HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.6.4 Homeostasis is the maintenance of a stable internal environment

Mark scheme

Version 1 · 14 October 2026

TOTAL MARKS	QUESTIONS
78	12

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

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Principles of homeostasis and negative feedback 3.6.4.1

Question	Marking guidance	Mark	Comments
01.1	A change from the norm is detected and the response returns the system to its original level;	**1** (1 × AO1)	Negative feedback restores systems to their original level.

Question	Marking guidance	Mark	Comments
01.2	Correct answer for 2 marks: 40.4 OR 40 (%);; Accept for 1 mark: a decrease of 38 (%) OR (94 − 56) ÷ 94 **OR** correct method using the student's readings from the graph	**2** (2 × AO2)	Plotted values: 94% at 37 °C and 56% at 43 °C **Accept** readings of 93–95 and 55–57, giving answers in the range 38.7 to 42.1 (%), for 2 marks **Reject** 59.6 (activity at 43 °C as a percentage of activity at 37 °C) for 2 marks

Question	Marking guidance	Mark	Comments
01.3	1. Above 39 °C/the optimum, activity falls (rapidly) OR at 43 °C activity is only 56% of the maximum; 2. Hydrogen/ionic bonds (in the tertiary structure) break OR the enzyme is denatured; 3. Active site changes shape, so fewer enzyme-substrate complexes form; 4. Below 37 °C, (molecules have) less kinetic energy, so fewer (successful) collisions/enzyme-substrate complexes; 5. So (metabolic) reactions, eg respiration, are slower OR a stable temperature keeps enzyme activity close to its maximum/optimum;	**3 max** (2 × AO1) (1 × AO2)	**Accept** E-S complex / ES complex. E-S alone only if 'enzyme-substrate complex' is written elsewhere. Ignore ESC. 2. **Reject** peptide bonds break 3. **Reject** the substrate changes shape **Ignore** 'enzymes are killed'

Question	Marking guidance	Mark	Comments
02.1	1. When calcium ion concentration falls below the normal range/2.2 (mmol dm^{-3}), (secretion of) parathyroid hormone increases, so the concentration rises (back to the norm); 2. When calcium ion concentration rises above the normal range/2.6 (mmol dm^{-3}), (secretion of) calcitonin increases, so the concentration falls (back to the norm); 3. Separate (negative feedback) mechanisms control departures in different/both directions; 4. So the concentration is returned to the norm/set point faster OR kept within narrower limits (than only reducing the secretion of one hormone);	**3 max** (1 × AO1) (2 × AO2)	**Accept** PTH for parathyroid hormone 1 and 2. **Accept** a correct reading from the graph, eg parathyroid hormone above 50% below 2.1 mmol dm^{-3} 4. **Accept** original level / optimum for norm **Ignore** descriptions of the curves that are not linked to a correction of the concentration

Question	Marking guidance	Mark	Comments
02.2	1. Calcium ion concentration rises above the normal range/2.6 (mmol dm^{-3}) because parathyroid hormone secretion is not reduced by negative feedback; 2. Calcitonin secretion increases (because calcium ion concentration is high), but cannot return the concentration to normal while parathyroid hormone is still secreted;	**2** (2 × AO3)	**Accept** PTH for parathyroid hormone 1. **Accept** calcium ion concentration high / increases only if linked to parathyroid hormone still being secreted / not switched off 2. **Accept** calcitonin secretion increases for the mark only if an explanation is given

Question	Marking guidance	Mark	Comments
03.1	1. The response/stronger contraction increases the stimulus/pressure on the cervix (so even more oxytocin is released); 2. So the change is amplified/moves further from the original state OR (in negative feedback) the response would reduce the stimulus/return it to the original level;	**2** (2 × AO2)	1. **Accept** 'more contractions cause more oxytocin release' **Ignore** 'it is not homeostasis' unqualified

