

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

5.2.1 THE NERVOUS SYSTEM AND THE IDENTIFICATION AND CONSEQUENCES OF DAMAGE

SCORE

/173

PERCENTAGE

%

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- 1 The table shows the roles of three different chemicals in the transmission of nerve impulses across a synaptic cleft.

Which of the rows, A to D, is correct?

	Binds to receptors on Na ⁺ channels in postsynaptic membrane	Generates an action potential in postsynaptic membrane	Causes vesicles containing neurotransmitter to fuse with presynaptic membrane
A	acetylcholine	calcium ions	sodium ions
B	calcium ions	sodium ions	acetylcholine
C	sodium ions	calcium ions	acetylcholine
D	acetylcholine	sodium ions	calcium ions

Your answer

[1]

2 Fig. 3.1 is a diagram of a section through the human brain.

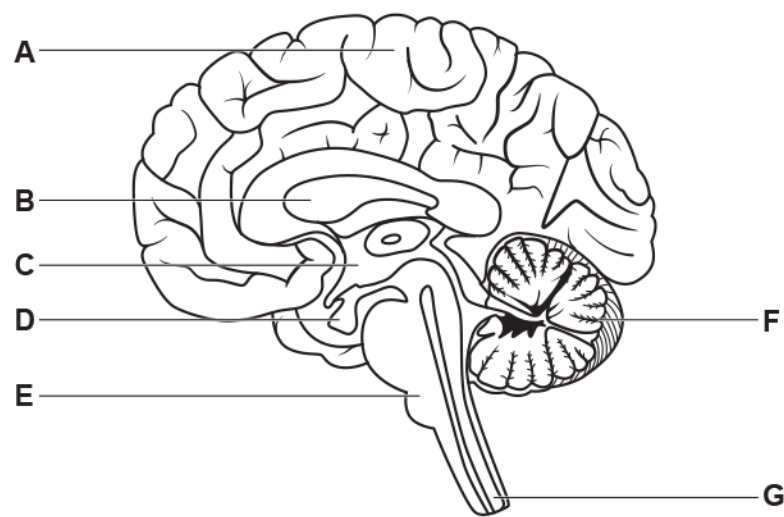


Fig. 3.1

The following table contains statements about areas of the brain shown in Fig. 3.1.

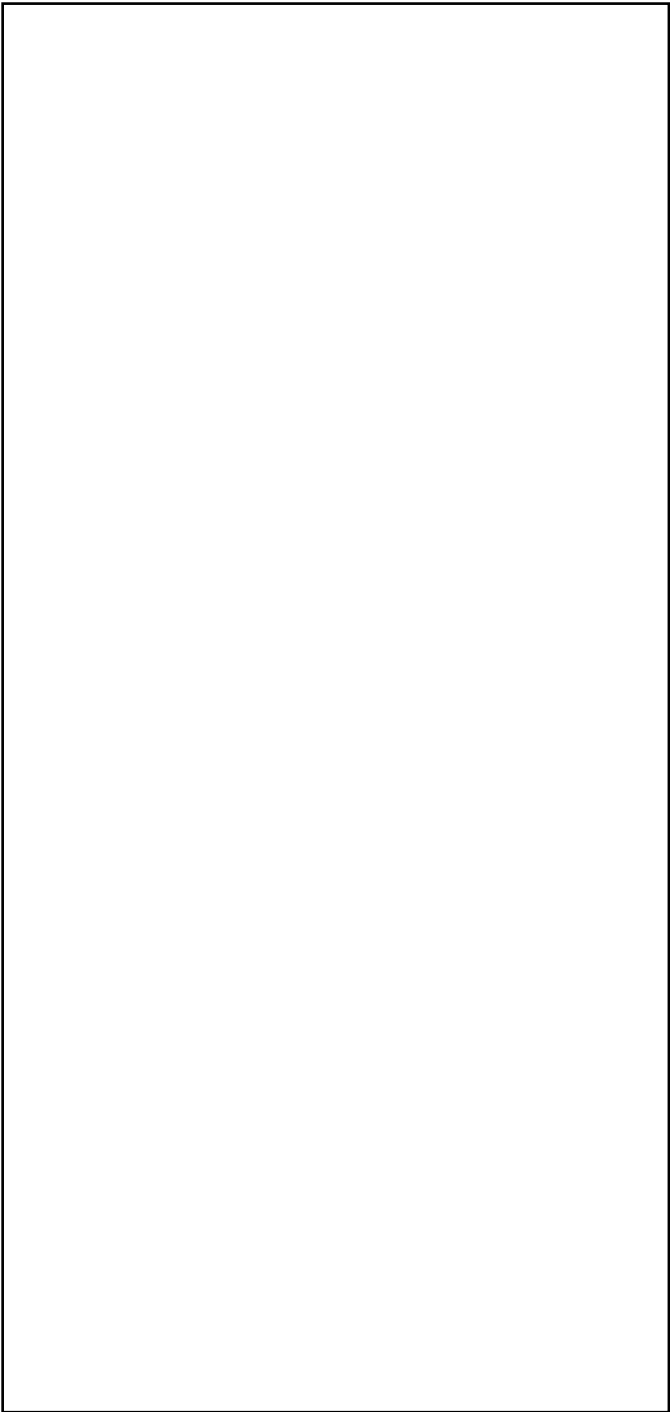
Complete the table using the most appropriate letter from Fig. 3.1. Each letter may be used once, more than once, or not at all.

Statement	Letter
fMRI shows this area of the brain to be active when playing a musical instrument.	
Temperature-sensitive neurones are located in this area of the brain.	
Traumatic injury to this area can lead to over- or under-production of sex hormones.	
This region of the brain controls heart rate and breathing rate.	
Stroke affecting part of this area of the brain could cause loss of conscious control of muscles in the arms or legs.	

[4]

3(a) Please refer to the Insert H422-03 November 2020. Fig. 4.1 is a light micrograph of a transverse section through a mammalian spinal cord.

In the space below, draw an annotated tissue plan of Fig. 4.1. Include labels for the following structures: central canal, grey matter, white matter, and meninges.



[4]

(b) Fig. 4.2 shows a light micrograph and Fig. 4.3 shows a scanning electron micrograph of nerve cells in the human brain.

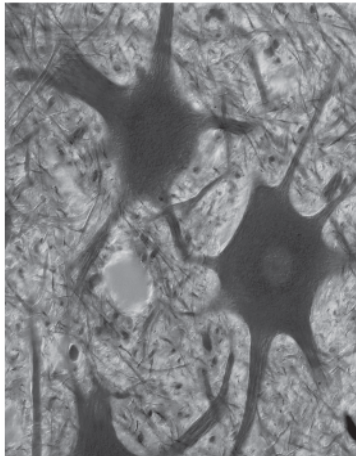


Fig. 4.2



Fig. 4.3

The images in Fig. 4.2 and Fig. 4.3 were taken from the same tissue and were produced at the same magnification.

Explain why the image in Fig. 4.3 shows greater detail compared with the image in Fig. 4.2.

----- [1]

- (c) The autonomic nervous system is divided into two branches, the sympathetic and parasympathetic nervous systems.

Complete the table to compare the sympathetic and parasympathetic nervous systems.

Feature	Parasympathetic nervous system	Sympathetic nervous system
Neurotransmitter		noradrenaline
Position of ganglion	ganglion is close to the effector	

[2]

- 4 Heart rate is affected by the sympathetic and parasympathetic nervous systems.

Which of the options, **A** to **D**, is an event that stimulates the accelerator nerve?

- A** decrease in blood pH
- B** increase in blood pressure
- C** release of adrenaline into the blood
- D** release of glucose into the blood

Your answer

[1]

- 5 Excitatory and inhibitory postsynaptic potentials have similarities and differences.

Which of the options, **A** to **D**, is a feature of an excitatory, but not inhibitory, postsynaptic potential?

- A** all-or-nothing response
- B** depolarising
- C** graded in response
- D** hyperpolarising

Your answer

[1]

6(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

difference

[2]

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

[2]

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

-----[2]

- (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.

-----[1]

- (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.

-----[1]

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

-----[3]

- (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.

[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.

[illegible]

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.

-----[1]

(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.

[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.

[2]

8 The statements below relate to the autonomic nervous system (ANS).

Which of the following statements is/are correct?

- 1 The ANS is a division of the peripheral nervous system.
2 Autonomic neurones between the CNS and the ganglia are myelinated.
3 Sympathetic neurones use acetylcholine and noradrenaline as neurotransmitters.
- A 1, 2 and 3 are correct
B Only 1 and 2 are correct
C Only 2 and 3 are correct
D Only 1 is correct

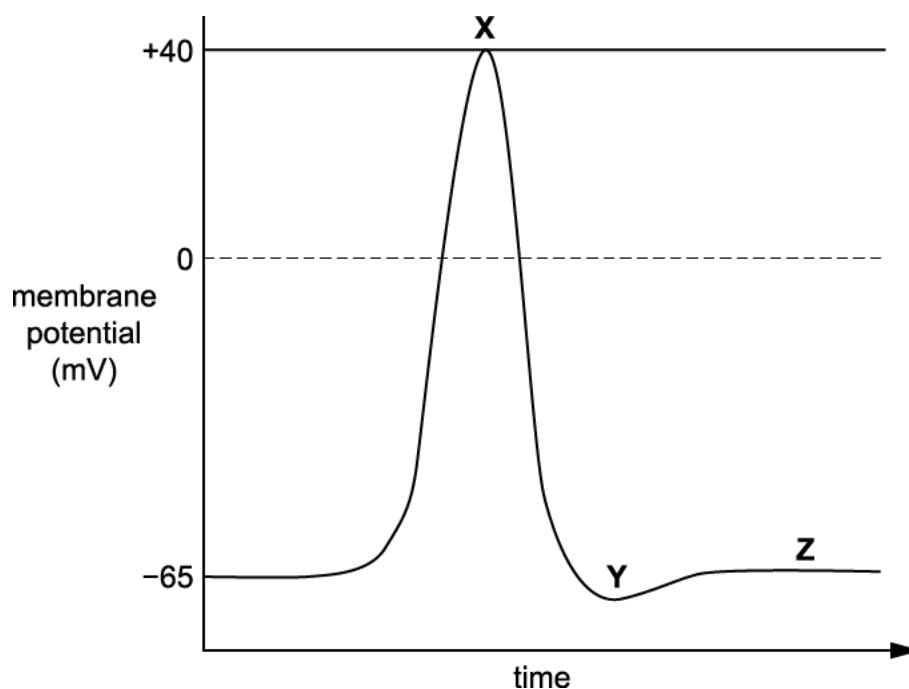
Your answer

5

[1]

- 9 The graph below shows changes in the membrane potential of an axon during a nerve impulse.

