PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 9: CONTROL SYSTEMS

CONTROL OF HEART RATE IN MAMMALS

SCORE	PERCENTAGE
/121	%

STEMUP

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Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: • {low pH / carbon dioxide / lactic acid / lactate} detected by {chemoreceptors / aortic body / carotid body} (1) • affects {cardiac centre / medulla oblongata / cardiovascular centre} (1) • sympathetic nerve is stimulated / sends impulse / action potential (1) • noradrenaline at SAN (1) • therefore {more } {impulses / depolarisation / waves of excitation} which increase heart rate (1)	**DO NOT ACCEPT** message / signals	**(4)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • use larger sample to identify anomalies (1) • people have same {lifestyle / health / diet / fitness level / sex / ethnicity / age / mass} (1) • control {intensity / type} of exercise / same exercise (1) • control {duration / length} of exercise (1)	**DO NOT ACCEPT** calculate mean / SD / use statistics **ACCEPT** 10 mins	**(4)**

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• correct numerical calculation (1) • correct units (1)	Example of Calculation: 22 ÷ 120 =0.183 beats per minute per minute / beats minutes^{-2}	**(2)**

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • the heart rate is slower (1) • because noradrenaline and beta blocker are similar {shapes / structures} (1) • so beta blocker binds to noradrenaline receptors (1) • therefore {prevents / blocks} binding of noradrenaline (to receptors) (1)	**DO NOT ACCEPT** same shape	**(3)**

Q4.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • { stress / fear } causes the adrenal glands to release adrenaline into the bloodstream (1) • because of impulses along sympathetic nerve (1) • from the { cardiac control centre / medulla (oblongata) } in the brain (1) • increase in heart rate caused by increased rate of depolarisation of SAN (1) • due to release of noradrenaline at SAN (1) ATP than other cells		**(5)**

Q5.

Question Number	Correct Answer	Additional guidance	Mark
	A description that makes reference to four of the following points: • increased pressure / CO_2 concentration / decreased pH detected by baroreceptors / chemoreceptors (1) • medulla oblongata (1) • sympathetic nerve stimulated (1) • release of noradrenaline (1) • excitation at SAN (1)		**(4)**

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	**A** 1 and 2 *B is incorrect because lidocaine binds to voltage gated sodiumchannels* *C is incorrect because lidocaine binds to voltage gated sodiumchannels* *D is incorrect because lidocaine binds to voltage gated sodiumchannels*		**1**
(ii)	B parasympathetic neurone reduce *A is incorrect because acetylcholine reduces the heartrate* *C is incorrect because acetylcholine is released byparasympathetic neurones* *D is incorrect because acetylcholine is released byparasympathetic neurones*		**1**
(iii)	An answer that makes reference to three from: • action potential / impulse arrives at pre-synaptic {terminal / knob}(1) • calcium channels open and calcium ions diffuse in(1) • vesicles move to membrane (1) • vesicles fuse with membrane and release acetylcholine (1)	**Allow** action potential stimulatespresynaptic membrane **Allow** Ca^{2+} **Allow** exocytosis	**3**

Q7.

Question Number	Answer	Mark
(a)	1. heart rate increases / eq ; 2. {stroke volume / eq} increases / eq ; 3. {SAN /eq} activity increases / ; 4. AVN time delay decreases / eq ; 5. idea that more blood returning (to the heart) causes {heart / muscle} to stretch ; 6. idea that ventricles contract with greater force ;	**(4)**

Question Number	Answer	Mark
(b) (i)	<table><tr><th>**Approximate value for**</th><th>**0.1 dm^3**</th><th>**0.5 dm^3**</th><th>**6 dm^3 min^{-1}**</th><th>**6 breaths min^{-1}**</th><th>**12 breaths min^{-1}**</th></tr><tr><td>Resting breathing rate</td><td></td><td></td><td></td><td></td><td>☒</td></tr><tr><td>Resting tidal volume</td><td></td><td>☒</td><td></td><td></td><td></td></tr></table>	**(2)**

Question Number	Answer	Mark
(b)(ii)	1. more {peaks / eq} in the same time / higher frequency / distance between (consecutive) peaks would decrease ; 2. idea of distance from peak to trough would increase ;	**(2)**

Question Number	Answer	Mark
(c)	Any **two** from the following: 1. how often they play 2. age 3. body size / BMI / eq 4. gender / eq 5. fitness level / eq 6. health status / eq 7. lifestyle e.g. smoker or swimmer ; ;	**(2)**

Q8.

