Nerve Impulses

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

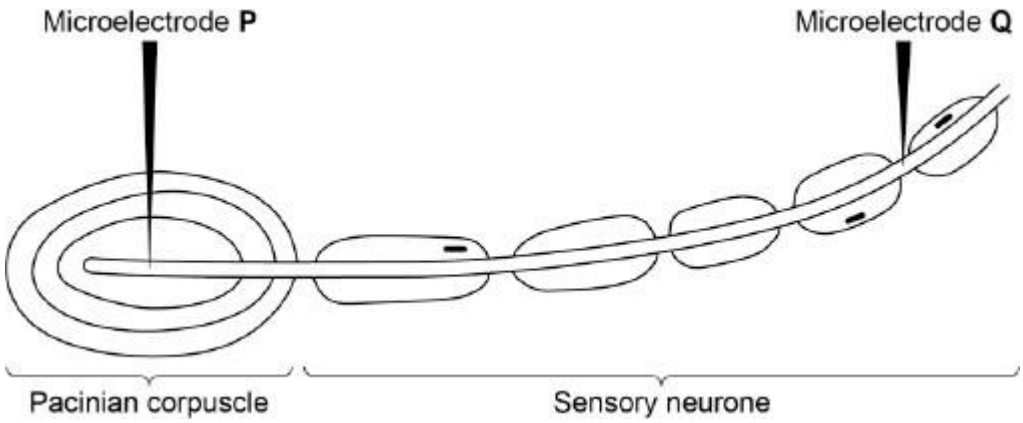
Exam Board: AQA A Level 7402

Topic: Nerve Impulses

1

She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

The figure below shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.



The table below shows some of the biologist's results.

Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
None	–70	–70
Light	–50	–70
Medium	+30	+40
Heavy	+40	+40

(a) Explain how the resting potential of –70 mV is maintained in the sensory neurone when nopressure is applied.

_____

_____

_____

_____

(2)

(b) Explain how applying pressure to the Pacinian corpuscle produces the changes inmembrane potential recorded by microelectrode **P**.

(Extra space) _____

(3)

(c) The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the finger tip. Explain why.

(2)

(d) Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neuronesare destroyed. Explain how this results in slower responses to stimuli.

(2)

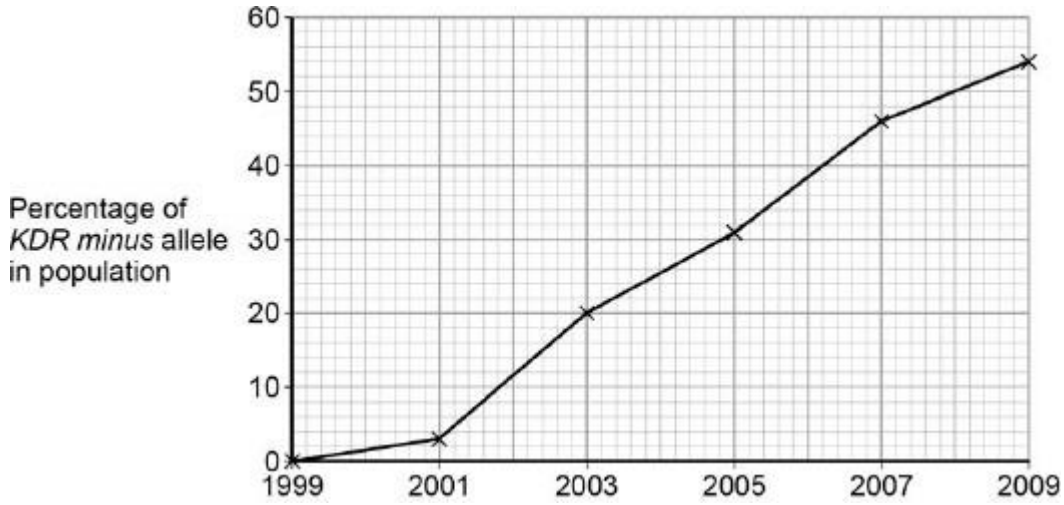
(Total 9 marks)

2 Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR plus*, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



(a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygousfor the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003 _____

(2)

(b) Suggest an explanation for the results in the figure above.

_____

_____

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

_____

_____

(4)

The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time.Use this information to suggest how DDT kills insects.

_____

_____

_____

_____

(2)

(d) Suggest how the *KDR minus* allele gives resistance to DDT.

_____

_____

_____

_____

(2)

(Total 10 marks)

3 (a) The blink reflex is caused by stimulation of receptors in the eye or eyelid.

Suggest **two** types of stimuli to which these receptors might respond.

1. _____

2. _____

(1)

(b) In humans, resting blink rate varies widely from 8 to 24 blinks per minute.
This variation could result in the investigations into effect of stimulation on blink rate producing means that are **not** significantly different. Explain why.

_____

_____

_____

_____

_____

(2)

(c) Some diseases cause changes in blink rate. Doctors do **not** often use blink rate to diagnose these diseases. Suggest **two** reasons why.

1. _____

_____

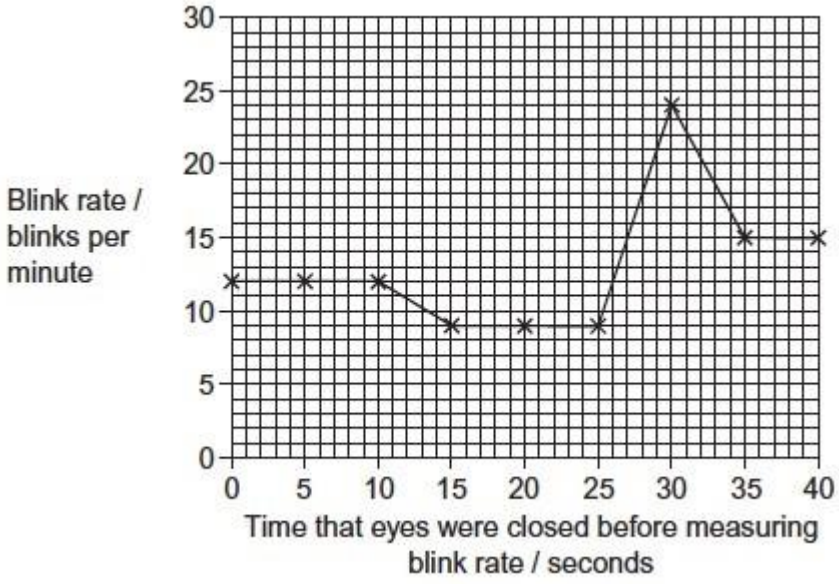
_____

2. _____

_____

(2)

(d) A student completed an investigation to determine if the length of time eyes are closedbefore opening them affected blinking rate. His results are shown below.



The student did **not** draw a line of best fit.
Suggest **two** reasons why.

1 _____

_____

_____

2 _____

_____

_____

(2)

(e) The student did **not** carry out repeats. He was still able to carry out a statistical test. Explain why.

_____

_____

(1)

(f) The blink reflex can be stopped by drugs which prevent the opening of sodium ion channelproteins in the axons of motor neurones.
Suggest how these drugs affect the passage of nerve impulses along the axons.

(2)

(g) The blink reflex involves synapses. Channel proteins on presynaptic neurones are involvedin reflex responses. Explain how.

(3)

(h) A student wanted to investigate the resting blink rate in people 60 years of age and people15 years of age.
Describe how the student could find out whether there was a significant difference in blink rates between the two age groups.

(3)

(Total 16 marks)

4 (a) The following statements are about events during an action potential.

A Potassium ions diffuse out across the neurone membrane.
B Sodium ions diffuse in across the neurone membrane.
C Sodium ion channels open.
D Active transport of sodium and potassium ions restores resting potential.
E Potassium ion channels open.
F Hyperpolarisation of the membrane occurs.

(i) Which of the events, **A** to **F**, starts depolarisation? Put the correct letter in the box.

(1)

(ii) Which of the events, **A** to **F**, requires the hydrolysis of ATP? Put the correct letter in the box.

(1)

(b) Synaptophysin is a protein involved in the production of synaptic vesicles.

Scientists can use the presence or absence of synaptophysin to identify presynaptic and postsynaptic membranes in synapses.

Explain why they are able to use synaptophysin for this purpose.

_____

_____

(1)

(c) Dopamine is a neurotransmitter. Production of too much dopamine is associated withschizophrenia. A drug used to treat schizophrenia binds to dopamine receptors in synapses. This binding does not lead to the formation of an action potential.

(i) Suggest why the drug used to treat schizophrenia is able to bind to the same receptoras dopamine.

_____

_____

(1)

(ii) Suggest why binding of the drug does **not** lead to production of an action potential.

