

1. Parkinson's is a neurological disorder that affects one in 500 people in the UK. **Table 8.1** lists some of the drugs available to treat Parkinson's.

Drug	Short-term effectiveness	Long-term effectiveness	Short-term side effects	Long-term side effects
Levodopa	Controls symptoms, especially late-stage symptoms	Can become less effective	Nausea, joint stiffness	Can cause a serious movement disorder called dyskinesia
Procyclidine	Relatively effective at improving early, mild symptoms such as tremors	Ineffective for symptoms such as slowness and stiffness	Possible confusion and blurred vision	Possible memory loss in older patients; can reduce the effectiveness of levodopa
Dopamine agonists	Delays and manages symptoms but less effective than levodopa	Relatively ineffective at controlling late-stage symptoms	Drowsiness, nausea	Drowsiness, nausea
Entacapone	Improves the effectiveness of levodopa	Improves the effectiveness of levodopa	Can worsen the effects of dyskinesia	Worsens dyskinesia, but this effect reduces over time

**Table 8.1**

- (i) A doctor will often decide on a 10-year treatment plan for a person who has been diagnosed with early-stage Parkinson's.

Suggest the best drugs to include in a long-term, 10-year plan, based on the evidence in **Table 8.1**.

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**[3]**

(ii) People with Parkinson's produce lower levels of the neurotransmitter dopamine.

Dopamine can act as either an excitatory or an inhibitory neurotransmitter.

Describe how dopamine can produce an excitatory post-synaptic potential.

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[2]

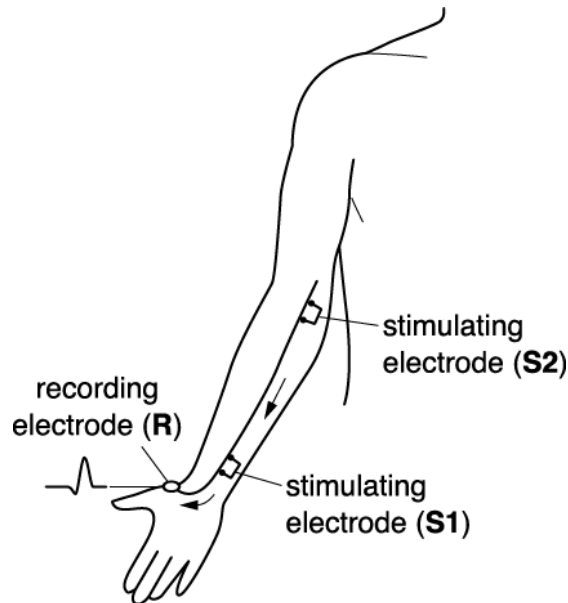
2(a). Muscle fibres must be stimulated by a motor neurone before they contract.

What **type** of motor neurone stimulates contraction in a skeletal muscle?

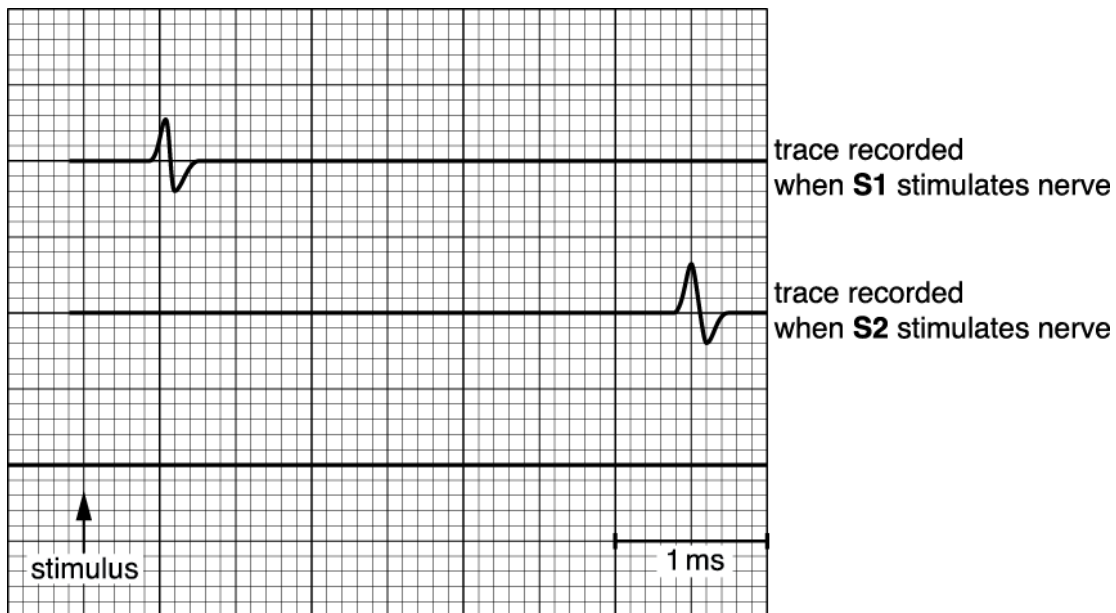
[1]

(b). A nerve conduction velocity (NCV) test can be carried out to measure the speed of conduction of a nerve impulse.

An NCV test on a nerve in the arm is shown in the following figure.



- Two stimulating electrodes (S1 and S2) are attached to the skin above the nerve.
- The distance (D) between the stimulating electrodes is measured.
- The first electrode (S1) stimulates the nerve and the resulting electrical response is recorded by the recording electrode (R).
- The second electrode (S2) stimulates the nerve and the electrical response is also recorded by R.
- An NCV trace is obtained, such as that shown in the following graph.



(i) The nerve conduction velocity (NCV) is calculated using the formula:

$$NCV = \frac{D}{T_{S2} - T_{S1}}$$

Where:

$D$  is the distance between the stimulating electrodes

$T_{S1}$  is the time taken between the stimulus given at  $S1$  and the wave recorded at  $R$

$T_{S2}$  is the time taken between the stimulus given at  $S2$  and the wave recorded at  $R$ .

Calculate the nerve conduction velocity, assuming  $D$  is 20 cm.

Show your working. Give your answer to the nearest whole number.

Answer ..... mm ms<sup>-1</sup> [2]

(ii) Suggest how a stimulus initiates an action potential in a motor neurone and explain how the action potential is transmitted.



In your answer, you should refer to both the initiation and the transmission of the action potential.

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[7]

(iii) NCV tests carried out on newborn babies give values that are only half of those found in adults.

