1 **(a)** Outline the ways in which the **structures** of a sensory neurone and a motor neurone are **similar**.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[4]**

(b) The table below lists a number of statements about the functions of neurones. Indicate whether each statement refers to:

- sensory neurones only (**S**)
- motor neurones only (**M**)
- sensory **and** motor neurones (**B**).

Statement	**S** or **M** or **B**
Have a resting potential of approximately –70 mV	**B**
Transmit nerve impulses from the CNS	
Connect to other neurones via synapses	
Connect to effectors	

[3]

(c) The presence of a pathogen in the body can cause a fever. During a fever, the body's thermoregulatory set-point (normal body temperature) rises.

(i) Fever is accompanied by sweating.

Explain the effect that this sweating will have on the body.

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..... **[2]**

(ii) Another feature of fever may be uncontrollable shivering.

Suggest why shivering occurs during fever.

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

(d) Hypothermia is a condition in which the body's core temperature is lowered. Hypothermia can affect people who take part in outdoor activities in winter without wearing suitable clothing.

Some people think that alcohol should be given to those who have hypothermia, as it makes them feel warmer. Alcohol causes vasodilation.

Explain why it is **not** a good idea to give alcohol to someone with hypothermia.

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..... **[2]**

[Total : 12]

2 The skin is important in enabling the body to detect changes in the environment. This allows the body to respond to these changes.

(a) Various types of sensory receptor are located in the skin.

Fig. 2.1 is a photomicrograph of a **transverse section** through a pressure receptor known as a Pacinian corpuscle.

