PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



MARK SCHEME

UNIT 5: COORDINATION, RESPONSE AND GENE TECHNOLOGY

SCORE	PERCENTAGE
/240	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points Label / Part L – dendrites M – cell body / centron N – axon O – (pre)synaptic {endings /knob/bulb}	all correct 2 marks 1 or 2 or 3 correct 1 mark 0 correct 0 marks accept dendrite / dendron accept axon terminal do not accept synapse(s)	Graduate (2)

Question number	Answer	Additional guidance	Mark
(a)(ii)	D is the correct answer • A in not correct because lidocaine inhibits sodium ion channels • B in not correct because lidocaine inhibiting sodium ion channels • C in not correct because lidocaine inhibiting sodium ion channels		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)(i)	• (scanning) electron (microscope) /sem / em (1)	Do not accept electric / electrical /electronic Do not accept transmission electron microscope / tem Do not accept microgram	Graduate (1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A calculation showing the following steps • correct measurement of X-Y in µm (1) • calculation of thickness of connecting tissue (1) OR • calculation of thickness (1) • conversion to µm (1)	11 000 µm (11 000 ÷ 3300)= 3.3 /3.33/3.333/ 3 µm 1 mark for power of 10 errors e.g. 0.33 or 0.0033 or 333 (11÷ 3300)= 0.00333 (1.1÷ 3300)= 0.0333 (0.00333) x 1000 = 3.3 /3.33/3.333/ 3 µm 1 mark for power of 10 errors e.g. 0.33 or 0.0033 or 333 No ECF	Expert (2)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes three of the following points • myelin (sheath) acts as an insulator (1) • gaps (in myelin sheath) are called nodes of Ranvier /nodes of Ranvier have higher number of (voltage gated) sodium channels (1) • {action potentials/depolarization} can only occur at nodes on Ranvier (in myelinated neurones)(1) • (therefore) impulse jumps from one node of Ranvier to the next(1)	accept {action potentials / depolarization}occur along the whole unmyelinated	Expert (3)

Q2.

Question number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: • determination of tidal volume (1) • calculation of volume of air in 1 min (1) • calculation of volume of air in one hour (1)	(500-150) = 350 350 x 12 = 4.2 (dm^3 min^{-1}) Accept 4200 (cm^3 min^{-1}) (4.2 x 60) = 250 dm^3 $hour^{-1}$ Accept (4200 x 60) = 250000 cm^3 ($hour^{-1}$) max 2 marks if no units / or incorrect units accept answer in standard form 2.5×10^5	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following point: • (cardiac) diastole (1)		(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	• 100	accept 1.67 beats per second accept range 100 - 125	(1)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes three of the following points: Similarity • both traces have the same {PQRST/ described} wave (1) • R wave of similar height (1) Differences • normal ecg shows a lower heart rate (1) • in the patient trace the gap between T & P is shorter (1)	both show clear PQRST wave accept converse accept converse	(3)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes four of the following points: • {identification / isolation} of (corrected) AAT gene (1) • description of one enzyme used to insert gene (1) • adenoviruses can enter host cell (1) • and combine their own genetic material with that of the cell (1) • therefore a functional AAT protein can be produced (1)	E.g. cut the adenovirus DNA using the same restriction endonuclease / insert the gene into the adenovirus DNA using DNA ligase adenovirus acts as a vector	(4)

Q3.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points C is the correct answer • A is not the correct answer as the iris does not have rod cells • B is not the correct answer as the pupil does not have rod cells • D A is not the correct answer as the spinal cord does not have rod cells		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes three of the following points: • rhodopsin is the {photoreceptor / photosensitive pigment} (1) • when light absorbed cis retinal (+ opsin) is converted to trans retinal (+ opsin) (1) • causes sodium channels to close (1) • membrane becomes hyperpolarised (1)	accept absorbs light accept Na^+ gated channels blocked	(3)

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: Indicative content – description from experimental data experiment 2 shows that substance responsible for phototropism passes through gel but not plastic experiment 1 shows that cause of phototropism is chemical in nature and is produced in the tip experiment 3 chemical substance can diffuse and cause curvature even in the dark Chemical nature of responses phototropism caused by auxins receptor proteins (phototropins) activate several hormones including auxin Auxin transported down dark side and less on bright side Auxin stimulates elongation on shaded side to give curvature		(6)

	Detailed mechanism of responses Auxin stimulates decrease in cell pH which activates enzymes responsible for cell growth and elongation Auxin affects hydrogen ion pumps (proton pumps) Auxin causes intracellular reserves of hydrogen ions to increase which lowers the pH on dark side lower pH activate enzymes these disrupt hydrogen cross links in cell wall increased osmotic gradient due to movement of solutes water enters cell (and increased turgor pressure) leads to swelling of cell Level 1: Discuss some of the results from experimental data. Level 2: Discuss all of level 1 plus reference to specific chemical nature of phototropism Level 3: Discuss all of level 2 plus detailed mechanism for phototropism at molecular level		

Q4.

