Mark scheme - Neuronal Communication

Question			Answer/Indicative content	Marks	Guidance
1			A	1	
			Total	**1**	
2			A	1	
			Total	**1**	
3			D ✓	1	
			Total	**1**	
4			C ✓	1	**Examiner's Comments** Many candidates who noted that data from both pre and post-synaptic neurones had been included in the table and were able to apply their knowledge of membrane potentials to this information went on to choose C as the correct option.
			Total	**1**	
5			D ✓	1 (AO1.1)	
			Total	**1**	
6			B ✓	1 (AO2.5)	
			Total	**1**	
7			C ✓	1 (AO1.2)	
			Total	**1**	
8	a	i	action potential / nervous impulse, in sensory neurone ✓ synapse / described ✓ relay / intermediate, neurone ✓ (nervous impulse in) motor neurone, passes to / AW, effector / muscle ✓	3 max	

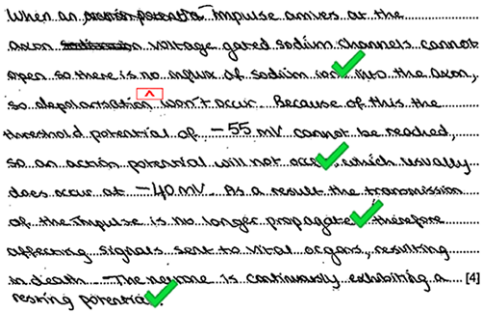
		ii	*idea of* maintains balance / efficiency of movement ✓	1	
		iii	kinetic / movement, energy converted ✓ to, electrical energy / action potential ✓ *idea of* movement of statolith moves sensory hairs ✓ membrane of sensory hairs depolarises ✓	3 max	
	b		*Support is weak because* *idea that* clasification based on phylogeny ✓ statocysts could, have evolved on more than one occasion / be an example of convergent evolution ✓	2	
			Total	**9**	
9		i	no, action potentials / (electrical) impulses (in response to acid stimulus) ✓ (along) sensory neurones / neurones to CNS ✓ (because) no / few, <u>voltage gated</u> (sodium) channels open ✓ less depolarisation (of receptor membrane) / fewer Na^+ ions move in ✓	2 max (AO3.1)	**ALLOW** fewer, action potentials / (electrical) impulses, generated **ALLOW** neurones to brain **IGNORE** fewer sodium ion channels opened **DO NOT ALLOW** no depolarisation / no Na^+ ions move in **<u>Examiner's Comments</u>** Candidates showed limited awareness of the difference between the initial generator potential depolarisation as a result of sodium ion entry through ligand-gated channels, and the all-or-nothing action potential depolarisation which relies on voltage-gated channels. Most scored at least one mark though for realising that the latter cannot open in the mole rat. Some answers referred to failure to send a signal or message rather than an action potential. A common error was to state that no sodium ions would enter, rather than fewer, or that no depolarisation would occur.

		ii	converts, chemical / stimulus, to action potential / electrical energy / electrical impulse ✓	1 (AO2.1)	**ALLOW** kinetic energy / pressure / temperature / mechanical energy / H^+ ions as examples of stimuli (as question states a pain receptor) **IGNORE** 'sensory information' / 'pain' **Examiner's Comments** This was generally well answered, with a number of candidates identifying the form of stimulus energy (mechanical or chemical for example) and stating that it was converted into electrical energy. Lower ability answers stated what a transducer is but did not apply this knowledge in the context of a pain receptor.
			Total	**3**	
10			D	1 (AO1.1)	
			Total	**1**	
11			C	1 (AO2.1)	
			Total	**1**	
12		i	motor neurone ✓	1	
		ii	saltatory conduction ✓ increases speed of, impulse / action potential, transmission ✓ insulates axon ✓	1 max	
			Total	**2**	
13		i	1. antigens on , neurones / nerve cell / Schwann cells / myelin sheath (activate immune system) ✓	**2**	**For mp 1,2,and 3**, **IGNORE** nerves **ACCEPT** oligodendrocytes / glial cells / cells in nervous system **ACCEPT** 'immune system fails to recognise antigens on , neurones / nerve cells / Schwann cells / myelin sheath , as self ' **ACCEPT** ' immune system recognises antigens on , neurones / nerve cells /

					Schwann cells / myelin sheath , as, foreign / non self '
			2. antibodies against , neurones / nerve cells / Schwann cells / myelin sheath (are produced)✓ 3. phagocytes / neutrophils / macrophages / T(killer) cells, attack / break down, neurones / nerve cells / Schwann cells / myelin sheath ✓		**IGNORE** T helper cells / T memory cells **IGNORE** 'kill' cells **Examiner's Comments** Successful candidates correctly used the key terms antigen and antibody and related their actions to the effects on nerve cells. The role of phagocytes, macrophages and T cells were frequently correctly stated. Candidates lost marks by failing to relate their answers to the nervous system instead giving a more general account of auto immune conditions. Weaker candidates were not specific enough in associating the correct part of the immune system with an attack on nerve cells. There was also confusion between the terms antigen and receptor.
		ii	fewer / damaged , Schwann cells ✓ no / less / incomplete / damaged, myelin (sheath) ✓ no saltatory conduction ✓	**2 max**	**IGNORE** no / dead, Schwann cells **ACCEPT** oligodendrocytes / glial cells **ACCEPT** less insulation (on neurone) **ACCEPT** description of lack of saltatory conduction e.g. action potential travels along whole axon membrane **IGNORE** ref to axon size **Examiner's Comments** Most candidates correctly identified that the Myelin sheath was missing or incomplete, and most could link this to a lack of saltatory conduction or fewer Schwann cells, to gain two marks.
			Total	**4**	
14			no nodes of Ranvier ✓ shorter local , currents / circuits ✓ whole axon needs to be depolarised ✓	1 max	**IGNORE** ref to jumping between nodes **ALLOW** more local currents / circuits **ALLOW** e.g. action potentials need to be generated all the way along the axon