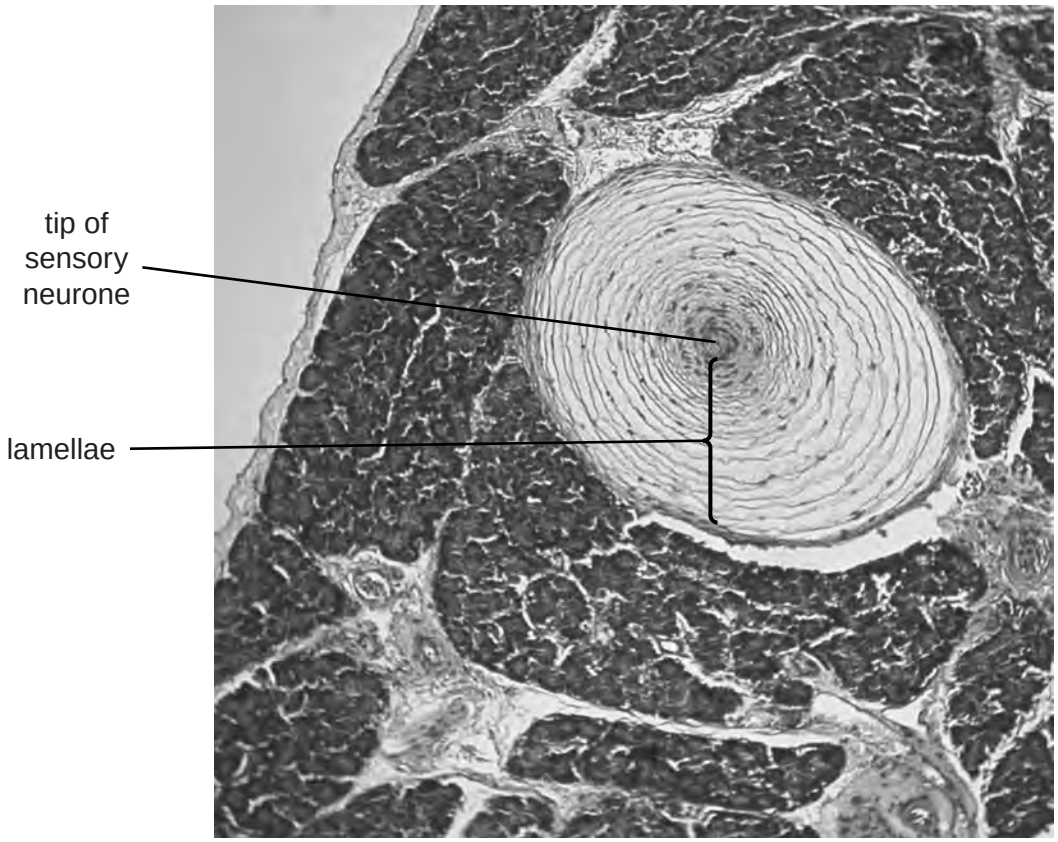

Fig. 2.1

Fig. 2.2 is a diagram of a **longitudinal section** through a Pacinian corpuscle. The tip of the sensory neurone is not covered by the myelin sheath.

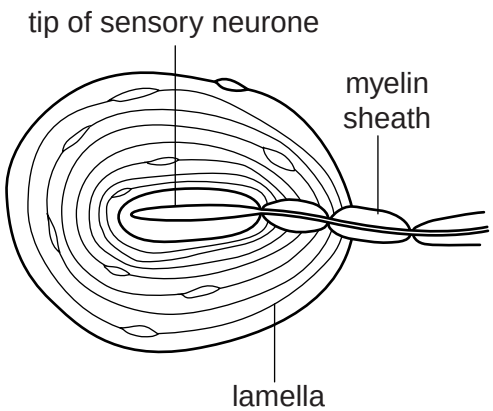

Fig. 2.2

The Pacinian corpuscle is a type of biological transducer.

- As a pressure stimulus is exerted on the corpuscle, the lamellae are compressed and exert pressure on the tip of the sensory neurone.
- The plasma (cell surface) membrane of the tip of the neurone becomes deformed and more permeable to sodium ions (Na^+).
- This region of the neurone becomes depolarised, reaching the threshold potential, and an action potential is generated.

(i) Why is the Pacinian corpuscle described as a transducer?

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

(ii) Deformation of the plasma membrane of the tip of the neurone causes the membrane to become more permeable to Na^+.

Suggest why.

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

(iii) The generation of an action potential follows the 'All-or-Nothing' law.

Explain what this means.

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

(iv) Describe how information about the strength and intensity of a stimulus is communicated to the brain.

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..... **[2]**

(b) When clothes are first put on the body, a constant gentle pressure is applied to the pressure receptors in the skin. After a short time, action potentials are no longer generated unless there is a change in pressure as the clothes move over the surface of the skin.

Suggest an explanation for the fact that action potentials are not generated constantly whilst wearing clothes.

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

(c) Synapses are an integral part of the nervous system.

Outline the roles of synapses in the nervous system.

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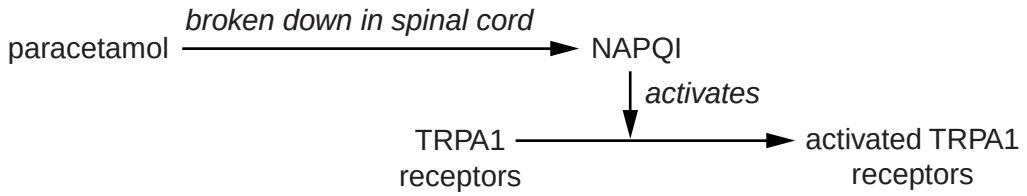
..... **[3]**

[Total: 9]

3 **(a)** Paracetamol is a drug that is commonly used as a painkiller. For many years, scientists have been uncertain about the way in which paracetamol works.

A recent study has shown that:

- paracetamol is broken down in the spinal cord into a compound called NAPQI
- NAPQI activates a receptor protein called TRPA1
- TRPA1 is found on the plasma (cell surface) membranes of neurones
- the activated receptor protein, TRPA1, interferes with the transmission of the nerve impulses from one neurone to the next.



(i) Name **one** chemical that transfers a nerve impulse from one neurone to another.

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

(ii) Suggest the part of the neurone where the plasma membrane has TRPA1 receptors.

Explain your answer.

part of neurone .....

explanation .....

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[2]

(b) One role of the liver is detoxification. Detoxification includes the breakdown of drugs such as paracetamol.