_____

_____

_____

_____

(2)

(Total 6 marks)

5 Multiple sclerosis (MS) is a disease that involves damage to the myelin sheaths of neurones.

Movement in MS sufferers may be jerky or slow.

(a) Damage to the myelin sheaths of neurones can lead to problems controlling the contraction of muscles.

Suggest **one** reason why.

_____

_____

_____

_____

[Extra space]

(2)

Scientists investigated the use of substances called cannabinoids to control muscle problems caused by MS.

(b) Cannabinoids are hydrophobic molecules. In the body, they easily pass into neurones.Explain why.

(1)

(c) Cannabinoid receptors are found in the **pre-synaptic** membrane of neuromuscular junctions. When a cannabinoid binds to its receptor, it closes calcium ion channels.

Suggest how cannabinoids could prevent muscle contraction.

[Extra space]

(4)

(d) Cannabinoids include substances found in cannabis that can enter brain tissue. Scientists are developing artificial cannabinoids that can enter neuromuscular junctions but cannot enter brain tissue.

Suggest why these artificial cannabinoids would be better to use than cannabis when treating someone with MS.

[Extra space]

(2)

(Total 9 marks)

6 (a) A myelinated axon conducts impulses faster than a non-myelinated axon.

Explain this difference.

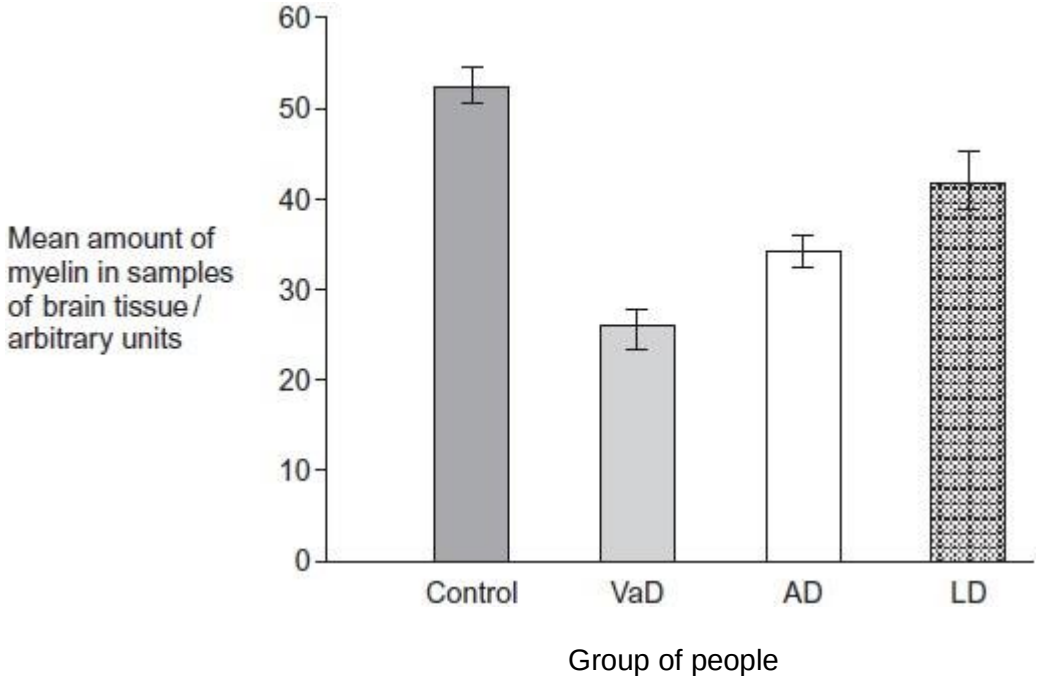
(3)

Doctors investigated the relationship between myelin in brain tissue and different types of dementia. All types of dementia involve loss of mental ability.

The doctors measured the mean amount of myelin in samples of brain tissue from:

- a control group of 12 people without dementia
- 20 people with vascular dementia (VaD)
- 19 people with Alzheimer's dementia (AD)
- 31 people with Lewy body dementia (LD).

The doctors' results are shown in the figure. The vertical bars show standard errors.



(b) The doctors used a statistical test to compare the results for AD and LD.They obtained a value for P of 0.047.

What does this result show about the difference between the means for AD and LD?

Use the words **probability** and **chance** in your answer.

_____

_____

_____

_____

(2)

(c) A student who read this investigation concluded that there was a relationship between theamount of myelin in a person's brain and whether or not they had dementia.

Do these data support this conclusion? Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

_____

(4)

(Total 9 marks)

7 The body loses heat quickly in cold water. A researcher investigated the effect of length of time in

a bath of ice-cold water on the reaction times of 20 healthy people aged between 21 and 23 years of age.

She measured each person's reaction time after being left in ice-cold water for 15, 30 or 45 seconds. She also recorded each person's reaction time before being placed in the ice-cold water (0 seconds).

The table shows her results.

Length of time in bath of ice-cold water / seconds	Mean reaction time / seconds	Standard error
0	0.395	0.0124
15	0.301	0.0105
30	0.297	0.0212
45	0.326	0.0183

(a) (i) One reason that reaction time is slower when body temperature falls is becausenerve impulse conduction is slower. Explain how a lower temperature leads to slower nerve impulse conduction.

_____

_____

_____

_____

(2)

(ii) Other than temperature, give **two** factors that affect the speed of nerve impulse conduction.

1. _____

2. _____

(2)

(b) Suggest the conditions that the researcher used when obtaining her data for 0 seconds.

_____

_____

_____

(1)

(c) Explain how the researcher could use her **raw** data to find

(i) the mode_____

_____

(ii) the range_____

_____

(2)

(d) A student reading the researcher's report concluded that the difference between the resultsfor 30 seconds and 45 seconds was significant. Do you agree with his conclusion? Explain your answer.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(Total 10 marks)

8 Serotonin is a neurotransmitter released in some synapses in the brain. It is transported back out

of the synaptic gap by a transport protein in the pre-synaptic membrane.

(a) Serotonin diffuses across the synaptic gap and binds to a receptor on the post-synapticmembrane.

Describe how this causes depolarisation of the post-synaptic membrane.

_____

_____

_____

_____

(2)

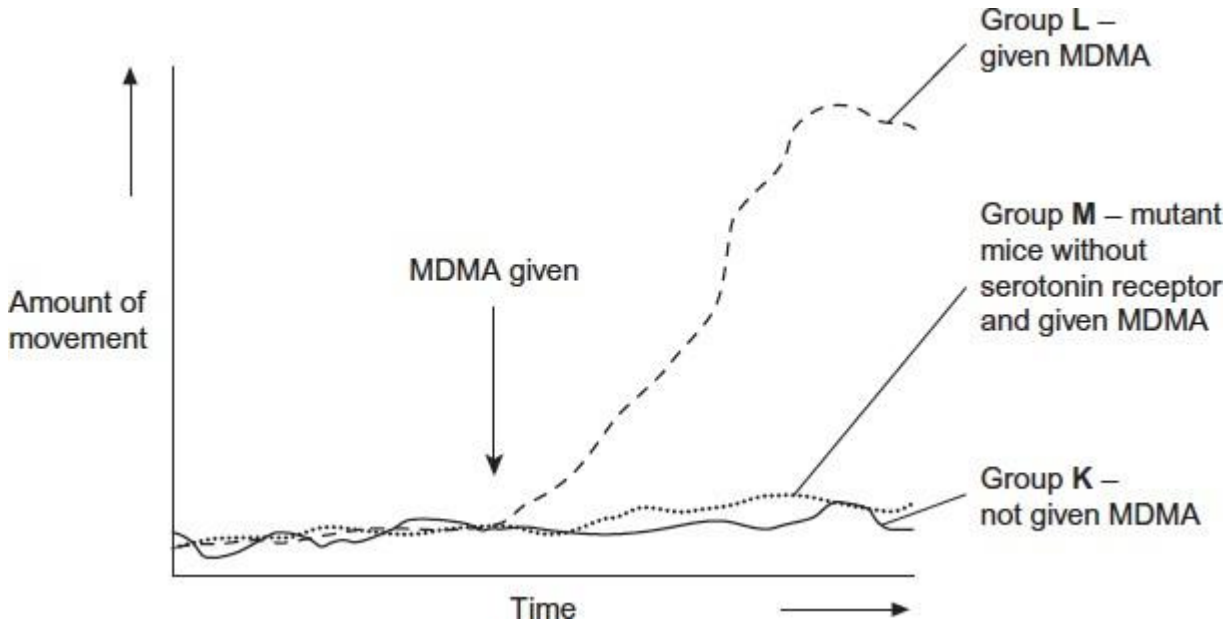
(b) It is important that a neurotransmitter such as serotonin is transported back out ofsynapses. Explain why.