Three points on the graph are labelled X, Y and Z.



Which of the following statements is/are correct?

- 1 At point X, Na^+ ion channels close.
- 2 Point Y ensures the action potential can only travel in one direction.
- 3 Active pumping of K^+ ions out of the axon contributes to the membrane potential at point Z.

- A 1, 2 and 3 are correct
B Only 1 and 2 are correct
C Only 2 and 3 are correct
D Only 1 is correct

Your answer

[1]

10 Cannabis contains a chemical that affects synaptic transmission.

Which of the options, **A** to **D**, correctly describes how synaptic transmission is affected by this chemical?

- A** dopamine receptors are bound
- B** degradation of dopamine is blocked
- C** release of an inhibitory neurotransmitter is prevented
- D** release of an inhibitory neurotransmitter is promoted

Your answer

[1]

11(a) Loss of memory is associated with the onset of Alzheimer's disease. One theory to explain this memory loss suggests that neurones in some areas of the brain stop producing acetylcholine.

(i) Which area of the brain is associated with memory?

-----[1]

(ii) *Describe the roles of acetylcholine and other neurotransmitters in the interaction between neurones in the brain.

-----[6]

(b) Three drugs used in the treatment of patients diagnosed with mild or moderate symptoms of Alzheimer's disease underwent clinical trials.

- Patients were tested using an Alzheimer's disease assessment scale (ADAS), which assessed cognitive performance.
- Patients were tested at intervals of 6 weeks.

The results are shown in Fig. 4.1.

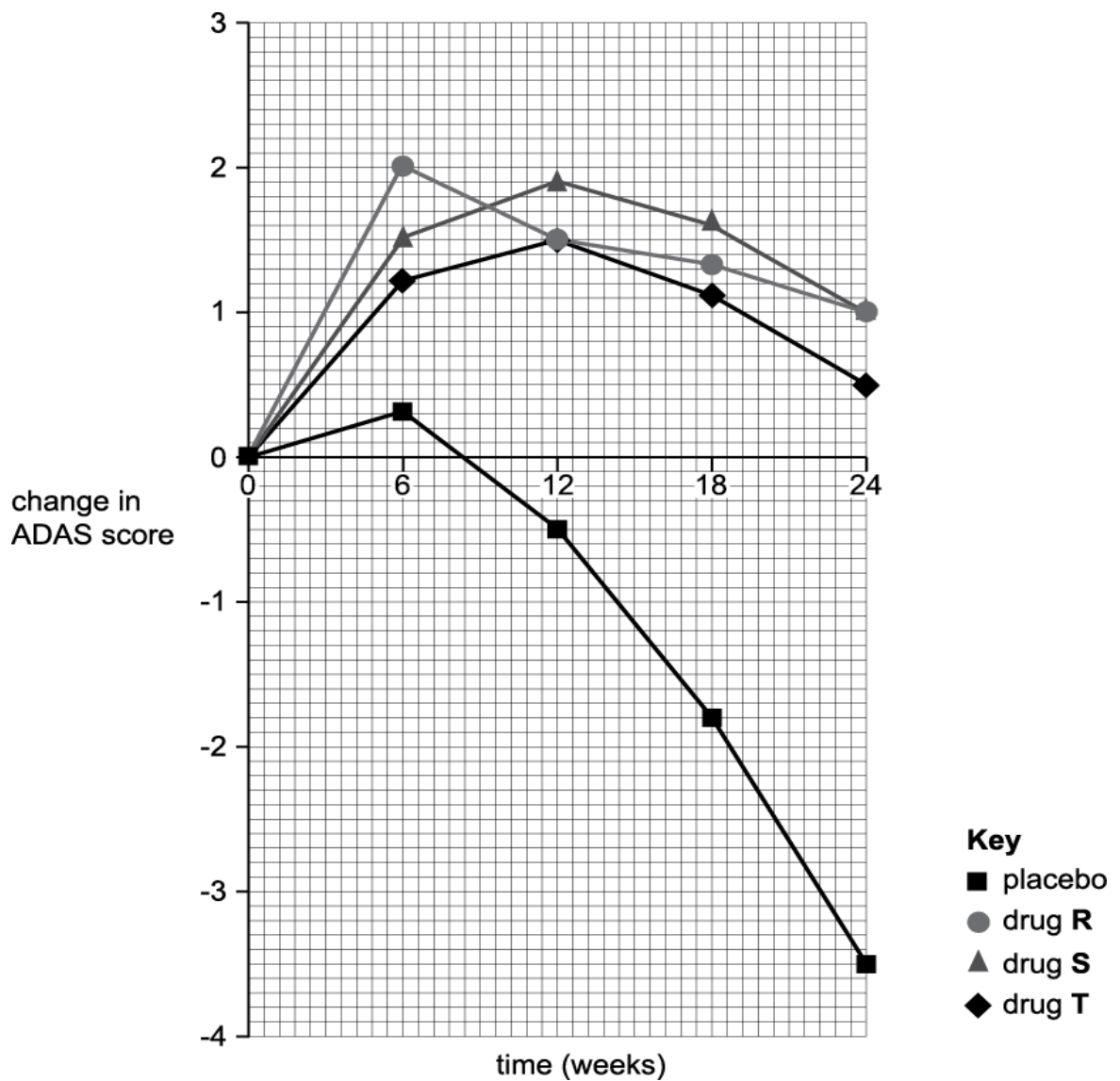


Fig. 4.1

- (i) Calculate the percentage decrease in ADAS score between 12 and 24 weeks for those patients who did not receive a drug treatment.

Show your working.

Answer % [2]

- (ii) Using the data in Fig. 4.1, evaluate the effectiveness of the three drugs in the treatment of the symptoms of Alzheimer's over the trial period.

[2]

(iii) All three of the tested drugs act as inhibitors of the enzyme acetylcholinesterase.

- Drug **R** acts as an irreversible inhibitor of acetylcholinesterase.
- Drugs **S** and **T** act as competitive inhibitors.

Fig. 4.2 shows the effect of increasing acetylcholine concentration on the rate of reaction of acetylcholinesterase in the presence of drug **S**.

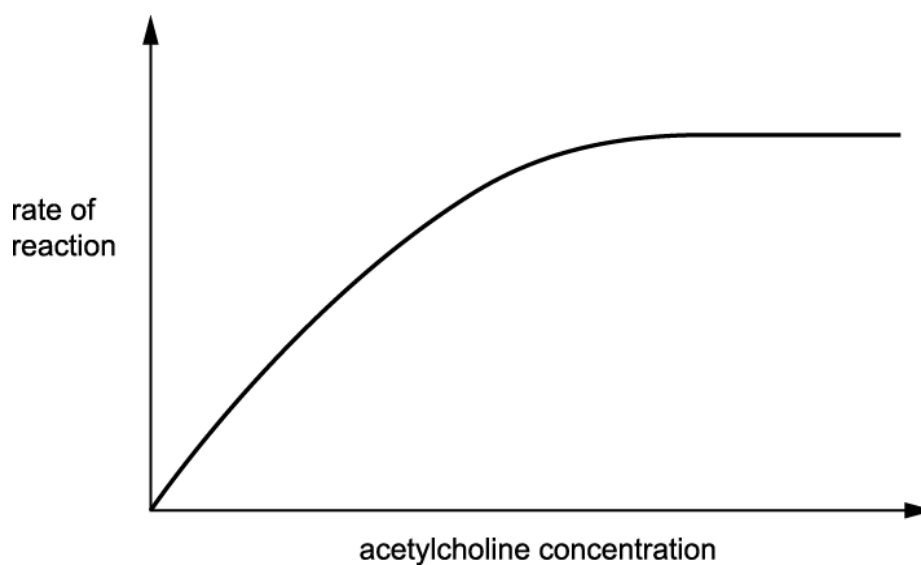


Fig. 4.2

Drug **R** was then used instead of drug **S**. Describe how the curve obtained from drug **R** would be different to the curve shown in Fig. 4.2.

[1]

- (c) The cytochrome P450 enzyme system (CYP) in the liver is responsible for breaking down many therapeutic drugs, including those used to treat Alzheimer's. CYP also breaks down recreational drugs, for example heroin and molecules found in cannabis.

Repeated use of recreational drugs can result in increased concentrations of CYP enzymes in liver cells.

Outline the possible consequences of increased concentrations of CYP enzymes on the use of recreational drugs.

[2]

12(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.