Suggest a reason for this observation.

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[1]

(c). The conduction velocity in neurones is thought to decrease as a person ages.

In a study of the effect of ageing on **sensory** neurones, NCV tests were carried out on 1000 people. The test was repeated five years later on 500 people from the original group. Two different nerves were tested on both arms for each subject.

The following controls were in place during the study:

- the temperature of the skin surface was kept at 32°C
- subjects diagnosed with diabetes mellitus were excluded from the study.

(i) Explain why it was important to keep skin temperature constant **and** suggest why a temperature of 37°C was **not** selected.

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(ii) Suggest a reason why subjects with diabetes mellitus were excluded from this study.

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----- [1]

(iii) The results from the NCV study are given in the table.

Nerve tested	Mean velocity change after 5 years ( $\text{ms}^{-1}$ )	Probability (P-value)	Confidence limits ( $\text{ms}^{-1}$ )
Nerve 1	-1.1	$p < 0.0001$	-1.49, - 0.62
Nerve 2	- 0.7	$p = 0.002$	-1.15, -0.27

What **two** conclusions about conduction velocity in neurones can be drawn from **all** the information shown in the table?

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3(a). MRI scans have been used to investigate the structure and function of the human brain.

Scans are essential when health professionals suspect that a stroke has occurred.

Fig. 1.1 is an MRI scan of the brain.



Fig. 1.1

Identify the following structures labelled on Fig. 1.1.

Letter	Name of structure
B	
C	

[2]

(b). Mrs G, a 72-year-old pensioner, collapsed while out shopping and an ambulance was called. The paramedics suspected a stroke and this was later confirmed at the hospital by a doctor. The doctor in Accident and Emergency based his diagnosis on a number of observations including the following:

- non-normal response to a reflex test on the foot (the plantar reflex)
- muscular weakness, decreased touch sensation and reduced awareness on the right side of the body
- mild confusion and slurring of speech.

(i) State what is meant by a 'reflex test' and give one example of a reflex test other than the plantar reflex.

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[3]

(ii) Using the doctor's observations, suggest which part of the brain has been affected by the stroke.

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[1]



- (c). Following several days on the specialist stroke ward, Mrs G was recovering well but appeared to have some problems with her short-term memory.

She was transferred to a rehabilitation unit where health professionals started a programme to improve her independence.

- (i) Outline what is meant by 'short-term memory loss'.

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- (ii) Suggest **two** different techniques that may be used to improve short-term memory in stroke patients.

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4. Hot flushes are one of the symptoms associated with the menopause. These symptoms are thought to be linked to falling oestrogen levels.

Low levels of oestrogen are thought to disrupt the thermoregulatory centre in the brain.

Name the part of the nervous system which includes the brain **and** state the exact location of the thermoregulatory centre.

Part of nervous system

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Exact location

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[1]

5(a). The autonomic nervous system plays an important role in homeostasis.

The box below contains some terms that could be used to describe the features or activity of the two branches of the autonomic nervous system.

acetylcholine    adrenaline    decrease    glycogenesis

glycogenolysis    increase    noradrenaline    motor    sensory

Complete Table 1.1 below by inserting the most appropriate term.

Terms may be used once, more than once or not at all.

Some boxes have been completed for you.

Feature or activity	Branch of autonomic nervous system	
	Parasympathetic	Sympathetic
Type of neurone	motor	
Process triggered in liver cells		
Effect on heart rate		
Neurotransmitter released at the SAN		noradrenaline

Table 1.1

[4]

(b). Re-warming by inhaling warmed air is also known as **core re-warming**. Fig. 1.2 shows the route taken by the warm air as it is inhaled by the person.

**Key:**

→ direction of warm air movement

➔ direction of heat transfer

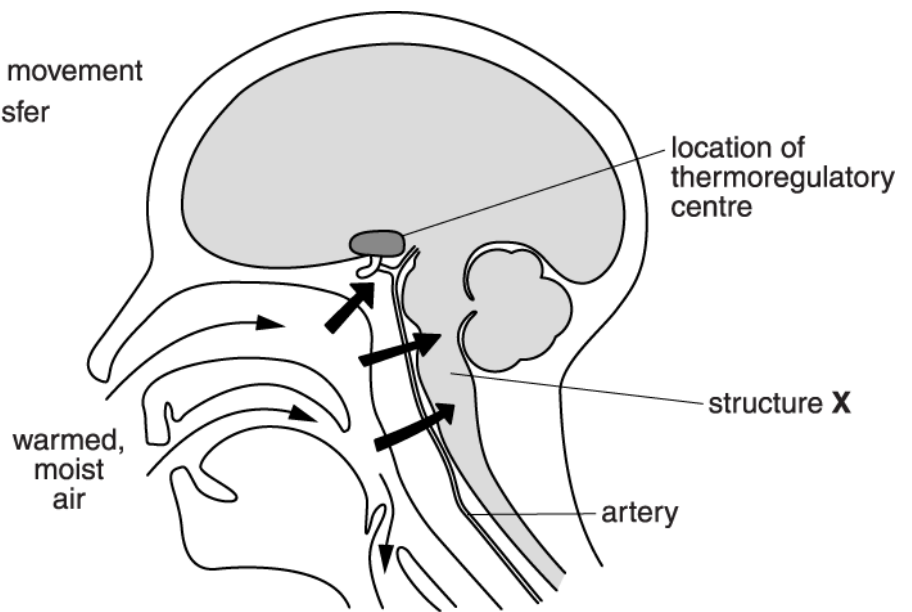


Fig. 1.2

(i) Name the part of the brain in which the thermoregulatory centre is located.

----- [1]

(ii) Identify structure X.

----- [1]

(iii) Using the information in Fig. 1.2, suggest why core re-warming is better than other methods of re-warming at treating severe hypothermia.

In your answer, you should refer to the symptoms of **severe** hypothermia.

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6(a). **GABA** (gamma-aminobutyric acid) is one of the most common neurotransmitters in the human central nervous system.

GABA is synthesised from the amino acid glutamate.

GABA acts as an **inhibitory neurotransmitter**.

When GABA binds to its receptor, a chloride ion channel is opened and chloride ions ( $Cl^-$ ) enter the neurone.

Fig. 3.2 represents two neurones forming synapses with a third neurone.