(2)

(c) Scientists investigated the effect of a drug called MDMA on movement of mice. Theymeasured the amount of movement of three groups of mice, **K, L** and **M.**

- Group **K,** mice not given MDMA.
- Group **L,** mice given MDMA.
- Group **M,** mutant mice that did not produce a serotonin receptor on their post-synaptic membranes and were given MDMA.

The graph shows their results.



The scientists concluded that MDMA affects movement by binding to serotonin receptors.

How do these results support this conclusion?

_____

_____

_____

_____

_____

_____

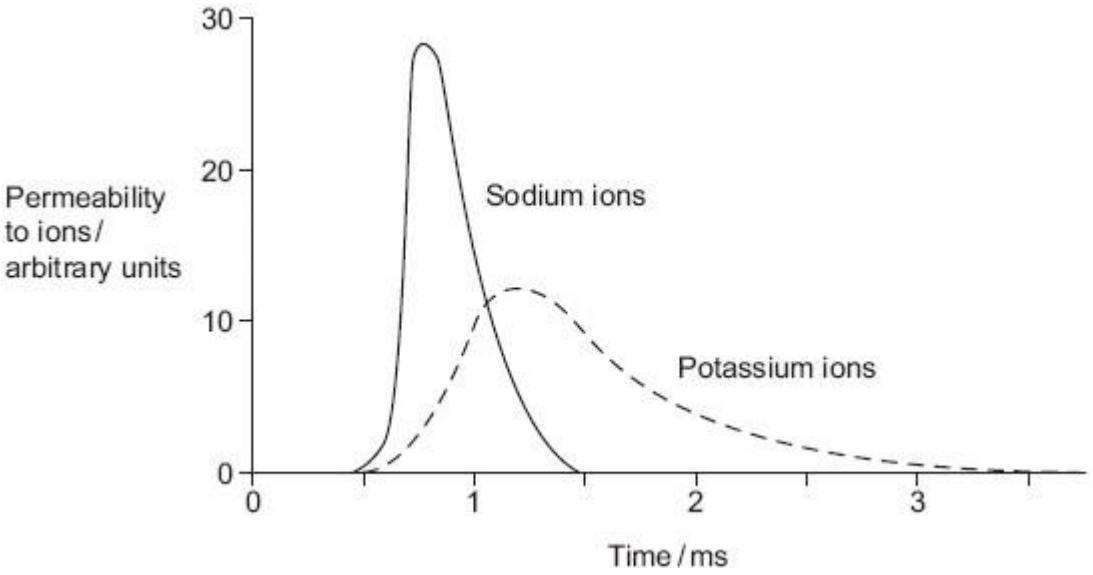
*(Extra space)*_____

(3)

(Total 7 marks)

During an action potential, the permeability of the cell-surface membrane of an axon changes.

9 The graph shows changes in permeability of the membrane to sodium ions (Na^+) and to potassium ions (K^+) during a single action potential.



(a) Explain the shape of the curve for sodium ions between 0.5 ms and 0.7ms.

(3)

(b) During an action potential, the membrane potential rises to +40 mV and then falls. Useinformation from the graph to explain the fall in membrane potential.

(3)

(c) After exercise, some ATP is used to re-establish the resting potential in axons. Explain howthe resting potential is re-established.

(2)

(Total 8 marks)

10 (a) The table shows the membrane potential of an axon at rest and during the different phases of an action potential. Complete the table by writing in each box whether the sodium ion (Na^+) channels and potassium ion (K^+) channels are open or closed.

	Resting	**Starting to depolarise**	**Repolarising**
Membrane potential/mV	–70	–50	–20
Na^+ channels in axon membrane			
K^+ channels in axon membrane			

(2)

(b) Describe how the resting potential is established in an axon by the movement of ions across the membrane.

_____

_____

_____

_____

(2)

S (c) Sodium and potassium ions can only cross the axon membrane through proteins.

Explain why.

_____

_____

_____

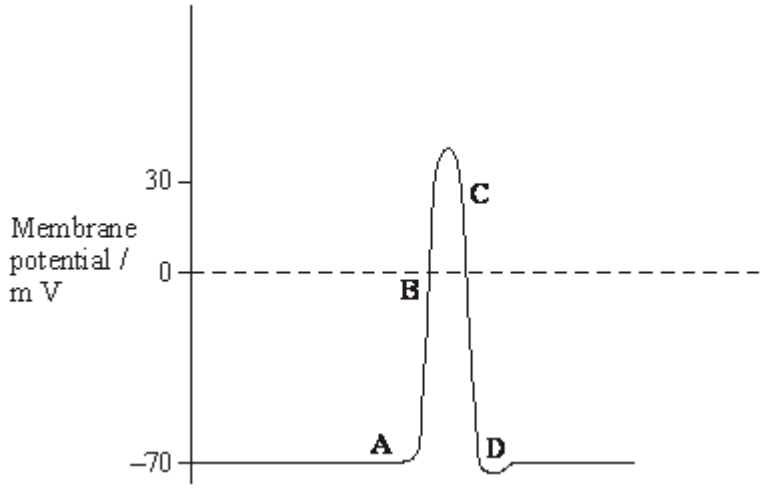
_____

(2)

(Total 6 marks)

11 (a) **Figure 1** shows the changes in membrane potential at one point on an axon when an action potential is generated.

Figure 1



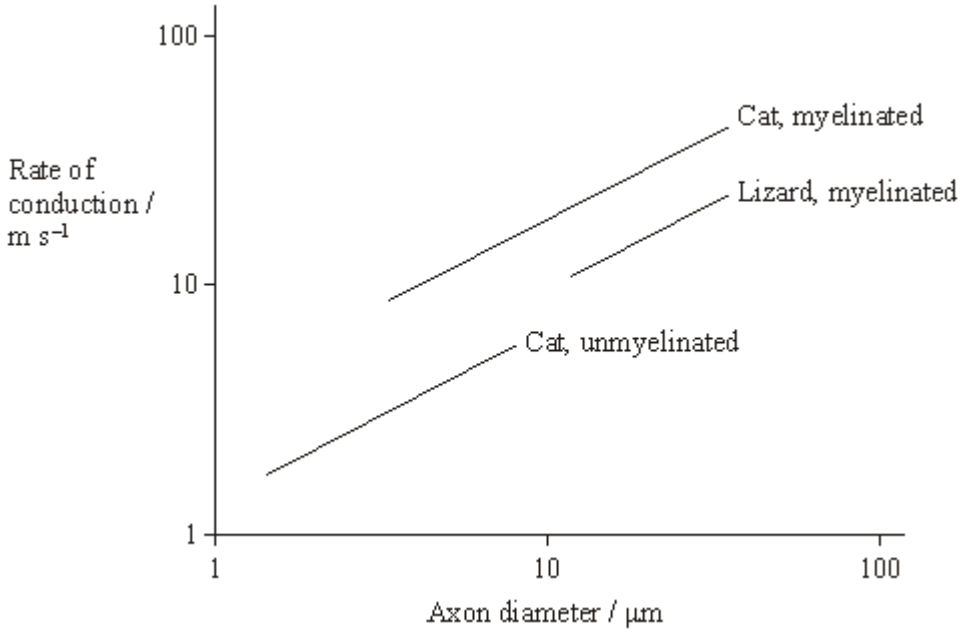
The changes shown in **Figure 1** are due to the movement of ions across the axon membrane. Complete the table by giving the letter (**A** to **D**) that shows where each process is occurring most rapidly.

Process	Letter
Active transport of sodium and potassium ions	
Diffusion of sodium ions	
Diffusion of potassium ions	

(2)

(b) **Figure 2** shows the relationship between axon diameter, myelination and the rate of conduction of the nerve impulse in a cat (a mammal) and a lizard (a reptile).

Figure 2



(i) Explain the effect of myelination on the rate of nerve impulse conduction.

_____

_____

_____

_____

(2)

S (ii) For the same diameter of axon, the graph shows that the rate of conduction of the nerve impulse in myelinated neurones in the cat is faster than that in the lizard. Suggest an explanation for this.