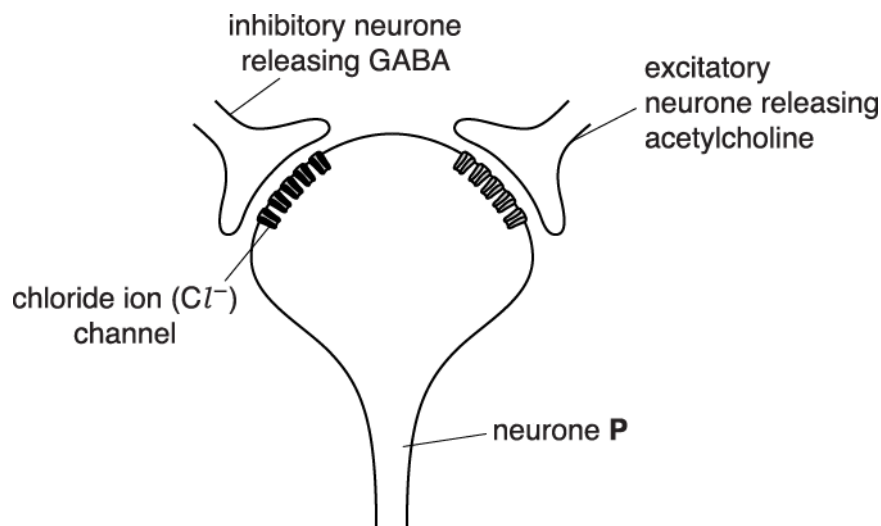


Fig. 3.2

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.

61

- 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.

- 2

[1]

- 11

13(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

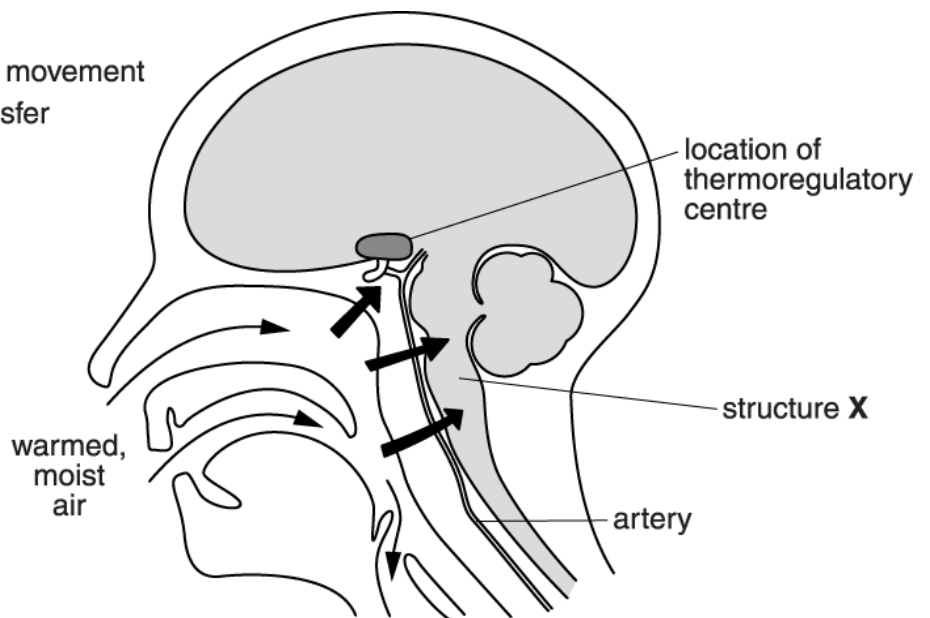


Fig. 1.2

- (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.

.....
.....
.....
.....
.....
.....
.....[3]

- 14 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

Exact location

[1]

15(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.

[3]

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

-----[1]

(c) Following an MRI scan, Mrs G was found to have an area of her brain that was deprived of oxygen due to a blood clot. She was immediately 'thrombolysed' and then transferred to a specialist stroke ward.

- 'Thrombolysis' involves the injection of a substance known as a plasminogen activator.
- The activator converts the protein **plasminogen** in blood into an active form called **plasmin**.
- Plasmin dissolves blood clots.

(i) Suggest the type of molecule that plasmin might be **and** how it dissolves blood clots.

----- [2]

(ii) Plasminogen activator is a glycoprotein. The plasminogen activator used in hospitals has been manufactured using genetically modified cells.

What **type** of modified cell might be used in the manufacture of plasminogen activator?

Explain your answer.

----- [2]

(iii) The recommended dose of plasminogen activator is 0.9 mg for each kilogram of body mass.

- Mrs G was prescribed a dose of 67.5 mg.
- Mrs G is 1.5 m tall.
- BMI is calculated using the formula below:

$$\frac{\text{body mass (kg)}}{(\text{height (m)})^2}$$

Using the above information, calculate a BMI for Mrs G.

Give your answer to the nearest whole number.

Answer = _____

[2]

(iv) Using your calculation of BMI in part (iii), discuss the risk factors that may have contributed to Mrs G's stroke.

[2]

(d) 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'.

[1]

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

[2]

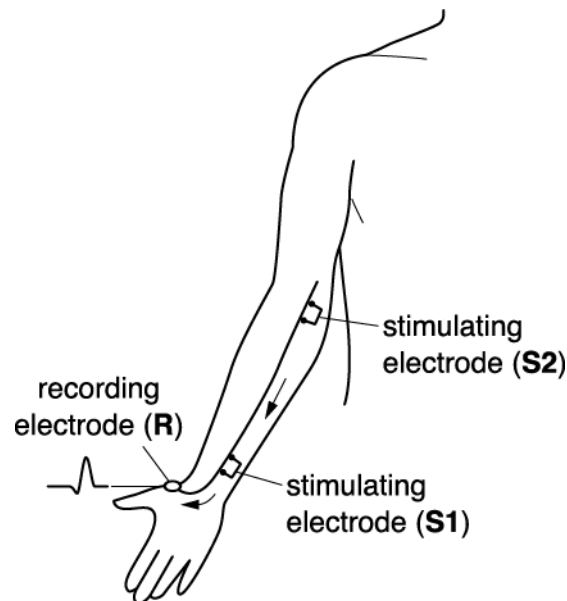
16(a) Muscle fibres must be stimulated by a motor neurone before they contract.

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

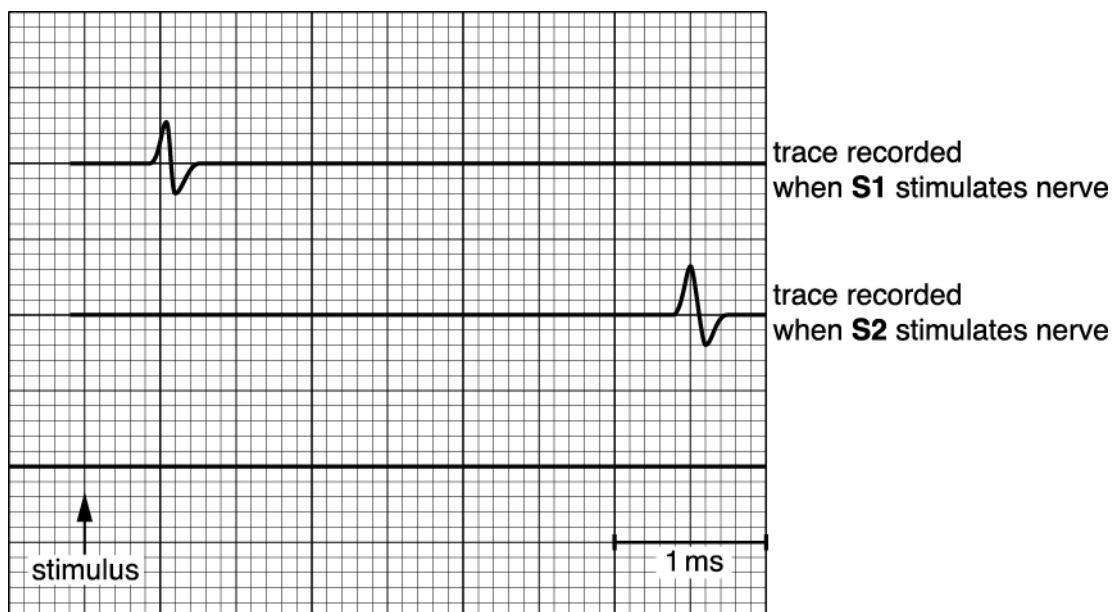
[1]

- (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⁻¹ [2]

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



[71]

Suggest a reason for this observation.

[1]

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.

[2]

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

[1]

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

Nerve tested	Mean velocity change after 5 years (ms^{-1})	Probability (P-value)	Confidence limits (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?

[2]

- 17 Catalase activity can vary between different tissues within the same organism. A student carried out an investigation using catalase from different muscle tissues. All the samples were taken from the same individual organism.

The results are shown in Table 1.1 below.

	Time for muscle tissue to produce 2 cm ³ oxygen from hydrogen peroxide (s)	
	Chicken leg muscle	Chicken wing muscle
1	76	98
2	78	96
3	84	85
4	86	78
5	94	102
6	79	104
7	83	116
8	85	94
9	78	89
10	86	112
Mean ($\bar{x}$)	82.9	97.4
SD (s)	5.4	11.7
Variance (s ²)		

Table 1.1

- (i) Complete Table 1.1, by calculating the variance for each set of data.

[1]

- (ii) The student decided to carry out a t -test to determine if the two sets of data were significantly different from each other.

Calculate the t value for the data in Table 1.1. Use the formula.

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

Show your working.

$t =$ [3]

- (iii) The student stated that “*there is no significant difference in the time it took to collect 2 cm³ oxygen so the activity of the catalase in both types of tissue was the same*”.

Use Table 1.2 below to decide if the student is correct. Explain your answer.