Question	Marking guidance	Mark	Comments
03.2	The baby's head no longer presses on the cervix, so the stretch receptors are no longer stimulated OR so less oxytocin is released;	**1** (1 × AO3)	**Accept** 'no more pressure on the cervix' **Ignore** 'the baby has been born' unqualified (restates the question)

Question	Marking guidance	Mark	Comments
03.3	1. Any rise/fall in blood glucose would be amplified, so the concentration would not return to the norm OR would move outside restricted limits; 2. If too low, less glucose/respiratory substrate available (for cells), so less respiration/ATP; 3. If too high, the water potential of the blood decreases/becomes more negative; 4. So water leaves (body) cells by osmosis;	**3 max** (1 × AO2) (2 × AO3)	2. **Reject** energy 'produced' in respiration 3. **Accept** Ψ for water potential. Reject WP 4. **Reject** water diffuses / 'concentration gradient' for osmosis **Max 2** if only one direction of change is explained

Control of blood glucose concentration 3.6.4.2

Question	Marking guidance	Mark	Comments
04.1	Process: Glycogenesis Conversion: Glucose to glycogen Hormone: Insulin;	**1** (1 × AO1)	Insulin activates enzymes involved in converting glucose to glycogen (glycogenesis).

Question	Marking guidance	Mark	Comments
04.2	1. A: adenylate cyclase; 2. B: cyclic AMP; 3. C: protein kinase;	**3** (3 × AO1)	B. Accept cAMP C. Accept protein kinase A C. Reject kinase unqualified A. Reject adenylate kinase

Question	Marking guidance	Mark	Comments
04.3	1. Cyclic AMP/B is not broken down, so it stays at a higher concentration OR stays for longer; 2. (So) more protein kinase/C is activated OR protein kinase stays active (for longer); 3. More glycogen is converted to glucose OR more glycogenolysis; 4. More glucose is released into the blood, so the blood glucose concentration increases/stays higher;	**3 max** (3 × AO2)	**Accept** cAMP; accept letters B and C **Accept** glycogen hydrolysed to glucose **Reject** glucagon converted to glucose **Reject** gluconeogenesis for point 3

Question	Marking guidance	Mark	Comments
04.4	1. Each hormone binds to a different (specific) receptor with a complementary shape; 2. Both receptors activate adenylate cyclase/enzyme A OR both cause the production of cyclic AMP/the same second messenger; 3. (Which) activates protein kinase/enzyme C (and the same enzymes that convert glycogen to glucose);	**2 max** (2 × AO2)	**Accept** cAMP 1. **Reject** active site / enzyme / substrate language for the receptor **Reject** adrenaline binds to the glucagon receptor

Question	Marking guidance	Mark	Comments
04.5	1. (Glucagon) activates enzymes (in liver cells) that convert glycerol/amino acids into glucose; 2. Gluconeogenesis; 3. Glucose is released (from liver cells) into the blood;	**2 max** (2 × AO1)	1. **Accept** glycerol or amino acids; both are not required **Ignore** fatty acids **Reject** glycogenolysis / glycogen converted to glucose **Reject** glucagon converted into glucose Spelling of gluconeogenesis must be unambiguous (not confused with glycogenesis/glycogenolysis)

Question	Marking guidance	Mark	Comments
05.1	1. As insulin concentration increases, more insulin binds to receptors (on the cells); 2. More channel proteins (for glucose) are added to the cell-surface membrane OR more vesicles containing channel proteins fuse with the cell-surface membrane; 3. So more glucose enters the cells by facilitated diffusion; 4. Levels off (above about 4 nmol dm^{-3}) because all the receptors are occupied/saturated OR the maximum number of channel proteins is in the membrane; 5. Some uptake (12 arbitrary units) without insulin because some channel proteins are always in the membrane;	**3 max** (3 × AO2)	2. **Accept** carrier proteins / transport proteins for channel proteins; accept a named glucose transporter (eg GLUT4), never required 2. Must refer to the (cell-surface) membrane; accept plasma membrane 3. **Reject** active transport **Reject** glucose binds to the insulin receptor **Reject** 'vesicles contain glucose'

