the effectors to compensate, e.g. in extreme heat or cold, vasodilation/vasoconstriction and sweating/shivering may be insufficient to prevent dangerous changes in core body temperature (heat stroke or hypothermia).
  - A balanced evaluation notes that negative feedback is very effective within the normal physiological range the system evolved to handle, but is not infallible outside that range or when a component of the pathway is damaged.

Question 10

- (a) **B1** the action potential travels down the T-tubules, causing the sarcoplasmic reticulum to release calcium ions into the sarcoplasm oe
- (a) **B1** calcium ions bind to troponin, causing it to change shape, pulling the attached tropomyosin away from the myosin-binding sites on the actin filament oe
- (a) **B1** this exposes the binding sites, allowing myosin heads to bind to actin, forming actin-myosin cross-bridges oe
- **(a) Answer: Calcium ions released from the sarcoplasmic reticulum bind troponin, which moves tropomyosin off the actin binding sites, allowing myosin heads to bind actin and form cross-bridges.**
- (b) **B1** ATP hydrolysis (by ATPase on the myosin head) provides the energy for the myosin head to change angle (power stroke), pulling the actin filament along the myosin, oe
- (b) **B1** a new ATP molecule must then bind to the myosin head to allow it to detach from actin, oe
- (b) **B1** ATP is also needed to actively pump calcium ions back into the sarcoplasmic reticulum, allowing tropomyosin to block the binding sites again and the muscle to relax oe
- **(b) Answer: ATP hydrolysis powers the myosin head's power stroke; a fresh ATP molecule is needed for the myosin head to detach from actin; and ATP is used to actively pump calcium back into the sarcoplasmic reticulum, allowing the muscle to relax.**
- (c) **M1** I band before = 2.6 - 1.5 = 1.1 micrometres; I band after = 2.0 - 1.5 = 0.5 micrometres
- (c) **M1** percentage decrease = (1.1 - 0.5)/1.1 x 100
- (c) **A1** 54.5% (accept 54-55%), awrt
- **(c) Answer: Approximately 54.5% decrease.**

Question 11

- (a) **B1** nervous communication is very fast (impulses travel rapidly along neurones) and short-lived, suiting responses that must occur immediately, such as antagonistic effector control of heart rate or thermoregulation oe
- (a) **B1** hormonal communication is comparatively slow (hormones travel in the blood to target cells) but long-lasting, suiting responses that need to be sustained over a longer period, such as blood glucose regulation oe
- (a) **B1** a valid supporting comparison, e.g. nervous responses act on specific, localised effectors via a synapse, whereas hormones act on any cell with the complementary receptor, giving a more widespread but less precisely localised effect oe
- **(a) Answer: Nervous responses are fast and short-lived, suiting immediate adjustments (e.g. heart rate); hormonal responses are slower but longer-lasting, suiting sustained regulation (e.g. blood glucose); hormones also act more widely on any responsive cell, while nerve impulses act on specific, localised effectors.**
- (b) **B1** the normal hormonal feedback loop for glucagon relies on a fall in blood glucose concentration to trigger a response, which takes time to develop and detect oe
- (b) **B1** direct nervous stimulation of the adrenal medulla allows adrenaline release to be triggered immediately by the brain's perception of a threat, before any change in blood glucose has occurred oe
- (b) **B1** this anticipatory response ensures blood glucose (and other resources, e.g. oxygen delivery via increased heart rate) is already being mobilised by the time it is needed for a rapid physical response, which is critical in a genuine emergency oe
- **(b) Answer: Nervous stimulation lets adrenaline be released immediately in anticipation of a threat, before blood glucose has actually fallen, mobilising energy resources faster than the slower glucagon feedback loop could, which is critical for a rapid fight-or-flight response.**
- (c) **B1** having two hormones allows blood glucose to be raised in response to two different types of stimulus: a genuine fall in blood glucose (glucagon) and an anticipated increase in demand due to stress/exercise (adrenaline), oe
- (c) **B1** this provides redundancy/back-up, so that if one signalling pathway is impaired, the other can still help raise blood glucose when needed oe
- (c) **B1** it allows a graded and more precisely appropriate response, since the two hormones can act together or independently depending on the situation, giving finer control than a single hormone alone oe
- **(c) Answer: Two hormones allow blood glucose to be raised in response to different situations (falling glucose versus anticipated stress), provide a degree of redundancy if one pathway is impaired, and allow more finely graded control than a single hormone could provide.**