

| Question Number | Answer | Mark |
|-----------------|--|------|
| 1 (a) | <p>The only correct answer is D – Schwann cell</p> <p><i>A is not correct because myelin is produced by the Schwann cell.</i></p> <p><i>B is not correct because myelin is produced by the Schwann cell.</i></p> <p><i>C is not correct because myelin is produced by the Schwann cell.</i></p> | (1) |

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|-----------------|--|------|
| 1 (b) (i) | <p>The only correct answer is B – an electrical insulator</p> <p><i>A is not correct because myelin does not act as an electrical conductor.</i></p> <p><i>C is not correct because myelin is impermeable to potassium ions.</i></p> <p><i>D is not correct because myelin is impermeable to sodium ions.</i></p> | (1) |

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| 1 (b) (ii) | <p>The only correct answer is A – axon</p> <p><i>B is not correct because myelin surrounds the axon.</i></p> <p><i>C is not correct because myelin surrounds the axon.</i></p> <p><i>D is not correct because myelin surrounds the axon.</i></p> | (1) |

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|------------------|--|--|------------|
| 1 (c) (i) | <ol style="list-style-type: none"> 1. 5.7 and 2.7 ; 2. difference divided by the smaller value ; 3. 111 / 111.1 ; | <p>MP1 ALLOW 5.6 to 5.8 and 2.7 to 2.8</p> <p>MP3 ALLOW ECF if they divide by larger value</p> | (3) |

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| 1 (c) (ii) | <ol style="list-style-type: none"> 1. as diameter of neurone increases speed of conduction increases for both ; 2. above 1 μm myelinated neurones have a faster speed of conduction than non-myelinated neurones / below 1 μm non-myelinated neurones have a faster speed of conduction ; 3. the diameter has a greater effect on the speed of conduction of a myelinated neurone / eq ; 4. in myelinated neurones linear relationship but not linear in non-myelinated neurone ; | <p>MP3 ALLOW gradient is steeper in myelinated neurones</p> | (2) |

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| 1 (c) (iii) | <ol style="list-style-type: none"> 1. idea that myelin sheath insulates the axon ; 2. there are breaks in the myelin sheath of myelinated fibres / nodes of Ranvier ; 3. action potentials occur at the nodes only / eq ; 4. nerve impulses jumping from node to node / saltatory conduction ; 5. in non-myelinated fibres action potential has to be generated all along the axon ; | <p>MP3 and 5 ALLOW depolarisation</p> <p>MP4 ALLOW action potential / depolarisation jumps from node to node</p> | (3) |

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|-----------------|---|---------------------------|------------|
| 2(a) | 1. $90 \text{ (mm)} \div 50\,000$; 2. $1.8 \times 10^{-3} \text{ mm}$; | ALLOW 91 / 9 / 9.1 | (2) |

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| 2(b)(i) | <p>The only correct answer is D</p> <p><i>A is not correct because D shows a sarcomere</i></p> <p><i>B is not correct because D shows a sarcomere</i></p> <p><i>C is not correct because D shows a sarcomere</i></p> | (1) |

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| 2(b)(ii) | <p>The correct answer is A</p> <p><i>B is not correct because it contains myosin and actin</i></p> <p><i>C is not correct because it contains regions with both actin and myosin</i></p> <p><i>D is not correct because it contains regions with both actin and myosin</i></p> | (1) |

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|-----------------|--|-----------|----------------|------------|
| 2(b)(iii) | <p>The correct answer is B - <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>decreases</td><td>stays the same</td></tr></table></p> <p><i>A is not correct because part B stays the same</i></p> <p><i>C is not correct because part A decreases and part B stays the same</i></p> <p><i>D is not correct because part D decreases</i></p> | decreases | stays the same | (1) |
| decreases | stays the same | | | |

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| 2(c) | <p>The correct answer is A – few mitochondria and few capillaries</p> <p><i>B is not correct because fast twitch fibres have few capillaries</i></p> <p><i>C is not correct because fast twitch fibres have few mitochondria</i></p> <p><i>D is not correct because fast twitch fibres have few mitochondria and few capillaries</i></p> | (1) |