Degrees of freedom	Level of probability		
	0.05	0.01	0.001
1	12.71	63.66	636.6
2	4.303	9.925	31.60
18	2.101	2.878	3.922
20	2.086	2.845	3.850

Table 1.2

.....
.....
.....
..... [3]

- (iv) Comment on the precision of the data obtained for the two types of muscle in Table 1.1.

.....
.....
.....
..... [1]

- (v) Hydrogen peroxide is produced in cells as an intermediate compound when oxygen is converted to water. It can interact with and destroy other molecules in the cell. The enzyme catalase is present in cells to reduce the damage.

Muscles consist of bundles of muscle cells (fibres).

Suggest which muscle, chicken leg or chicken wing, contains cells with a high number of mitochondria.

Explain your suggestion.

.....

18(a) Temperature control is a key aspect of homeostasis. Changes to skin temperature can be measured using an infrared sensor.

A group of students was comparing skin temperature at different locations on the arm. They used an infrared sensor, as shown in Fig. 3.1, and a data logger.

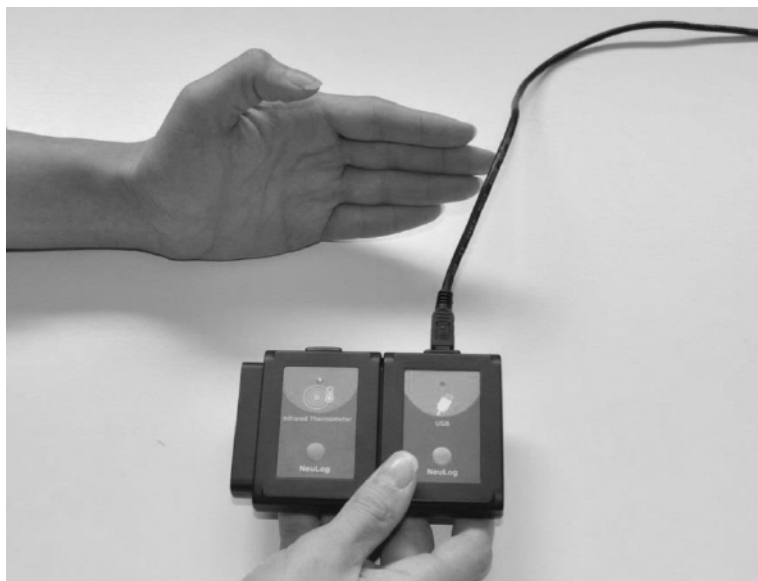


Fig. 3.1

The procedure they followed is described below.

- An infrared sensor was positioned a short distance from the hand of one student, as shown in Fig. 3.1.
- The sensor was aimed at a point on the hand, and temperature readings were recorded every 6 seconds for 2 minutes.
- The student then moved so that the sensor was aimed at the upper arm.
- Again the temperature was recorded every 6 seconds for 2 minutes.
- The data was downloaded and analysed.
- The procedure was repeated for each student in the group.

- (i) Suggest two variables that should be controlled in order to obtain a valid comparison of skin temperature in different parts of the arm. Explain how each of these variables could be controlled.

Variable 1 _____

Variable 2 _____

[4]

(ii) Table 3.1 shows the data collected by the students using the procedure described on page 10.

Student	Temperature (°C)			
	Fingers	Upper arm	Difference (d)	Difference squared (d ²)
1	21.2	31.7	10.5	110.3
2	21.5	31.3	9.8	96.0
3	21.4	32.0	10.6	112.4
4	20.9	31.6	10.7	114.5
5	21.7	31.4	9.7	94.1
6	21.2	32.1	10.9	118.8
7	21.3	31.5	10.2	104.0
8	21.0	31.7	10.7	114.5
9	21.7	31.6	9.9	98.0
10	21.2	31.8	10.6	112.4
11	21.2	31.7	10.5	110.3
12	21.5	31.3	9.8	96.0
13	21.4	32.0	10.6	112.4
14	20.9	31.6	10.7	114.5
15	21.7	31.4	9.7	94.1
16	21.2	32.1	10.9	118.8
17	21.3	31.5	10.2	104.0
18	21.0	31.7	10.7	114.5
19	21.7	31.6	9.9	98.0
20	21.2	31.8	10.6	112.4
		Mean =	10.36	

Table 3.1

$$t = \frac{\bar{d}\sqrt{n}}{S_d}$$

where S_d is calculated from the formula:

$$S_d = \sqrt{\frac{\sum d^2 - n\bar{d}^2}{n-1}}$$

n = number of samples

$\bar{d}$ = mean difference.

Using the formulae provided, calculate the value of t for the data given in Table 3.1.

Show your working. Give your answer to **three** significant figures.

Answer = _____ [4]

- (iii) The students chose to carry out a **paired Student t -test** to analyse the data obtained.

Explain why this choice of test is appropriate.

----- [2]

- (iv) The skin temperature values obtained for the fingers were always approximately 10 °C lower than those

obtained for the upper arm.

The value of t obtained by the students indicated that this difference was significant.

Suggest one **biological** reason for the above observation. Explain your suggestion.

[2]

(b) * In some people, the ability to regulate body temperature declines with age.

Fig. 3.2 shows the mean changes to blood flow in the hand when two groups of elderly subjects, **Group A** and **Group B**, were subjected to three different temperature treatments.

Subjects in **Group A** showed a normal response to temperature changes. Subjects in **Group B** showed an abnormal response.

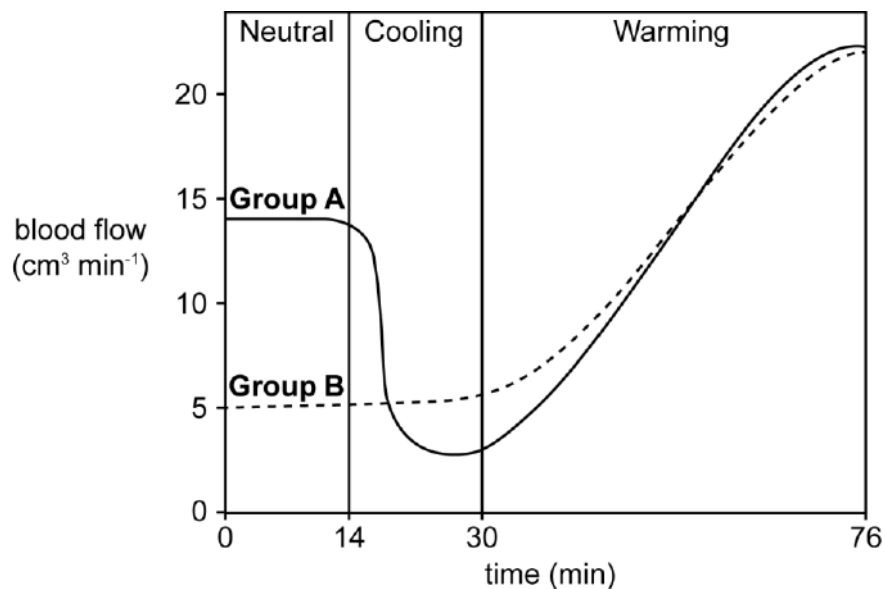


Fig. 3.2

Describe the physiological responses shown by **Group A** and **Group B** during the cooling and warming treatments.

[6]

19(a) The sciatic nerve is one of the largest nerves in animals. It is a **mixed** nerve, which means that it contains different types of neurones.

Fig. 2.1 shows a transverse section through part of the sciatic nerve as seen with a light microscope.

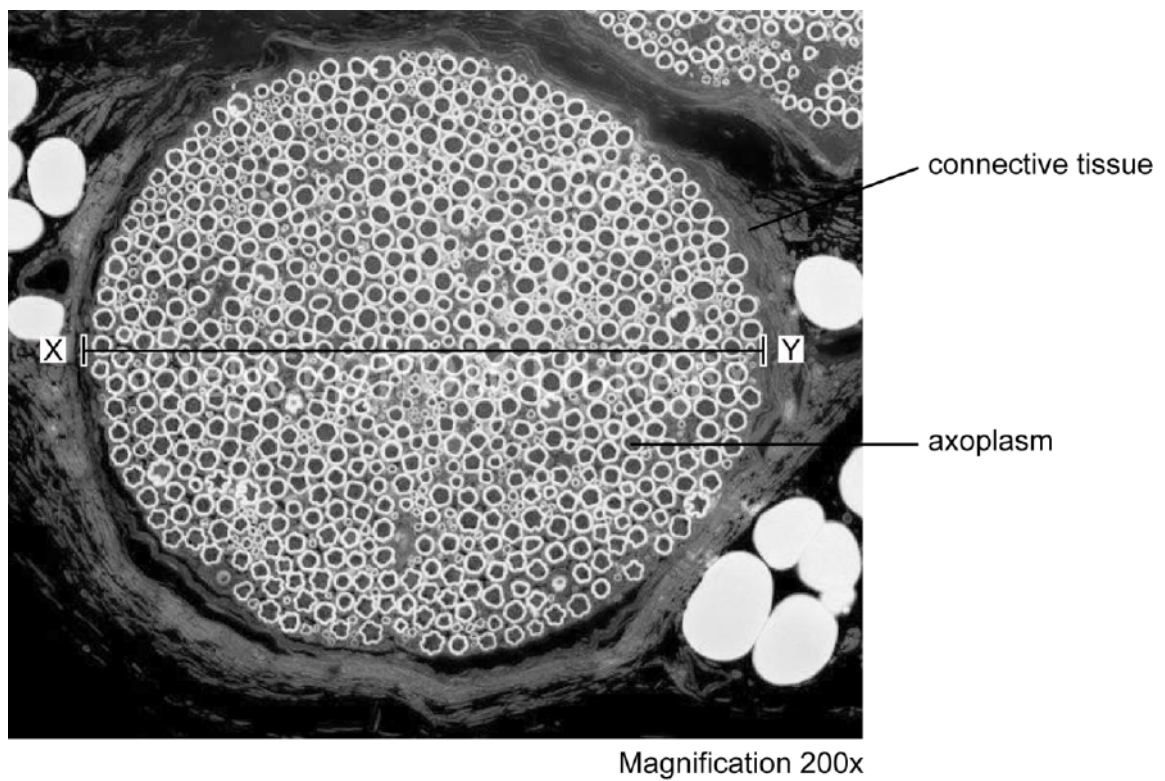


Fig. 2.1

(i) Calculate the actual diameter of the sciatic nerve between X and Y as shown in Fig. 2.1.

