

**WJEC (Wales) Biology A-level
Topic 3.8: The Nervous System
Questions by Topic - Mark
Scheme**

1.	Question	Marking details	Marks Available
1	(a)	(i) Both X and Y correct for one mark X White matter Y Grey matter; Explanation: Grey matter contains the (darkly staining) cell bodies/nuclei of neurones whilst the white matter is mainly {axons/myelin};	1 for both 1
		(ii) L Dorsal Root ganglion; Z Central canal;	2
	(b)	(i) Schwann cell; Myelin/ phospholipid; NOT lipid	2
		(ii) Insulates the axon; Allows saltatory conduction/ impulse jumps from node to node; So speeding up the transmission of the action potential/ increase speed of conduction;	Max 2
		(iii) Impulses cannot jump node to node/ saltatory conduction is stopped/ local circuits {too short/insufficient}/ {Few/no} voltage gated Na ⁺ channels (between Nodes of Ranvier); So action potential cannot be generated/ speed of conduction is reduced/ action potential does not reach destination;	2
		(iv) Remyelinate the axon/use of stem cells/make the membrane add Na ⁺ channels in bare areas/prevent further demyelination/ immune {suppressants/ inhibitory} drugs; Accept physiotherapy	1
	(c)	(i) Nerve net drawn	1
		(ii) Respond to a limited number of stimuli; Cannot detect source of stimulus/ impulses pass in all directions; Number of effectors is small; No CNS; Accept no brain Action potential can be carried in more than one direction along a neurone; Only one type of cell/ unmyelinated/ facilitation - qualified/ slower response;	Max 2

Question 1 Total [14]

2.	Question	Marking details	Marks Available
2	(a)	<p>Any three from</p> <p>Sodium/potassium pumps;</p> <p>ATP / active transport;</p> <p>3 Na⁺ out 2 K⁺ in;</p> <p>Organic anions, -ve charged molecules/proteins;</p> <p>Pd across membrane -60mV / -70mv;</p> <p>Membrane leakage, more permeable to K⁺ than Na⁺;</p>	max 3
	(b)	<p>A. Threshold reached;</p> <p>Sodium voltage gated channels open;</p> <p>Sodium ions diffuse into {cytoplasm/ cell};</p> <p>Depolarised;</p> <p>B. Sodium voltage gated channels close;</p> <p>Potassium voltage gated channels open;</p> <p>Potassium diffuses out;</p> <p>Ref. to Sodium/potassium pumps;</p> <p>Repolarised;</p> <p>Max 3 for A or B.</p>	max 5
	(c)	<p>Any three from</p> <p>Myelin sheath electrical insulation;</p> <p>Ion exchange only at nodes of Ranvier/ depolarisation only at nodes;</p> <p>Action potential jumps from one node of Ranvier to next;</p> <p>Saltatory conduction;</p> <p>If no myelin sheath local circuits;</p> <p>Saltatory conduction much faster than local circuits;</p>	max 3
	(d)	<p>Increase:</p> <p>Mimic action of normal transmitters / bind to receptors;</p> <p>Prevent breakdown of transmitter;</p> <p>Stimulate release of transmitters;</p> <p>Reduce threshold for excitation of post synaptic membranes;</p> <p>Accept; more calcium ions diffuse in</p> <p>Decrease:</p> <p>Block receptors on post synaptic membrane;</p> <p>Prevent Ca²⁺ being released;</p> <p>Prevents exocytosis;</p> <p>Prevents recycling of neurotransmitter/ active transport back across presynaptic membrane;</p> <p>Raises threshold;</p> <p>changes shape of neurotransmitter;</p>	max 2
			max 2

Question 2 Total

[15]

3.

