1 Humans have a nervous system that has a variety of neurones.

(a) The human brain is made up of a number of areas containing many millions of neurones.

Place a cross in the box ☒ that identifies the areas of the brain associated with riding a bicycle uphill.

(i) the decision to ride the bicycle

(1)

☒ **A** cerebrum

☒ **B** cerebellum

☒ **C** hypothalamus

☒ **D** medulla

(ii) initiating an increase in sweating during the ride

(1)

☒ **A** cerebrum

☒ **B** cerebellum

☒ **C** hypothalamus

☒ **D** medulla

(b) Voltage-gated K^+ and Na^+ channels are involved in the transmission of impulses in sensory and motor neurones.

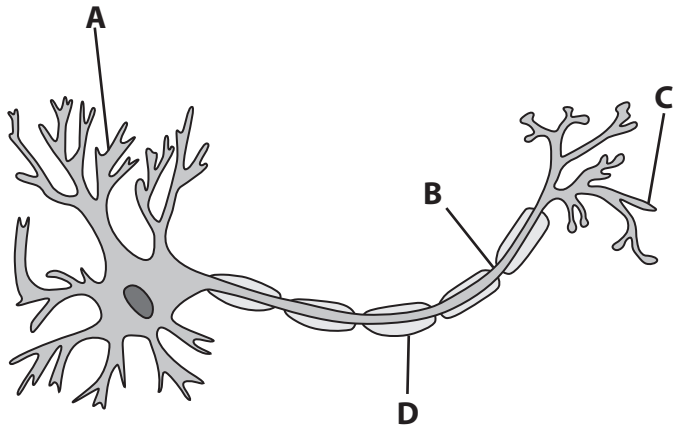
(i) The table below identifies two stages in the transmission of an impulse in a sensory neurone.

Place a tick (✓) in each box that correctly identifies whether the channels are open or closed during these two stages.

(2)

Stage	Voltage-gated K^+ channels open	Voltage-gated K^+ channels closed	Voltage-gated Na^+ channels closed
Depolarisation			
Repolarisation			

(ii) The diagram below shows a myelinated motor neurone.



Place a cross in the box ☒ that labels the site where neurotransmitters bind and initiate depolarisation.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(iii) Describe the differences in the structure of a myelinated sensory neurone and a myelinated motor neurone.

(3)

(Total for Question 1 = 8 marks)

2 An investigation was carried out to study the effect of light on the mammalian retina.

Part of the retina of a young rat was removed and kept in the dark for two hours. This allowed the pigment in the rod cells to recover from bleaching caused by exposure to light.

(a) Suggest what happens in the rod cells during this two hours of darkness.

(5)

(b) When the retina had recovered from bleaching, the resting potential of the bipolar neurones in the retina was found to be –43 mV.

The retina was then exposed to a range of light intensities. Each light intensity caused the bipolar neurones to depolarise. The peak voltage of the depolarisation for each light intensity was recorded.

All other variables were kept constant.

The investigation used retinas from an additional 14 rats.

The mean results are shown in the table below.

Light intensity / arbitrary units	**Mean peak voltage of depolarisation / mV**
1	11
3	18
6	19
9	20
12	20

(i) Using the information in the table, describe the effect of light intensity on the mean peak voltage of depolarisation.

(2)

(ii) Suggest an explanation for the effect of light intensity on the mean peak voltage of depolarisation in these neurones.

(4)

(c) Suggest **two** reasons why some people might have objections to the use of rats in this investigation.

(2)

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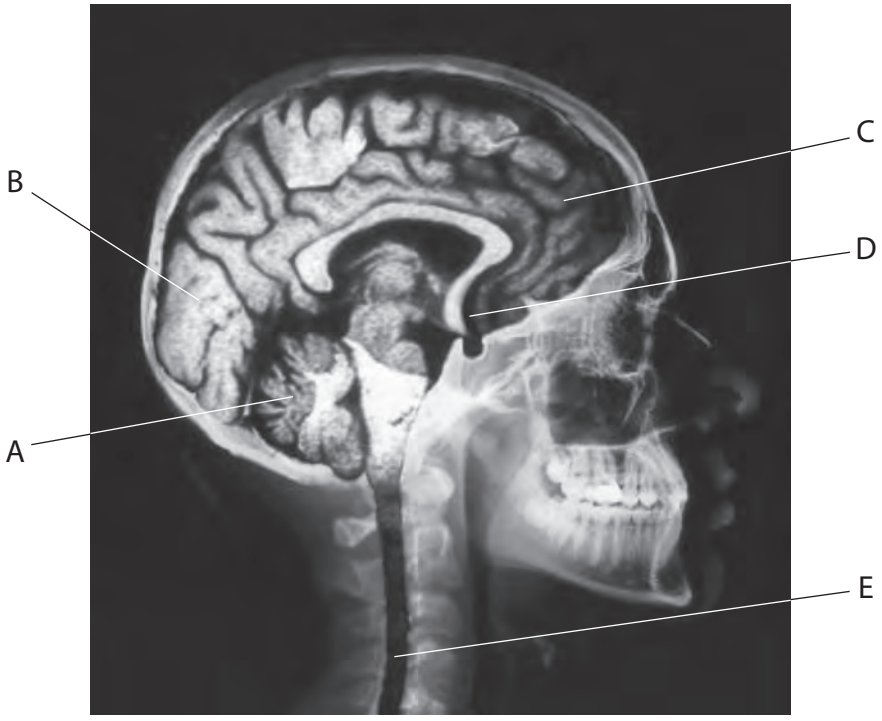
(Total for Question 2 = 13 marks)