Show your working. Give your answer to **two** significant figures.

Answer = _____ mm [2]

(ii) Identify the white structure surrounding the axoplasm in Fig. 2.1.

----- [1]

(b) The neurones in the sciatic nerve form part of the peripheral nervous system.

Some of the neurones connect receptors in the lower limb to the central nervous system.

Some of the neurones connect the central nervous system to different types of muscle tissue in the lower limb.

Tick the correct term or terms that apply to the sciatic nerve neurones described in the table below:

Description of neurone(s)	Sensory	Motor	Autonomic	Somatic
Stimulates muscle tissue and causes contraction				
Parasympathetic				
Contains a long dendron				
Involved in the plantar reflex				
Sympathetic				

[5]

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**.

[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.

[2]

Around 20 million years ago, the Colorado River began to carve into the land to form a deep valley. This valley separated the former continuous land into the North Rim and South Rim.

S. aberti and *S. aberti kaibabensis* form two populations, as shown in Fig. 32.1.

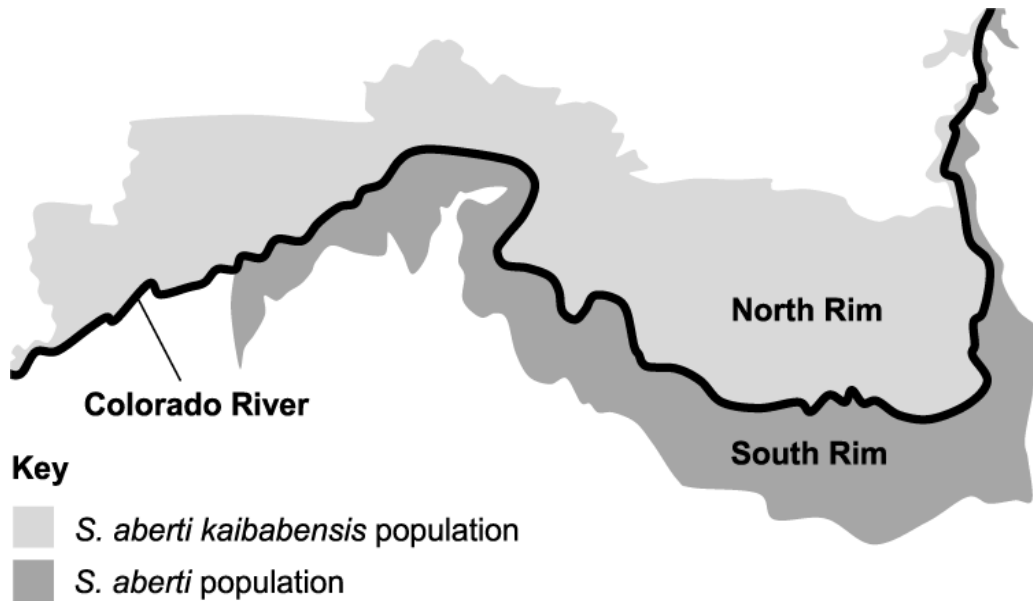


Fig. 32.1

Scientists think that *S. aberti kaibabensis* evolved as a distinct subspecies of *S. aberti*.

Using Fig. 32.1, explain how *S. aberti kaibabensis* could have evolved from *S. aberti*.

22(a) A traumatic brain injury is caused by an external force to the head, such as during a traffic accident.

Fig. 31.1 is a diagram showing a cross-section of the human brain with regions labelled A to F.

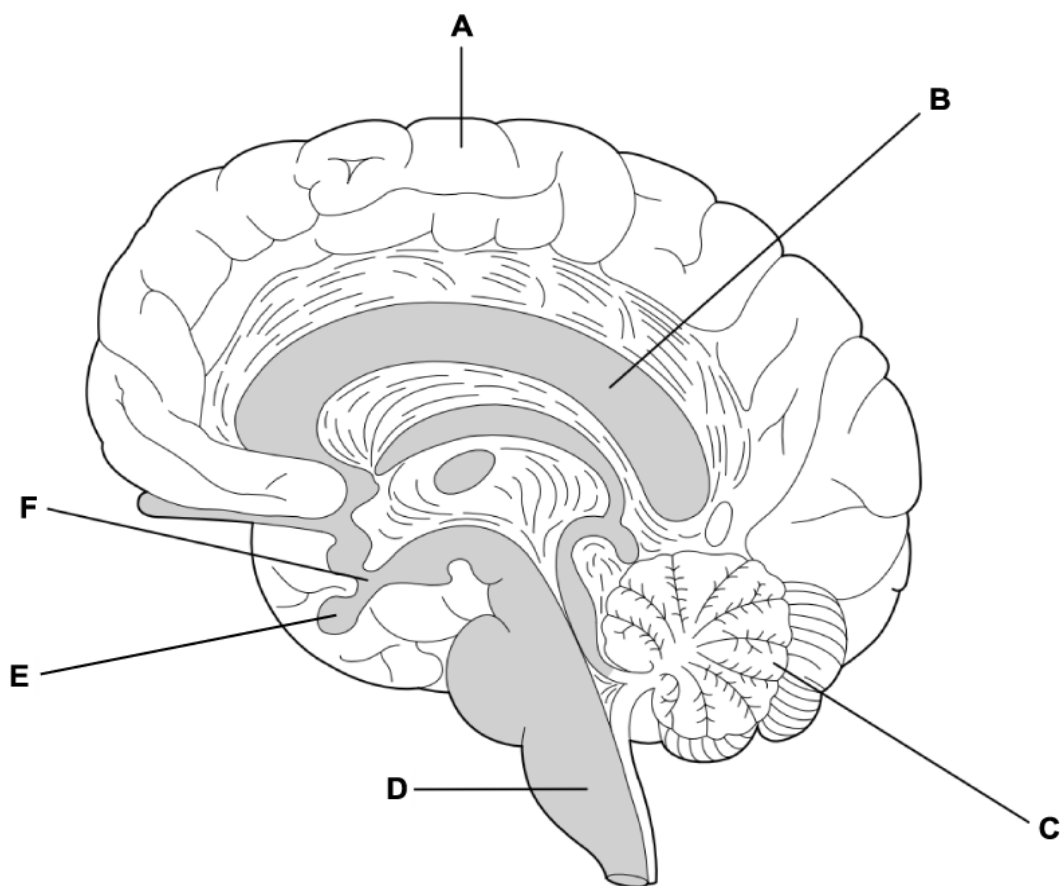


Fig. 31.1

Complete each blank in the paragraph below by inserting the letter corresponding to the appropriate brain region from Fig. 31.1.

The symptoms of a traumatic brain injury are dependent on the region(s) of the brain affected. Damage to _____ may lead to the release of hormones such as ADH and oxytocin into the blood. Damage to _____ may cause a poor regulation of body temperature. Motor function may be affected if there is damage to _____.

Brain death is confirmed if there is a permanent loss of function in _____.

[4]

(b) Functional magnetic resonance imaging (fMRI) can identify regions of brain damage by measuring brain activity.

(i) Explain how fMRI measures brain activity.

[3]

(ii) Suggest **two** advantages of fMRI over computed tomography (CT) for the measurement of brain activity.

1.

2.

[2]

(iii) Another imaging method can identify regions of brain damage by measuring electrical activity across the brain. Name this method.

[1]

23 A study was conducted to determine the effect of alcohol on reaction time.

Twenty participants were asked to respond as fast as possible to visual cues, before and after drinking a fixed quantity of alcohol. Two data sets were produced.

Which of the options, **A** to **D**, would be the appropriate statistical method for analysing the data from this study?

- A chi squared test
- B paired Student's t-test
- C unpaired Student's t-test
- D Spearman's rank correlation coefficient

Your answer

[1]

24 The Na^+/K^+ pump helps to maintain the resting potential across the membrane of a neurone.

Which of the statements about the pump's activity, **A** to **D**, is correct?

- A for every three Na^+ ions that enter the cell, two Ca^{2+} ions leave
- B for every three Na^+ ions that leave the cell, two Ca^{2+} ions enter
- C for every three Na^{2+} ions that enter the cell, two K^+ ions leave
- D for every three Na^{2+} ions that leave the cell, two K^+ ions enter

Your answer ☐

[1]

25 Neurotransmitters such as gamma-aminobutyric acid (GABA) are found at synapses within the human brain and are known as inhibitory neurotransmitters.

GABA binds to receptors in the post-synaptic membrane and causes potassium ion channels to open.
This prevents an action potential in the post-synaptic neurone.

An action potential is prevented because potassium ions diffuse:

- A out of the post-synaptic neurone causing depolarisation
- B out of the post-synaptic neurone causing hyperpolarisation
- C into the post-synaptic neurone causing depolarisation
- D into the post-synaptic neurone causing hyperpolarisation

Your answer ☐

[1]

26 The medulla oblongata is a region of the brainstem. It regulates the activity of several organs within the human body.

Which of the following would result from the action of the medulla oblongata via the sympathetic nervous system?