Question		Marking details	Marks Available	
3	(a)	X is the node of <u>Ranvier</u> ; Y is axon /axoplasm;	2	
	(b)	Schwann (cell);	1	
	(c)	-60 <u>mV</u> ;	1	
	(d)	(i)	(voltage-gated) sodium channels open/ increase in sodium ion permeability; {sodium ions / Na ⁺ } {diffuse/ flood/ rush/ sudden intux} <u>in</u> ;	2
		(ii)	repolarisation;	1
	(e)	resting potential is lower / more negative in {B/ the cardiac muscle fibre}/ ORA; slower repolarisation / time taken to get back to resting potential is longer in {B/ the cardiac muscle fibre}/ ORA; higher peak of depolarisation /more positive potential reached in {A/ neurone}/ ORA; {no hyperpolarisation/ refractory period/ undershoot;} in Trace B;	2 max	
	(f)	contraction; NOT contract faster	1	
(g)	Frog has right to life / {suffering/ pain/ distress/ harm} of frog / frogs scarce in the wild; NOT cruel benefits to <u>medicine/ health of heart</u> research,	2		
		Question 3 Total	[12]	

4.	Question	Marking details	Marks Available
3	(a)	milliVolts/mV; NOT microvolts milliseconds/msec/ ms;	2
	(b)	A Resting potential; B Depolarisation C Repolarisation; D Hyperpolarisation/ refractory ;	4
	(c)	(i) Threshold (potential);	1
		(ii) Failed to reach threshold potential; All or nothing response; -55; So (too few) sodium gates opened/not enough depolarisation;	max 2
		Question 3 Total	[9]

5.	Question			Marking details	Marks available					
	(a)	(i)			AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		Labelled Motor Neurone on ventral side and labelled sensory neurone on dorsal side (1) Labelled Cell body of sensory nerve in ganglion (1) Labelled cell Body of motor nerve in grey matter (1)	3			3		
		(ii)		Protective/prevents {damage/injury/harm} NO I defence mechanism	1			1		
	(b)	(i)		<u>Nerve net</u>	1			1		
		(ii)		Impulse must pass along whole length of {neurone/membrane/axon} (1) Mammals have {myelin/nodes} which cause {saltatory conduction/or description of} (1) ORA for non myelinated		2		2		
				Question 5 total	5	2	0	7	0	0

6.

Question		Marking details	Marks Available
6	(a)	<p>Any 5 from:</p> <ol style="list-style-type: none"> 1. Acetylcholine is normally hydrolysed / broken down by Acetyl Cholinesterase; 2. Organophosphates prevent the breakdown of acetylcholine; 3. So Acetylcholine remains bound to receptors on post-synaptic membrane; 4. So {synaptic transmission / action potentials} continue to be generated; 5. Sustained contraction of muscle; 6. Uncontrolled contractions of {diaphragm / intercostal muscles} interferes with breathing / OWTTE; 	5
	(b)	<p>Any 4 from:</p> <ol style="list-style-type: none"> 1. Some drugs prevent {synthesis / resynthesis} of neurotransmitter; 2. Blocking of {calcium ions / Ca^{2+}} uptake; 3. Some drugs inhibit {release / exocytosis} of neurotransmitters; 4. Some drugs block receptors in post-synaptic membrane preventing neurotransmitters binding to them; 5. Sodium ion channels change shape; 6. Faster reabsorption of neurotransmitter; 7. Hyperpolarisation of post-synaptic membrane; 8. Named example: Valium / Temazepam / benzodiazepines / beta-blockers / cannabis / alcohol; 	4
		Question 6 Total	[9]

7.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)	Both answers correct for 1 mark: I A and B II A, C and D	1			1		
		(ii)	hamstring has more synapses/ ORA (1) hamstring has more neurones/ ORA(1) Accept use of data if comparative/ or descriptions of neurones involved in both reflex arcs		2		2		
	(b)		A. Sodium ion (gated) channels open (1) B. Sodium ions {rush in/influx} (1) NOT into membrane C. Threshold {reached/exceeded} (1) D. Charge changes to become positive inside axon and negative outside axon/ correct references to suitable values (-70 and + 40 mV) (with units)/ depolarisation (1) MPs A and B in context of ions (does not need to appear in both)	4			4		
	(c)	(i)	Any two (x1) from: testing (significance_of) differences between {means/ sets of {continuous / normally distributed/ interval }}data(1) Chi squared used to test significance of differences in {discontinuous / nominal} data /can calculate expected value (1) T test there are no expected values/ chi squared has expected values (1)		2		2	2	
		(ii)	A. Critical value is 2.10 (1) NOT circled in table alone B. because t value is greater than critical value (at p=0.05)(1) C. reject null hypothesis (1) D. {results/ means } are significantly different(1) ECF MP b,c,d if incorrect critical value chosen			4	4	4	
			Question 7 total	5	4	4	13	6	0

8.