Question	Marking guidance	Mark	Comments
05.2	1. Cells were given the same insulin concentrations, but cells from people with type II diabetes took up less glucose at every concentration of insulin (above 0), eg maximum 45 compared with 80; 2. So the cells/receptors are less sensitive/responsive to insulin OR a lack of insulin cannot explain the difference because insulin was supplied; 3. Uptake without insulin is similar (11 and 12), so the difference is in the response to insulin;	**2 max** (2 × AO3)	2. **Accept** insulin 'resistant'; accept faulty / fewer receptors 2. **Reject** 'the body' is less sensitive **Accept** values read from the graph within 2 arbitrary units of the plotted values

Question	Marking guidance	Mark	Comments
06.1	1. Q, because Q's insulin concentration is (very) low and does not increase after the glucose drink (5 to 6), so Q does not produce insulin; 2. R produces insulin (95 to 420, more than P), but R's blood glucose stays high, so R's cells/receptors are less sensitive/responsive to insulin;	**2** (2 × AO3)	Identifying Q without an explanation = 0 marks 1. **Accept** Q does not produce enough insulin 2. **Accept** insulin 'resistant'; reject 'the body' is less sensitive

Question	Marking guidance	Mark	Comments
06.2	Correct answer for 2 marks: 3.1×10^{-2} (mmol dm^{-3} min^{-1});; Accept for 1 mark: 0.031 OR 0.0311 (correct, not in standard form) **OR** 2.8 ÷ 90	**2** (2 × AO2)	Working: 7.8 − 5.0 = 2.8; 2.8 ÷ 90 = 0.0311 **Accept** 3.11×10^{-2} for 2 marks

Question	Marking guidance	Mark	Comments
06.3	1. Q/type I does not produce insulin (eg pancreatic cells destroyed by an immune response), so insulin must be supplied; 2. R/type II does produce insulin, but cells/receptors are less sensitive/responsive to it; 3. Reducing intake of sugar/carbohydrate reduces the rise in blood glucose (after meals) OR less insulin is needed; 4. Losing body mass/reducing obesity (by diet) can make cells/receptors more responsive to insulin;	**3 max** (2 × AO1) (1 × AO2)	**Max 2** if only one person is explained 1. **Accept** beta cells non-functional; never required 2. **Reject** 'the body' is less sensitive 4. **Accept** weight for body mass; ignore 'lifestyle' 3. **Accept** sugar for dietary carbohydrate; reject 'sugar' for blood glucose

Question	Marking guidance	Mark	Comments
07	1. (Supports adviser) positive correlation: countries with higher consumption of sugar-sweetened drinks have a higher percentage of adults with type II diabetes; 2. (Supports adviser) the correlation is significant OR the probability that it is due to chance is less than 5%/0.05; 3. (Supports adviser) sugar-sweetened drinks increase sugar/energy intake, which can lead to obesity/high body mass, a risk factor for type II diabetes; 4. (Supports company) correlation does not show causation; 5. (Supports company) other factors were not controlled, eg physical activity, the rest of the diet, body mass, age, genetics; 6. (Supports company) data are means for whole countries, so they do not show that the people who drink the most develop diabetes; 7. (Against adviser) no evidence that a tax would reduce consumption or the number of cases; 8. (Against adviser) only nine countries OR diagnosis/testing of diabetes may differ between countries; 9. (Against company) the data do not test the effect of total food intake or exercise either OR eating less overall would include drinking fewer sugar-sweetened drinks;	**5 max** (5 × AO3)	**Max 4** if only one position is evaluated 2. **Accept** 'not due to chance' 3. **Ignore** 'sugar causes diabetes' unqualified **Ignore** 'lifestyle' unqualified