- A sweat is produced
- B heart rate decreases
- C heart rate increases
- D ventilation rate decreases

Your answer ☐

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
1			D	1(AO1.2)													
			Total	1													
2			<table><tr><th>Statement</th><th>Letter(s)</th></tr><tr><td>fMRI shows these areas of the brain to be active when playing a musical instrument</td><td>A or F</td></tr><tr><td>Temperature-sensitive neurones are located in this area of the brain</td><td>C</td></tr><tr><td>Traumatic injury to either of these areas can lead to over- or under-production of sex hormones.</td><td>C or D</td></tr><tr><td>This region of the brain controls heart rate and breathing rate.</td><td>E</td></tr><tr><td>Stroke affecting part of this area of the brain could cause loss of control of muscles in the arms or legs.</td><td>A</td></tr></table> ✓✓✓✓ 5 correct = 4 marks, 4 correct = 3 marks, 3 correct = 2 marks 2 correct = 1 mark	Statement	Letter(s)	fMRI shows these areas of the brain to be active when playing a musical instrument	A or F	Temperature-sensitive neurones are located in this area of the brain	C	Traumatic injury to either of these areas can lead to over- or under-production of sex hormones.	C or D	This region of the brain controls heart rate and breathing rate.	E	Stroke affecting part of this area of the brain could cause loss of control of muscles in the arms or legs.	A	4(AO2.1) (AO1.1)(AO2.1)(A O1.1)(AO 2.1)	
Statement	Letter(s)																
fMRI shows these areas of the brain to be active when playing a musical instrument	A or F																
Temperature-sensitive neurones are located in this area of the brain	C																
Traumatic injury to either of these areas can lead to over- or under-production of sex hormones.	C or D																
This region of the brain controls heart rate and breathing rate.	E																
Stroke affecting part of this area of the brain could cause loss of control of muscles in the arms or legs.	A																
			Total	4													

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance						
3	a		Plan should <u>only</u> show tissue regions and no cellular detail Entire specimen drawn AND 4 distinct regions shown AND drawn to appropriate scale AND covering a minimum of 50% of the box ✓ Sharp, clear and continuous lines drawn for each region AND label lines are drawn with a ruler and do <u>not</u> have arrow heads ✓ the 4 specified tissues labelled correctly ✓ <u>any</u> 4 tissues annotated correctly ✓	4 AO 2.3	There should not be any shading or other detail within the plan DO NOT ALLOW (mp1) if cells drawn DO NOT ALLOW (mp1) if the diagram has clearly just been traced DO NOT ALLOW (mp2) if label lines are not ruled or if the label lines have arrowheads Examples of suitable labels and annotations • grey matter = dark(er) pink/purple • white matter = light(er) pink/purple • central canal = white/central, void/area • meninges = red/purple exterior band /AW Additional tissues that could be identified by the candidate • dura matter = peripheral / outer, band / layer • posterior/dorsal, horn(s) = narrow(er) area • anterior/ventral, horn(s) = wide(r) area • lateral horn(s) = bulbous / pointed / AW • dorsal/ventral rootlets = pink/purple 'lobed' areas under dura / AW • ventral median fissure = thin, dark red/purple line • grey commissure = above central canal • white commissure = below central canal						
	b		(Fig 4.3 is an electron micrograph and has) <u>higher / greater. resolution</u> ✓	1 AO 1.2	IGNORE 'better' resolution						
	c		<table><tr><td>Parasympathetic nervous system</td><td>Sympathetic nervous system</td></tr><tr><td>acetylcholine ✓</td><td></td></tr><tr><td></td><td>ganglion is close to <u>spinal cord</u> ✓</td></tr></table>	Parasympathetic nervous system	Sympathetic nervous system	acetylcholine ✓			ganglion is close to <u>spinal cord</u> ✓	2 AO 1.1	
Parasympathetic nervous system	Sympathetic nervous system										
acetylcholine ✓											
	ganglion is close to <u>spinal cord</u> ✓										

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	7	
4			A	1 AO2.5	<u>Examiner's Comments</u> The most common incorrect distractor here was option C. Candidates were aware that adrenaline would increase the heart rate but adrenalin does not act on the accelerator nerve. High ability students were able to identify that a decrease in blood pH would trigger chemoreceptors which would cause the sympathetic region of the medulla oblongata to generate impulses along the accelerator nerve. So the correct answer was option A.
			Total	1	
5			B	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6	a	i	<i>Similarity (presence of)</i> axon / cell bodies / dendrites / synaptic knobs / myelin (sheath) / Schwann cells / nodes of Ranvier ✓ <i>difference</i> cell body at end of motor neurone AND cell body in middle of sensory neurone OR sensory neurone has a dendron / sensory neurone has short axon AND motor neurone has long axon ✓	2	IGNORE ref to function or direction of impulse. ALLOW suitably labelled diagrams DO NOT ALLOW both have long axons <u>Examiner's Comments</u> 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.  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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	both sensory and motor neurones are damaged ✓ impulse cannot, reach muscles / pass through motor neurone ✓ prevents impulse transmission, through sensory neurone / from receptors ✓	2 max	IGNORE signals/messages/information for 'impulses' ALLOW from stimulus for 'from receptors'. <u>Examiner's Comments</u> 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.
		iii	insulates (the axon) / prevents passage of ions ✓ saltatory conduction ✓ (this) increases / speeds up , (rate of) transmission of impulses ✓	2 max	IGNORE signals/messages/information for 'impulses' ALLOW action potential jumps from node to node for 'saltatory conduction'. <u>Examiner's Comments</u> Most candidates recognised myelin as an insulator and could either state saltatory conduction or describe it.  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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					descriptions can be found at: https://www.sciencedirect.com/topics/neuroscience/myelin (1aii & 1aiii)  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. Key Misconception 
		iv	Schwann cells	1	<u>Examiner's Comments</u> Generally, well answered although many candidates stated glial cells. There were a few NR for this question part.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	MRI / fMRI (functional MRI) / CT ✓	1	ALLOW lower case letters <u>Examiner's Comments</u> 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.  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. https://www.bing.com/videos/search?q=herniated+disc+mri&view=detail&mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&FORM=VIRE

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	1 (both) show difference, between healthy and damaged areas ✓ <i>MRI / fMRI</i> M2 uses magnet(s) / magnetic field ✓ M3 detects, increase in water (content) / swelling / inflammation / (changes in) blood flow ✓ M4 (can be used to) detect areas of demyelination ✓ OR <i>CT</i> C2 uses X-rays (and computer) ✓ C3 builds up 3-D image (of the spinal cord) ✓ C4 shows areas with, poor blood supply / bleeding / blood clot ✓	3 max	IGNORE ref to tumours or other conditions not related to SCI IGNORE ref to technique other than <i>1bi</i> answer ALLOW 3DMRI gives a 3D image <u>Examiner's Comments</u> 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.  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. https://www.bing.com/videos/search?q=herniated+disc+mri&view=detail&mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&FORM=VIRE

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		1 neural stem cells / human brain tissue stem cells / MSCs, are <u>multipotent</u> ✓ 2 (as) derived from adult (stem cells) / able to differentiate into a limited range of cell types ✓ 3 embryonic stem cells are <u>pluripotent</u> ✓ 4 (as) they can differentiate into any type of cell ✓	3 max	ALLOW ref to trial names (e.g. Balgrist / Neuralstem) for 'neural stem cells/MSCs' ALLOW pluripotent in the context of iPSCs ALLOW ref to Asterias trial for 'embryonic stem cells' ALLOW embryonic stem cells are <u>toti</u> potent as <u>early</u> embryo used <u>Examiner's Comments</u> Well answered with most candidates clearly extracting relevant information from the Advance Notice article. Marks were lost for confusing pluripotent with totipotent stem cells.  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.
	d		<i>Summary of instructions to markers:</i> <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 <i>italics</i>):</i> award the higher mark where the Communication Statement has		