Question number	Answer	Additional guidance	Mark
(a)(i)	An explanation that includes four of the following points: • circular muscles contract **and** radial muscles relax (1) • circular muscles arrange in concentric rings around pupil **and** radial muscles run radially (1) • pupil reflex is the reflex contraction and relaxation of theantagonistic muscles of the iris (1) • therefore pupil becomes smaller so less light enters theeye. (1)	ignore reference to photoreceptorsaccept diagram	(3)

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes three of the following points: • (rhodopsin) absorbs light (1) • (rhodopsin) splits into opsin and retinal (1) • sodium ions are not taken up (1) • causing hyperpolarisation (1)		(4)

Question number	Answer	Mark
(b)	**Indicative content** **Description of named responses** • Many different photoresponses that affect the growth and development of plants. • Light triggering key events in a plants growth and development – photomorphogenesis. • Photoperiodisms – a physiological response to photoperiods eg seed germination.	(6)

Chemical nature of responses

Photoreceptor receive light, reacts to it and initiates a response.

Phytochromes regulate many other responses to light eg seed germination.

- Seeds need sunlight to grow. Far-red light makes plants think they are not getting sunlight.As a result, too much far-red on your seedlings may prevent germination altogether.
- There are two forms of phytochrome. These are Pr and Pfr. These two pigments differ intheir absorption peak.

- **Phytochrome red (Pr):** It absorbs maximum light in the red region of the spectrum. It haswavelength of 660p Pr is the inactive form.
  2.Phytochrome far red (Pfr): It has the absorption peak in the far-red region at 730 p. OnlyPfr phytochrome is physiologically active.

- Metabolic activity and mitosis in embryos are stimulated by red light and inhibited by far-red light in light-sensitive seeds.

- plants also use light as a source of information, allowing for the adjustment of growth anddevelopment in response to changing environmental conditions. This process,
  termed photomorphogenesis, is regulated by a suite of photoreceptors

	Detailed mechanism of responses • Photoreceptor receive light, reacts to it and initiates a response • Phytochrome red (Pr): It absorbs maximum light in the red region of the spectrum. It haswavelength of 660p Pr is the inactive form. Phytochrome far red (Pfr): It has the absorption peak in the far-red region at 730 p. Only Pfrphytochrome is physiologically active. • Phytochrome has two identical subunits. The chromophore of the phytochrome isphotoreversible between the two isomers depending on the wavelength of light. • Subcellular circadian rhythms include cycles in gene regulation (at the levels of transcription,transcript abundance, translation, and post-translational modification). • Germination stimulated by the hormone gibberellin. • Phytochrome red stimulates transcription. • Leads to production of enzymes that metabolise active forms of gibberellins. Level 1: Description of (a minimum of 2 specific) results from experimental data. eg. more exposure to farred light at all red light times reduces percentage germination. Less exposure to far red light increases percentage of germination in general. Level 2: Reference to specific chemical nature of the effect of red light and far red light on germination. Level 3: Detailed mechanism for at least 1 photo-response at a sub-cellular level eg. Effect on transcription.	

Q5.

Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes three of the following points: • dopamine cannot cross the blood brain barrier (1) • this drug ensures more L-dopa {is present in blood /can cross the brain barrier / reaches the brain} (1) • resulting in (a greater) increase in dopamine levels in the brain (1) • statement about why increased dopamine would help treat Parkinson's (1)	ACCEPT larger ignore large ACCEPT L-dopa (only) converted to dopamine in the brain e.g. transmission of electrical impulses to post synaptic neurones / increase in motor responses	**(3)**

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • {control gene / genetic engineering process} has no effect (on L-dopa synthesis) (1) • MYB12 gene has {little / no} effect on L-dopa synthesis (1) • The CYP76 gene causes a {big/ 9mg} increase in concentration of L-dopa (because it codes for a protein involved in the production of L-dopa) (1) • combination of MYB12 and CYP76 produce largest concentration of L-dopa because {MYB12/ the transcription factor} increases production of CYP76 protein (1)	ACCEPT it increases it by 1.25 times/eq ACCEPT CYP76 gene gives {most / more / larger} L-dopa when used individually NOTE if they state CYP76>MYB12>control then award mp3	**(4)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • {the gene / CYP76} that converts tyrosine to L dopa is {extracted / isolated} (1) • use of same {endonuclease / restriction enzyme} to cut genetic material of plasmid (and isolated gene) (1) • method of insertion of vector into a {tomato/host} cell (1)	ACCEPT {isolate / extract / cut out / synthesise} the gene ACCEPT description of method of insertion e.g. use of {gene gun /heat shock/ liposomes / CRISPR} e.g. infect using {non-lytic virus / Agrobacterium tumefaciens}	**(3)**

Q6.