Question			Marking details	Marks Available
8	(a)		circle on diagram at +40; Action potential membrane depolarised / inside becomes +ve;	2
	(b)		Synaptic vesicles only on presynaptic membrane side of synapse; Refractory period / hyperpolarisation;	2
	(c)	(i)	Z = Schwann cell ; X = Axon / axoplasm; Y = myelin sheath / coiled membrane of Schwann cell;	3
		(ii)	Slow down; saltatory conduction would not take place / local circuit shortened;	2
	(d)	(i)	Any 3 from: Curare has a complementary shape binds to receptors on post synaptic membrane; prevents transmitter substance / acetylcholine binding; post synaptic membrane not depolarised / Na ⁺ ions do not move in / Na ⁺ gated channels remain closed / no action potential;	3
		(ii)	Different transmitter used to trigger contraction in heart / adrenalin used / heart is myogenic / AVP;	1
			Question 8 Total	[13]

9.

Question		Marking details			Marks Available
9					[4]
		<i>Statement</i>	<i>True</i>	<i>False</i>	
		Motor neurones have only a single dendrite.		✓	
		Motor neurones have many axons.		✓	
		Dendrites receive and integrate impulses.	✓		
		Dendrites of motor neurones are rarely myelinated.	✓		
Question 9 total				[4]	

- 10.
- (a) (rapid) reaction/ response to a stimulus; [1]
 automatic / involuntary / not under conscious control /
 brain not involved (not: cannot be controlled / automated without thinking) [1]
- (b) A – motor;
 B – relay / intermediate / connector;
 C – sensory
 (all three) [1]
- (c) (i) X – myelin sheath / Schwann cell
 Y – node of Ranvier [2]
- (d) (i) Na^+ or sodium ions are actively removed / pumped out /
 faster than K^+ ions are moved in; [1]
 K^+ or potassium ions diffuse out more rapidly than Na^+ /
 membrane has a higher permeability to K^+ than Na^+ . [1]
 or Na / K pumps 3Na^+ out and 2K^+ in = 2 marks
 (Ref. to ions needed at least once; 1 mark if no number)
- (ii) Sudden change /increase in the permeability of the membrane to Na^+ /
 sodium gates / channels open;
 sodium ions diffuse in or ref. concentration gradient
 (not: move in) [2]
- (e) (i) As the axon diameter increases the speed of conduction increases
 (ref. linear/proportional needs direction allow: positive correlation) [1]
- (ii) Speed of transmission (of the action potential) depends on [1]
 resistance (of axoplasm)
 (This resistance is related to the diameter of the axon). The greater /
 larger the diameter of the axon the less the resistance. [1]
- Or** increased diameter means increased surface area (of axon)
 over which exchange of ions can take place.
- (iii) ATP is required for active transport / ref Na/ K pumps;
 Na^+ ions (actively) moved out only at nodes in myelinated;
 Na^+ ions (actively) moved out along whole length of
 axon in non-myelinated. (Any 2) [2]

[Total 14 marks]