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|-----------------|---|---|------------|
| 2(d) | <ol style="list-style-type: none">1. calcium ions {are released from sarcoplasmic reticulum / enter the sarcoplasm } ;2. calcium ions bind to troponin ;3. (change in shape of troponin) moves tropomyosin away from myosin binding site ;4. allowing myosin (heads) to attach to actin ;5. (contraction as) actin is pulled past the myosin / reference to sliding filament theory ; | MP3 ALLOW this exposes the myosin binding site | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|---|------------|
| 3(a)(i) | <ol style="list-style-type: none"> 1. as age increases (median) FEV₁ decreases ; 2. at lower altitudes (median) FEV₁ is lower ; | <p>ACCEPT converse statements</p> <p>MP1 ALLOW negative correlation</p> | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|--|------------|
| 3(a)(ii) | <ol style="list-style-type: none"> 1. { lungs / alveoli } lose their { elasticity / elastic tissue } ; 2. weaker {breathing muscles / diaphragm / intercostal muscles } ; 3. idea of respiratory disease ; 4. idea of fewer alveoli ; | <p>MP3 ALLOW description of environmental factor e.g. more smoking damage</p> | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|------------------|--|---|------------|
| 3(a)(iii) | <ol style="list-style-type: none"> 1. less oxygen available / eq ; 2. need to breathe more forcefully / eq ; 3. stronger breathing muscles / eq ; 4. larger lung capacity / eq ; | <p>MP1 ALLOW lower concentration of oxygen</p> <p>MP4 ALLOW more air needs to be breathed in / breathed out / larger tidal volume / larger vital capacity</p> | (2) |

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|-----------------|--|--|------------|
| 3(b) | <ol style="list-style-type: none"> 1. (collect traces) from each group of Andean males and North American males ; 2. (for each individual) count the number of breaths / eq ; 3. divide by the time taken (to find the rate) ; 4. find the middle value (for each group) ; | <p>MP1 ALLOW collect enough result to find the median</p> | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|---|------------|
| 4(a) | <ol style="list-style-type: none"> 1. exposure to pesticide increases the risk of developing Parkinsons / eq ; 2. the more pesticides an individual is exposed to the greater the risk of developing Parkinsons / eq ; 3. correct manipulation of data to support MP1 or 2 ; | <p>e.g. (relative) risk for P, Q and R exposed group is 2.1 greater than control group</p> <p>IGNORE simple descriptions of the data</p> | (2) |

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| 4 (b) (i) | <ol style="list-style-type: none"> 1. idea that pesticides are {absorbed through skin / inhaled} ; 2. idea that blood carries pesticides to the brain ; 3. pesticide kills the dopamine secreting neurones in the (mid) brain ; 4. {inhibits release / reduces production} of dopamine ; 5. {binds to / blocks} post synaptic receptors for dopamine 6. idea of effect on motor pathway ; | <p>MP3 ACCEPT basal ganglia / substantia nigra</p> <p>MP4 ALLOW no dopamine production / not enough dopamine in the synaptic cleft</p> <p>MP6 e.g. stops impulses reaching muscle cells / reduces action potentials in motor neurones</p> | (3) |

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| 4(b)(ii) | <p>1. reference to L dopa ;</p> <p>2. idea that L dopa can cross the blood brain barrier ;</p> <p>3. L dopa is converted to dopamine in the brain / eq ;</p> <p>4. dopamine binds to receptors on the post-synaptic membrane ;</p> <p>OR</p> <p>1. use an enzyme inhibitor ;</p> <p>2. reference to {monoamineoxidase B / MAOB} ;</p> <p>3. to prevent the breakdown of dopamine</p> <p>4. dopamine binds to receptors on the post-synaptic membrane ;</p> <p>OR</p> <p>1. reference to dopamine agonist ;</p> <p>2. idea that dopamine agonist can cross the blood brain barrier ;</p> <p>3. (dopamine agonist) binds to receptors on the post-synaptic membrane ;</p> | <p>MP2 ALLOW diffuse from blood into brain</p> <p>MP4 ALLOW idea of effect on motor pathway</p> <p>MP2 ALLOW named MAOB e.g. selegline</p> <p>MP4 ALLOW idea of effect on motor pathway</p> <p>MP3 ALLOW idea of effect on motor pathway</p> | (3) |

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|-----------------|--|------|
| 5(a) | <p>The only correct answer is B – homeostasis</p> <p><i>A is not correct because chemiosmosis is movement of ions across a partially permeable membrane down their electrochemical gradient</i></p> <p><i>C is not correct because phototropism is the orientation of an organism in response to light</i></p> <p><i>D is not correct because respiration is the process by which living organisms produce energy</i></p> | (1) |