Question number	Answer	Additional guidance	Mark
(a)(i)	Choose an item. C is the correct answer as habituation is a long term physicalchange D is not the correct answer as sensitisation is a learningprocess resulting in amplification of a response B is not the correct answer as absorption relates to fluidmovement A is not the correct answer as adaptation is a change inbehaviour		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	Choose an item. A is the correct answer B is not the correct answer C is not the correct answer D is not the correct answer		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes three of the following points: • male and female crabs respond differently to the predator(1) • female crabs showed greater habituation than male crabs(1) • after 10 exposures there seems to variability in the data(1)		(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	Choose an item. A is the correct answer because correlation being tested. B is not the correct answer as Hardy-Weinberg does not testa correlation. C is not the correct answer as index of diversity does not testa correlation D is not the correct answer as Student t test does not test a correlation		(1)

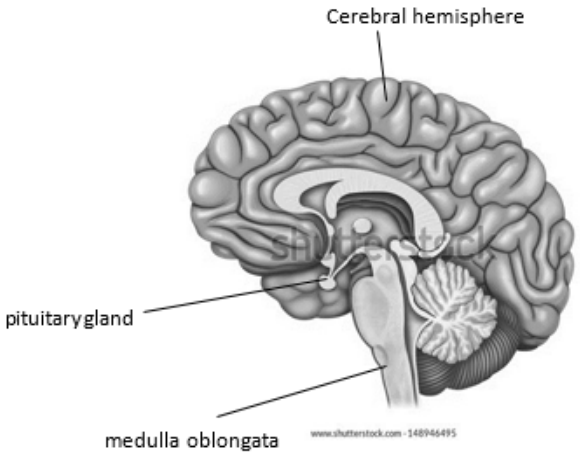
Q7.

Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes three of the following points: • the myelin sheath is an (electrical) insulator • therefore the action potential only occurs at nodes of Ranvier (1) • and therefore the nerve impulse 'jumps' from one node to the next / reference to saltatory conduction (1)	**Accept** The influx of sodium ions at onenode creates enough depolarization toreach the threshold of the next.	(3)

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes two of the following points: • when the myelin sheath is destroyed transmission of thenerve impulse is impaired (1) • fewer nerve impulses reach the muscle (1) • fewer muscle fibres are stimulated to contract which leadsto muscle weakness (1)	Accept suggestion impulse is slower asmyelin destroyed	(2)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes two of the following points: • all types of dementia have a lower level of myelin than the control group • there is no relationship between the amount of myelin in the brain and the type of dementia • no overlap in any of the standard deviation for any type of dementia and control which suggests that the conclusionsmay be valid (1)	Accept converse if correct figures used	(2)

Q8.

Question number	Answer	Additional guidance	Mark
(a)	• correctly labelled pituitary gland (1) • correctly labelled medulla oblongata (1) • correctly labelled cerebral hemisphere / cerebrum (1)	 do not accept two lines from a label do not accept cerebellum label	**(3)**

Question number	Answer		Additional guidance	Mark
(b)	**Part of the brain**	**Function**	**2 marks** maximum ACCEPT posture, balance and speech ignore co-ordination unqualified ACCEPT pons / medulla ACCEPT memory / learning / thinking/ emotions / imagination / voluntary response/ motor skills (only if they refer to cerebral cortex) **all 3 spaces correct = 2 marks** **2 spaces correct = 1 mark** **1 space correct = 0 mark**	**(2)**
	cerebellum	**(coordination of voluntary) movements**		
	medulla oblongata	control of heartbeat and breathing		
	cerebral hemisphere (cerebrum)	**(control of) voluntary behaviour / site of intelligence**		

Q9.

Question number	Answer	Additional guidance	Mark
(a)	A description that includes four of the following points: • Chemoreceptors detect {pH of blood / blood CO_2 concentration} (1) • send (fewer) impulses to the {respiratory centre / ventilation centre / medulla} (1) • decreased frequency of impulses to {intercostal muscles/diaphragm} (1) • allowing (breathing muscles) to {relax / contract less frequently} (1) • rate set by the {respiratory centre / ventilation centre / medulla / pons} (1) **OR** • As air enters the lungs, stretch receptors in the lungs are activated (1) • Send impulses to inhibit inspiratory centre (1)	Do not accept message / signal ACCEPT impulses sent via parasympathetic nervous system	**(4)**

	• (resulting in) {no/fewer} impulses to {intercostal muscles/diaphragm} (1) • allowing (breathing muscles) to {relax / contract less frequently} (1) • rate set by the {inspiratory centre / expiratory centre / medulla / pons} (1)	ignore ventilation centre	

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • receptors on post-synaptic membrane (1) • (receptors) have (different) three-dimensional shapes/ are specific for (different) neurotransmitters (1) • description of response once the neurotransmitter has bound to the receptor (1)	ACCEPT {ion channel / gates} on post-synaptic membrane ACCEPT (receptors have) complementary shape to specific neurotransmitter e.g. opening of sodium channels / causing an action potential / depolarising membrane / inhibitory neurotransmitter prevents {depolarisation /action potential}	**(3)**

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes two of the following points: • release neurotransmitters (1) • that act on white blood cells / (stimulate) {spleen/thymus/lymph nodes} (1) • to {release (more/ less) cytokines / release white blood cells into blood / recruit white blood cells from blood} (1)	ACCEPT release of named neurotransmitter e.g. noradrenaline / adrenaline / epinephrine / acetylcholine ignore release of chemicals ACCEPT release (more/ less) of named chemical e.g. histamine	**(2)**