Question Number	Answer	Additional Guidance	Mark
*	**(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)** 1. increase in *respiration* rate in *muscle* cells ; 2. more {CO_2/*carbonic* acid/eq} in blood ; 3. more {*lactate* / *lactic acid*} in blood / eq ; 4. idea that *chemoreceptors* in *medulla* stimulated ; 5. ref to *cardiovascular* control centre in *medulla* ; 6. ref to *autonomic nervous system /sympathetic nerve* ; 7. more *impulses* from {*medulla / cardiovascular* control centre} to SAN OR along neurones to SAN ; 8. More {*noradrenaline / norepinephrine*} released onto SAN ; 9. SAN (excitation) rate increased / eq ; 10. (causing an) increased {heart rate / eq} / eq ; 11. Comment on other mechanism e.g. presence of adrenaline, stretch receptor role ;	**QWC emphasis is on spelling** 2 OR 3 **ACCEPT** reduced blood pH 4. **ACCEPT** in *aorta, carotid* 6. **ACCEPT** *accelerator* nerve 10. **ACCEPT** beats per min for heart rate	**(6)**

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	127.6 – 130.4 beats per minute / bpm	**Accept** any number between and including 127.6 and 130.4 beats per minute / bpm	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to four of the following: • exercise {increases carbon dioxide / lowers pH / increases H^+ / increases lactate} in blood (1) • detected by chemoreceptors in the {carotid artery / aorta / aortic body / carotid body} (1) • impulses sent to {medulla / cardio acceleratory centre / cardiac control centre} (1) • impulses along sympathetic {nervous system / nerve / neurone} (1) • noradrenaline {is released onto / stimulates} SA node (1)	**Do not accept** signal / message **Do not accept** signal / message **Accept** adrenaline stimulates SA node	**(4)**

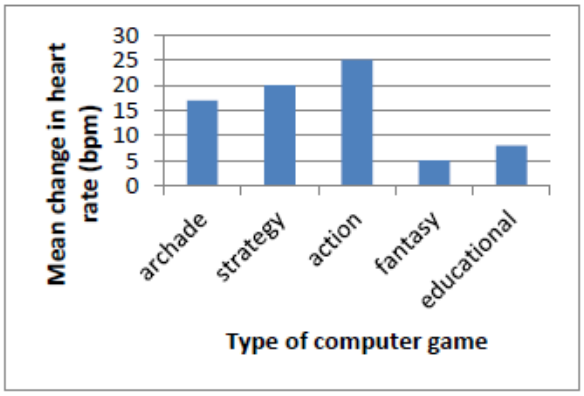
Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • {charge / shape} of active site changes (1) • so acetylcholine will not bind / can no longer form E/S complex (1)		**2**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • acetylcholine (from parasympathetic neurone) is not broken down / builds up in synaptic cleft (1) • so continues to bind to (acetylcholine) receptors (in SA node) (1) • so fewer impulses from SA node (1) • and noradrenaline has no / less effect (1)	**Accept** fewer depolarisations from SA node	3

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: • all games must be played for the same length of time to make a valid comparison (1) • a recovery period is needed for the heart rate to return to normal before each subsequent game (1) • repeats should be { at the same time of day / under the same conditions } to avoid effect of other variables (1) • games should be tested in a different sequence each time, to account for effects of fatigue (1) • more individuals should be tested, other than the student himself, to obtain valid results (1)		(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	• bar chart (1) • x-axis: type of computer game and y-axis: mean change in heart rate (1)		**(2)**

Q12.