_____

_____

_____

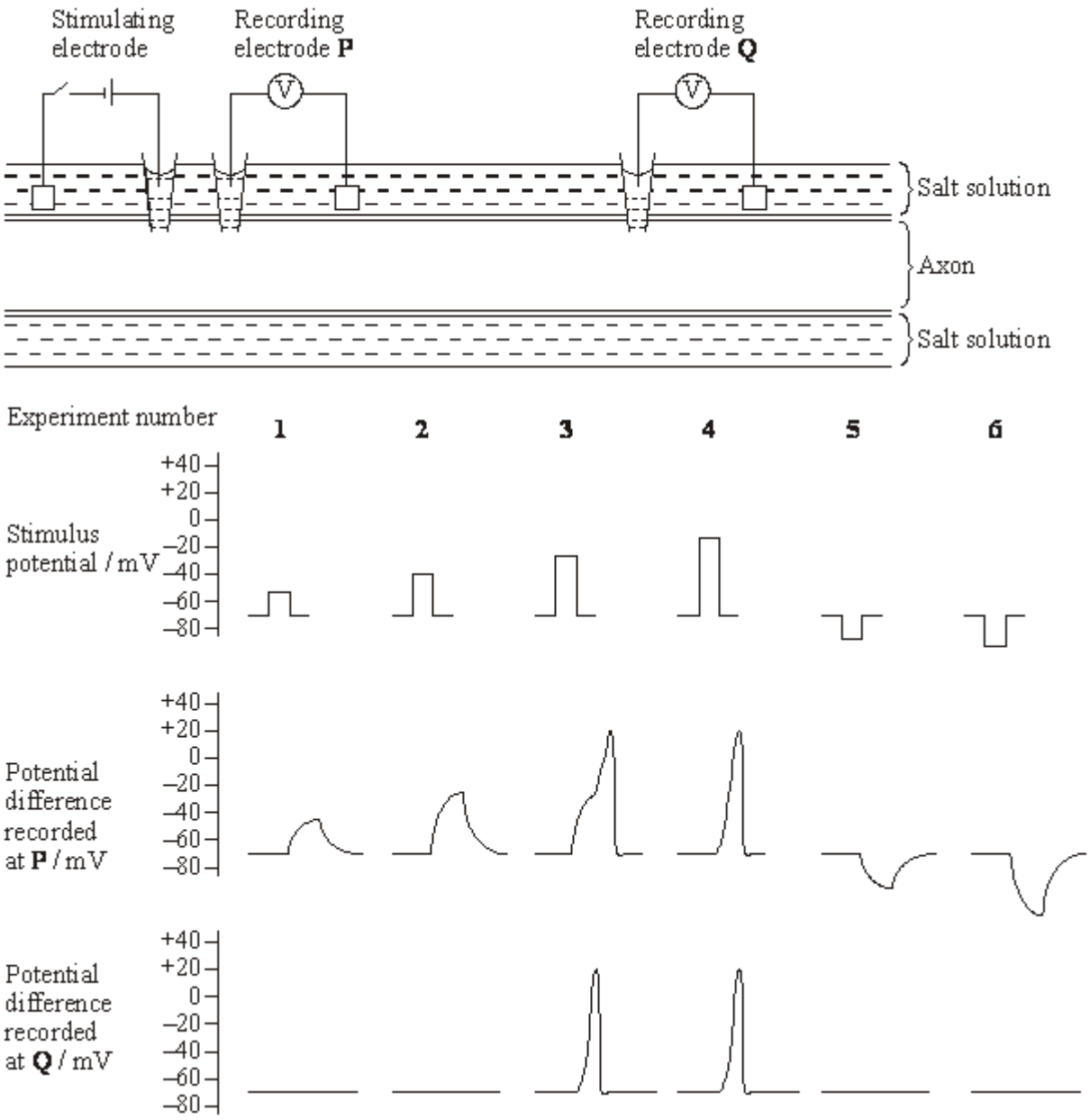
_____

_____

(2)

Figure 3 shows how a stimulating electrode was used to change the potential difference across an axon membrane. Two other electrodes, **P** and **Q**, were used to record any potential difference produced after stimulation. The experiment was repeated six times, using a different stimulus potential each time. In experiments **1** to **4**, the stimulating voltage made the inside of the axon less negative. In experiments **5** and **6**, it made the inside of the axon more negative.

Figure 3

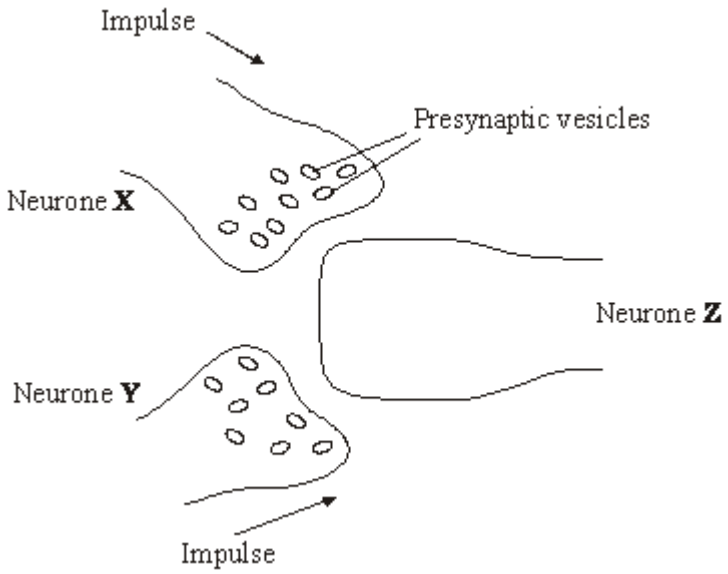


(c) Explain the results of experiments **1** to **4**.

(5)

(d) **Figure 4** shows two neurones, **X** and **Y**, which each have a synapse with neurone **Z**.

Figure 4

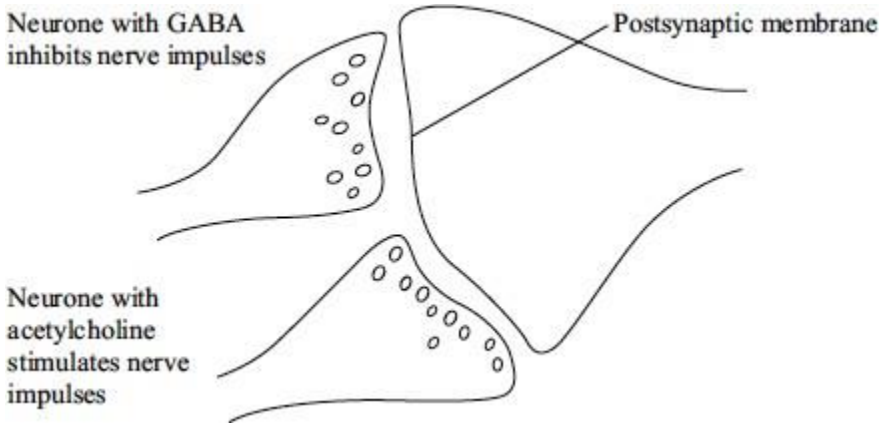


Neurone **X** releases acetylcholine from its presynaptic vesicles. Neurone **Y** releases a different neurotransmitter substance which allows chloride ions (Cl^-) to enter neurone **Z**. Use this information, and information from **Figure 3**, to explain how neurones **X** and **Y** have an antagonistic effect on neurone **Z**.

(4)

(Total 15 marks)

12 Acetylcholine is a neurotransmitter which binds to postsynaptic membranes and stimulates the production of nerve impulses. GABA is another neurotransmitter. It is produced by certain neurones in the brain and spinal cord. GABA binds to postsynaptic membranes and inhibits the production of nerve impulses. The diagram shows a synapse involving three neurones.



(a) Describe the sequence of events leading to the release of acetylcholine and its binding tothe postsynaptic membrane.

(4)

(b) The binding of GABA to receptors on postsynaptic membranes causes negatively chargedchloride ions to enter postsynaptic neurones. Explain how this will inhibit transmission of nerve impulses by postsynaptic neurones.

(3)

(c) Epilepsy may result when there is increased neuronal activity in the brain.

(i) One form of epilepsy is due to insufficient GABA. GABA is broken down on thepostsynaptic membrane by the enzyme GABA transaminase. Vigabatrin is a new drug being used to treat this form of epilepsy. The drug has a similar molecular structure to GABA. Suggest how Vigabatrin may be effective in treating this form of epilepsy.

(2)

(ii) A different form of epilepsy has been linked to an abnormality in GABA receptors. Suggest and explain how an abnormality in GABA receptors may result in epilepsy.

(3)

(d) During an epileptic seizure muscular contractions may occur. In which part of the brain would neuronal activity produce muscular contractions of the right leg?