(i) Fig. 4.1 is a diagram that represents the structure of part of a liver lobule.

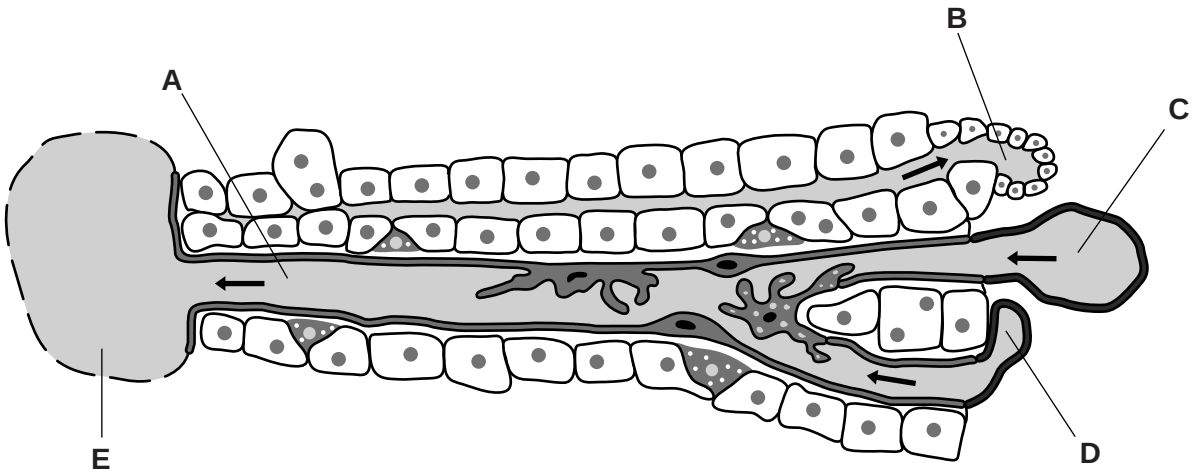

Fig. 4.1

Identify the parts labelled **A** to **E**.

A .....

B .....

C .....

D .....

E .....

[5]

(ii) During detoxification, paracetamol is metabolised in the liver cells as follows:

- approximately 90% is combined with two chemicals, sulfate and glucuronide, and excreted
- approximately 5% is oxidised by the P450 enzyme system, which produces NAPQI
- the NAPQI is then metabolised using another compound called glutathione.

Once the sulfate and glucuronide reserves in the liver are used up, the P450 system takes over completely. However, continued metabolism of paracetamol will result in high concentrations of NAPQI accumulating in the liver cells, causing cell death.

Suggest a reason for the accumulation of high concentrations of NAPQI in the liver cells.

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

(iii) The liver has considerable powers of regeneration, even if a high proportion of its cells are damaged.

Name the liver cells that can lead to this regeneration **and** the type of cell division that they carry out.

name of liver cells .....

type of cell division ..... **[1]**

[Total: 10]

4 **(a)** Fig. 1.1 represents a cross section through a myelinated neurone.