Required practical 11: measuring glucose concentration 3.6.4.2

Question	Marking guidance	Mark	Comments
08.1	All four rows correct for 2 marks;; Two or three rows correct for 1 mark 2 mmol dm^{-3}: 2.0 and 8.0; 4 mmol dm^{-3}: 4.0 and 6.0; 6 mmol dm^{-3}: 6.0 and 4.0; 8 mmol dm^{-3}: 8.0 and 2.0	**2** (2 × AO2)	**Accept** volumes written without a decimal place, eg 2 and 8 A row is correct only if both volumes are correct

Question	Marking guidance	Mark	Comments
08.2	Correct answer for 2 marks: 25 (mmol dm^{-3});; Accept for 1 mark: 5.0 (read from the graph) **OR** reading from the graph × 5	**2** (2 × AO2)	The plotted line passes through 5.0 mmol dm^{-3} at an absorbance of 0.57. Accept readings of 4.8–5.2, giving 24–26 for 2 marks **Reject** 20 (multiplied by 4) for 2 marks; award 1 mark for the reading

Question	Marking guidance	Mark	Comments
08.3	Absorbance of the undiluted sample (0.08) was below the lowest value on the curve (0.22), so its concentration was outside the range of the calibration curve OR could not be read off without extrapolating;	**1** (1 × AO3)	**Accept** 'concentration above 10 mmol dm^{-3}' / 'higher than the most concentrated standard' **Ignore** 'to make it more accurate' unqualified

Question	Marking guidance	Mark	Comments
08.4	1. Volume/concentration of Benedict's reagent; 2. Temperature of the water bath; 3. Time of heating; 4. Colour of filter OR wavelength/colour of light (in the colorimeter); 5. Colorimeter zeroed/calibrated with the same blank (eg distilled water);	**2 max** (2 × AO1)	**Ignore** 'same colorimeter' **Ignore** 'amount' of reagent **Reject** calorimeter

Question	Marking guidance	Mark	Comments
08.5	1. Benedict's reagent also reacts with other reducing sugars (eg fructose/lactose) in urine, so the glucose concentration is overestimated; 2. Urine is coloured / contains other substances that absorb light, so the absorbance is affected; 3. Not all the precipitate may have been removed (so the absorbance is affected); 4. Only one reading at each concentration / large intervals between standards, so the curve may not be accurate; 5. Any error in diluting the urine is multiplied (by 5);	**2 max** (2 × AO3)	**Ignore** 'human error' unqualified **Ignore** 'same colorimeter'

Control of blood water potential 3.6.4.3

Question	Marking guidance	Mark	Comments
09.1	All three correct for 2 marks;; Two correct for 1 mark Ultrafiltration: J; most glucose reabsorbed: K; sodium ions actively transported: M	**2** (2 × AO1)	**Accept** the names of the parts only if the letter is also given

Question	Marking guidance	Mark	Comments
09.2	1. Glucose, urea and sodium ions are small (molecules/ions), so they are forced out of the glomerulus (by high hydrostatic pressure) in ultrafiltration, at the same concentration as in plasma; 2. (Plasma) proteins are too large; 3. To pass through the basement membrane (of the glomerulus);	**2 max** (1 × AO1) (1 × AO2)	**Max 1** if the answer does not use the data, ie does not refer to glucose, urea or sodium ions as well as protein 2. **Accept** protein molecules are too big to be filtered 3. **Ignore** other structures, eg capillary wall / endothelium / podocytes, and 'membrane' unqualified **Reject** proteins are reabsorbed (in the proximal convoluted tubule) **Ignore** 'nephron'

Question	Marking guidance	Mark	Comments
09.3	1. Water is reabsorbed (from the proximal convoluted tubule into the blood) by osmosis; 2. (A larger proportion of) water is reabsorbed than urea OR urea is not (all) reabsorbed, so the same amount of urea is in a smaller volume;	**2** (2 × AO2)	1. **Reject** water is actively transported 1. **Reject** PCT **Ignore** references to ADH

Question	Marking guidance	Mark	Comments
10.1	1.5 (mmol min^{-1});	**1** (1 × AO2)	Working: 2.5 − 1.0 = 1.5 **Accept** 1.4 to 1.6