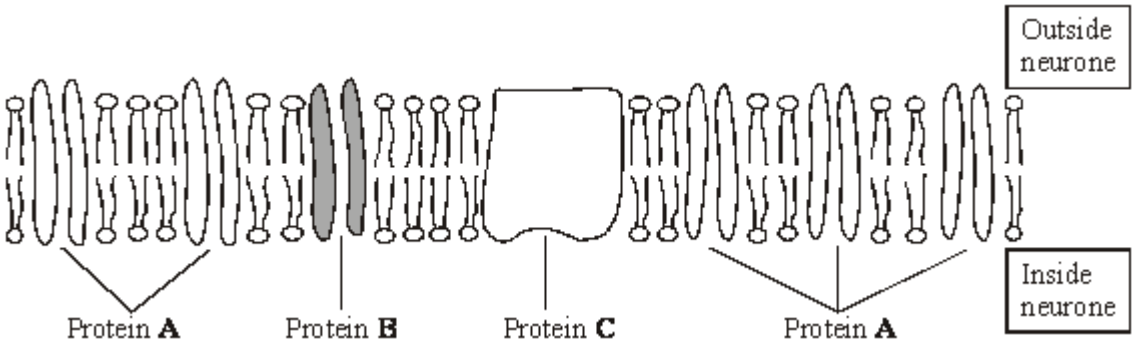
_____

_____

(2)

(Total 14 marks)

13 The resting potential of a neurone is maintained by the unequal distribution of ions inside and outside the plasma membrane. The diagram shows the plasma membrane of a neurone and the three different proteins that are involved in maintaining the resting potential.



(a) Protein **C** requires ATP to function. Describe the role of protein **C**.

_____

_____

_____

_____

(2)

S (b) (i) Proteins **A** and **B** differ from each other. Explain why different proteins are required for the diffusion of different ions through the membrane.

_____

(2)

(ii) The plasma membrane of the neurone is more permeable to potassium ions than to sodium ions. Give the evidence from the diagram that supports this observation.

_____

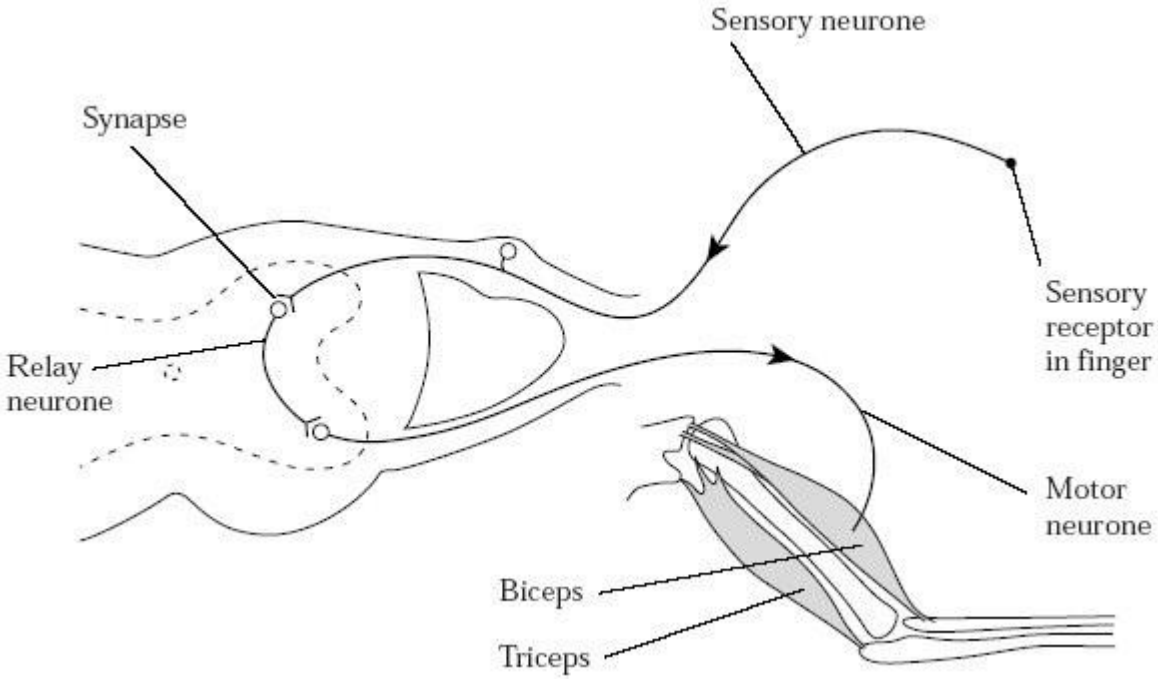
_____

_____

(1)

(Total 5 marks)

14 When a finger accidentally touches a hot object, a reflex action occurs. The biceps muscle contracts, causing the arm to be flexed and the finger is pulled away. The diagram shows the arrangement of the bones in the arm, the muscles used for flexing and straightening the arm and the nervous pathways associated with the contraction of these muscles.



(a) Explain the importance of reflex actions.

(3)

(b) (i) Describe the sequence of events which allows information to pass from one neuroneto the next neurone across a cholinergic synapse.

(6)

(ii) Give **two** differences between a cholinergic synapse and a neuromuscular junction.

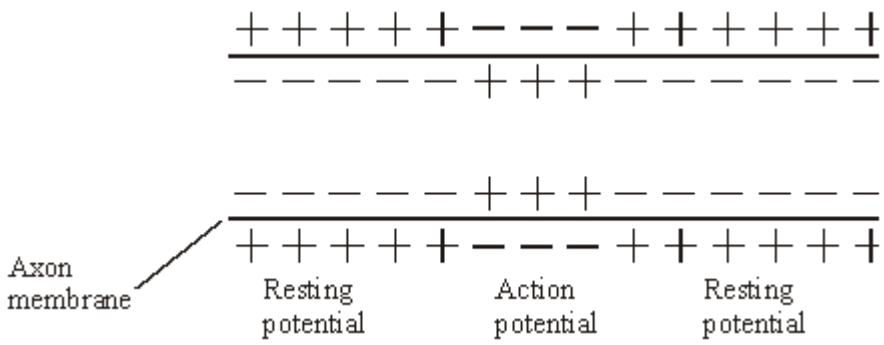
1. _____

2. _____

(2)

(Total 11 marks)

15 The diagram shows the change in the charge across the surface membrane of a non-myelinated axon when an action potential is produced.



(a) Describe how the change shown in the diagram occurs when an action potential isproduced.

(2)

(b) Explain what causes the conduction of impulses along a non-myelinated axon to be slowerthan along a myelinated axon.

(3)

(Total 5 marks)

Answers should be written in continuous prose, where appropriate.

16

Quality of Written Communication will be assessed in these answers.

The kidney plays an important part in the regulation of blood water potential. This involves control of the amount of water reabsorbed from the filtrate produced in the kidney tubules. The

amount of water reabsorbed affects the volume of urine produced, the rate at which the bladder fills and how often it has to be emptied.

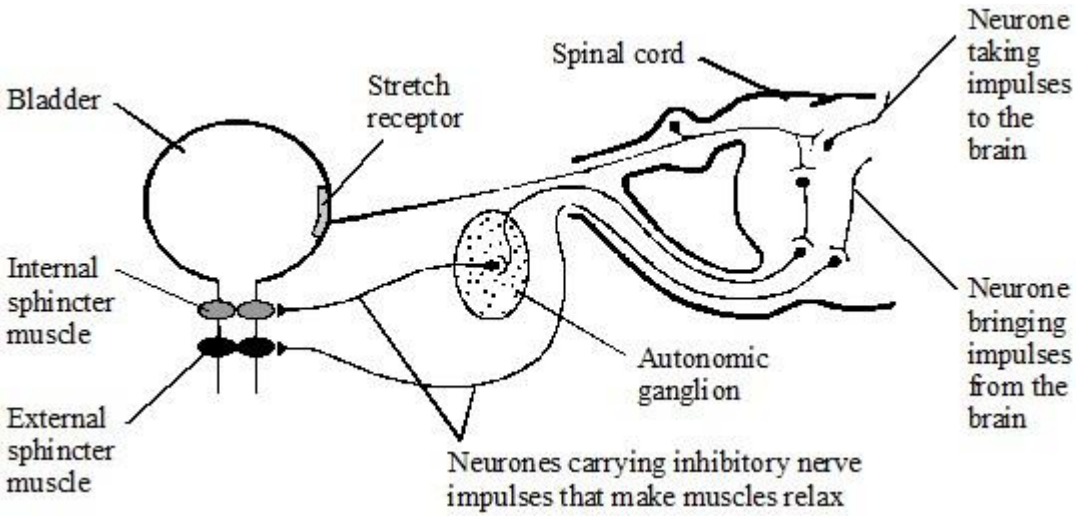
(a) Explain how the loop of Henle maintains the gradient of ions which allows water to be reabsorbed from filtrate in the collecting duct.