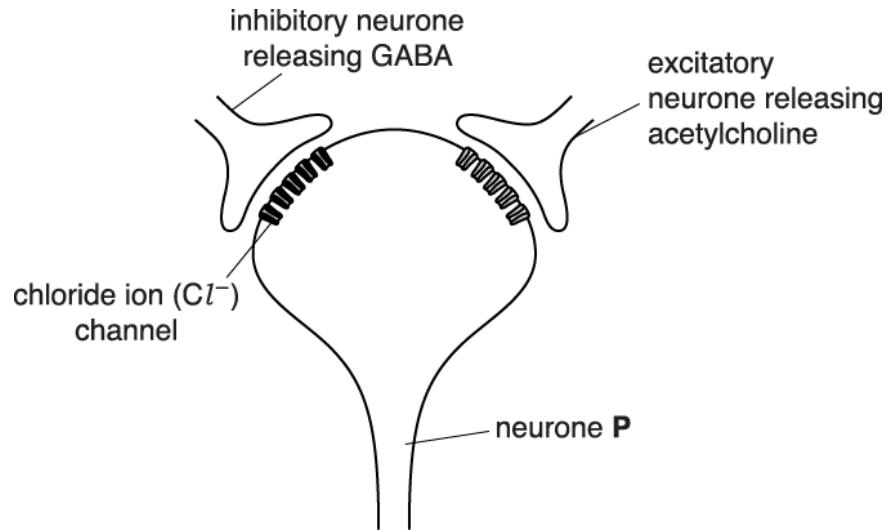


Fig. 3.2

Suggest how GABA is released from the inhibitory neurone and, using the information in Fig. 3.2, explain why an action potential may not occur in neurone P if both GABA and acetylcholine are released.



*In your answer, you should make clear both the sequence of events in the release of the neurotransmitter and why an action potential could be prevented by GABA.*

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[6]

(b). GABA is the neurotransmitter in the parts of the brain responsible for sensations such as fear and anxiety. These sensations result from neurones becoming **over-stimulated**.

Diazepam is a drug which is often prescribed to reduce anxiety. This drug can also be used to reduce alcohol withdrawal symptoms and muscle spasms.

(i) State **two** symptoms of alcohol withdrawal **other than** anxiety.

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[1]

(ii) Name **one other** condition for which Diazepam could be used therapeutically.

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[1]

7(a).

There is evidence that heart rate increases when people experience pain. Heart rate is one physiological factor that is regulated tightly and kept within narrow limits.

(i) Name the process by which the internal environment of an organism is kept within narrow limits.

----- [1]

(ii) A student made the following revision notes about the control of heart rate.

Complete the student's notes using the most appropriate word(s).

'The resting heart rate of an adult human is about 70 beats per minute. This is known as the set point. There are two types of receptor that control heart rate: \_\_\_\_\_ in the walls of the carotid artery that detect changes in blood pH and pressure receptors in the carotid artery and the aorta. When blood pressure rises, pressure receptors transmit nervous impulses to the \_\_\_\_\_ which decreases heart rate via the \_\_\_\_\_ nervous system. This is an example of \_\_\_\_\_.'

[4]

(iii) Some doctors who study pain ask patients to give an estimate of the level of their pain by using a scale of 1 to 10.

Explain why some researchers think that measuring heart rate is a more accurate way of determining the level of pain.

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(b). Neuropathic pain is a type of pain caused by neurones malfunctioning following nerve damage. When this happens, some voltage-gated sodium ion channels (VGSCs) in pain receptors open spontaneously.

(i) Explain how the spontaneous opening of a VGSC in a pain receptor leads to the generation of a nerve impulse in the sensory neurone attached to the pain receptor.

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[3]

(ii) Three different types of VGSC in different parts of the nervous system have been linked to neuropathic pain. Drugs to treat neuropathic pain are now being developed that specifically block these types of VGSC.

Suggest why it is important to develop drugs that only block these three types of VGSC.

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[2]

8(a). (See insert for H42202, June 2018)

This question is based on the Advance Notice article **SPINAL CORD INJURIES: HOW COULD STEM CELLS HELP?**, which is an insert.

The spinal cord contains both motor and sensory neurones.

(i) State one similarity and one difference between the structure of motor and sensory neurones.

similarity -----  
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difference -----  
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[2]

(ii) Explain why a spinal cord injury (SCI) causes both paralysis **and** loss of feeling below the site of the injury.

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(iii) Describe the role of the myelin sheath in the propagation of nerve impulses.

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(iv) The Advance Notice discusses oligodendrocytes, which are cells found only in the central nervous system (CNS).

State the name of the cells that perform a function equivalent to oligodendrocytes in the peripheral nervous system.

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(b). Treatment of injuries to the spinal cord, including with stem cell therapy, requires surgeons to determine the exact location and extent of the injury.

(i) State the name of an imaging technique that could be used for this purpose.

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(ii) Describe how the technique you have given in (i) can be used to help surgeons to assess the location and extent of injury.

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(c). The Advance Notice article describes several types of stem cell.

Stem cells can be classified as totipotent, pluripotent, and multipotent.

Suggest which of these types of stem cell have been used in the clinical trials described in the Advance Notice. Give reasons for your choice.

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[3]

(d). \* Using information from the Advance Notice, evaluate the risks, benefits and ethical issues related to the use of stem cells in the treatment of spinal cord injury (SCI).

*In your answer, you should demonstrate an understanding of the current and future potential of stem cell therapy.*