Question Number	Answer	Additional guidance	Mark
(a)	1. alpha glucose in starch and beta glucose in cellulose; 2. only {starch / amylopectin} can be branched / cellulose only a linear molecule ; 3. starch contains two types of molecule, cellulose only one ; 4. alternate monomers rotated through 180^0 in cellulose only ; 5. only {amylopectin / starch} can have 1-6 glycosidic bonds / cellulose has 1-4 glycosidic bonds only ;	ACCEPT 3 - the two named molecules of starch – amylose and amylopectin ACCEPT 5 – starch can have 1-6 & 1-4 glycosidic bonds but cellulose only 1-4	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. thermoreceptors in hypothalamus / eq ; 2. detect the increase in (core) blood temperature / eq ; 3. reference to heat loss centre activated ; 4. reference to autonomic nervous system ; 5. reference to impulses down motor neurones ; 6. to {effectors / named effector} / eq ; 7. detail of method of heat loss / eq ;	ACCEPT 5 - effector neurone for motor neurone ACCEPT 7 – vasodilation of blood vessels, sweat released, heat loss from blood through radiation	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	1. (shivering) is muscle contraction ; 2. which uses {respiration / ATP / eq} ; 3. which release heat (to warm body) / eq ;	ACCEPT 2 - oxidative phosphorylation, ATP being converted to ADP and Pi	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)	1. (cancer causing) gene identified / eq ; 2. gene {cut / isolated / eq} from DNA / eq ; 3. using a {restriction / eq} enzyme / eq ; 4. gene in {vector / named vector} ; 5. mechanism for getting {gene / vector} into host cells (of naked mole rats) / eq ;	ACCEPT 4 – named examples including retrovirus, virus, liposome ACCEPT 5 - reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler	**(3)**

Question Number	Answer	Additional guidance	Mark
* **(d)**	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence) 1. idea that this air has higher CO_2 content ; 2. {CO_2 level in blood increases / pH of blood falls / eq} ; 3. change detected by chemoreceptors in {carotid body / carotid artery / aortic body / aorta / medulla} ; 4. reference to {ventilation centre / eq} (in medulla) ; 5. sends more impulses along neurones / eq ; 6. to intercostal muscles / diaphragm / eq ; 7. causing an increased {ventilation rate / rate of breathing / depth of breathing} / eq ;	ACCEPT 2 - high, higher (for CO_2) ACCEPT 4 – respiratory centre, inspiratory centre for ventilation centre ACCEPT 5 – impulses sent more often	**(5)**

Question Number	Answer	Additional guidance	Mark
(e)	1. naked mole rat's {incisors / eq} grow through {skin / lip} without {damage / eq} ; 2. lead to new {coatings / permanent seal /eq} at {skin / bone / metal} interface ; 3. so soft tissue is {not damaged / eq } (by the prosthetic) / eq ;		**(2)**
Question Number	Answer	Additional guidance	Mark
(f)	gonadotrophin-releasing (hormone) and anterior pituitary / gonadotrophins and {ovaries / testes} ;	ACCEPT - testosterone and testes ACCEPT - gonads for testes or ovaries	**(1)**

Question Number	Answer	Additional guidance	Mark
(g)	1. idea of irregularity of flagellum ; 2. Idea of irregularity associated with mid-region ;	ACCEPT 1 – no or more than one flagellum ACCEPT 2 – not enough mitochondria	**(2)**

Question Number	Answer	Additional guidance	Mark
(h)	1. idea of high levels of inbreeding ; 2. low level of genetic diversity / eq ; 3. idea that there is some variation because more than one male is involved in ; 4. unfamiliar males used as mates (by queen) / eq ; 5. fusion of colonies / eq ; 6. arrival of a dispersal phenotype (from a different colony) ; 7. mutations / eq ;	ACCEPT 1 – accept idea in context of only one queen/female breeds ACCEPT 2 – restricted gene pool, low genetic variation	**(3)**