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| *5(b)(i) | <ol style="list-style-type: none"> 1. core temperature falls ; 2. receptors in hypothalamus detect the change ; 3. idea of an increase in { shivering / metabolic activity } ; 4. increasing heat production ; 5. once (core body) temperature increases {shivering stops / metabolic activity reduces} ; 6. body hair insulates ; 7. curling up reduces surface area (to volume ratio) reducing heat loss ; | <p>QWC emphasis on clarity of expression</p> <p>MP1 IGNORE body / skin temperature</p> <p>MP5 ACCEPT negative feedback</p> <p>MP6 ALLOW description of hair erector muscles standing hairs up to create insulation layer</p> | (5) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|--------------------------------------|------------|
| 5(b)(ii) | <ol style="list-style-type: none"> 1. body mass will decrease ; 2. fat { broken down / used as a respiratory substrate / provides energy for shivering / eq } ; | <p>ALLOW muscle / protein</p> | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 5(c)(i) | <p>The only correct answer is D - <input type="text" value="increases"/> <input type="text" value="increases"/></p> <p><i>A is not correct because</i> <i>B is not correct because</i> <i>C is not correct because</i></p> | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|---|------|
| 5(c)(ii) | <ol style="list-style-type: none"> 1. count number of bears (living near paths) ; 2. introduce humans (on paths) ; 3. idea of controlling level of disturbance (by humans on paths) ; 4. count number of bears that remain (near) after disturbance ; 5. idea of repeating disturbance at regular time intervals ; 6. habituation has occurred when the number of bears (around the paths) stops decreasing after human use of paths ; | <p>MP4 ALLOW other reasonable methods of assessing response of bears</p> <p>MP6 ALLOW other reasonable methods of demonstrating habituation</p> | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|----------------------------------|------------|
| 6(a)(i) | <ol style="list-style-type: none"> the lower the concentration of oxygen the more EPO (that is synthesised) / eq ; the longer the time the more EPO (that is synthesised) / eq ; | ALLOW converse statements | (2) |

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| 6(a)(ii) | <ol style="list-style-type: none"> idea that low oxygen concentration triggers second messenger systems ; reference to transcription factors ; transcription factor binds to (the promotor region of) the EPO gene ; more (EPO mRNA) transcription ; increased (EPO) protein synthesis / eq } ; | <p>MP1 ALLOW an example of a second messenger e.g. cAMP / protein kinases</p> <p>MP3 ALLOW EPO DNA</p> | (4) |

| Question Number | Answer | Additional Guidance | Mark |
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| 6(b) | <ol style="list-style-type: none"> 1. isolate the EPO gene (from human cells) / eq ; 2. using restriction enzymes / eq ; 3. insert the EPO gene into a vector / eq ; 4. example of a vector ; 5. insert { vector / gene } into udder of a sheep / eq ; 6. idea of modifying several (udder) cells ; | <p>MP4 e.g. plasmid / virus / bacteria</p> <p>MP5 ALLOW insert {vector / gene} into breast cells / milk protein genes</p> | (4) |

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|-----------------|---|--|------------|
| 7(a) | <ol style="list-style-type: none"> 1. they have a {suppressed / weakened} immune system ; 2. identify particular aspect of immune system that could be suppressed ; 3. idea of close contact (with others with viral infections) ; | <p>MP2 e.g. produce fewer T killer cells / less antibody to virus</p> <p>MP3 ALLOW more opportunities for injuries</p> | (2) |

| Question Number | Answer | Additional Guidance | Mark |
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| 7(c) | <ol style="list-style-type: none"> 1. work as a neurotransmitter ; 2. binding to serotonin receptors / eq ; 3. reference to {synapses / post synaptic membrane} ; 4. in the pleasure centres of the brain / eq ; | <p>MP2 ALLOW stimulate the release of serotonin / production of serotonin / prevents the re-uptake of serotonin</p> <p>MP3 ALLOW synaptic cleft</p> <p>MP4 ALLOW nucleus accumbens</p> <p>MP4 IGNORE other named parts of the brain</p> | (3) |