(5)

(b) Explain how ADH is involved in the control of the volume of urine produced.

(4)

(c) The diagram shows the systems involved in controlling the emptying of the bladder. Inbabies, emptying of the bladder is controlled by an autonomic reflex involving the internal sphincter muscle. Conscious control is learnt between the ages of two and three and involves the external sphincter as well.



Using information in the diagram,

explain how the autonomic reflex arc is different from a simple reflex arc involving voluntary muscle;

_____

_____

_____

_____

(2)

(Total 11 marks)

This question should be written in continuous prose, where appropriate.

17

(a) Explain how a resting potential is maintained in a neurone.

_____

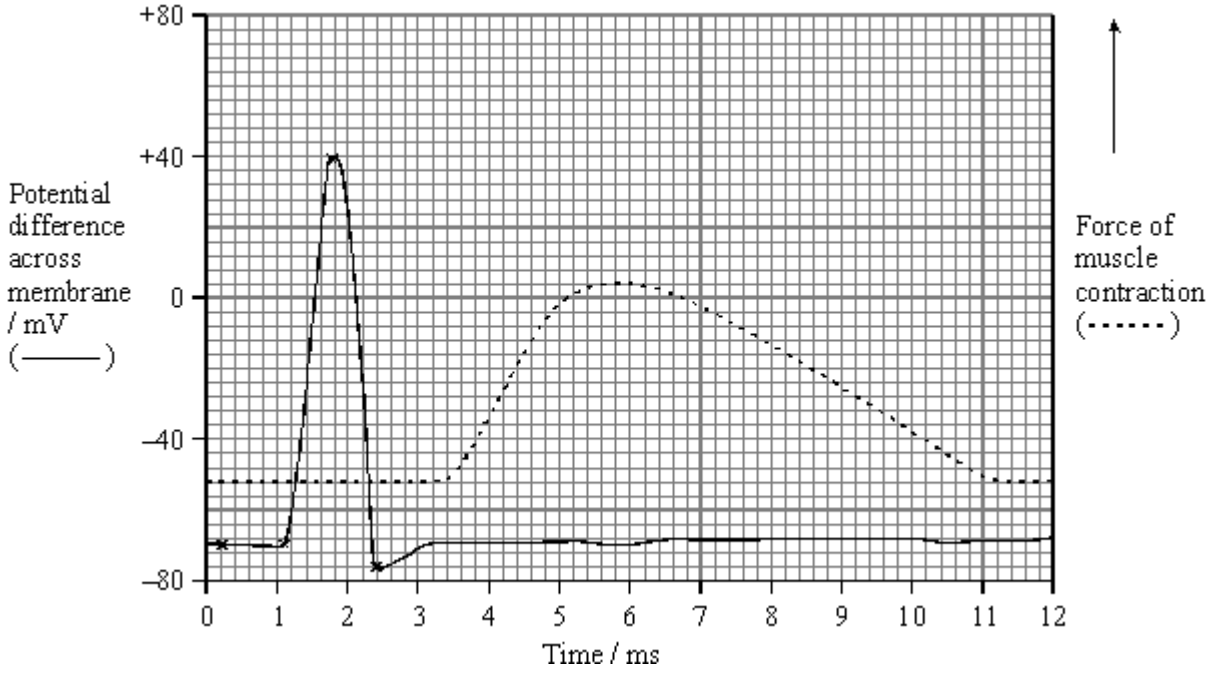
_____

_____

(4)

(b) In an investigation, an impulse was generated in a neurone using electrodes. Duringtransmission along the neurone, an action potential was recorded at one point on the neurone. When the impulse reached the neuromuscular junction, it stimulated a muscle cell to contract. The force generated by the contraction was measured. The results are shown in the graph.

The distance between the point on the neurone where the action potential was measured and the neuromuscular junction was exactly 18 mm.



(i) Use the graph to estimate the time between the maximum depolarisation and thestart of contraction by the muscle cell.

Time _____ ms

(1)

(ii) Use your answer to part (i) to calculate the speed of transmission along this neuroneto the muscle cell. Give your answer in mm per second.

Show your working.

Speed _____ mm s^{-1}

(2)

(iii) Give **one** reason why the value calculated in part (ii) would be an underestimate of the speed of transmission of an impulse along a neurone.

_____

_____

(1)

Acetylcholine is the neurotransmitter at neuromuscular junctions.

(c) Describe how the release of acetylcholine into a neuromuscular junction causes the cellmembrane of a muscle fibre to depolarise.

_____

_____

_____

_____

_____

_____

(3)

(d) Use your knowledge of the processes occurring at a neuromuscular junction to explaineach of the following.

(i) The cobra is a very poisonous snake. The molecular structure of cobra toxin is similarto the molecular structure of acetylcholine. The toxin permanently prevents muscle contraction.

_____

_____

_____

_____

(2)

(ii) The insecticide DFP combines with the active site of the enzymeacetylcholinesterase. The muscles stay contracted until the insecticide is lost from the neuromuscular junction.

_____

_____

_____

_____

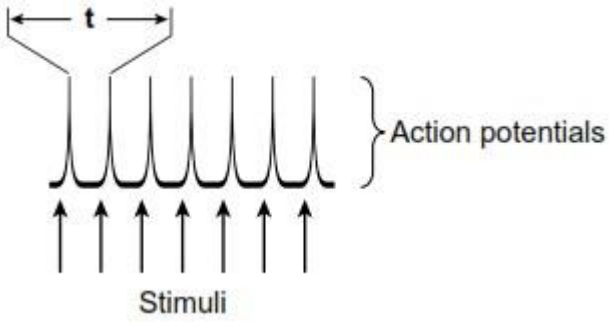
(2)

(Total 15 marks)

18 Scientists investigated the effect of different frequencies of stimulation on the production of action potentials by a neurone.

(a) **Figure 1** shows a recording of the action potentials produced when the frequency of stimulation was 160 per second. At this frequency, each stimulus produced one action potential.

Figure 1



The time needed to complete one action potential is **t**, as shown in **Figure 1**. Calculate the value of **t**. Give your answer in milliseconds.

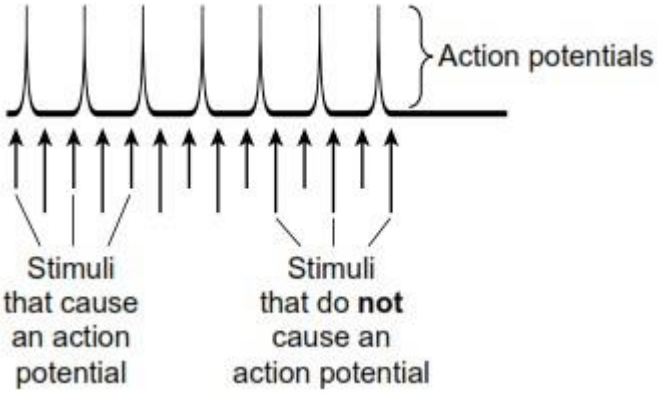
Show your working.

t = _____ milliseconds

(2)

(b) **Figure 2** shows the results when the frequency of stimulation was 200 per second.

Figure 2



Not every stimulus in **Figure 2** produced an action potential.
Explain why.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

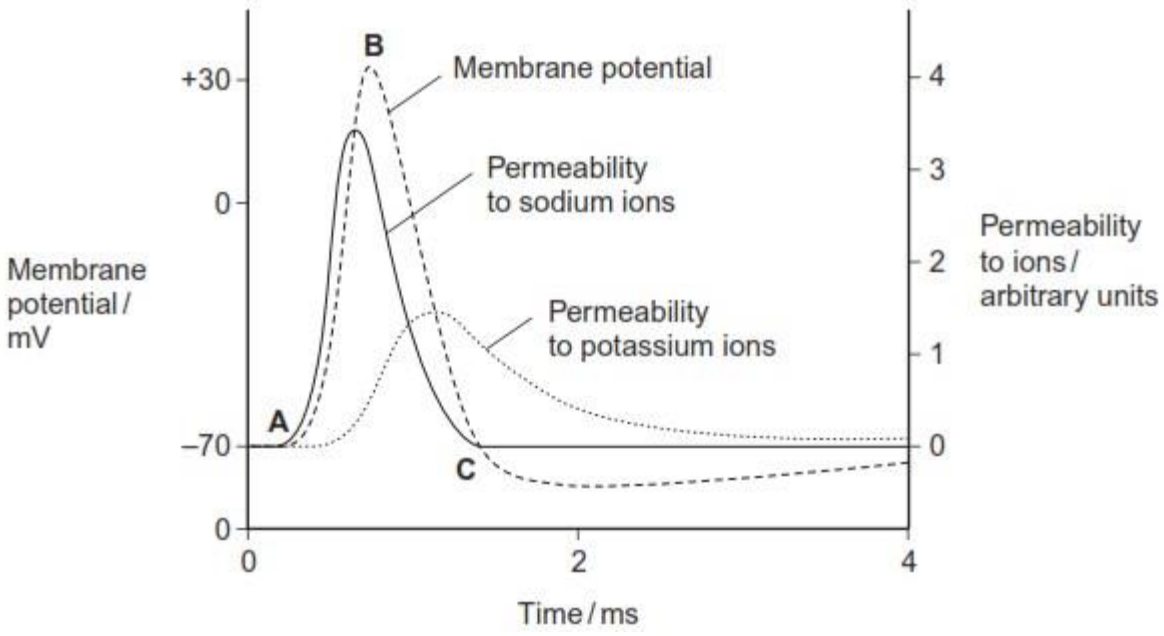
_____

(3)

(Total 5 marks)

19 The graph shows changes in membrane potential that occur during an action potential.

It also shows changes in the permeability of the axon membrane to sodium and potassium ions.