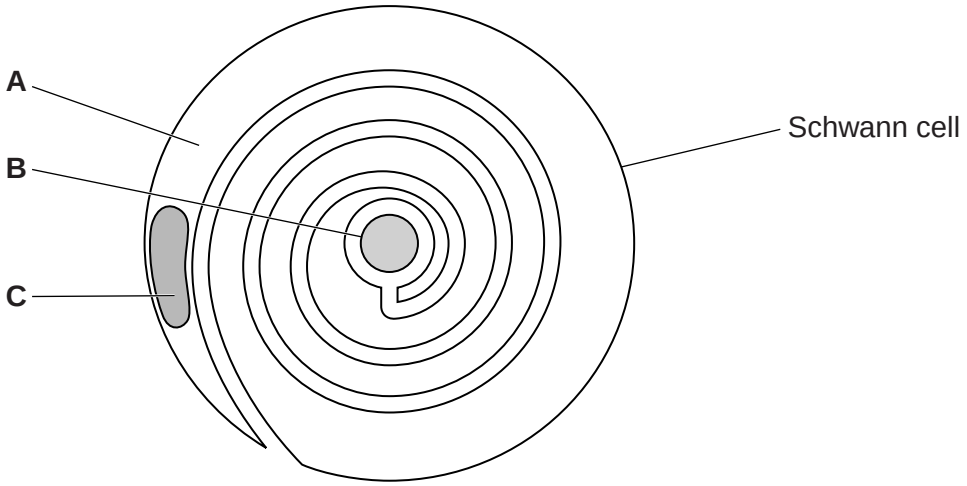

Fig. 1.1

(i) Identify **A** to **C**.

A .....

B .....

C .....

[3]

(ii) Name the gap between two adjacent Schwann cells along the length of the neurone.

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

(b) There are a number of differences between myelinated and non-myelinated neurones. One difference is the distribution of voltage-gated sodium ion channels in the membrane.

myelinated neurone

- voltage-gated sodium ion channels only occur at gaps between Schwann cells
- each gap is approximately 2 μm long
- gaps occur at approximately 1000 μm intervals

non-myelinated neurone

- voltage-gated sodium ion channels occur along the total length of the neurone

Use the information above to explain the difference in the speed of conduction of an action potential along the length of a myelinated neurone and a non-myelinated neurone.

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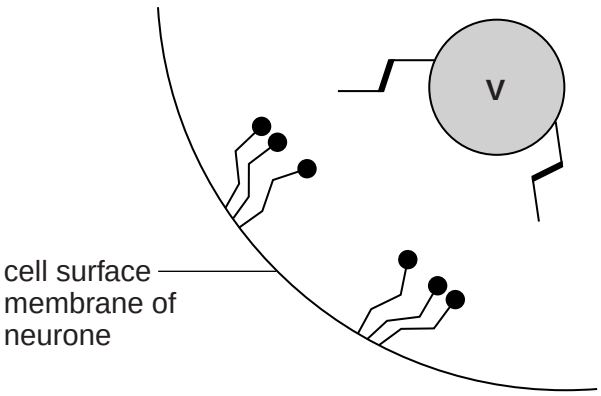
..... **[4]**

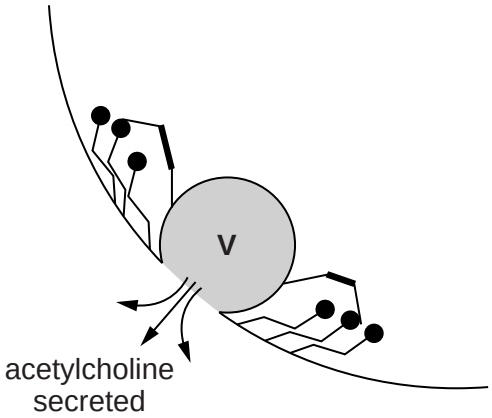
(c) A family of membrane proteins known as SNARE proteins are attached to vesicle membranes and cell surface membranes.

Fig. 1.2 summarises the mechanism by which vesicles secrete acetylcholine from a neurone.



Vesicle (**V**) has a type of SNARE protein attached to its membrane. This protein is known as vesicle associated membrane protein (VAMP).

The cell surface membrane of the neurone has a complex of SNARE proteins attached to it.



When the VAMP protein locks onto the SNARE complex, it enables the vesicle membrane to fuse with the cell surface membrane. This allows secretion of acetylcholine from the neurone.

Fig. 1.2

(i) Name the process by which the acetylcholine is secreted.

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

(ii) Name the part of a neurone from which acetylcholine is secreted.

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

(iii) Botulinum toxin is a protease that is produced by the bacterium, *Clostridium botulinum.*

If this toxin is present in the body, for example as a result of eating contaminated food, the toxin enters neurones.

With reference to Fig. 1.2, suggest, with reasons, the effects that botulinum toxin may have once it has entered a neurone.

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..... **[2]**

[Total: 12]

5 Organisms respond to changes in their internal environment. These responses are controlled by nervous and hormonal mechanisms.