Question	Marking guidance	Mark	Comments
10.2	1. Below 8 (mmol dm^{-3}), all the (filtered) glucose is reabsorbed in the proximal convoluted tubule; 2. By co-transport (with sodium ions) OR using carrier/co-transport proteins; 3. At high concentrations, the carrier/co-transport proteins are saturated/working at their maximum rate; 4. So the rate of reabsorption cannot rise above 1.5 mmol min^{-1} OR not all the glucose is reabsorbed, and the rest is lost in the urine;	**3 max** (1 × AO1) (2 × AO2)	Proximal convoluted tubule in full; reject PCT 2 and 3. **Accept** symport; accept 'not enough carrier proteins' 3. **Reject** carrier proteins 'used up' **Reject** 'no glucose is reabsorbed' at high concentrations **Reject** glucose reabsorbed in the loop of Henle / distal convoluted tubule / collecting duct **Reject** 'amount' or 'level' for concentration

Question	Marking guidance	Mark	Comments
10.3	1. High blood glucose concentration (above about 8–12 mmol dm^{-3} OR above the concentration at which glucose appears in the urine), so glucose remains in the filtrate; 2. Lowers the water potential of the filtrate; 3. So less water is reabsorbed by osmosis (from the collecting duct/distal convoluted tubule);	**2 max** (2 × AO3)	2. **Accept** Ψ; reject WP 3. **Reject** DCT

Question	Marking guidance	Mark	Comments
11.1	1. Positive correlation: as the relative thickness of the medulla increases, the maximum concentration of urine increases; 2. A thicker medulla contains a longer loop of Henle; 3. More sodium ions are actively transported out of the ascending limb (into the medulla); 4. Greater sodium ion gradient OR lower water potential in the medulla; 5. More water leaves the collecting duct by osmosis (into the medulla/blood);	**4 max** (2 × AO1) (2 × AO2)	3. **Accept** sodium ions pumped out; reject sodium ions diffuse out of the ascending limb 4. **Accept** Ψ; reject WP 5. **Reject** water moves into the collecting duct **Reject** water actively transported

Question	Marking guidance	Mark	Comments
11.2	1. Y has more carrier proteins/mitochondria in the ascending limb, so a faster rate of active transport of sodium ions (and a lower water potential in the medulla); 2. Y secretes more ADH OR has more ADH receptors (in the collecting duct); 3. Y has more channel proteins in the collecting duct (cell) membranes, so they are more permeable to water; 4. Y has more nephrons with (long) loops of Henle (extending into the medulla);	**2 max** (2 × AO3)	**Accept** sodium-potassium pumps for carrier proteins 3. **Accept** aquaporins for channel proteins **Ignore** 'Y drinks less water' unqualified

Question	Marking guidance	Mark	Comments
12	1. Water potential of the blood decreases/becomes more negative (because more water is lost than taken in); 2. Detected by (osmoreceptors in) the hypothalamus; 3. (Hypothalamus produces) more ADH, which is released from the posterior pituitary (into the blood); 4. ADH binds to receptors on cells of the distal convoluted tubule and collecting duct; 5. Channel proteins (for water) are added to the cell-surface membranes (of these cells); 6. Increased permeability to water OR more water reabsorbed (into the blood); 7. By osmosis, into the medulla, which has a low water potential (because of the sodium ion gradient maintained by the loop of Henle); 8. Small volume of concentrated urine produced; 9. Negative feedback: as the water potential of the blood returns to normal, less ADH is released;	**6 max** (4 × AO1) (2 × AO2)	**Accept** antidiuretic hormone for ADH 1 and 7. **Accept** Ψ; reject WP 3. 'Posterior' is required; reject ADH released from the hypothalamus 4. Distal convoluted tubule in full; reject DCT 5. **Accept** aquaporins for channel proteins 6. **Reject** if glucose or ions are also said to be reabsorbed because of ADH 7. **Reject** water moves into the collecting duct **Ignore** references to thirst or drinking

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