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| 7(d) | <ol style="list-style-type: none"> 1. cardiac muscle is weaker (in unfit heart) ; 2. stroke volume is smaller / eq ; 3. needs to beat faster to maintain cardiac output / eq ; 4. to ensure a supply of oxygen to tissues ; | <p>ALLOW converse statements</p> <p>MP4 ALLOW muscles need oxygen for aerobic respiration</p> | (2) |

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|-----------------|--|---|------------|
| 7(e) | <ol style="list-style-type: none"> 1. cells forming the SAN are myogenic ; 2. SAN receives impulses from the {cardiovascular centre / medulla } ; 3. sympathetic nerves stimulate the SAN / parasympathetic nerves inhibit the SAN ; 4. idea that waves of depolarisation from the (SAN) initiate contraction of the {atria / heart} ; 5. pressure changes cause a pulse / eq ; | <p>MP1 ALLOW cells of SAN have an intrinsic rhythmicity / SAN act as the (primary) pacemaker</p> <p>MP4 ALLOW passes an (electrical) impulse to AVN</p> | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|---|------------|
| 7(f) | <ol style="list-style-type: none"> 1. (some) ion channels open and allow the movement of ions ; 2. the membrane potential becomes less negative ; 3. reference to threshold potential ; 4. causes (more) ion channels to open (depolarising the cell membrane) ; | <p>MP1 and 4 ALLOW calcium ions / sodium ions / potassium ions</p> <p>MP2 ALLOW membrane becomes more positive / inner membrane becomes positive</p> <p>MP4 ALLOW calcium ions / sodium ions</p> | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|---|-------------------|
| 7(g) | <ol style="list-style-type: none"> 1. genes code for membrane protein channels ; 2. exercise is an environmental factor ; 3. idea that exercise does not change the number of genes ; 4. exercise can affect ion channel {gene expression / transcription / mRNA production / synthesis} ; 5. by { increasing / decreasing / changing } the activity of transcription factors ; | <p>MP4 ALLOW less activation of genes / less ion channel protein made / genes switched off</p> | <p>(3)</p> |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|---|------|
| *7(h) | <ol style="list-style-type: none"> 1. ribosomes on the rough endoplasmic reticulum translate (beta-1-adrenergic receptor) mRNA ; 2. polypeptide chains are released into the endoplasmic reticulum ; 3. transported to the Golgi apparatus ; 4. { sugars added / carbohydrate added / glycosylation takes place } in the Golgi apparatus ; 5. the glycoprotein is packaged into vesicles / eq ; 6. vesicles fuse with the cell membrane ; 7. idea of inserting the beta-1-adrenergic receptor into the (cell) membrane ; | <p>QWC emphasis is for logical sequence</p> <p>MP1 ALLOW description of translation that includes role of ribosomes on rER</p> <p>MP2 ALLOW primary structure enters the ER</p> <p>MP3 ALLOW Golgi body</p> <p>MP4 ALLOW protein is converted into a glycoprotein in the Golgi</p> <p>MP4 IGNORE glycogen added</p> <p>MP5 ALLOW vesicles with (beta-1-adrenergic receptor) in their membrane leave the Golgi / glycoproteins leave the Golgi in vesicles</p> | (5) |

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|-----------------|--|---|------|
| 7(i) | 1. distance between peaks will increase / peaks will be less frequent / eq ; | <p>ALLOW any named peak (P, Q, R, S, T)</p> <p>ALLOW increase in length of interval between any pair of letter P, Q, R, S and T</p> <p>ACCEPT correct annotated diagram</p> <p>ALLOW shorten the QT interval (in some) ;</p> <p>IGNORE fewer peaks</p> <p>IGNORE descriptions of heart beats or pulse</p> | (1) |

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|-----------------|--|---|------|
| 7(j) | <p>1. adrenalin is absorbed into the blood stream / eq ;</p> <p>2. causes (smooth) muscle in blood vessels to contract ;</p> <p>3. resulting in reduced blood flow ;</p> | <p>MP2 ALLOW causes vasoconstriction</p> <p>MP2 IGNORE causes capillaries to constrict / blood vessels contract</p> | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|--|------------|
| 7(k) | <ol style="list-style-type: none"> 1. atropine inhibits nerve impulses in the parasympathetic system ; 2. the sympathetic system still functions ; 3. this causes contraction of the radial muscles ; 4. circular muscles {are not stimulated / relax} ; | <p>MP1 ALLOW stops / inhibits parasympathetic system</p> <p>MP3 IGNORE retinal / radical muscles</p> | (3) |