3 The central nervous system (CNS) is made up of the brain and the spinal cord.

(a) The image below of a human head and neck shows part of the CNS.



Using the image and your knowledge, complete the table below.

(4)

Labelled structure	Name of structure	One function
A		
		Thermoregulation

(b) The structure involved in thermoregulation may cause sweat glands to release more sweat.

Explain how increased sweating is involved in the regulation of body temperature.

(3)

(c) The photograph below shows a California sea lion (*Zalophus californianus*), a large marine mammal.

Magnification × 0.005

Domoic acid is a neurotoxin, produced by algae, that harms the brains of these mammals. This neurotoxin damages brain cells that release a neurotransmitter called glutamate.

(i) Describe how a neurotransmitter, such as glutamate, is released from a brain cell.

(4)

(ii) Scientists have used magnetic resonance imaging (MRI) to provide evidence that domoic acid may damage the brains of California sea lions.

Suggest how MRI can provide this evidence.

(2)

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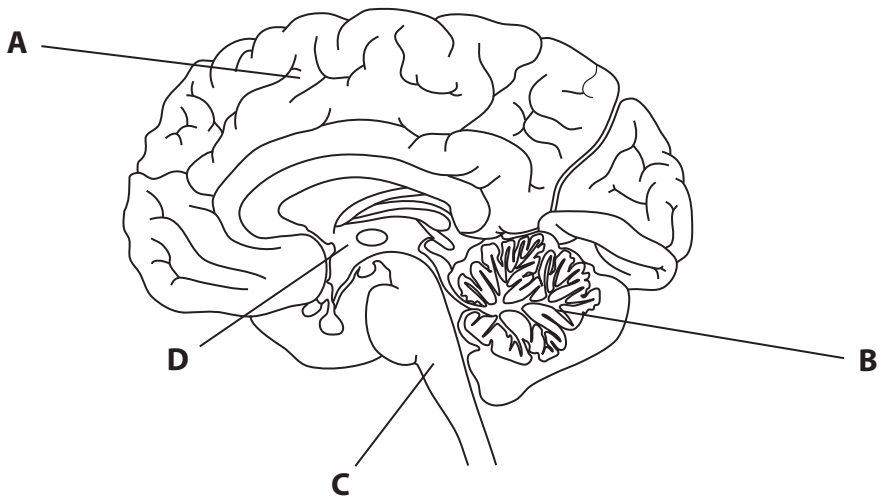
(Total for Question 3 = 13 marks)

4 (a) The brain acts as the main coordinating centre for nervous activity. It receives information, interprets it and responds accordingly.



(i) Coordination of movement is controlled by the part of the brain labelled

(1)

☒ **A** Cerebral hemisphere

☒ **B** Cerebellum

☒ **C** Medulla oblongata

☒ **D** Hypothalamus

(ii) During exercise, chemoreceptors in the carotid artery detect a decrease in pH due to increased carbon dioxide.
This results in nerve impulses being sent to the

(1)

☒ **A** Cerebral hemisphere

☒ **B** Cerebellum

☒ **C** Medulla oblongata

☒ **D** Hypothalamus

(b) At the start of depolarisation, the ions that move into the axon causing the action potential are

(1)

- ☒ **A** Calcium
- ☒ **B** Chloride
- ☒ **C** Potassium
- ☒ **D** Sodium

(c) When an impulse arrives at a synapse, the ions that enter the pre-synaptic membrane are

(1)

- ☒ **A** Calcium
- ☒ **B** Chloride
- ☒ **C** Potassium
- ☒ **D** Sodium

(d) Acetylcholine is a chemical which acts as

(1)

- ☒ **A** an enzyme
- ☒ **B** a hormone
- ☒ **C** a neurotransmitter
- ☒ **D** a receptor

(e) The drug MDMA (ecstasy) changes behaviour by

(1)

- ☒ **A** decreasing the concentration of adrenaline in brain synapses
- ☒ **B** decreasing the concentration of serotonin in brain synapses
- ☒ **C** increasing the concentration of adrenaline in brain synapses
- ☒ **D** increasing the concentration of serotonin in brain synapses

(Total for Question 4 = 6 marks)