(a) The concentration of blood glucose is regulated by hormones.

Complete the passage below, using the **most suitable** term in each case.

The pancreas releases hormones directly into the blood and these regulate the concentration of blood glucose. The pancreas, therefore, acts as an ..... gland.

When the blood glucose concentration increases, insulin is released from the beta cells in the regions of the pancreas known as the ..... .

A different hormone, glucagon, is released from the alpha cells of the pancreas and this hormone causes ..... to be broken down into glucose, in a process known as ..... . **[4]**

(b) The heart rate is controlled by both nervous and hormonal mechanisms.

(i) Name **one** hormone which will **increase** the heart rate.

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

(ii) State **one** way in which the nervous system **decreases** the heart rate.

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

[Total: 6]

6 **(a)** Fig. 1.1 represents a sensory neurone connected to its associated receptor cells.

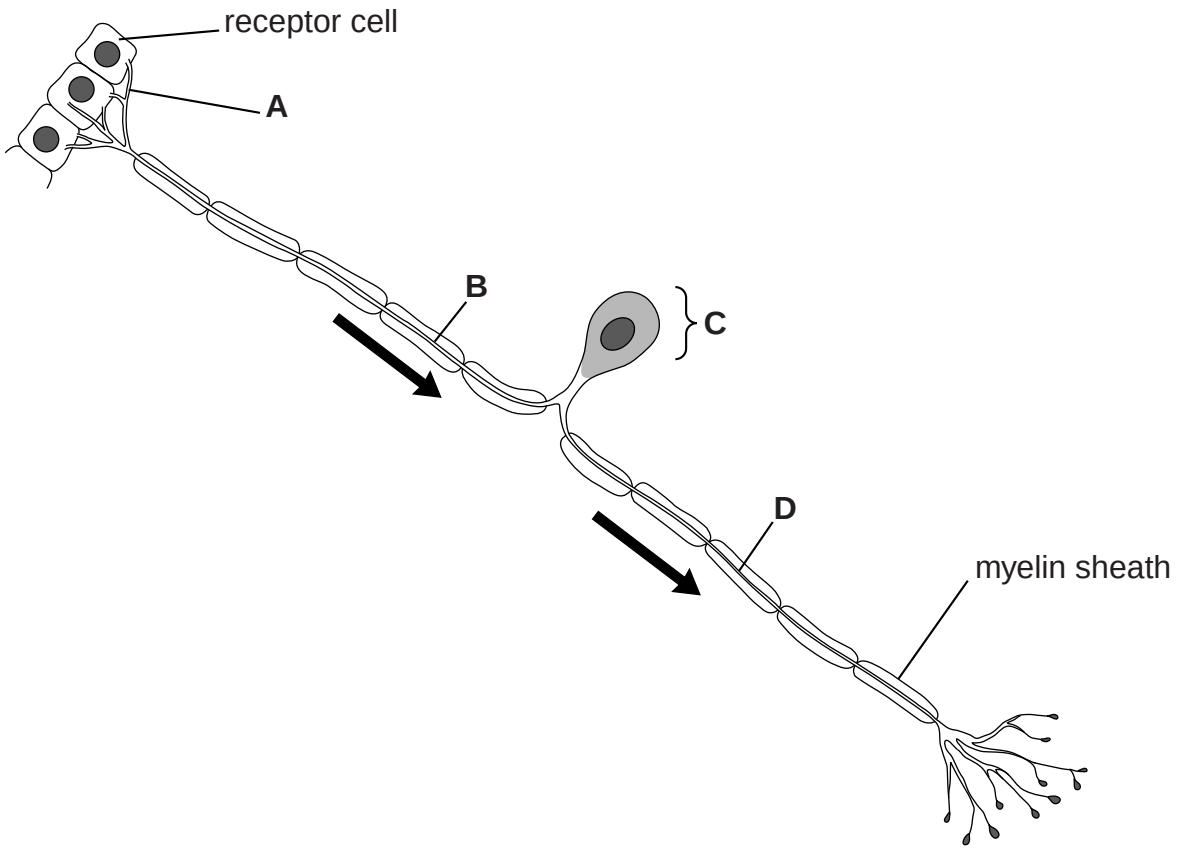

Fig. 1.1

(i) Identify the parts of the neurone labelled **A** to **D**.

