HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.6.1 Stimuli, both internal and external, are detected and lead to a response

Mark scheme

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TOTAL MARKS	QUESTIONS
74	9

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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Tropisms in flowering plants 3.6.1.1

Question	Marking guidance	Mark	Comments
01.1	1. IAA moves (from the tip) to the shaded side; 2. (More) elongation of cells on the shaded side (so the shoot bends towards the light);	**2** (2 × AO1)	**Accept** auxin for IAA 1. 'IAA accumulates on the shaded side' alone is not enough: the idea of movement is required 1. **Reject** IAA is broken down/destroyed by light 2. 'Grows more on the shaded side' alone is not enough: elongation of cells is required 2. **Accept** cells on the shaded side elongate/get longer

Question	Marking guidance	Mark	Comments
01.2	Elongation of root cells is inhibited by lower concentrations of IAA than elongation of shoot cells;	**1** (1 × AO3)	Root segments grow less than in water from 10^{-6} mol dm^{-3} (65%); shoot segments grow less than in water only at 10^{-2} mol dm^{-3} (80%)

Question	Marking guidance	Mark	Comments
01.3	1. (Removing tips) tips produce IAA, so only the IAA in the solution affects elongation OR so the concentration of IAA (acting on the segments) is known; 2. (Water) segments grow/elongate (a little) without IAA, so the comparison shows the effect of the IAA alone;	**2** (2 × AO3)	Each feature must be explained, naming it as a control is not enough 1. **Accept** tips are a source of IAA; ignore tips 'contain'/'store' IAA 1. **Accept** auxin for IAA **Ignore** 'fair test' unqualified

Question	Marking guidance	Mark	Comments
01.4	Correct answer for 2 marks: 3.04 OR 3.0 (mm);; Accept for 1 mark: reading of 190 (%) from Figure 1 **OR** 1.6 × 190 ÷ 100 OR 1.6 × 1.9	**2** (2 × AO2)	Plotted value at 10^{-4} mol dm^{-3} for shoot segments: 190% **Accept** readings of 185–195%, giving answers in the range 2.96 to 3.12 (mm), for 2 marks **Reject** 1.44 (the extra increase only) for 2 marks

Question	Marking guidance	Mark	Comments
01.5	1. (Shoot) more elongation of cells on the lower side than the upper side (145% compared with 115%), so the shoot bends/curves upwards; 2. IAA has moved to the lower side (of the root and shoot) in response to gravity; 3. (Root) the higher concentration on the lower side inhibits elongation of cells (65%, less than in water); 4. (Root) cells on the upper side elongate more (105%), so the root bends/curves downwards; 5. Root cells are more sensitive to IAA than shoot cells OR the same concentration of IAA has different/opposite effects in roots and shoots;	**4 max** (1 × AO1) (3 × AO2)	**Max 3** if only the root or only the shoot is explained Bending upwards/downwards alone restates the question: no mark 2. **Accept** IAA is redistributed by gravity; 'IAA accumulates on the lower side' alone is not enough Points 1, 3 and 4 need elongation of cells: 'more growth' alone is not enough **Reject** references to light or the shaded side (the seedling was in the dark) **Accept** auxin for IAA **Accept** positive/negative gravitropism if the explanation is correct

Taxes, kineses and simple reflexes 3.6.1.1

Question	Marking guidance	Mark	Comments
02.1	1. (Once only) a woodlouse cannot learn/remember the maze OR the results (for each woodlouse) are independent OR more of the population is sampled; 2. (Swapping) removes the effect of a preference for turning left/right OR of another variable on one side (eg light/draught/smell), so movement is in response to humidity only;	**2** (2 × AO3)	Each feature must be explained: naming or restating it is not enough **Ignore** 'fair test' and 'more accurate' unqualified 2. **Accept** 'so the side of the maze is not a variable'

Question	Marking guidance	Mark	Comments
02.2	Any **one** from: return the woodlice to where they were collected; handle them gently, eg with a soft paintbrush/pooter; keep them out of their habitat for as short a time as possible; keep them in damp conditions/with food between trials;	**1** (1 × AO1)	**Ignore** 'do not hurt them' unqualified **Ignore** safety of the student, eg wash hands

Question	Marking guidance	Mark	Comments
02.3	Correct answer for 2 marks: 8.1;; Accept for 1 mark: expected number = 20 (in each arm) **OR** $(29 - 20)^2 \div 20 = 4.05$ OR $(11 - 20)^2 \div 20 = 4.05$	**2** (2 × AO2)	Working: 4.05 + 4.05 = 8.1 **Accept** 8.10