Question number	Answer	Additional guidance	Mark
(d)	An explanation that includes the following points: • record ECG before and (for 10 minutes) after changing {posture / position} (1) • count the number of a named peaks in one minute (1) • description of how POTS is identified (1)	ACCEPT calculate heart rate e.g. {heart rate / peaks per minute} will increase by 30 bpm / heart rate will be above 120 bpm (within 10 minutes of posture change)	**(2)**

Question number	Answer	Additional guidance	Mark
(e)	An explanation that includes four of the following points: • bolus acts as a stimulus/ receptor detects bolus (1) • motor neurone transmits (electrical) impulse to (smooth) muscle (1) • detail of how nerve impulse stimulates muscle contraction (1) • therefore {circular muscle contracts / longitudinal muscles relax} {around/above} bolus (1) • therefore {circular muscle relax / longitudinal muscles constrict} in {front/below} of bolus (1)	ACCEPT description of food stretching gut wall ACCEPT release of neurotransmitter ACCEPT {circular muscle contracts / longitudinal muscles relax} in {propulsive / proximal} segment ACCEPT {circular muscle relax / longitudinal muscles constrict} in receiving segment	**(4)**

Question number	Answer	Additional guidance	Mark
(f)	• inadequate blood supply to a {tissue / organ} (1)	ACCEPT a named organ e.g. heart ACCEPT {inadequate / decreased / no} blood supply	**(1)**

Question number	Answer	Additional guidance	Mark
(g)	An answer that includes one of the following points: • mutation (in gene expressed by embryological ENS) (1) • (embryological ENS) do not have surface {antigens/ receptors} that allow them to locate to bowel (1)	ACCEPT so embryological ENS do not differentiate (into working neurones) ACCEPT conditions in the bowel may not be suitable for the growth of the embryonic cells	**(1)**

Question number	Answer	Additional guidance	Mark
(h)	An explanation that includes three of the following points: • environmental factor changes conditions in the gut / causes a change in the gut flora (1) • therefore microbial {chemicals/toxins} released (1) • (chemicals / toxins / microbes) stimulate an {inflammatory response / immune response} (1) • explanation of how the inflammatory response occurs (1)	ACCEPT new microorganism / pathogen / microbe / bacteria ACCEPT release of {histamine / cytokines} e.g effect of histamine such as vasodilation / oedema occurs / recruitment of inflammatory cells / recruitment of white blood cells	**(3)**

Q10.

Question number	Answer	Additional guidance	Mark
(a)(i)	Choose an item. B Q is the SAN and P is the AVN A is not correct because R is not the AVN C is not correct because Q is not the bundle of His D is not correct because P is not the Purkinje fibres		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	Choose an item. B myogenic A is not correct because diastole is when the heart muscle relaxes C is not correct because polarisation is where there is a differencein electrical charge between inside and outside of a cell D is not correct because systole is when the heart musclecontracts		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A explanation that includes the following points: • cardiovascular control centre detects a drop in pH ofblood (or increased CO_2) • therefore SAN (stimulated) to generate more impulses persecond • therefore the cardiac cycle is shorter	Accept reference to carotid / aorticbodies	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A calculation showing the following step: • Correct calculation of stroke volume	(4500/51) 88.24 Accept 88.2	(1)

Question number	Answer	Additional guidance	Mark
(b)(iii)	A calculation showing the following steps: • correct calculation of heart beat in unit time. (1)	Eg 18 beats in 7 seconds 60/7 x 18 = 154.3 = 154 Do not accept fraction of heart rate.	(1)

Question number	Answer	Additional guidance	Mark
(b)(iv)	An answer that includes three of the following points: • comment on the wave pattern of the two traces (1) • comment on the frequency of heart rate in the two traces(1) • comment on the size of the R wave (1) • comment on the ST segment of the wave (1)	For each mark there must be a clearcomparison between the two ecgs. Eg more normal (PQRST) wave patternin second trace Accept wave pattern is different Eg less heart beats in second traceAccept reference to correct figures Eg R wave higher in first trace Eg no clear S segment in first trace	(3)

Q11.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point: • D is the correct answer • A is not the correct answer as an axon is not the space between sensory and relay neurone • B is not the correct answer as a cell body is not the space between sensory and relay neurone • C is not the correct answer as a post synoptic membrane is not the space between sensory and relay neurone		**(1)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes three of the following points: Similarities • both transmit (electrical) impulses (1) • both may synapse with relay neurones (1) Differences • sensory neurone impulses go towards the {CNS/relay neurone} whereas motor neurone impulses go away from {CNS/relay neurone} (1) • sensory neurones transmit impulses from {receptor /sensory} cells whereas motor neurone transmit impulses to {effector/muscle} cells (1)	do not piece together – has to be in same / adjacent sentences (but not separate paragraphs) do not accept messages / signals for S1, D1 and D2 ACCEPT both release neurotransmitters (in synapse) ignore brain Note: sensory sends impulses from receptor to CNS and motor brings impulse from CNS to effector = both D1 and D2	**(3)**