Question Number	Answer	Additional guidance	Mark
(i)	1. reduces inbreeding (depression) / eq ; 2. increases outbreeding / outbreeding qualified ; 3. (leading to) increase in genetic diversity ; 4. idea of colony size regulation ; 5. idea of increase in fecundity ; 6. idea of increased chance of survival ;	ACCEPT 1 - less genetic drift ACCEPT 2 – disperser/new comer more likely to breed ACCEPT 3 – increased genetic variation, increase in variety of alleles ACCEPT 6 – appropriate ref to natural selection, due to environmental changes	**(2)**

Question Number	Answer	Additional guidance	Mark
(j)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. high CO_2 in air (of tunnels) ; 3. haemoglobin has higher affinity for oxygen / brain can tolerate eq ; 4. low O_2 levels (in tunnels) / eq ; 5. increased number of oxytocin receptors in brain ; 6. overcrowding / eq ; 7. non-pigmented ; 8. lack of UV light ; 9. outbreeding mechanisms such as disperser; 10. low genetic diversity ; 11. hairless/ naked/ reduction of sweat gland / loose skin / no insulating layer / poikilothermic ; 12. due to nature of its temperature environment / eq ; 13. teeth arrangement / eq ; 14. for digging underground ; 15. keen sense of smell/reduce eyesight / ref to circadian rhythms ; 16. dark conditions ; 17. division of labour ; 18. for the survival of the eusocial colony ;	ACCEPT1 - lack or receptor for chemical pain ACCEPT 3 – ref to brain's hypoxia response, neurones or brain resistance to hypoxia ACCEPT13 - forward of lips or long	**(4)**

Q13.

Question Number	Answer	Additional Comments	Mark
(a)	1. only (alpha) 1-4 glycosidic bonds in amylose / (alpha) 1-6 only found in amylopectin ; 2. only amylopectin has side branches / only amylose is {coiled / eq} ; 3. Amylopectin is a {larger / eq} molecule than amylose ;	**1. ACCEPT** 1-6 and 1-4 in amylopectin	**(2)**

Question Number	Answer	Additional Comments	Mark
(b)	1. Different individuals in the {colony / eq} take on specific {roles / jobs / eq} ; 2. Example given e.g. queen produces offspring ;	**1. Accept** division of labour **2. Accept** dominance by queen, {few of the males / kings} involved in breeding	**(2)**

Question Number	Answer	Additional Comments	Mark
(c) (i)	Idea that body temperature of animal mimics the ambient temperature ;	**Accept** body temp follows environmental temperature	**(1)**

Question Number	Answer	Additional Comments	Mark
(c) (ii)	1. Lack of insulating layer: Idea that does not impede transfer of heat energy / allows exchange of heat energy more easily ; 2. A marked reduction in sweat glands: Idea that they do not need to cool down OR less water lost ;	**1. Accept** enables heat transfer between environment and NMR	**(2)**

Question Number	Answer	Additional Comments	Mark
(d)	1. (Cancer causing) gene identified / eq ; 2. Gene {cut / isolated / eq} from DNA / eq ; 3. Using a {restriction / eq} enzyme / eq ; 4. Gene in {vector / named vector} ; 5. Mechanism for getting {gene/vector} into host cells (of mice) / eq ;	**1. Accept** screen for the gene **2. Accept** extracted **3. Accept** correctly named restriction enzyme e.g. EcoR1 **4. Accept** Named egs – retrovirus, virus, liposome, plasmid, bacteria **5. Accept** reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler, transduction	**(3)**

Question Number	Answer	Additional Comments	Mark
* (e)	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence 1. {*neurone* (cell) surface membrane exposed / no *myelination* / eq} at nodes of *Ranvier* ; 2. Nodes are the site of clusters of {*sodium-gated channel proteins / potassium channels*} ; 3. Which {open / close} when *impulse* arrives / eq ; 4. Allowing *depolarisation* at nodes / eq ; 5. idea that *myelin*/eq acts as an (electrical) *insulator* (on *neurone* surface between nodes) ; 6. reference to *Schwann* cell ; 7. idea that *impulse*/*depolarisation* 'jumps' to next node ; 8. Reference to this being *saltatory conduction* ; 9. idea that this happens between the *myelin* layers of the *Schwann* cell ;	**QWC emphasis on spelling** **3. Accept** influx of sodium ions	**(5)**