Question	Marking guidance	Mark	Comments
02.4	1. χ^2 (8.1) is greater than the critical value (3.84), so the null hypothesis is rejected; 2. The probability that the difference (between observed and expected numbers) is due to chance is less than 0.05/5%; 3. So the woodlice show a (significant) preference for the humid arm OR humidity affects the movement of woodlice;	**2 max** (2 × AO3)	**ECF** from the previous part: correct conclusion from the student's value of χ^2 **Reject** 'the null hypothesis is accepted' if χ^2 is above the critical value **Reject** 'proves' **Ignore** 'results are reliable'

Question	Marking guidance	Mark	Comments
02.5	1. Kinesis; 2. In dry air, woodlice move faster/spend more time moving (7.6 compared with 1.9 mm s^{-1} OR 88% compared with 34%), so they are more likely to leave dry places/reach humid places; 3. In humid air, woodlice slow down/stop moving, so they stay in humid places; 4. Humid places reduce water loss OR stop woodlice drying out;	**3 max** (1 × AO1) (2 × AO2)	1. **Reject** taxis or tropism **Ignore** references to the rate of turning (neither credited nor penalised) **Ignore** 'favourable conditions' or 'to survive' unqualified

Question	Marking guidance	Mark	Comments
03.1	A single-celled alga swims towards a light source;	**1** (1 × AO1)	A taxis is a directional movement of a whole organism in response to a directional stimulus

Question	Marking guidance	Mark	Comments
03.2	1. Movement is directional OR is directly away from the (direction of the) stimulus/light; 2. A kinesis is non-directional OR (in a kinesis) only the speed of movement/rate of turning changes; 3. Keeps flatworms in dark places, eg under stones, where they are less likely to be seen/eaten by predators;	**3** (1 × AO1) (2 × AO2)	1. **Accept** negative (photo)taxis; reject positive (photo)taxis 3. **Accept** other suitable advantages linked to staying under stones, eg less likely to be washed away, find food 3. **Ignore** 'to survive' or 'favourable conditions' unqualified 3. **Reject** reasons linked to photosynthesis

Question	Marking guidance	Mark	Comments
03.3	1. X: sensory (neurone); 2. Y: relay (neurone); 3. Z: motor (neurone);	**2 max** (2 × AO1)	3 correct = 2 marks; 2 correct = 1 mark; 1 or 0 correct = 0 marks Y: accept intermediate neurone/interneurone/connector neurone **Ignore** 'nerve' for neurone

Question	Marking guidance	Mark	Comments
03.4	1. Rapid (response) because only three neurones/two synapses are involved OR involuntary/automatic/does not need a (conscious) decision by the brain; 2. So the hand/body part is removed from the harmful stimulus before (much) damage/burning occurs;	**2** (2 × AO1)	1. Rapid and involuntary are alternatives for one mark: giving both still gains only 1 mark 1. **Ignore** 'fast' unqualified 2. Must link the response to preventing/reducing damage **Reject** 'signals/messages' for impulses, once

Receptors 3.6.1.2

Question	Marking guidance	Mark	Comments
04.1	P: lamella(e) **and** Q: (ending of) sensory neurone;	**1** (1 × AO1)	P: accept capsule/connective tissue Q: accept axon (membrane)/nerve ending/nerve cell; ignore 'nerve' **Reject** sodium ion channels for P

Question	Marking guidance	Mark	Comments
04.2	1. Pressure deforms/stretches the lamellae OR the membrane (of the neurone ending); 2. Stretch-mediated sodium ion channels (in the membrane) open; 3. Sodium ions diffuse in; 4. Depolarisation (of the membrane), producing a generator potential; 5. Greater displacement opens more (sodium ion) channels, so a larger generator potential;	**3 max** (2 × AO1) (1 × AO2)	**Max 2** if 'sodium' is used but 'sodium ions' never is **Accept** Na^+ for sodium ions 3. **Accept** sodium ions move in down a concentration gradient; 'influx' alone does not gain the point but is not penalised 4. **Accept** the inside becomes less negative/more positive **Reject** 'stretch-mediated membrane'

Question	Marking guidance	Mark	Comments
04.3	The generator potential (about 6.5 mV) is below the threshold (10 mV);	**1** (1 × AO2)	Plotted value at 10 µm: 6.5 mV. Accept readings of 6–7 mV **Accept** 'threshold is not reached' without a value

Question	Marking guidance	Mark	Comments
04.4	(Almost) all the (stretch-mediated) sodium ion channels are already open OR few more channels can open;	**1** (1 × AO3)	**Accept** the maximum rate of sodium ion entry is (nearly) reached **Accept** Na^+ for sodium ions