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes three of the following points: • {loss of / no} (insulating) myelin (1) • decreases speed of nerve impulse / depolarisation no longer just occurs at nodes of Ranvier (1) • motor neurones {no longer transmit impulses / impulses are transmitted slower} (causing loss of function in the affected area) (1) • impulses from receptors do not reach CNS / impulses are not transmitted along sensory neurones to CNS (1)	ACCEPT nerve impulses take longer as has to go through all neurone not just nodes of Ranvier ACCEPT saltatory conduction does not occur ignore impulses being lost ACCEPT {fewer/slower} impulses reaching {effector /muscles} (so loss of function) (slower both mp2&3) ACCEPT fewer impulses from receptors reach CNS	**(3)**

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes four of the following points: • a mutation changes {the base sequence (of this gene) / the amino acid sequence} (of the calcium ion channel protein) (1) • {resulting in a change in shape / prevents the opening} of the calcium ion channel (1) • this stops influx of calcium ions (across presynaptic membrane) (1) • (fewer calcium ions result in) fewer vesicles containing neurotransmitter fusing with presynaptic membrane (1) • fewer {nerve impulses/action potentials} generated at post synaptic {membrane / neurone} (1)	ACCEPT stops calcium ions passing through {membrane / ion channel} ACCEPT prevents release of neurotransmitter /less neurotransmitter will be released (into synapse) ACCEPT less depolarisation of post synaptic {membrane / neurone}	**(4)**

Q12.

Question number	Answer	Mark
(a)	• x values read from the graph and subtracted (1) • mean percentage drop calculated (1) • mean percentage of insects calculated (1) Example of calculation: 58 – 1 = 57 100 ÷ 57 = 1.75 350 × 1.75 ÷ 100 = 6	**(3)**

Question number	Answer	Mark
(b)	An explanation that includes the following points: • investigation demonstrates habituation (1) • because the {response / number of insects showing PER} decreased each time the stimulus was repeated (1) • because they learned that the heat pad was not a source of blood (1)	(3)

Question number	Answer	Mark
(c)	An answer that includes the following points: • energy saved by not extending proboscis (1) • less likely to damage the proboscis (1)	(2)

Q13.

Question number	Answer	Additional guidance	Mark
(a)	A is the correct answer • B is not the correct answer as Pr does not break down in the dark • C is not the correct answer as Pr does not absorb far red light • D is not the correct answer as Pr does not absorb far red light nor break down in the dark		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • auxin accumulates on shaded side (of the tip/stem/shoot/plant) (1) • {stimulating/causing} cell elongation (1) • detail of mechanism of action of auxin (1) • causing the plant to grow towards {light / sun} (1)	accept accumulates on the left of diagram accept auxins move away from the exposed light e.g. auxins stimulate the transport of Hydrogen ions into the cell wall or decrease pH activating {cell wall proteins / enzymes / chemicals /expansins} / {altering the hydrogen bonding within / decreasing strength of} the cell wall allowing elongation when water taken in / ref to activation of transcription factors accept causing positive phototropism do not accept bend towards light	Expert (3)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes four of the following points: • (gibberellin) binds to receptor / carrier molecule in the cell / acts as a transcription factor(1) • (amylase) {transcription factor/gene is activated} (1) • allowing {(amylase gene) transcription / production of (amylase) mRNA / translation mRNA / production of amylase} (1) • amylase (hydrolyses/ converts) starch into {maltose / glucose} (1)	ignore amylose transcription factor binding to promotor region of gene cause the inactivation of (amylase) gene {inhibitor protein/repressor molecule} ignore monomers activates gene that produces amylase = mps 2 and 3	Expert (4)

Question number	Answer	Additional guidance	Mark
(d)	An answer that includes four of the following points: • both natural and synthetic auxin cause an increase (in cell number) (1) • {natural auxin/ IAA} greater effect on growth than {synthetic auxin / NAA} (1) • IAA at 0.1 (µmol dm^{-3}) was the most effective at increasing {growth / cell number} (1) • 1 (µmol dm^{-3}) was the most effective NAA concentration at increasing {growth / cell number} (1) • IAA is {better / more effective / has more cells} at lower concentrations(1)	can piece together both natural and synthetic auxin are better than the control at all concentrations IAA gives a greater increase in number of cells than NAA Accept most cell number Accept most cell number Accept higher concentrations of auxin(IAA) {had lower increase in growth / had lower increase in number of cells} Accept converse Accept negative correlation	Expert (4)

Q14.