					Examiner's Comments There were few correct responses for this part of the question which was assessing AO2 with many candidates referring to the impulse not being able to jump from node to node, which is a description of saltatory conduction already stated in the stem of the question. Good responses referred to the need for depolarisation to occur along the whole axon (membrane).
			Total	**1**	
15			B	1(AO2.6)	
			Total	**1**	
16			B	1(AO2.6)	
			Total	**1**	
17			***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication*	•	

			Statement have been missed. • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level*** **Level 3 (5-6 marks)** A comprehensive description of the differences between the two action potentials with some explanations for the differences. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3-4 marks)** A good description of some of the differences between the two action potentials with limited explanation. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1-2 marks)** A limited description of some of the differences between the two action potentials with an attempt at some explanation. *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.* **0 marks**	6	**Indicative scientific points may include:** *Descriptions* Dopamine neurone: • Is less polarised / has a less negative resting potential • Depolarisation shows less change • Action potential peak is lower/less positive • No clear refractory period • Action potential duration is longer • Repolarisation is slower *Explanations* Resting potential set up by: • Different type/number of sodium/potassium pumps in neuron membrane • Different type/number of potassium ion channels • Steeper sodium ion gradient in the Purkyne neurone • Steeper potassium ion gradient in the dopamine neurone • Different type/more voltage-gated sodium and potassium ion channels in the Purkyne neurone

			No response or no response worthy of credit.		
			Total	**6**	
18		i	sodium ions / Na ions / Na+ , cannot enter ✓ no / prevents , depolarisation of membrane ✓ (membrane) remains at resting potential ✓ prevents action potential being generated ✓ impulse not conducted (along axon) ✓ (so) no release of neurotransmitter ✓	4 max	**Award 3 max** if explanation refers to what would normally happen in neurone instead of in presence of TTX **DO NOT ALLOW** cannot enter membrane **ALLOW** sodium ions / Na ions / Na+ , stay outside **ALLOW** action potential for impulse **Examiner's Comments** Higher ability candidates were able to demonstrate understanding of the transmission of nerve impulses and the consequences of voltage-gated sodium ion channels being unable to open. Responses from lower ability candidates often lacked detail such as not stating that it is the axon **membrane** that is not depolarised. Some responses also showed confusion regarding the concepts. **Exemplar 5**  This exemplar shows an excellent response. The candidate uses terms correctly in applying their knowledge of nerve transmission to this novel context.
		ii		2 max	**Award 1 max if explanation refers to what would normally happen rather than if diaphragm is paralysed**

			diaphragm is paralysed so: no / little , change / increase , in volume of thorax ✓ no / little , change / decrease , in pressure in thorax ✓ no / little / less , air drawn into lungs ✓		**ALLOW** chest cavity / lungs for thorax throughout **IGNORE** oxygen **Examiner's Comments** Many good responses were seen where candidates gave concise descriptions for all marking points. Some candidates that did not achieve full marks were not specific enough in their statements or made reference to what normally happens during inspiration rather than what happens under the influence of TTX.
		iii	*suggestion:* slows / decreases , heart rate ✓ *explanation:* ***Any two from*** slows transmission of impulse from AVN to ventricles ✓ slows ventricular , systole / contraction ✓ longer delay before ventricular , systole / contraction , begins ✓ increases time (the heart is) in diastole / relaxation ✓	3 max	**ALLOW** bradycardia **ALLOW** prevents / stops for 'slows' for MP2 and MP3 'ventricular' must be mentioned once **Examiner's Comments** Many candidates gained credit for suggesting that ventricular systole would slow down which would lead to a decrease in heart rate. In good responses, candidates also suggested that there would be a longer delay between atrial and ventricular systole.
			Total	**9**	
19		i	can be used with , living cells / thick samples ✓ AVP ✓	1 max (AO2.3)	**Mark first response** e.g. high resolution e.g. can see distribution of molecules within cells e.g. can control depth of field e.g. sharper / less blurred image
		ii	***conclusion is valid because:*** **1** concentration of Ca^{2+} is proportional to strength of stimulus ✓ **2** Ca^{2+} change from low to ,	4 max (AO2.4) (AO3.2)	**ALLOW** calcium ions for Ca^{2+} throughout **DO NOT ALLOW** Ca^{+} / calcium but penalise once then ECF **ALLOW** reference to +40 mV as alternative to action potential throughout **IGNORE** ref to fluorescence / FURA-2

			medium / high , causes increase in (membrane) potential ✓ **3** action potential in , presynaptic neurone / synaptic bulb, leads to , opening of Ca^{2+} channels / entry of Ca^{2+} ✓ **4** Ca^{2+} , causes / AW , release of (named) neurotransmitter ✓ **5** (named) neurotransmitter causes , Na+ / sodium ion , channels to open in (post-synaptic) neurone ✓ **6** if threshold is exceeded this causes , action potential in (postsynaptic) neurone / depolarises (postsynaptic) membrane ✓ ***conclusion may not be valid because:*** **7** changes in Ca^{2+} concentration may not be the cause of (postsynaptic) action potential ✓ **8** Ca^{2+} change from medium to high but no change in (membrane) potential ✓		**MP 1 ALLOW e.g.** the greater the strength of stimulus the greater the Ca^{2+} concentration **MP2 ALLOW** figs go from -60 to +40mV **MP8 ALLOW** figs stay at + 40mV
			Total	**5**	