Question	Marking guidance	Mark	Comments
04.5	1. (Shows) Pacinian corpuscles respond only to (mechanical) pressure OR are specific to one type of stimulus OR respond to pressure but not to temperature; 2. (Explanation) their sodium ion channels are stretch-mediated OR open only when deformed, and warming does not deform the membrane/lamellae;	**2** (1 × AO2) (1 × AO3)	1. **Accept** 'receptors are specific to one stimulus' 2. **Accept** Na^+ for sodium ions **Ignore** 'heat damages the receptor'

Question	Marking guidance	Mark	Comments
05.1	1. (Blindfold) so the volunteer cannot see how many points are used OR so the answers depend only on touch; 2. (One point) to check the volunteer is not guessing OR to check one point is not reported as two;	**2** (2 × AO3)	2. **Accept** 'as a control' only if the purpose is explained **Ignore** 'fair test' unqualified

Question	Marking guidance	Mark	Comments
05.2	1. More touch receptors per unit area in the fingertip OR receptors are closer together in the fingertip; 2. Each fingertip receptor connects to a separate sensory neurone OR each sensory neurone receives impulses from a smaller area of skin; 3. So two points close together stimulate different neurones, which send separate impulses to the brain;	**2 max** (1 × AO2) (1 × AO3)	**Reject** 'signals/messages' for impulses, once **Ignore** 'the fingertip is more sensitive' unqualified

Question	Marking guidance	Mark	Comments
06.1	All rods contain the same type of optical pigment;	**1** (1 × AO1)	Colour vision needs more than one type of photoreceptor, each with a different optical pigment

Question	Marking guidance	Mark	Comments
06.2	50 : 1;	**1** (1 × AO2)	**Accept** 50 Working: 340 000 ÷ 6 800

Question	Marking guidance	Mark	Comments
06.3	1. Nocturnal mammal has more rods (340 000 compared with 120 000 per mm^2) OR a higher ratio of rods to cones; 2. Many rods connect to one neurone (80 compared with 15); 3. Spatial summation OR enough neurotransmitter is released (onto the neurone) to reach threshold, so (high) sensitivity in dim light; 4. (Optical) pigment in rods is broken down by low light intensity; 5. Diurnal mammal has more cones (40 000 compared with 6 800 per mm^2); 6. Each cone connects to its own neurone (1 cone per neurone), so cones send separate (sets of) impulses to the brain, giving high (visual) acuity;	**5 max** (2 × AO1) (3 × AO2)	**Max 4** if Table 3 is not used **Accept** retinal convergence for points 2 and 6 (eg 'no retinal convergence' for cones) **Accept** bipolar cell for neurone **Ignore** named pigments, eg rhodopsin/iodopsin **Reject** 'signals/messages' for impulses, once 6. **Accept** optic nerve for brain

Question	Marking guidance	Mark	Comments
06.4	1. Colour vision depends on comparing how much different types of cone are stimulated OR each type of cone has a different (optical) pigment that absorbs a different range of wavelengths; 2. Without red-sensitive cones, red and green light (mainly) stimulate only the green-sensitive cones/one type of cone, so they cannot be distinguished;	**2** (2 × AO2)	1. 'Absorbs different colours' is not enough: wavelengths are required **Reject** 'red cones'/'green cones' without 'sensitive', once **Accept** 'detecting'/'absorbing' for 'sensitive' **Reject** references to rods giving colour vision

Control of heart rate 3.6.1.3

Question	Marking guidance	Mark	Comments
07.1	Cardiac muscle is myogenic, so the sinoatrial node (SAN) starts each heartbeat without nervous stimulation;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
07.2	1. 100 (ms); 2. So the atria contract (and empty blood into the ventricles) before the ventricles contract;	**2** (1 × AO1) (1 × AO2)	2. **Accept** so the ventricles fill (with blood) before they contract 2. **Reject** 'so the atria and ventricles do not contract at the same time' unqualified

Question	Marking guidance	Mark	Comments
07.3	Correct answer for 2 marks: 2.8 (m s^{-1});; Accept for 1 mark: time = 35 ms OR 0.035 s **OR** 0.098 ÷ 0.035	**2** (2 × AO2)	Working: 175 − 140 = 35 ms; 0.098 m ÷ 0.035 s = 2.8 m s^{-1} **Reject** 0.56 (175 ms used) for 2 marks

Question	Marking guidance	Mark	Comments
07.4	1. Purkyne tissue carries the wave to the apex first (at 175 ms), before the top of the ventricles (at 225 ms); 2. Blood is pushed upwards, towards/out into the arteries OR the ventricles empty more completely;	**2** (1 × AO2) (1 × AO3)	1. **Accept** Purkinje (or similar spelling) 2. **Accept** named arteries, eg aorta/pulmonary artery