Question number	Answer	Additional guidance	Mark
(a)	A description that includes four of the following points: • {identify / isolate} gene(s) involved in makingbeta-carotene in bacteria (1) • cut {DNA sequence / extract (beta carotene) gene}using restriction {endonuclease /enzyme} (1) • insert (beta carotene) gene into vector (1) • method of inserting vector into rice described (1) • grow rice and select for modified rice plants with high yields of beta carotene (1)	ACCEPT obtain gene by reverse transcriptase from mRNA synthesize gene (from a database) ACCEPT gene isolated using restrictionenzyme = 2 marks (mp1 and 2) ACCEPT a named vector eg plasmid,liposomes e.g. heat shock, gene gun. micro-injection	(4)

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes three of the following points: • accumulation of genetically engineered material inthe environment / other species (1) • cross breeding with other species (1) • unknown long term effects of eating GMOs (1) • allows production of superpests (1)	ACCEPT accumulate in non-target organisms altered gene is found in other speciesACCEPT pollen transfer to related species, ACCEPT Named symptom e.g. yellowing of skin, joint pain, dizziness, bleeding, beta carotene isa gene inhibitor, ref allergies credit idea of superweeds/superpests	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • appropriate suggestion to reduce risk (1) .	accept grow in secure greenhouses, growseparately GM and non GM crops	(1)

Q15.

Question number	Answer	Additional guidance	Mark
(a)	An answer that includes the following points:		2

Part of Brain	Function
cerebellum	co-ordination of (voluntary) movement
cerebral hemispheres	interpretation of information from retina
medulla oblongata	regulation of (cardiovascular / respiratory system)
(posterior) Pituitary	secretion of ADH

Accept posture, balance, muscular activity
accept if answers are descriptive

accept cerebrum / visual cortex / occipital lobe/ cerebral cortex

Accept hypothalamus

Two correct cells = 1 mark
All four cells = 2 marks

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes four of the following points: Similarity • both are (neuro-imaging) methods giving high resolution (1) • both give images of areas with plaques in the brain (1)Differences • fMRI expensive CT cheaper (1) • fMRI will show {metabolism / oxygen uptake / brain activity} CT only shows structures (1) • fMRI uses magnetic resonance CT uses X rays (1)	2 marks max for similarities, 2 marks for differences needs to be compare and contrast. ACCEPT fMRI 45 mins CT 5-10 mins fMRI does not use ionising radiation CT does (so increased risk of cancer developing) ignore fMRI has higher resolution thanCT	4

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes four of the following points: • amyloid protein will cause bacteria to stick together(1) • enhancing phagocytosis of the bacteria / stimulates activityof white blood cells (1) • acts as an antibiotic / anti-microbial (1) • amyloid protein could disrupt ability of bacteria to adhere directly to host cell (1) • prevents entry of bacteria into cells (1)	ACCEPT agglutinate / sticks to the surface ofthe bacteria ACCEPT description of phagocytosis do not accept trigger immune response.	4

Question number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: • bacteria carried in blood from (infected) gums (1) • bacteria penetrate the blood-brain barrier (1) • bacteria /bacterial products cause the release of {histamine/ chemicals / cytokines} (1) • resulting in vasodilation (1) • consequence of vasodilation (1)	ACCEPT bacteria can invade white blood cells whichcross the blood brain barrier eg increased blood flow / oedema /increase in wbc inbrain/increased oxygen.	4

Question number	Answer	Additional guidance	Mark
(e)	An answer that includes three of the following points: • gingipains are enzymes (that break down proteins inmembranes) (1) • degrading/break down cell membranes (1) • resulting in loss of (active) brain tissue (in thecerebrum) (1) • leads to reduction in memory (especially short-termmemory) (1)	ACCEPT reference to an effect on transport channels within membrane ACCEPT in context effect on nerveimpulses / action potentials	3

Question number	Answer	Additional guidance	Mark
(f)	A description that includes three of the following points: • extraction of infected part of cerebral cortex (1) • use microarray (to identify mRNAs in sample) (1) • (analysis of mRNA) to identify genetic material from Porphyromonas (1) • use of bioinformatics / algorithms to analyse the (enormous quantity of) data (from the microarray)(1)	ACCEPT use of specific microarray egoligo- nucleotide microarray	3

Q16.

Question number	Answer	Additional guidance	Mark
(a)(i)	A description that includes four of the following points: • {identify/isolate/ cut out} the (human) rHE gene (1) • Cut {DNA sequence / gene} using restriction {endonuclease / enzyme} (1) • insert the gene into a vector (1) • inserting vector into suitable target (sheep) {cell / tissue} (1)	gene coding for rHE is isolated using restriction enzymes = 2 marks accept named vector e.g. plasmid, virus ignore bacteria e.g. udder cells / milk (protein) producing cells /fertilized sheep egg cell / embryo /zygote	Expert (4)

Question number	Answer	Additional guidance	Mark
(a)(ii)	• 77.5 (%)	accept 77 or 78	Graduate (1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes four of the following points: • rHE acts as an antigen (1) • {(phagocyte /macrophage / APC} presents antigen to (B/T) lymphocyte (1) • T helper cells activate the B cells (1) • differentiate into plasma cells (1) • plasma cells {release/ produce} (anti-rHE) antibodies (1)	accept antigen recognized as foreign accept B cells present antigen to themselves. accept T helper cells cause the production / formation of B effector cells and B memory cells	Expert (4)