Question Number	Answer	Additional Comments	Mark
(f)	1. idea of heart working less efficiently ; 2. idea of less oxygen absorbed at lungs / eq ; 3. less blood pumped to brain ; 4. concentration gradient (for oxygen) at brain reduced / eq ; 5. less oxygen in blood (in brain) diffuses into brain tissue / eq ; 6. idea of less oxygen in brain tissue due to continual (aerobic) respiration ;		(3)

Question Number	Answer	Additional Comments	Mark
(g)	gonadotrophin-releasing (hormone) stimulates gonadotrophin release / gonadotrophin stimulates ovulation / testosterone stimulates {sperm production / (male) secondary sexual characteristics / other named example} ;		(1)

Question Number	Answer	Additional Comments	Mark
(h)	1. Idea of effect on mitochondria ; 2. (therefore) reduced {energy / ATP / eq} for flagellum movement ;	**1. Accept** less efficient / fewer / none **2. Accept** tail for flagellum	(2)

Question Number	Answer	Additional Comments	Mark
(i)	1. idea that fat is an energy store ; 2. reduces dependence on external food source / eq ; 3. enables disperser to travel / eq ; 4. (metabolic) water is released (on oxidation) / eq ; 5. acts as a thermal insulator / eq ;	**Accept** energy-rich	(3)

Question Number	Answer	Additional Comments	Mark
(j)	1. idea that unfamiliar males are likely to be genetically different ; 2. idea that this is outbreeding ; 3. idea that this increases genetic diversity ;	**3. Accept** producing offspring that are genetically different	(2)

Question Number	Answer	Additional Comments	Mark
(k)	the order of the {bases / genes and non-coding sequences / eq} in the DNA (of the naked mole rats) is found / eq ;	**Accept** exons and introns **Ignore** genes unqualified	(1)

Question Number	Answer	Additional Comments	Mark
(I)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. Idea of pain relief e.g. dealing with post traumatic pain, post surgical pain, joint pain after a knee operation ; 3. haemoglobin has higher affinity for oxygen ; 4. Idea of dealing with reduced oxygen situations such as due to a heart attack or stroke ; 5. Naked mole rat {incisors / eq } grow through skin (of lip) without damage ; 6. Idea of better prosthesis e.g. new {coatings / permanent seal} at {skin / bone / metal} interface, soft tissue not damaged, avoid infection ; 7. High protein stability / does not (easily) lose 3D shape ; 8. (so) reduced effect of oxidative {damage / stress} / reduced effect of oxygen-containing free radicals / live healthily into old age ; 9. Cell overcrowding early warning gene / ref. to two tiered contact inhibition / presence of gene p16 ; 10.Idea of cancer prevention e.g. cancer resistance, future cancer therapy ; 11.Naked mole rat neurones display immature {characteristics / physiological properties} / brain cells that cope with {low oxygen / hypoxia} ; 12.To treat people with temporary loss of oxygen to brain e.g. heart attack, stroke, drowning / to prevent permanent brain damage ; 13.High levels of oxytocin receptors in {brain / nucleus accumbens}; 14.Idea of links to autism ; 15.Naked mole rats do not experience menopause ; 16.Ref to osteoporosis {treatment / prevention} (without side effects) ; 17.circadian rhythms / sleep patterns of naked mole rats ; 18.Idea that may help with sleep disorders ;	**9. Accept** anticancer mechanism	

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is: **D** *A is incorrect because W is the hypothalamus* *B is incorrect because X is the cerebrum* *C is incorrect because Y is the cerebellum*		**1 comp**

Question Number	Answer	Additional Guidance	Mark
(ii)	The only correct answer is: **C** release of noradrenaline by the sympathetic nervous system *A is incorrect because acetylcholine decreases the rate* *B is incorrect because acetylcholine decreases the rate* *D is incorrect because noradrenaline is released by the sympathetic nervous system*		**1 comp**