Question	Marking guidance	Mark	Comments
08.1	1. During exercise, (more respiration so) the concentration of carbon dioxide rises OR pH falls (from 7.41 to 7.33); 2. Detected by chemoreceptors; 3. (Chemoreceptors) in the aorta/carotid arteries/medulla; 4. Impulses (from chemoreceptors) to the cardiac centre/medulla; 5. (More) impulses along sympathetic neurones/pathway to the SAN; 6. SAN sends out waves of electrical activity more frequently, so heart rate rises (from 68 to 156 beats min^{-1}); 7. After exercise, pH rises/carbon dioxide concentration falls, so fewer impulses from the chemoreceptors; 8. (More) impulses along parasympathetic neurones/pathway OR fewer along sympathetic neurones to the SAN, so heart rate falls (to 72 beats min^{-1});	**6 max** (3 × AO1) (3 × AO2)	**Max 5** if Table 5 is not used 1. **Accept** increase in acidity/H^+ concentration; reject 'pH increases' during exercise **Ignore** chemoreceptors detecting oxygen **Ignore** pressure receptors/baroreceptors in this answer 3. **Accept** carotid body/aortic body 4. **Accept** medulla oblongata 5 and 8. **Credit** the direction (more/fewer) when given; reject the wrong direction, eg more parasympathetic impulses to increase heart rate 8. **Accept** vagus for parasympathetic; reject PNS **Accept** sinoatrial node for SAN; accept action potentials for impulses **Reject** 'signals/messages' for impulses, once **Reject** 'an impulse'/'one impulse', once

Question	Marking guidance	Mark	Comments
08.2	Correct answer for 2 marks: 120 (cm^3);; Accept for 1 mark: 0.12 (dm^3 not converted to cm^3) **OR** V = CO ÷ R OR 18 720 ÷ 156	**2** (2 × AO2)	Working: 18.72 dm^3 = 18 720 cm^3; 18 720 ÷ 156 = 120

Question	Marking guidance	Mark	Comments
08.3	1. (Supports) heart rate is highest when pH is lowest (156 beats min^{-1} at pH 7.33) OR both return towards resting values after exercise; 2. (Against) a correlation does not show that the change in pH caused the change in heart rate; 3. (Against) other factors that affect heart rate were not measured, eg carbon dioxide concentration/blood pressure; 4. (Against) data are from only one volunteer, so it cannot be concluded that pH is the only cause in other people; 5. (Against) no data from the start of the exercise, so it cannot be told whether heart rate rose before pH fell (another cause acting first);	**3 max** (3 × AO3)	**Max 2** if no supporting point is given 4 and 5. 'Only one volunteer' or 'only four times measured' alone is not enough: it must be linked to the claim that pH is the only cause **Ignore** 'repeat the experiment' unqualified 3. **Accept** adrenaline/a named hormone as another factor

Question	Marking guidance	Mark	Comments
09.1	1. Activity/exercise before the investigation; 2. Intake of caffeine/food/drink before the investigation; 3. Time spent counting the pulse OR method of measuring the pulse (eg same artery/same pulse monitor); 4. Talking/moving during the measurement OR how the student stands (eg standing still);	**2 max** (2 × AO3)	**Ignore** age/sex/fitness/height of the students, room temperature and time of day: each student is compared with themselves, a few minutes apart **Ignore** time after standing up (stated in the method) **Ignore** 'amount of exercise' unless linked to before the test

Question	Marking guidance	Mark	Comments
09.2	1. Pressure receptors (in the carotid arteries) detect the fall (in blood pressure); 2. Impulses (from pressure receptors) to the cardiac centre/medulla; 3. (More) impulses along sympathetic neurones OR fewer impulses along parasympathetic neurones; 4. To the SAN, which sends out waves of electrical activity more frequently;	**3 max** (1 × AO1) (2 × AO2)	1. **Accept** baroreceptors for pressure receptors 1. **Reject** chemoreceptors 2. **Ignore** the direction (more/fewer) of impulses from the pressure receptors 3. **Reject** the wrong direction, eg more parasympathetic impulses; reject PNS; accept vagus for parasympathetic **Accept** sinoatrial node for SAN **Reject** 'signals/messages' for impulses, once

Question	Marking guidance	Mark	Comments
09.3	The response is rapid/short-lived OR blood pressure (and so pulse rate) soon returns to normal, so the change would be missed;	**1** (1 × AO3)	**Ignore** 'so the result is accurate' unqualified

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