Question number	Answer Additional guidance	Mark
(b)	An answer that includes the following points: **Indicative content** - description from graphs and experimental data • (many) crops have been engineered to provide resistance to pests or herbicides eg. soybean, corn • soybean will not be killed by (glycophosphate) herbicides • corn will not be eaten by the core borer • ---------- • herbicide tolerant soybean went from 7% of planted area in 1996 to 95% in 2017 • insect resistant corn went from 6% in 1996 to 88% in 2017 • increase in planting of both GM soybean and GM corn • more GM soybean planted (than GM corn) • general increase in production of genetically modified crops ---------- **explanation of benefits** • higher yields / less damage by pests • more appealing colour / useful feature • GE foods having longer shelf life • more predictable food supplies for ever growing population ---------- • improved nutritional content • 'medication' provided through GE foods • can help prevent {malnutrition / disease} ---------- • (reduced use / cost) of herbicides and pesticides • withstand environmental conditions ---------- **discussion of risks** • increasing demand agricultural resources and land • reducing land available to grow other crops ---------- • increasing monoculture • declining biodiversity / stated effect on (stated local ecosystem) ---------- • unknown consequences of foreign gene expression / long term effect unknown • horizontal gene transfer to other organisms and species eg antibiotic resistance, weeds becoming herbicide resistant ----------	Expert (6)

	To go in published MS **Level 1:** 1 mark - table or graph commented on 2 marks - both graph and table commented on **Level 2:** all level 1 plus: basic discussion of both benefits and risks (only 1 section) OR detailed discussion of EITHER benefits OR risks **Level 3:** all level 2 plus: detailed discussion of BOTH benefits AND risks selective and concise and logical	

Q17.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point B is the correct answer • A is not the correct answer • C is not the correct answer • D is not the correct answer		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: B is the correct answer • A is not the correct pathway • C is not the correct pathway • D is not the correct pathway		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes three of the following points: • heart rate decreases when diving (1) • the longer the whale is diving the lower the heart rate (1) • the difference between maximum heart rate at the surface and minimum heart rate in dive increases as dive duration increases (1)	accept ref to max and min HR	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes three of the following points: • relevant physiological change during a dive described (1) • {pH/oxygen / carbon dioxide concentrations} in the blood monitored by {chemoreceptors /sensors} (1) • increase in impulses from medulla to SAN (1) • increase impulses from SAN leading to increased heart rate (1)	E.g. blood oxygen decreases / {CO_2/lactate} increases /pH decreases / oxygen debt develops accept increased depolarisations	(3)

Q18.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point: B is the correct answer • A is not the correct answer as adrenal glands do not produce ADH • C is not the correct answer as the medulla oblongata does not produce ADH • D is not the correct answer as the pituitary gland does not produce ADH		**(1)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: B is the correct answer • A is not the correct answer as ADH does not act on the capillaries • C is not the correct answer as ADH does not act on the proximal tubules • D is not the correct answer as ADH does not act on the ureters		**(1)**

Question number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following point: C is the correct answer • A is not the correct answer as the countercurrent multiplier does not control plasma volume • B is not the correct answer as habituation is a behavioural response • D is not the correct answer as control of plasma volume is not a positive feedback		**(1)**

Question number	Answer	Additional guidance	Mark
(a)(iv)	• osmoreceptors	ACCEPT osmotic receptor	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: • increasing concentration of the gibberellin increases {length / growth} (of all internodes) (1) • increase is mostly in the length of the first internode (1)	ACCEPT positive correlation ignore gibberellin increases plant growth unqualified ACCEPT {least / smallest} effect on the last/3rd internode	**(2)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes three of the following points: • gibberellin {enters the nucleus / binds to cell surface receptors} (1) • gibberellin {acts as a transcription factor / activates transcription factor} (1) • effect of transcription factor (1) • (causing) cell elongation / cell division (and causes internode elongation) (1)	ACCEPT secondary messenger e.g. activates protein synthesis / stimulates amylase production / amylase breaking starch down into glucose for respiration	**(3)**

Q19.

Question number	Answer	Mark
(a)(i)	The only correct answer is **D** ***A*** *is not the correct answer as cis retinal is changed by light* ***B*** *is not the correct answer as phytochrome is a photoreceptor in plants* ***C*** *is not the correct answer as rhodopsin is a photoreceptor found in rod cells*	(1)

Question number	Answer	Mark
(a)(ii)	The only correct answer is **B** ***A*** *is not the correct answer* ***C*** *is not the correct answer* ***D*** *is not the correct answer*	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes two of the following points: • as light intensity increases up to 12 a.u. meanpotential difference increases (1) • mean potential difference stays constant at 12 a.u.and above (1)	both mps may be in one sentence Accept maximum potential difference reachedat 12 a.u.	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A calculation showing the following steps: • calculation of change in mean potential difference (1) • calculation of percentage change (1)	20 - 17 =3 3/17 x100 = 17.6 /17.65 % correct answer = 2 marks	2

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes two of the following points: • removing retina (from mammals) cause {blindness/harm} (1) • using anaesthetic causes harm to mammals (1) • not ethical/ unethical (1)	do not accept killing ACCEPT benefits do not outweigh harm caused/animals cannot giveconsent	2

Question number	Answer	Mark
(c)	The only correct answer is **C** ***A*** *is not the correct answer* ***B*** *is not the correct answer* ***D*** *is not the correct answer*	1

Q20.