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### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	<p><b>Any 3 from:</b>  <i>Idea that</i> levodopa is used, late in treatment plan / when symptoms become worse  <b>OR</b>                      dosage of levodopa increased over time</p> <p>to delay / AW, onset of dyskinesia                      procyclidine / dopamine agonists, given in early stages  <i>idea of use of</i> entacapone in late stages (with levodopa) needs to be monitored (to avoid worsening dyskinesia)</p>	3	
		ii	<p><b>Any 2 from:</b>                      binds / attaches, to receptor on postsynaptic, membrane / neurone                      sodium channels open                      sodium, moves / diffuses, into postsynaptic neurone</p>	2	
			<b>Total</b>	<b>5</b>	
2	a		somatic (motor neurone);	1	<p><b>ACCEPT</b> voluntary  <b>DO NOT CREDIT</b> sympathetic</p> <p><b>Examiner's Comments</b></p> <p>Again, this proved to be a challenging question overall. It was surprising how many candidates gave answers such as 'sensory' or even 'relay' with 'peripheral' being another common incorrect answer. The learning outcome on the autonomic nervous system had been tested several times previous but Centres are advised to stress that these motor neurones are also peripheral.</p>
	b	i	57 / 58 $\text{mms}^{-1}$ ;;	2	<p><b>Correct answer = 2 marks</b></p> <p>If answer is incorrect, look for <b>200 / 3.5 OR 20/3.5 = 1 mark</b></p> <p><b>6 = 1 mark</b> (they have calculated (5.7) correctly but not converted cm to mm)</p> <p><b>CREDIT 1 mark</b> for an error carried forward for <math>200 \div x</math> (any number) if answer is correct and a whole number</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	<p>1. (voltage gated) sodium (ion) channels open;</p> <p>2. sodium ions / diffuse in / rush in;</p> <p>3. (membrane becomes) depolarised / AW;</p> <p>4. <i>idea of</i> local circuits, ahead (and behind) the active zone;</p> <p>5. (circuit due to) sideways movement of sodium ions;</p> <p>6. Ref to (circuit / sodium ion movement) depolarisation / AW, of next region / node;</p> <p>7. Ref to hyperpolarisation of, previous region / previous node;</p> <p>8. ref to saltatory conduction / described;</p> <p>9. ion movement (only) at nodes of Ranvier / myelin sheath insulates between nodes;</p>	6 max	<p>1. <b>DO NOT CREDIT</b> in context of acetylcholine  <b>CREDIT</b> Na<sup>+</sup> enters down a concentration gradient  <b>ACCEPT</b> influx of sodium ions</p> <p>3. <b>CREDIT</b> a description e.g. + 40mv  <b>IGNORE</b> 'neurone' or 'cell' in this context</p> <p>4. <b>ACCEPT</b> alternative wording e.g. local currents</p> <p>7. <b>CREDIT</b> ref to refractory period in previous region</p>
	ii	QWC;	1	AWARD any two mark points from 4, 5, 6 or 7

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>iii</p> <p><i>idea that</i> myelin sheath is not present at birth  <b>OR</b>                      myelin sheath takes time to develop;</p> <p>AVP;</p>	1	<p><b>DO NOT CREDIT</b> reference to nervous system not being fully developed</p> <p><b>IGNORE</b> reference to shorter axons / neurones e.g. ref to neurones having a smaller diameter</p> <p><b>Examiner's Comments</b></p> <p>Calculations such as that in (i) have not been asked before and it was pleasing to see how many candidates grasped the principle. The commonest answer was '6' where candidates had not converted their measurements to mm but had followed the rubric and given a whole number for their answer and this gained a mark. Part (ii) was not answered well with many candidates who referred to transmission between neurones rather than the transmission of an impulse within a neurone. The synapse is clearly taught well in Centres and candidates were anxious to display their knowledge but answers written in terms of synaptic transmission did not allow candidates to access the full mark range. The use of the word 'stimulus' in the question prompted some candidates to answer in terms of the reflex arc. Even answers which scored full marks struggled to explain how action potentials are propagated and, although many candidates wrote that the refractory period ensures a single direction of travel, few went on to explain how or why that is the case. A common mistake was candidates referring to sodium ions diffusing into the axon membrane. While lack of myelination was the most common correct answer to (iii), it was pleasing to see answers referring to small axon diameters. However, many candidates simply referred to babies being smaller or axons being shorter despite having calculated an NCV at the beginning of the question.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c i	<p><i>Idea that</i> higher temperatures would give faster, conduction / impulses / diffusion  <b>OR</b>                      lower temperatures would give slower, conduction / impulses / diffusion of ions;</p> <p>(not 37°C)  <i>idea that</i> peripheral/skin temperature will be lower than 37°C  <b>OR</b>                      37°C is the, core body temperature / AW  <b>OR</b>                      AVP;</p>	2	<p><b>IGNORE</b> reference to controlling a variable as this is given in the question</p> <p><b>IGNORE</b> reference to high temperatures denaturing proteins (in this context)</p> <p>e.g. 37°C could cause sweating (which could interfere with the readings)</p>
	ii	<p><i>idea that</i> diabetes / high blood glucose leads to damaged neurones /nerves;</p> <p>AVP;</p>	1	<p><b>CREDIT</b> <i>idea of</i> damage to receptors e.g. reduced sensitivity  <b>CREDIT</b> <i>idea of</i> damage to Schwann cells or myelin sheath or reduction in myelination</p> <p>e.g. medication taken could interfere with the results  <b>OR</b> low blood sugar / hypoglycaemia slows impulses</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	iii	<p><i>idea that</i> Conduction velocity slows, (significantly) / AW (over 5 years);</p> <p><i>idea that</i> (means) not all neurones change at the same rate <b>OR</b> (confidence limits) changes within the same nerve varies within populations;</p>	2	<p><b>CREDIT</b> answers in either order</p> <p><b>ACCEPT</b> reference to age slowing transmission in neurones (without further qualification).</p> <p><b>DO NOT CREDIT</b> references to either nerve being faster or slower (since the data is about change in velocity)</p> <p><b>ACCEPT</b> nerve 1 changes more than nerve 2</p> <p><b>Examiner's Comments</b></p> <p>In (i), although many candidates could explain that 37°C was core body temperature and that the skin would be cooler, too many wrote in very general terms about why it needed to be controlled. The fact that a variable has been controlled is because it would otherwise invalidate the investigation - but that statement applies to any variable. The question referred specifically to temperature and correct answers referred to higher temperatures speeding up the nerve impulse or the diffusion of ions across the axon membrane. Part (ii) proved to be a challenge and, although many candidates were able to refer to neurone damage, several candidates referred to high blood sugar resulting in the production of too much ATP. This misconception has appeared before. Part (iii) again proved a challenging question with too many candidates focussing on the statistics rather than the question which asked for conclusions about nerve conduction velocity. Good candidates spotted that velocity declined in both neurones but not all neurones declined to the same extent, while weaker candidates answered in terms of one nerve being faster than the other.</p>
		<b>Total</b>	<b>16</b>	



### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
3	a	<p>B cerebellum;</p> <p>C medulla (oblongata);</p>	2	<p><b>Mark the first answer in each box.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = <b>0 marks</b></p> <p><b>ACCEPT</b> 'brain stem / hind brain'</p> <p><b>Examiner's Comments</b></p> <p>This was accessibly to most candidates with the commonest mistake being to confuse the spinal cord with the medulla or to confuse the cerebellum with the cerebrum. Phonetic spellings were accepted but these had to be unambiguous.</p>
	b	i	3	<p>e.g. a stereotypical or unlearned or involuntary response or look for the idea that the response has a form that is always predictable</p> <p>e.g. light shone in eye, striking the patellar tendon</p> <p><b>IGNORE</b> a general description of a reflex arc which is not in the context of <i>testing</i> a reflex</p> <p><b>Examiner's Comments</b></p> <p>In (i) a surprising number of candidates stated that reflex tests were assessing the autonomic nervous system – a mix-up between the terms automatic and autonomic. Some candidates confused reflex tests with Nerve Conduction Velocity testing.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	(left) cerebral hemisphere / (left side of) cerebrum / (left) frontal lobe / Broca's area;	1	<p><b>ACCEPT</b> '(left side of) A' '(left side of) fore brain'</p> <p><b>IGNORE</b> left side of brain / left side unqualified  <b>IGNORE</b> parietal lobe</p> <p><b>Examiner's Comments</b></p> <p>Part (ii) was an AO2 question testing the candidates' knowledge of the functions of different parts of the brain. The commonest incorrect answer was cerebellum with other answers such as 'cortex' or 'left side' failing to score as they were too imprecise.</p> <p>Most candidates stated that plasmin was an enzyme but very few could state that it was fibrin that was broken down. A common misconception was that the blood clot fitted into the active site of the enzyme indicating a failure to grasp the relative sizes of cells and molecules which has been an issues in previous exam sessions.</p>
c	i	<i>idea that</i> unable to remember what, has just happened / is currently happening;	1	<p><b>CREDIT</b> a description such as 'can't remember things from a few days ago'</p> <p><b>Examiner's Comments</b></p> <p>Part (i) was an example where candidates inability to express themselves well led to a mark being lost. Some candidates misinterpreted the 'short term' idea as a memory loss which was only temporary and which would be restored in the near future. Most candidates were able to suggest two techniques although vague description such as 'play games' were not credited. It was gratifying to see responses which referred to cognitive therapy and to the 'loci' method where patients link events or people to specific objects.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	<p>have a calendar so patient can keep track of days;</p> <p>leave reminder notes around;</p> <p>place a selection of objects on a tray, cover them and ask them to remember;</p> <p>show patient recent photos to remember people / photos of current celebrities from magazines / AW;</p> <p>repetition of activities;</p> <p>AVP;</p>	2	<p><b>ACCEPT</b> <i>idea of 'cues' or 'prompts'</i></p> <p><b>ACCEPT</b> Kim's game or a similar memory game described</p> <p><b>CREDIT ONCE ONLY</b> references to showing photos or images as the question asks for different techniques</p>
		<b>Total</b>	<b>9</b>	
4		<p><i>part of nervous system</i></p> <p>central / CNS</p> <p><b>AND</b></p> <p><i>exact location</i></p> <p>hypothalamus; ✓</p>	1	<p><b>Both</b> correct answers required for the mark</p> <p><b><u>Examiner's Comments</u></b></p> <p>The commonest incorrect responses were spinal cord or autonomic.</p>
		<b>Total</b>	<b>1</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance																	
5	a	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="text-align: left; vertical-align: top;"><i>Feature or activity</i></th> <th colspan="2" style="text-align: center;"><i>Branch of autonomic nervous system</i></th> </tr> <tr> <th style="text-align: center;"><i>Parasympathetic</i></th> <th style="text-align: center;"><i>Sympathetic</i></th> </tr> </thead> <tbody> <tr> <td style="text-align: left;"><i>Type of neurone</i></td> <td style="background-color: #cccccc;"></td> <td style="text-align: center;">motor</td> </tr> <tr> <td style="text-align: left;"><i>Process triggered in liver cells</i></td> <td style="text-align: center;"><u>glycogenesis</u></td> <td style="text-align: center;"><u>glycogenolysis</u></td> </tr> <tr> <td style="text-align: left;"><i>Effect on heart rate</i></td> <td style="text-align: center;">decrease</td> <td style="text-align: center;">increase</td> </tr> <tr> <td style="text-align: left;"><i>Neurotransmitter released at the SAN</i></td> <td style="text-align: center;"><u>acetylcholine</u></td> <td style="background-color: #cccccc;"></td> </tr> </tbody> </table>	<i>Feature or activity</i>	<i>Branch of autonomic nervous system</i>		<i>Parasympathetic</i>	<i>Sympathetic</i>	<i>Type of neurone</i>		motor	<i>Process triggered in liver cells</i>	<u>glycogenesis</u>	<u>glycogenolysis</u>	<i>Effect on heart rate</i>	decrease	increase	<i>Neurotransmitter released at the SAN</i>	<u>acetylcholine</u>		4	<p><b>DO NOT CREDIT</b> incorrect spelling of underlined terms since these have been provided</p> <p><b>Examiner's Comments</b></p> <p>The commonest mistake was to assume that, as motor was given for the parasympathetic then the sympathetic neurone must be sensory. As in previous sessions, candidates still confuse the terms glycogenesis and glycogenolysis.</p>
<i>Feature or activity</i>	<i>Branch of autonomic nervous system</i>																				
	<i>Parasympathetic</i>	<i>Sympathetic</i>																			
<i>Type of neurone</i>		motor																			
<i>Process triggered in liver cells</i>	<u>glycogenesis</u>	<u>glycogenolysis</u>																			
<i>Effect on heart rate</i>	decrease	increase																			
<i>Neurotransmitter released at the SAN</i>	<u>acetylcholine</u>																				
	b	i	hypothalamus;	1	<p><b>ACCEPT</b> phonetic spelling</p> <p><b>Examiner's Comments</b></p> <p>Answered well.</p>																
		ii	medulla (oblongata);	1	<p><b>ACCEPT</b> phonetic spelling</p> <p><b>Examiner's Comments</b></p> <p>Answered well although some candidates mistook the medulla for the spinal cord.</p>																
		iii	<b>two</b> symptoms of hypothermia;	1	<p><b>CREDIT</b> any <b>two</b> of the following symptoms for <b>one</b> mark:</p> <p>stops shivering little or no breathing            weak/irregular/no pulse difficulty speaking            poor coordination / laboured movement            confusion</p>																