A .....

B .....

C .....

D .....

[4]

(ii) What is represented by the arrows on Fig. 1.1?

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

(b) Describe and explain how the **resting potential** is established **and** how it is maintained in a sensory neurone.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[4]**

(c) Fig. 1.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

Fig. 1.3 indicates the strength of the stimuli that results in the corresponding changes in membrane potential.

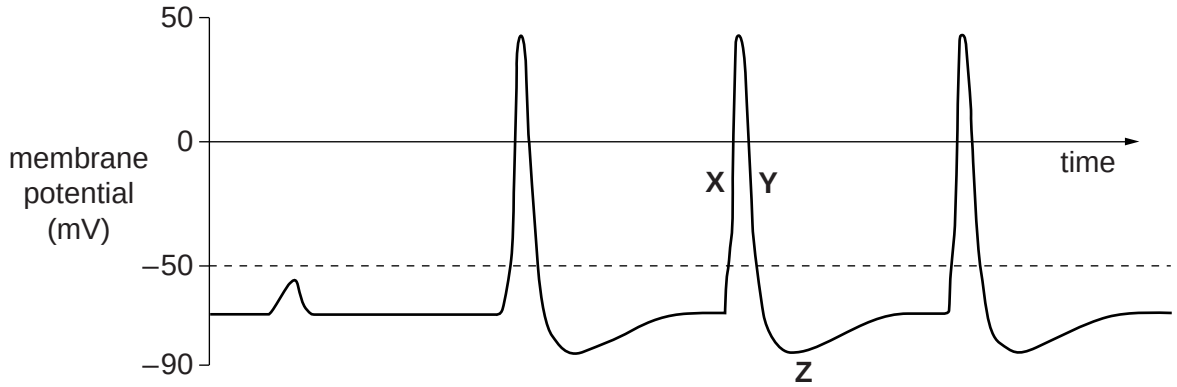

Fig. 1.2

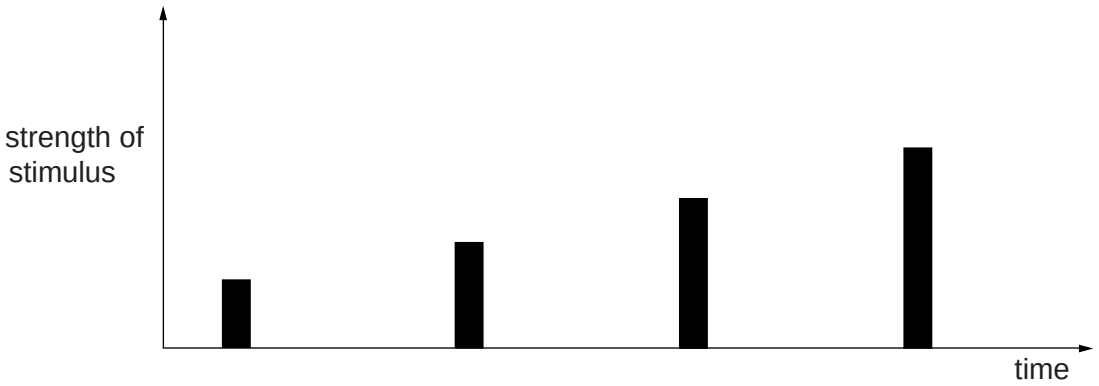

Fig. 1.3

(i) State the term used to describe what is happening at each of the points **X**, **Y** and **Z** on Fig. 1.2.

X .....

Y .....

Z .....

[3]

(ii) What term is used to refer to the value of −50 mV on Fig. 1.2?

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

(iii) Comment on the relationship between the strength of a stimulus, as shown in Fig. 1.3, and the resulting action potential, as shown in Fig 1.2.

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..... **[2]**

[Total: 15]