11. (a)	sensory neurone from <u>finger tip</u> , cell body in root ganglion;	1
	relay neurone in grey matter;	1
	<u>motor</u> neurone same side of arc through ventral root to muscle.	1
(b)	sensitivity of nerve membrane lost during depolarisation/refractory period;	1
	in synapses transmitter substances diffuse from knob to post synaptic membrane	1
(c) (i)	<u>general</u> shape of spike including overshoot dip. accurate values -70 to +40 or +50 mV (width c.3ms) (allow: 68-80 + 30-60)	2
	(ii) correct labelling of depolarisation on upward and repolarisation on downward side of graph	1
(d) (i)	I proteins	1
	II phospholipids	1
(ii)	Ref. to pumps e.g. resting potential – Na ⁺ /K ⁺ pump pumps Na ⁺ out and K ⁺ in;	1
	Ref. why difference between two sides e.g. organic anions inside create <u>pd</u> /K ⁺ channels open; less permeable to Na ⁺ (not: ref. concentration gradient)	1
	depolarisation - impulse opens Na ⁺ channel/voltage gated channel;	1
	Na ions rush in/sudden increase in permeability to Na ⁺	1
(e)	transmitter substances synthesised in synaptic knob; impulse causes secretory vesicle to migrate to (presynaptic) membrane/Ca ions to rush in; vesicle fuses with membrane discharges transmitter substance/exocytosis; diffusion of transmitter substance across cleft; <u>transmitter</u> binds to post-synaptic membrane/stimulates depolarisation/reference to receptors. (Any 3 in correct sequence; no mention of transmitter substance=2 max)	3

12. (a) (rapid) response to a stimulus;
automatic / involuntary / not under conscious control /

- (b) A – motor;
 B – relay / intermediate / connector;
 C – sensory. (all three) [1]
- (c) (i) X – myelin sheath
 Y – node of Ranvier [2]
- (d) (i) Na⁺ or sodium ions are actively removed / pumped out /
faster than K⁺ ions are moved in;
 K⁺ or potassium ions diffuse out more rapidly than Na⁺ /
membrane has a higher permeability to K⁺ than Na⁺.
 Na / K pump pumps 3Na⁺ out and 2K⁺ in = 2 marks
 (1 mark if no number)
- (ii) Sudden increase in the permeability of the membrane to Na⁺ /
sodium channels open; sodium diffuses in. [2]
- (e) (i) acts as a neurotransmitter / transmits impulse across synapse;
synaptic vesicles fuse with pre-synaptic membrane;
released acetylcholine diffuses across synaptic cleft;
attaches to receptor site on post-synaptic membrane;
sodium channels open and Na⁺ diffuse in;
membrane is depolarised;
action potential is generated. (any 5 points) [5]
- (ii) fewer branches in Alzheimer's patient / B;
shorter branches in Alzheimer's patient / B;
fewer synaptic knobs in Alzheimer's patient / B; [2]
- (iii) fewer knobs less enzyme (less acetylcholine synthesised) [1]

[Total 17 marks]

13.	Question	Marking details	Marks Available
13	(a)	(i) A + 40mV C - 70mV [both needed for 1 mark] (accept suitable alternatives eg., -60 / + 30)	1
		(ii) depolarisation Sodium / Na ⁺ (ion) channels open; Na ⁺ {flood / diffuse rapidly} into axon; (pd) inside axon becomes {positive/ +40}; repolarisation Na ⁺ (ion) channels close and K ⁺ (ion) channels open; K ⁺ {flood / diffuse rapidly} out of axon ; Must infer <u>sudden</u> movement out (pd) inside axon becomes {negative/ returns to-70};	max 2 max 2
		(iii) <u>threshold</u> potential not reached / all sub- <u>threshold</u> stimuli; stimulus / depolarisation not enough to open Na ⁺ (ion) channels; ref. to action potential being 'All or Nothing';	max 2
	(b)	(i) Myelin; Accept phospholipid	1
		(ii) Schwann cell;	1
		(iii) Accept annotation on diagram myelin inhibits{loss of charge/ movement of ions} (from axon) / insulates (axon)/ prevents depolarisation; {gaps/ spaces} (between Schwann cells) called nodes of Ranvier; no myelin present in {nodes/ gaps/ spaces}; depolarisation only possible at Nodes of Ranvier / action potential can only form {at the nodes/ where there is no myelin}/ channels can only {open/close} in the nodes; action potential jumps from one node to the next / saltatory conduction/ lengthens local circuits/ OWTTE; nerve impulse transmission faster;	max 4