(a) Explain what causes

(i) the change in membrane potential between points **A** and **B**,

(ii) the change in membrane potential between points **B** and **C**.

(4)

(b) When a neurone transmits a series of impulses, its rate of oxygen consumption increases.Explain why.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

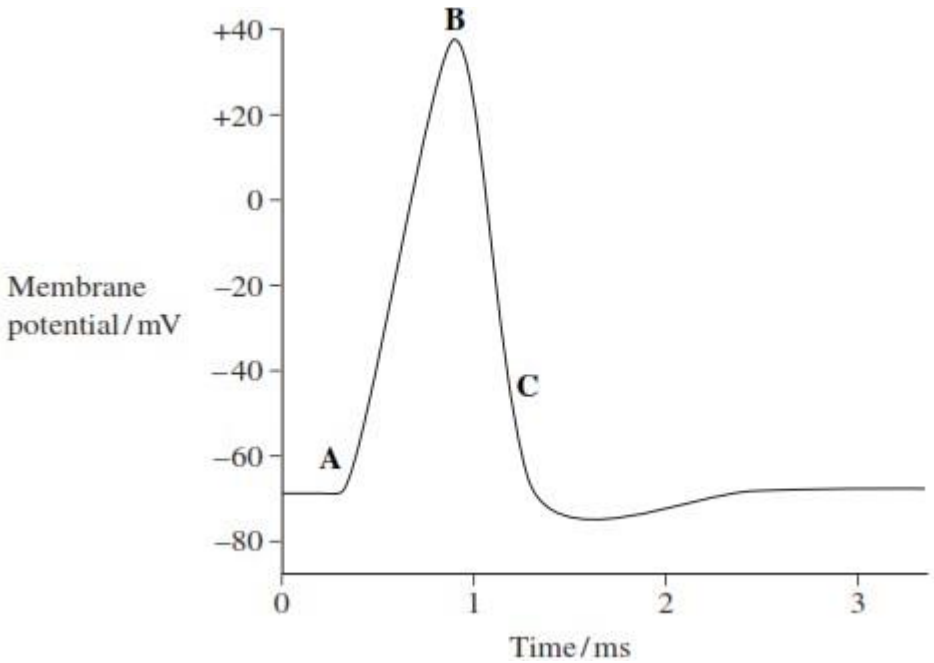
_____

(3)

(Total 7 marks)

20 **Figure 1** shows changes in the membrane potential of a neurone during one action potential.

Figure 1



(a) What happens in the membrane to cause the change in membrane potential at time **B**?

(2)

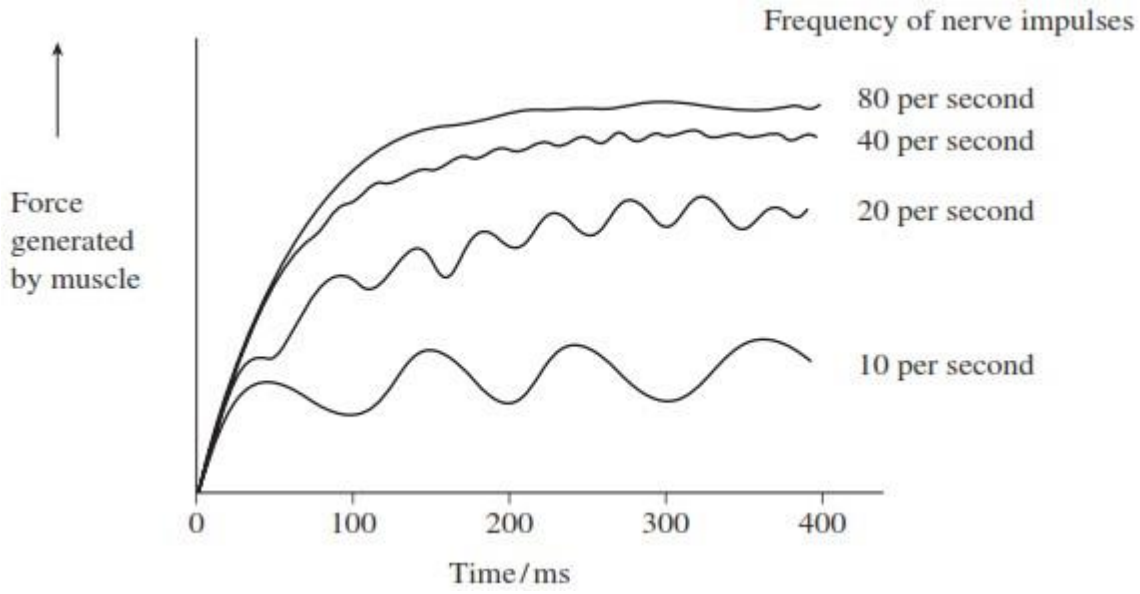
(b) No further action potential can be produced between times **A** and **C**.

What is the name given to the period between times **A** and **C**?

(1)

(c) **Figure 2** shows the force generated by a muscle when it was stimulated by different frequencies of nerve impulse.

Figure 2



A taser is a device used by the police to arrest violent suspects. It fires electrical impulses very similar to action potentials into a suspect. The frequency of the impulses is between 15 and 20 per second.

(i) Suggest the effect a taser has on a suspect's muscles.

_____

_____

(2)

(ii) Tasers with frequencies of between 40 and 80 per second are not used, because theyare considered too dangerous. Suggest how they might be dangerous to a suspect.

_____

_____

_____

_____

(2)

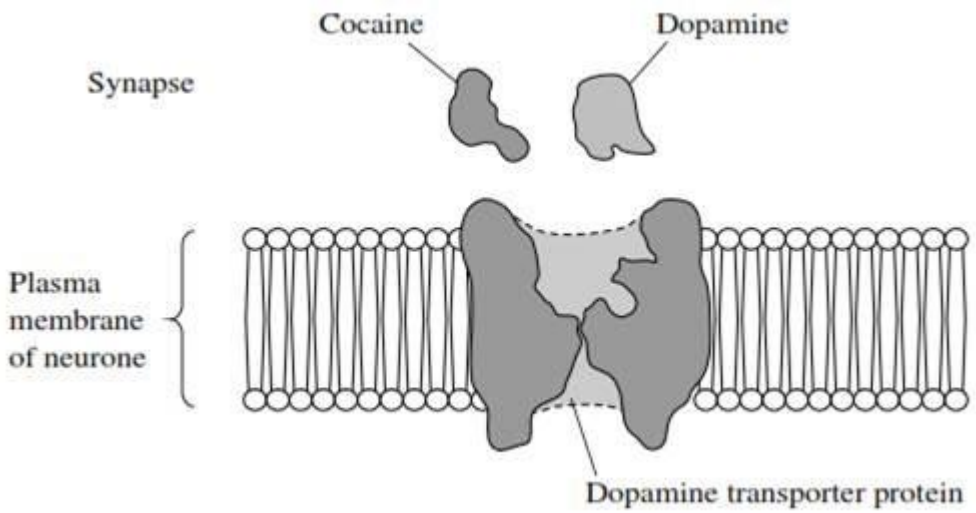
(Total 7 marks)

21 Cocaine is a highly addictive and illegal drug.

The release of the neurotransmitter dopamine in specific synapses in the brain leads to feelings of pleasure. Dopamine is removed from synapses by dopamine transporter proteins in the plasma membrane of neurones. Cocaine binds to the dopamine transporter protein.

Figure 1 shows a dopamine transporter protein and molecules of cocaine and dopamine.