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	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) 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. <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> Level 2 (3–4 marks) 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. <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> Level 1 (1–2 marks) 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. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of	6	Indicative scientific points may include Risks 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 Benefits 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 Ethical Destroying embryos Use of iPSCs Use of human brain tissue Gives false hope Future potential Stem cell therapies will be approved Use of iPSCs Data gathered can be used in future <u>Examiner's Comments</u>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			credit.		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. Exemplar 1 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 restoring neurons, replace lost myelin, and protect the cord from spreading the damage after injury. Then the financial, social, for 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, thereby making stem cells a great idea for the patient's spinal cord injury. You are also helping their family and support system. The risks associated with stem cell use created the stem cells from induced pluripotent stem cells. Another risk is with the use of stem cells on the patient the patient may have to take low level immunosuppression medication 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 receive human enhancement. 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. 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.
			Total	20	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a	i	homeostasis ✓	1	IGNORE negative feedback Examiner's Comments Most candidates achieved the mark for (a)(i) although a minority of candidates wrote negative feedback.
		ii	<u>chemoreceptors</u> ✓ <u>medulla oblongata</u> ✓ <u>parasympathetic</u> ✓ negative feedback ✓	4	Examiner's Comments 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'.
		iii	an objective / quantitative measurement OR level of pain is (too) subjective ✓ <i>idea that</i> heart rate is controlled by the autonomic nervous system ✓	1	Examiner's Comments 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.
	b	i	(opening of VGSC leads to) Na⁺ / sodium ions, entering, cell / neurone / receptor ✓ (leads to production of) generator potential ✓ (if potential) exceeds the threshold value / reaches -50mV ✓ positive feedback / more VGSCs open ✓ (this) creates an <u>action potential</u> ✓	3 max	DO NOT ALLOW Na⁺ / sodium ions, entering membrane Examiner's Comments 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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	drugs will not interfere with other types of VGSC ✓ other parts of the nervous system, continue to function / generate action potentials ✓	2	Examiner's Comments (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.
			Total	11	
8			A ✓	1	Examiner's Comments This question brought together various pieces of information about the autonomic nervous system. Incorrect response B was most common which indicated that some candidates had overlooked the fact that the pre-ganglionic neurotransmitter in the sympathetic nervous system is acetylcholine.
			Total	1	
9			B ✓	1	
			Total	1	
10			C ✓	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	cerebral cortex ✓	1	ALLOW cerebrum / hippocampus
		ii	<i>Please refer to the marking instructions on page X of this mark scheme for guidance on how to mark this question.</i> <i>In summary:</i> 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 <i>italics</i>): ◦ <i>award the higher mark where the Communication Statement has been met.</i> ◦ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • The science content determines the level. • The Communication Statement determines the mark within a level.		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Level 3 (5–6 marks) A comprehensive description of the action of acetylcholine and other neurotransmitters, including inhibitory neurotransmitters. <i>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.</i> Level 2 (3–4 marks) A description of the action of acetylcholine and reference to the idea of inhibitory neurotransmitters. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–2 marks) A description of the action of either an excitatory or an inhibitory neurotransmitter. <i>The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.</i> 0 marks No response or no response worthy of credit.	6	Indicative scientific points may include: • named excitatory neurotransmitter e.g. acetylcholine, glutamate • named inhibitory neurotransmitter e.g. GABA • neurones interact at synapses • formation of new synapses linked to memory • neurotransmitter released from pre-synaptic membrane by exocytosis • neurotransmitter released following arrival of action potential in pre-synaptic neurone • entry of calcium ions causes vesicles containing neurotransmitter to fuse with pre-synaptic membrane • neurotransmitter diffuses across the synaptic cleft • neurotransmitter binds to complementary receptor on post synaptic membrane • (excitatory) results in opening of (ligand or chemical gated) sodium ion channels • sodium ions enter post synaptic neurone • post-synaptic membrane is depolarised • (inhibitory) causes potassium ions to leave post-synaptic neurone • (inhibitory) causes chloride ions to enter post synaptic neurone • (inhibitory) hyper-polarises the post-synaptic membrane (becomes more negative)
	b	i	600 ✓✓	2	For incorrect reading(s) from the graph but a correct calculation allow 1 max

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	<i>idea that</i> (over trial period), cognitive function improved / was higher than baseline for all three drugs tested OR <i>idea that</i> no significant difference between the three drugs OR <i>idea that</i> improvement not sustained / dropping back to baseline ✓ figures given in support ✓	2	
		iii	(the curve would) plateau / AW, below the curve in Fig. 4.2 ✓	1	
	c		<i>idea that</i> higher drug concentration will be needed to achieve same effect ✓ <i>idea of</i> tolerance linked to physical drug dependency ✓	2	
			Total	14	

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
				1	mp 1,2 in that order plus mp 5 or mp 6 Examiner's Comments 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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	<i>any two from:</i> restlessness / involuntary movements / twitching / shaking muscle / bone pain diarrhoea vomiting sweating / fever irritability / anger / aggression increased heart rate confusion hallucinations depression seizures headache insomnia fatigue mood swings	1	Mark the first answer on each line ACCEPT alternative correct symptoms
		ii	Parkinson's (disease);	1	CREDIT Tetanus, Meniere's disease, Multiple sclerosis IGNORE anxiety Examiner's Comments (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).
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																		
13	a		<table><tr><th rowspan="2">Feature or activity</th><th colspan="2">Branch of autonomic nervous system</th></tr><tr><th>Parasympathetic</th><th>Sympathetic</th></tr><tr><td>Type of neurone</td><td></td><td>motor</td><td rowspan="5">;</td></tr><tr><td>Process triggered in liver cells</td><td><u>glycogenesis</u></td><td><u>glycogenolysis</u></td></tr><tr><td>Effect on heart rate</td><td>decrease</td><td>increase</td></tr><tr><td>Neurotransmitter released at the SAN</td><td><u>acetylcholine</u></td><td></td></tr></table>	Feature or activity	Branch of autonomic nervous system		Parasympathetic	Sympathetic	Type of neurone		motor	;	Process triggered in liver cells	<u>glycogenesis</u>	<u>glycogenolysis</u>	Effect on heart rate	decrease	increase	Neurotransmitter released at the SAN	<u>acetylcholine</u>		4	DO NOT CREDIT incorrect spelling of underlined terms since these have been provided Examiner's Comments 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.
Feature or activity	Branch of autonomic nervous system																						
	Parasympathetic	Sympathetic																					
Type of neurone		motor	;																				
Process triggered in liver cells	<u>glycogenesis</u>	<u>glycogenolysis</u>																					
Effect on heart rate	decrease	increase																					
Neurotransmitter released at the SAN	<u>acetylcholine</u>																						
	b	i		hypothalamus;	1	ACCEPT phonetic spelling Examiner's Comments Answered well.																	
		ii	medulla (oblongata);	1	ACCEPT phonetic spelling Examiner's Comments Answered well although some candidates mistook the medulla for the spinal cord.																		
		iii	two symptoms of hypothermia;	1	CREDIT any two of the following symptoms for one mark: stops shivering little or no breathing weak/irregular/no pulse difficulty speaking poor coordination / laboured movement confusion																		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	<i>core rewarming</i> temperature of, medulla (oblongata) / X, restored (rapidly) and <i>idea that</i> heart rate / pulse rate, is controlled (by medulla); temperature of, medulla (oblongata) / X, restored (rapidly) and <i>idea that</i> breathing rate, is controlled (by medulla); cerebrum temperature is restored and speech controlled (by cerebrum); cerebrum temperature is restored and cognitive function controlled (by cerebrum); temperature of, medulla (oblongata) / X, restored (rapidly) and shivering, is controlled by autonomic nervous system (in medulla); cerebellum temperature is restored (faster) and movement coordination, restored / AW;	2	LOOK FOR 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. ACCEPT ref to frontal lobe, motor cortex ACCEPT reference to muscles being coordinated by the cerebellum for this mark ACCEPT movement becomes less laboured IGNORE unconscious Examiner's Comments 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.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14			<i>part of nervous system</i> central / CNS AND <i>exact location</i> hypothalamus; ✓	1	Both correct answers required for the mark <u>Examiner's Comments</u> The commonest incorrect responses were spinal cord or autonomic.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a		B cerebellum; C medulla (oblongata);	2	Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks ACCEPT 'brain stem / hind brain' <u>Examiner's Comments</u> 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.
	b	i	<i>idea of an automatic / fixed pattern, response;</i> (given) stimulus / described; blink (reflex test) / pupil response (reflex test) / knee jerk (reflex test) / AW;	3	e.g. a stereotypical or unlearned or involuntary response or look for the idea that the response has a form that is always predictable e.g. light shone in eye, striking the patellar tendon IGNORE a general description of a reflex arc which is not in the context of <i>testing</i> a reflex <u>Examiner's Comments</u> 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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(left) cerebral hemisphere / (left side of) cerebrum / (left) frontal lobe / Broca's area;	1	ACCEPT '(left side of) A' '(left side of) fore brain' IGNORE left side of brain / left side unqualified IGNORE parietal lobe <u>Examiner's Comments</u> 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. 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.
	c	i	(plasmin is) an enzyme / globular protein; breaks down / digests / AW, fibrin;	2	CREDIT hydrolysis of fibrin IGNORE ref to 'anticoagulant' ACCEPT (as ecf) mechanism for anticoagulant e.g. removal of calcium ions or (COX) enzyme inhibitor

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	eukaryotic cell / named eukaryotic (animal) cell; (glycoprotein) needs Golgi (apparatus) to, modify / add sugars to, protein OR prokaryotic cells do not have Golgi apparatus; AVP;	2	CREDIT named eukaryotic cell line e.g. Chinese hamster ovary cells ACCEPT 'stem cells' DO NOT CREDIT 'bacteria' or 'prokaryotic' for mp1 but allow 'ecf' for mp 2 (as in AVP) e.g. ease of growing in laboratory, rapid growth rate, can take up plasmids (for prokaryotic cells) <u>Examiner's Comments</u> In (ii) where candidates correctly stated a 'eukaryotic' cell then they invariably went on to explain why and scored both marks. Texts frequently give examples of commonly used eukaryotic cell lines such as Chinese Hamster Ovary cells which probably explains why several candidates gave an 'ovum' incorrectly as an example.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	33;;	2	Correct answer = 2 marks If answer is incorrect: Award one mark for correct calculation of weight ($67.5 \div 0.9 = 75$) OR for a BMI given as 33.3(3333333) OR for correct BMI calculated from an incorrect body weight (e.g. a body mass divided by 2.25 (height in metres squared) (given to the nearest whole number) <u>Examiner's Comments</u> In (iii) the calculation was done well with the majority of candidates stating the correct answer to the required degree of precision.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	<i>for body mass calculated above 30</i> <i>idea that</i> (BMI means that, Mrs G is) obese / obesity is a risk factor; (risk of) high blood pressure / high (blood) cholesterol / atherosclerosis / described; <i>for body mass calculated less than 25,</i> <i>applying ecf</i> another risk factor (other than BMI) may have contributed to stroke; <i>(for any body mass calculation)</i> example of other risk factors (independent of BMI);	2	CREDIT reference to 'overweight' rather than obesity if BMI was calculated to be between 25 and 30 IGNORE reference to overweight (other than in above statement) ACCEPT (risk of) diabetes ACCEPT idea that this BMI does not pose an increased risk e.g. smoking / used HRT / age / family history <u>Examiner's Comments</u> Part (iv) asked them to interpret this answer and was synoptic to F222. A common mistake was to state that a BMI of 33 meant that the person was overweight rather than obese but otherwise this question was done well.
	d	i	<i>idea that</i> unable to remember what, has just happened / is currently happening;	1	CREDIT a description such as 'can't remember things from a few days ago' <u>Examiner's Comments</u> 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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	have a calendar so patient can keep track of days; leave reminder notes around; place a selection of objects on a tray, cover them and ask them to remember; show patient recent photos to remember people / photos of current celebrities from magazines / AW; repetition of activities; AVP;	2	ACCEPT <i>idea of</i> 'cues' or 'prompts' ACCEPT Kim's game or a similar memory game described CREDIT ONCE ONLY references to showing photos or images as the question asks for different techniques
			Total	17	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16	a		somatic (motor neurone);	1	ACCEPT voluntary DO NOT CREDIT sympathetic Examiner's Comments 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.
	b	i	57 / 58 mms ⁻¹ ;;	2	Correct answer = 2 marks If answer is incorrect, look for 200 / 3.5 OR 20/3.5 = 1 mark 6 = 1 mark (they have calculated (5.7) correctly but not converted cm to mm) CREDIT 1 mark for an error carried forward for $200 \div x$ (any number) if answer is correct and a whole number

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	<i>idea that</i> myelin sheath is not present at birth OR myelin sheath takes time to develop; AVP;	1	DO NOT CREDIT reference to nervous system not being fully developed IGNORE reference to shorter axons / neurones e.g. ref to neurones having a smaller diameter Examiner's Comments 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.