Question number	Answer	Mark
(a)	• diameter of lesion and length of brain measured (1) • diameter of lesion multiplied by the magnification (1) Example of calculation: 6 mm and 63 mm 6 × (150 ÷ 63) = 14 / 14.3 / 14.29	**(2)**

Question number	Answer	Mark
(b)(i)	• mean increase in conduction per 1 μm increase in diameter for each type of neurone calculated (1) • value for myelinated neurone divided by value for non-myelinated to give an answer that is at least 1 SF more (1) Example of calculation: myelinated = (8.5 – 2.6) ÷ 2 = 2.95 non-myelinated = (4.2 – 2.3) ÷ 4 = 0.475 2.95 ÷ 0.475 = 6.2 / 6.21	**(2)**

Question number	Answer	Mark
(b)(ii)	An explanation that includes the following points: • both an increase in diameter and the presence of a myelin sheath increase speed of transmission (1) • myelin insulates the axon because it is hydrophobic (1) • therefore {nerve impulses jump from node to node / action potentials only occur at the nodes of Ranvier / saltatory conduction occurs} (1) • as diameter increases the resistance to flow decreases (1)	**(4)**

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes any three of the following points: • demyelination in a person with MS will result in impulses travelling slower (1) • blindness in one eye will result from demyelination of {nerve from eye to brain / one side of the brain} (1) • lack of coordination will result from sensory neurones and motor neurones transmitting nerve impulses at different speeds (1) • {blindness in one eye / lack of coordination} will result if demyelination occurs in the part of the brain associated with {vision / coordination} (1)	Accept occipital lobe	(3)

Q21.

Question number	Answer	Mark
(a)	• so other scientists could repeat the study / because different species might respond differently to microgravity	(1)

Question number	Answer	Mark
(b)	• nematodes may be {harmed / killed}	(1)

Question number	Answer	Mark
(c)	A description that includes the following points: • epigenetic changes to {prevent / allow} gene expression (1) • transcription factors to switch {on / off} genes (1) • post-transcriptional modification to determine which protein is produced from a particular gene (1)	(3)

Question number	Answer	Mark
(d)	An answer that includes any three of the following points: • (lower fat accumulation because) the diet that the nematodes were fed did not have an energy content greater than that being used (1) • (lower fat accumulation because) nematodes did not need to store energy as they were not very active (1) • (shorter body length because) diet was low in protein (1) • genes controlling {fat accumulation / body length} had been switched off (1) • microgravity resulted in less protein being synthesised (1)	(3)

Question number	Answer	Mark
(e)	An explanation that includes any four of the following points: • less muscle {protein / named protein} synthesised because of muscle atrophy (1) • because the microgravity decreases the force that needs to be exerted by the muscles (1) • less muscle activity, therefore less ATP required (1) • therefore fewer {enzymes / named enzyme} needed for respiration (1) • fewer proteins involved in gluconeogenesis because less glucose needed for respiration (1)	(4)

Question number	Answer	Mark
(f)	An explanation that includes the following points: • microarrays analyse the {active DNA / RNA} of a cell (1) • therefore less {active DNA / RNA} for the electron transport genes and increased {active DNA / RNA} for the sirtuin gene (1) • compared to nematodes, they are not exposed to microgravity (1)	(3)

Question number	Answer	Mark
(g)	An explanation that includes the following points: • because the scientists wanted to assess the lipid stores of the nematodes (1) • Sudan Black binds specifically to fat (1)	(2)

Question number	Answer	Mark
(h)	An answer that includes three of the following points: • mean values are given throughout (1) • frequency data reliable as the standard deviations do not overlap (1) • frequency and wavelength data reliable as p values are less than {0.01 / 0.05} (1) • they are not very reliable as the sample sizes are very small (1)	**(3)**

Q22.

Question number	Answer	Mark
(a)(i)	A -70 mV B is not correct as -78 mV is the potential when the axon is hyperpolarised C is not correct as 38 mV is the action potential D is not correct as 108 mV is the change in potential from resting to action potential	**(1)**

Question number	Answer	Mark
(a)(ii)	C voltage-gated potassium ion channel only A is not correct as the voltage-gated sodium ion channels will be closed and the potassium ion channelsopen at Y B is not correct as the voltage-gated sodium ion channels will be closed and the potassium ion channelsopen at Y D is not correct as the voltage-gated sodium ion channels will be closed and the potassium ion channelsopen at Y	**(1)**

Question number	Answer	Mark
(a)(iii)	B hyperpolarised A is not correct as the membrane at Z is hyperpolarised C is not correct as the membrane at Z is hyperpolarised D is not correct as the membrane at Z is hyperpolarised	**(1)**

Question number	Answer	Mark
(a)(iv)	B one A is not correct as only the third statement is correct. C is not correct as only the third statement is correct D is not correct as only the third statement is correct	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because ATP is used by the sodium-potassium pump (1) • to move sodium ions and potassium ions across the cell membrane (1) • to establish concentration gradients for sodium ions and potassium ions (1)		**(3)**