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	iii	<p><i>core rewarming</i> temperature of, medulla (oblongata) / X, restored (rapidly) <b>and</b> <i>idea that</i> heart rate / pulse rate, is controlled (by medulla);</p> <p>temperature of, medulla (oblongata) / X, restored (rapidly) <b>and</b> <i>idea that</i> breathing rate, is controlled (by medulla);</p> <p>cerebrum temperature is restored <b>and</b> speech controlled (by cerebrum); cerebrum temperature is restored <b>and</b> cognitive function controlled (by cerebrum);</p> <p>temperature of, medulla (oblongata) / X, restored (rapidly) <b>and</b> shivering, is controlled by autonomic nervous system (in medulla);</p> <p>cerebellum temperature is restored (faster) and movement coordination, restored / AW;</p>	2	<p><b>LOOK FOR</b> a link made from a symptom to restoring the temperature in the part of the brain responsible for that activity for the remaining two marks.</p> <p><b>ACCEPT</b> ref to frontal lobe, motor cortex</p> <p><b>ACCEPT</b> reference to muscles being coordinated by the cerebellum for this mark <b>ACCEPT</b> movement becomes less laboured</p> <p><b>IGNORE</b> unconscious</p> <p><b>Examiner's Comments</b></p> <p>In (iii) the arrows on the diagram were indicating several areas of the brain. By requesting candidates to list the symptoms of severe hypothermia and then referring to Fig. 1.2 as directed, good candidates linked the symptoms to the relevant control area in the brain being warmed. Weaker candidates were mostly able to list symptoms but then failed to take any account of the diagram.</p>
		<b>Total</b>	<b>9</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
6	a	<p>1 nerve impulse / action potential, causes, influx / AW, of calcium ions / <math>\text{Ca}^{2+}</math> (into pre-synaptic / inhibitory neurone);</p> <p>2 (causes) vesicles to fuse / AW, with the pre-synaptic membrane and release GABA;</p> <p>3 GABA diffuses across the synaptic cleft;</p> <p>4 binds to (complementary) receptors on, post - synaptic neurone (membrane) / neurone P (membrane);</p> <p>5 <i>idea that</i> influx / AW, of chloride (ions) makes, the post synaptic neurone / neurone P, more negative / hyperpolarised;</p> <p>6 <i>idea that</i> (not enough sodium ions can enter so) the threshold potential not reached;</p>	5	<p><b>DO NOT CREDIT</b> 'Calcium' or <math>\text{Ca}^{+}</math> but penalise <b>ONCE</b> only</p> <p><b>ACCEPT</b> 'calcium enters' if calcium ion channels have been referred to</p> <p><b>ACCEPT</b> a clear implication of inhibitory neurone</p> <p><b>2. CREDIT</b> exocytosis of GABA</p> <p><b>CREDIT</b> 'chloride ion channel' for receptor</p> <p><b>ACCEPT</b> lower for negative</p> <p><b>ACCEPT</b> a suitable value for threshold</p>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
		1	<p>mp 1,2 in that order plus mp 5 or mp 6</p> <p><b>Examiner's Comments</b></p> <p>This question was split into two parts. Many candidates successfully described the sequence of events at the GABA synapse although some stated that it was the influx of chloride ions that was responsible for exocytosis. Weaker candidates made the same mistake seen in previous sessions when this topic was tested and implied that it is the vesicle that is released and diffuses across the synapse with some referring to seminal vesicles. Many candidates struggled with the second part of the question. Some answered in terms of competitive binding by GABA on acetylcholine binding sites despite information on how GABA affects the post-synaptic chloride ion channels. Some answered in terms of GABA or acetylcholine entering the post-synaptic neurone. Several candidates attempted to answer in terms of the effects of more negative ions inside the post-synaptic neurone but contradicted themselves by using the term hyperpolarisation when they meant depolarisation. However, there were some excellent responses where candidates explained that hyperpolarisation due to chloride ions meant the influx of sodium ions would be insufficient to achieve a threshold potential.</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	<p><i>any two from:</i></p> <ul style="list-style-type: none"> <li>restlessness / involuntary movements / twitching /shaking</li> <li>muscle / bone pain</li> <li>diarrhoea</li> <li>vomiting</li> <li>sweating / fever</li> <li>irritability / anger / aggression</li> <li>increased heart rate</li> <li>confusion</li> <li>hallucinations</li> <li>depression</li> <li>seizures</li> <li>headache</li> <li>insomnia</li> <li>fatigue</li> <li>mood swings</li> </ul>	1	<p>Mark the first answer on each line</p> <p>ACCEPT alternative correct symptoms</p>
		ii	Parkinson's (disease);	1	<p>CREDIT Tetanus, Meniere's disease, Multiple sclerosis</p> <p>IGNORE anxiety</p> <p><b>Examiner's Comments</b></p> <p>(i) and (ii) were done well - an extensive list of symptoms was credited in part (i) and answers which were 'off spec' but correct were credited in part (ii).</p>
			<b>Total</b>	<b>8</b>	



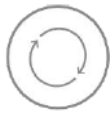
### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a	i	homeostasis ✓	1	<p>IGNORE negative feedback</p> <p><b>Examiner's Comments</b> Most candidates achieved the mark for (a)(i) although a minority of candidates wrote negative feedback.</p>
		ii	<p><u>chemoreceptors</u> ✓</p> <p><u>medulla oblongata</u> ✓</p> <p><u>parasympathetic</u> ✓</p> <p>negative feedback ✓</p>	4	<p><b>Examiner's Comments</b> For (a)(ii), more able candidates answered all omissions with the detail required. Many candidates wrote autonomic for parasympathetic and medulla for medulla oblongata. Candidates could be reminded of the origins of some words / prefixes to help them realise that abbreviations or omissions would not be sufficient, e.g. Latin 'medulla' meaning 'middle region of an organ'.</p>
		iii	<p>an objective / quantitative measurement OR level of pain is (too) subjective ✓</p> <p><i>idea that</i> heart rate is controlled by the autonomic nervous system ✓</p>	1	<p><b>Examiner's Comments</b> Most candidates achieved the mark for (a)(iii) with a good description of the subjectivity of the level of pain. A few candidates merely described the correlation of heart rate to pain without discussing the relevance of using this technique compared to another.</p>
	b	i	<p>(opening of VGSC leads to) Na<sup>+</sup> / sodium ions, entering, cell / neurone / receptor ✓</p> <p>(leads to production of) generator potential ✓</p> <p>(if potential) exceeds the threshold value / reaches -50mV ✓</p> <p>positive feedback / more VGSCs open ✓</p> <p>(this) creates an <u>action potential</u> ✓</p>	3 max	<p><b>DO NOT ALLOW</b> Na<sup>+</sup> / sodium ions, entering membrane</p> <p><b>Examiner's Comments</b> Although candidates described the influx of sodium ions in their responses to (b)(i), they often did this after describing a synapse transmission. Clearly candidates felt that the receptor was not joined to the sensory neurone directly but via a synapse even though the question stated they were attached. Specific examples of receptors that are part of the sensory neurone e.g. Pacinian corpuscles, may help with this understanding. Some candidates confused the complete depolarisation value of 40 mV with the threshold value of -50 mV. Few candidates mentioned generator potential even though this is a key word that should be associated with receptors and transduction.</p>


### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	<p>drugs will not interfere with other types of VGSC ✓</p> <p>other parts of the nervous system, continue to function / generate action potentials ✓</p>	2	<p><b>Examiner's Comments</b></p> <p>(b)(ii) was well answered by candidates although a few were vague in their description and it wasn't clear they were referring to a nervous system failure, merely stating a consequence of this e.g. cannot move muscles.</p>
			<b>Total</b>	<b>11</b>	



Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a	i	<p><i>Similarity (presence of)</i> axon / cell bodies / dendrites / synaptic knobs / myelin (sheath) / Schwann cells / nodes of Ranvier ✓</p> <p><i>difference</i> cell body at end of motor neurone <b>AND</b> cell body in middle of sensory neurone</p> <p><b>OR</b></p> <p>sensory neurone has a dendron / sensory neurone has short axon <b>AND</b> motor neurone has long axon ✓</p>	2	<p><b>IGNORE</b> ref to function or direction of impulse. <b>ALLOW</b> suitably labelled diagrams</p> <p><b>DO NOT ALLOW</b> both have long axons</p> <p><u><b>Examiner's Comments</b></u></p> <p>Similarities were well answered with a good spread of answers. Candidates who did not gain the difference mark had difficulty explaining the position of the cell body. Many candidates described the direction of the impulse and so did not appreciate the key word 'structure' in the question.</p>  <p>Few candidates attempted diagrams to answer this but appropriately labelled diagrams would be an excellent way of illustrating both differences and similarities and avoid the difficulties some candidates encountered when trying to describe the position of the cell body for the two types of neurones. Candidates should not be restricted to text just because lines are provided.</p>


### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>ii</p> <p>both sensory and motor neurones are damaged ✓</p> <p>impulse cannot, reach muscles / pass through motor neurone ✓</p> <p>prevents impulse transmission, through sensory neurone / from receptors ✓</p>	<p>2 max</p>	<p>IGNORE signals/messages/information for 'impulses'</p> <p>ALLOW from stimulus for 'from receptors'.</p> <p><b>Examiner's Comments</b></p> <p>This was well answered with many candidates appreciating the relevance of the two consequences of damage to the two types of neurone. More candidates recognised the significance of the (damaged) motor neurone to paralysis than the (damaged) sensory neurone to loss of feeling.</p>
	<p>iii</p> <p>insulates (the axon) / prevents passage of ions ✓</p> <p>saltatory conduction ✓</p> <p>(this) increases / speeds up , (rate of) transmission of impulses ✓</p>	<p>2 max</p>	<p>IGNORE signals/messages/information for 'impulses'</p> <p>ALLOW action potential jumps from node to node for 'saltatory conduction'.</p> <p><b>Examiner's Comments</b></p> <p>Most candidates recognised myelin as an insulator and could either state saltatory conduction or describe it.</p> <div style="text-align: center;">  </div> <p>Myelin was often referred to as protecting the axon which suggests an analogy with adipose tissue in various parts of the body. This is not correct and myelin should be described purely in terms of its role in increasing the axon's membrane resistance and decreasing the membrane capacitance. Relating the role of myelin to symptoms of multiple sclerosis often helps to emphasise the importance of its function in a contextual sense. Succinct</p>


### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					<p>descriptions can be found at:</p> <p><a href="https://www.sciencedirect.com/topics/neuroscience/myelin">https://www.sciencedirect.com/topics/neuroscience/myelin</a></p> <p>(1aii &amp; 1aiii)</p>  <p>Too many candidates use terms like signals, messages and information to describe an action potential. When describing the propagation of an action potential, avoid using signalling or messaging as transitive verbs referring to the direction of impulse, e.g. avoid 'an impulse signals to the CNS'. This will help to remove these words in any context (verb or noun). Concentrate on using words e.g. transmitted, propagated. This should help candidates to disconnect the use of signals and messages when describing any aspect of nerve transmission.</p> <p><b>Key</b></p> <p><b>Misconception</b></p> 
		iv	Schwann cells	1	<p><b><u>Examiner's Comments</u></b></p> <p>Generally, well answered although many candidates stated glial cells. There were a few NR for this question part.</p>


Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
b	i	MRI / fMRI (functional MRI) / CT ✓	1	<p>ALLOW lower case letters</p> <p><u>Examiner's Comments</u></p> <p>Most candidates described MRI and recalled the use of a magnetic field and radio-waves to produce an image. Those who described a CT scan successfully recalled the use of X-rays and producing a 3D image.</p> <p></p> <p>Candidates described the resultant images as showing damaged areas, as if the whole image would focus only on areas of injury. It should be demonstrated that images would show damaged areas compared to surrounding healthy tissue. Many images can be found that illustrate small areas of damage compared to surrounding tissue. Videos can also be shown that can be in any context e.g. herniated disc, as it serves to illustrate the relevance and limitations of these techniques.</p> <p><a href="https://www.bing.com/videos/search?q=herniated+disc+mri&amp;view=detail&amp;mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&amp;FORM=VIRE">https://www.bing.com/videos/search?q=herniated+disc+mri&amp;view=detail&amp;mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&amp;FORM=VIRE</a></p>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>ii</p> <p>1 (both) show difference, between healthy and damaged areas ✓</p> <p><i>MRI / fMRI</i></p> <p>M2 uses magnet(s) / magnetic field ✓</p> <p>M3 detects, increase in water (content) / swelling / inflammation / (changes in) blood flow ✓</p> <p>M4 (can be used to) detect areas of demyelination ✓</p> <p>OR</p> <p><i>CT</i></p> <p>C2 uses X-rays (and computer) ✓</p> <p>C3 builds up 3-D image (of the spinal cord) ✓</p> <p>C4 shows areas with, poor blood supply / bleeding / blood clot ✓</p>	<p>3 max</p>	<p>IGNORE ref to tumours or other conditions not related to SCI</p> <p>IGNORE ref to technique other than <i>1bi</i> answer</p> <p>ALLOW 3DMRI gives a 3D image</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates described MRI and recalled the use of a magnetic field and radio-waves to produce an image. Those who described a CT scan successfully recalled the use of X-rays and producing a 3D image.</p> <div style="text-align: center;">  </div> <p>Candidates described the resultant images as showing damaged areas, as if the whole image would focus only on areas of injury. It should be demonstrated that images would show damaged areas compared to surrounding healthy tissue. Many images can be found that illustrate small areas of damage compared to surrounding tissue. Videos can also be shown that can be in any context e.g. herniated disc, as it serves to illustrate the relevance and limitations of these techniques.</p> <p><a href="https://www.bing.com/videos/search?q=herniated+disc+mri&amp;view=detail&amp;mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&amp;FORM=VIRE">https://www.bing.com/videos/search?q=herniated+disc+mri&amp;view=detail&amp;mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&amp;FORM=VIRE</a></p>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
c	<p>1 neural stem cells / human brain tissue stem cells / MSCs, are <u>multipotent</u> ✓</p> <p>2 (as) derived from adult (stem cells) / able to differentiate into a limited range of cell types ✓</p> <p>3 embryonic stem cells are <u>pluripotent</u> ✓</p> <p>4 (as) they can differentiate into any type of cell ✓</p>	3 max	<p>ALLOW ref to trial names (e.g. Balgrist / Neuralstem) for 'neural stem cells/MSCs'</p> <p>ALLOW pluripotent in the context of iPSCs</p> <p>ALLOW ref to Asterias trial for 'embryonic stem cells'</p> <p>ALLOW embryonic stem cells are <u>toti</u> potent as <u>early</u> embryo used</p> <p><b><u>Examiner's Comments</u></b></p> <p>Well answered with most candidates clearly extracting relevant information from the Advance Notice article. Marks were lost for confusing pluripotent with totipotent stem cells.</p> <div style="text-align: center;">  </div> <p>As both pluripotent and totipotent stem cells derive from embryos and can differentiate into any type of cell, candidates confuse the terms and focus on totipotent stem cells. It should be emphasised that the medical use of stem cells use pluripotent stem cells that are also called embryonic stem cells or ESC's.</p>
d	<p><b><i>Summary of instructions to markers:</i></b>  <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i>  <i>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.</i>  <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i></p> <ul style="list-style-type: none"> <li>◦ award the higher mark where the Communication Statement has</li> </ul>		



## Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>been met.</p> <ul style="list-style-type: none"> <li>◦ award the lower mark where aspects of the Communication Statement have been missed.</li> <li>• The science content determines the level.</li> <li>• The Communication Statement determines the mark within a level.</li> </ul> <p><b>Level 3 (5–6 marks)</b> An evaluation of the risks and benefits and the ethical issue of using stem cells. There is clear reference to the future potential of stem cell therapy.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. There are clear links to the information in the article. All the information presented is relevant and forms a continuous narrative.</i></p> <p><b>Level 2 (3–4 marks)</b> An evaluation of the benefits and risk or risks and benefit of using stem cells including any ethical issue surrounding this use. There is reference to the future potential of stem cell therapy.</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. There is a link to the information in the article The information presented is mostly relevant.</i></p> <p><b>Level 1 (1–2 marks)</b> An evaluation of the risk or benefit and any ethical issue related to the use of stem cells. However, there is no reference to future potential.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 marks</b> No response or no response worthy of</p>	6	<p>Indicative scientific points may include</p> <p><b>Risks</b> Risk of rejection Risk of infection with many injections or collection of MSCs Risk of further injury with many injections Need for immunosuppression Unknown long-term effect May not work Risk of teratogenesis / oncogenesis (with iPSCs) Too much emphasis on data with small sample size</p> <p><b>Benefits</b> Reduces symptoms of SCI/ treats SCI Replace damaged cells Patients could walk/move, again Prevents further damage due to SCI Still under research/ not known Lack of other treatments Gives hope to patients No rejection if from own bone marrow Data used to help future sufferers</p> <p><b>Ethical</b> Destroying embryos Use of iPSCs Use of human brain tissue Gives false hope</p> <p><b>Future potential</b> Stem cell therapies will be approved Use of iPSCs Data gathered can be used in future</p> <p><b><u>Examiner's Comments</u></b></p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	credit.		<p>Well answered with most candidates covering all aspects of ethical risks, benefits and potential future benefit. Many candidates had learned about the use and potential of induced pluripotent stem cells (iPSCs). Some candidates used up too much space (and time) discussing ethical issues in terms of playing god, embryos can't give consent, etc. without mentioning the obvious fact that producing embryonic stem cells usually means destroying an embryo. Candidates often lost marks for failing to appreciate the future potential of stem cell therapy.</p> <p><b>Exemplar 1</b></p> <p>The benefits of using stem cells in the treatment of spinal cord injuries are that they may be able to treat the spinal cord injury, restoring function and feeling to affected areas, by regenerating neurons, replacing lost myelin and protect the cord from spreading the damage after injury, then the financial, social, physical and psychological burdens on the patients with the injury will be reduced and hopefully removed, these financial, social and psychological burdens also affect the patients' family, therefore using stem cells to treat the patient's spinal cord injury you are also helping their family and support system. The risks associated with stem cell use are that the stem cells may make tumours in the patients, the tumours are known as teratomas. Another risk is when the white of stem cells on the patient the patient may have to take you back to hospital for infection, antibiotics, which may leave them vulnerable to opportunistic infections, etc. tuberculosis, the ethical issues associated with the use of stem cells for spinal cord injuries are that if the stem cells used are from human embryos some people believe this is wrong, as you are destroying a potential human life, while others believe the embryo is simply a ball of undifferentiated cells lacking human qualities. Also some people worry that using stem cells in medicine may lead to the cloning of humans or that people may modify human behaviour. Also stem cells in the future can be used to test drugs which could help treat diseases such as spinal cord injuries in vitro rather than in the patient.</p> <p>Good use of all available space on page. Clearly moves through ethical benefits, risks and potential for future benefit. There was good discussion of each, with no focus on any particular component and always related to SCI.</p>
	Total	20	