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	<i>idea that</i> Conduction velocity slows, (significantly) / AW (over 5 years); <i>idea that</i> (means) not all neurones change at the same rate OR (confidence limits) changes within the same nerve varies within populations;	2	CREDIT answers in either order ACCEPT reference to age slowing transmission in neurones (without further qualification). DO NOT CREDIT references to either nerve being faster or slower (since the data is about change in velocity) ACCEPT nerve 1 changes more than nerve 2 Examiner's Comments 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.
			Total	16	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	<i>variance for leg muscle</i> 29.16 AND <i>variance for wing muscle</i> 136.89 (1)	1	Look for answer written outside of the table
		ii	<i>t value</i> 3.558 (1)(1)(1)	3	DO NOT ALLOW if negative sign is given If incorrect t value is given, marks can be given for intermediate stages as follows: <i>one mark for modulus calculation 14.5</i> <i>one mark for denominator calculation prior to square rooting 16.605</i> AWARD ecf from either / both previous calculations
		iii	Any 3 from: t_{critical} is 2.101 at 5% probability level (1) the (calculated) value is greater than the critical value at the 5% ($p = 0.05$) significance level (1) the (calculated) value is also greater than the critical value at the 1% ($p = 0.01$) significance level (1) (therefore the student can) reject the null hypothesis (1) the difference in enzyme activity is not due to random chance (1)	3	
		iv	precision of the leg muscle is greater (than the data for the wing muscle) AND as the SD for the wing muscle is higher than that of the SD for the leg muscle (1)	1	ALLOW use comparative use of figures
		v	(<i>chicken leg muscle</i>) <i>idea that</i> higher catalase activity so more, aerobic respiration / oxidative phosphorylation (1)	1	
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18	a	i	variable: distance of arm from sensor (1) control: keep distance same for both hand and arm (1) variable: (room) temperature (1) control: any reasonable control procedure (1) variable: activity of student (1) control: any reasonable control procedure (1)	4	ALLOW other alternative variables linked to an appropriate control procedure e.g. stay in same place in the room throughout, keep all doors and windows closed e.g. make sure arm is still throughout
		ii	$t = 109 (1)(1)(1)(1)$	4	Correct answer = 4 marks If answer incorrect, look for the following: $\Sigma d^2 = 2150 = 1 \text{ mark}$ $(2150 - 2146.592) \div 19 = 1 \text{ mark (0.17937)}$ Sqrt of 0.17937 = 0.42352 = SD = 1 mark $(10.36 \times 4.472) \div \text{SD} = 1 \text{ mark}$
		iii	<i>idea that</i> means can be calculated for hand and arm (1) <i>idea that</i> both data sets come from one individual (1)	2	
		iv	larger surface area to volume ratio in fingers (1) more heat loss from surface of fingers (1) more muscle mass in upper arm (1) more heat generated (in muscle) (1)	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	* Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but 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 set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. In summary: • The science content determines the level. • The communication statement determines the mark within a level.		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (5–6 marks) Provides a comprehensive description of the responses to falling and rising temperatures and links the responses correctly to the information in Fig.3.2 for both groups. <i>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.</i> Level 2 (3–4 marks) Describes some of the responses to falling and rising temperatures and links the responses correctly to the information in Fig.3.2 for either Group A or B. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–2 marks) Describes some of the responses to falling and rising temperatures with limited references Figure 3.2. <i>There is a logical structure to the answer. The explanation, though basic, is clear.</i> 0 marks No response or no response worthy of credit.	6	Indicative scientific points may include <i>When temperatures fall (Group A):</i> • vasoconstriction of arterioles in skin • reduced blood flow in skin capillaries • (so) vasoconstriction leads to less heat lost by radiation • hairs (on skin) pulled to vertical position • (so) less heat lost by convection • insulation conserving heat • shivering leads to more heat released through repeated muscle contraction • heat released from increased respiration rate <i>When temperatures fall (Group B):</i> • Group B show no change in blood flow on cooling • No evidence of vasoconstriction • (B) would continue to lose heat on cooling (resulting in hypothermia) <i>When temperatures rise (both):</i> • vasodilation of arterioles in skin • increased blood flow in surface capillaries • (so) more heat lost through radiation • sweating • (so) heat loss through evaporation of sweat • hairs lie flat • (so) more heat lost by convection
			Total	18	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																																			
19	a	i	0.45 mm (1)(1)	2	If answer is incorrect look for: 90 ÷ 200 OR 9 ÷ 200 OR 0.045 for max 1 mark																																			
		ii	myelin sheath	1																																				
	b		<table><tr><th>Description</th><th>Sensory</th><th>Motor</th><th>Autonomic</th><th>Somatic</th></tr><tr><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>(1)</td></tr><tr><td></td><td></td><td>✓</td><td>✓</td><td></td><td>(1)</td></tr><tr><td></td><td>✓</td><td></td><td>(✓)</td><td>(✓)</td><td>(1)</td></tr><tr><td></td><td>✓</td><td>✓</td><td></td><td>✓</td><td>(1)</td></tr><tr><td></td><td></td><td>✓</td><td>✓</td><td></td><td>(1)</td></tr></table>	Description	Sensory	Motor	Autonomic	Somatic			✓	✓	✓	(1)			✓	✓		(1)		✓		(✓)	(✓)	(1)		✓	✓		✓	(1)			✓	✓		(1)	5	One mark for each correct row IGNORE autonomic or somatic for this mark point
Description	Sensory	Motor	Autonomic	Somatic																																				
		✓	✓	✓	(1)																																			
		✓	✓		(1)																																			
	✓		(✓)	(✓)	(1)																																			
	✓	✓		✓	(1)																																			
		✓	✓		(1)																																			
			Total	8																																				
20		i	Any 3 from: Idea that levodopa is used, late in treatment plan / when symptoms become worse OR dosage of levodopa increased over time to delay / AW, onset of dyskinesia procyclidine / dopamine agonists, given in early stages idea of use of entacapone in late stages (with levodopa) needs to be monitored (to avoid worsening dyskinesia)	3																																				
		ii	Any 2 from: binds / attaches, to receptor on postsynaptic, membrane / neurone sodium channels open sodium, moves / diffuses, into postsynaptic neurone	2																																				
			Total	5																																				

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
21	* Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but 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 set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. In summary: • The science content determines the level. • The communication statement determines the mark within a level. Level 3 (5–6 marks) Provides a comprehensive explanation of the speciation process, including the ideas of geographical isolation, selection pressures and adaptations. <i>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</i>	6	Indicative scientific points may include • geographical isolation / allopatric speciation / canyon is physical barrier • (different) selection pressures for each population / in North / South rim areas • example of selection pressure difference • (original) gene pool had allelic variation • different mutations (in separated populations) • alleles / mutations may provide improved adaptation to environment • mutations / alleles passed to offspring • by surviving / selected individuals IGNORE genes passed to offspring • change in allele frequencies / genetic variation between populations • genetic drift • past bottleneck event

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<i>continuous narrative.</i> Level 2 (3–4 marks) Provides an outline of the speciation process, with some ideas about geographical isolation, selection pressures and / or adaptations. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–2 marks) Shows limited understanding of the speciation process, which may include the idea of geographical isolation. <i>There is a logical structure to the answer. The explanation, though basic, is clear.</i> 0 marks No response or no response worthy of credit.		
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22	a		E / F (1) F (1) A (1) D (1)	4	ALLOW C in place of A
	b	i	any 3 from: shows which parts of brain are active (1) magnetic properties of oxyhaemoglobin and deoxyhaemoglobin different (1) higher blood flow / oxygen uptake, in active regions (1) greater emission of radio signal from active regions (1) produces 3D image (1)	3	ALLOW oxygenated / deoxygenated blood ALLOW hb for haemoglobin ORA ORA IGNORE ref to brain damage
		ii	any 2 from: real-time measurement / CT only gives still image (1) view brain activity directly (1) greater soft tissue detail / contrast / resolution (1) no need for, dyes / contrast agents (1) no exposure to radiation (1)	2	IGNORE ref to safety unqualified
		iii	electroencephalography / EEG	1	ALLOW magnetoencephalography / MEG
			Total	10	
23			B	1	
			Total	1	
24			D	1	
			Total	1	
25			B	1	
			Total	1	
26			C	1	
			Total	1	