Figure 1



(a) Using all of the information, suggest how cocaine leads to feelings of pleasure.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(b) (i) Scientists isolated a mutated gene for the dopamine transporter protein.

Name **one** method that the scientists could have used to produce many copies of the mutated gene in the laboratory.

_____

(1)

(ii) Copies of the gene were then inserted into early embryos of mice. When these mice were born, samples of their DNA were tested using DNA probes to make sure that the mutated gene was present in the mice.

What is a DNA probe?

_____

_____

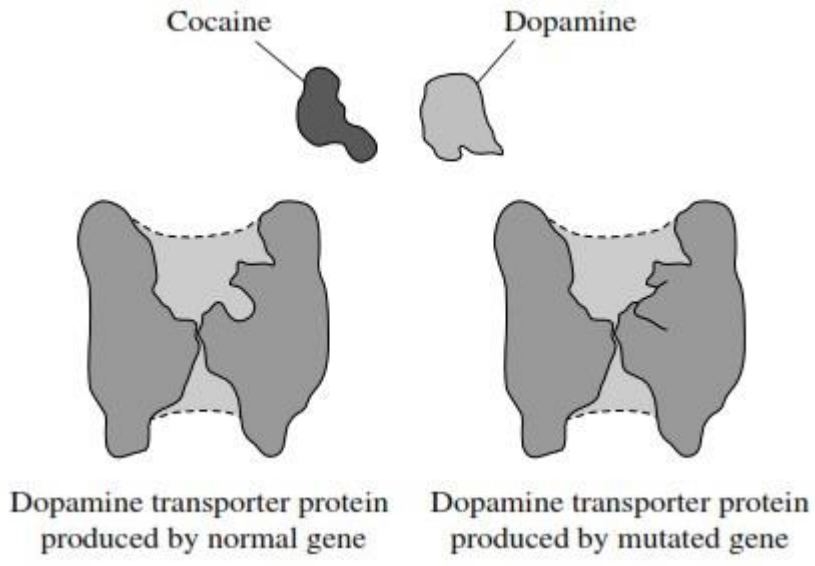
_____

_____

(2)

(c) **Figure 2** shows dopamine transporter proteins produced from the normal gene and from the mutated gene.

Figure 2



Explain how the mutation leads to the production of a protein that transports dopamine but is **not** affected by cocaine.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(Total 9 marks)

Mark schemes

(a) 1. Membrane more permeable to potassium ions and less permeable to sodium ions;

1

2. Sodium ions actively transported / pumped out and potassium ions in.

2

(b) 1. (Pressure causes) membrane / lamellae to become deformed / stretched;2. Sodium ion channels in membrane open and sodium ions move in; 3. Greater pressure more channels open / sodium ions enter.

3

(c) 1. Threshold has been reached;
2. (Threshold or above) causes maximal response / all or nothing principle.

2

(d) 1. Less / no saltatory conduction / action potential / impulse unable to 'jump' fromnode to node;
2. More depolarisation over length / area of membranes.

2 **[9]**

2

(a) 0.32.

Correct answer = 2 marks

Accept 32% for 1 mark max

Incorrect answer but identifying 2pq as heterozygous = 1 mark

2

(b) 1. Mutation produced *KDR minus* / resistance allele;
2. DDT use provides selection pressure;
3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce; 4. Leading to increase in *KDR minus* allele in population.

4

(c) 1. Neurones remain depolarised;
2. So no action potentials / no impulse transmission.

2

(d) 1. (Mutation) changes shape of sodium ion channel (protein) / of receptor(protein);
2. DDT no longer complementary / no longer able to bind.

2

[10]

3

(a) Any **two** from:

- light
- pressure

- touch
- temperature
- chemicals
- (loud) noise
- smell;

Two required for 1 mark
Do not accept unqualified reference to dust / particles / objects
Accept (rapid) movement (of particles / air) towards the eye
Accept humidity / moisture / tears

1

(b) 1. Standard deviations / standard errors;

2. (So) likely to overlap;

2

(c) 1. Would not know the patient's / human's normal blink rate so unable to make a comparison;

2. Blink rate could be affected by stress of seeing a doctor;

3. Many factors could affect blink rate so it would be difficult to tell if blink rate was due to illness

2 max

(d) 1. Not possible to predict intermediate values;

2. Only one result for each time period / not mean values;

2

(e) Collected paired data;

1

(f) 1. No / low influx of sodium ions;

2. So no depolarisation / action potential;

2. 'so no impulses' insufficient

2

(g) 1. Allows calcium ions in;

2. At end of presynaptic neurone;

3. Causing release of neurotransmitter;

1. Accept Ca^{2+}/Ca ions but not Ca/Ca+
2. The idea of the end of the presynaptic neurone must be given e.g. presynaptic knob

3

(h) 1. Reference to large group size;

2. Reference to matching a specific, named variable;

3. Applying a statistical test to the data;

1. Accept '≥ 20 / many / lots' but not 'several / less than 20'
2. Accept any named variable other than age.
3. Accept 'use SE / 95% confidence limits'

3

[16] (a) (i) C;

4 **1**

(ii) D;

1

(b) (Synaptic) vesicles (only) found in presynaptic (part of synapse);

Accept bulb of synapse for presynaptic
*Reject vesicles **in** the membrane*

1 (c) (i) Has similar shape/structure to dopamine

OR

Complementary (to binding site on receptor);

Ignore competitive inhibitor
Accept tertiary structure
Reject active site
*Reject **same** shape as dopamine/as receptor*

1

(ii) 1. (Binding) does not lead to opening of sodium ion channels;
2. (So) no depolarisation / threshold not reached / sodium ions do not diffuse in;

OR

3. Opens chloride ion channels;

4. Causing hyperpolarisation / preventing depolarisation

*Mark either 1 and 2 **OR** 3 and 4*

1. Accept stops dopamine opening sodium ion channels

1. Reject sodium unqualified

2. Accept no generator potential

3. Reject chlorine

2

[6]

5

(a) One suitable suggestion; explained;

E.g.

1. Action potentials travel more slowly / don't travel;

Accept: fewer / no saltatory movement of potentials

2. So delay in muscle contraction / muscles don't contract / muscles contractslow(er);

OR

3. Action potentials / depolarisation 'leaks' to adjacent neurones;*Accept: neurones not insulated*

4. So wrong muscle (fibres) contract.

2 max

(b) Lipid-soluble / pass through phospholipid bilayer.

Not just 'pass through membranes'

1

(c) 1. Prevents influx of calcium ions (into pre-synaptic membrane);

Need idea of moving into pre-synaptic membrane / synaptic knob

Accept Ca^{++} / Ca^{2+}

2. (Synaptic) vesicles don't fuse with membrane / vesicles don't releaseneurotransmitter;

Accept vesicles don't release acetylcholine

3. Neurotransmitter does not diffuse across synapse / does not bind to receptors (on post-synaptic membrane);

Accept: sarcolemma / muscle membrane for post-synaptic membrane

4. No action potential / depolarisation (of post-synaptic membrane) / sodium (ion) channels do not open / prevents influx of sodium ions.

Accept Na^{+}

Accept prevents depolarisation of muscle cell

Ignore: descriptions of events at post-synaptic membrane involving calcium ions and muscle contraction

4

(d) 1. They won't affect synapses in brain;

2. They won't cause problems with the brain's function / won't damage brain;

Accept: suitable named problem e.g. hallucination

Ignore: unqualified references to 'side effects'

Accept: reference to addiction / harm of smoking (cannabis)

3. (So only the) muscle / neuromuscular junctions treated / affected.

2 max

[9] (a) 1. (In myelinated) action potential / depolarisation only at node(s);

6

2. (In myelinated, nerve impulse) jumps from node to node / saltatory;

3. (In myelinated) action potential / impulse does not travel along whole length;

The question is about speed of transmission, not repolarisation or related matters

Accept converse for non-myelinated

3

(b) 1. Probability of obtaining this difference by chance;

Reject 'results' once only

This statement often split round 2.

2. Is less than 5% / less than 0.05 / less than one in twenty;*Accept is 4.7% / 0.047 but reject less than 4.7% / 0.047*

Accept correct greater than 95% / greater than 0.95 arguments

3. Difference is significant;*Reject 'results' once only*

2 max

(c) 1. (All) dementia results lower (than control group) / non-dementia result higher;

2. Error bars do not overlap so differences are (possibly) significant;

Neutral results

Accept not due to chance / statistically significant

In this context, accept references to standard deviation

3. Dementia may be due to other factors / not only due to a lack of myelin;*Accept suitable named factor e.g. genetic*

4. (Because) big / significant differences in myelin in different dementia;*Not just 'different'*

5. Only small sample sizes / only one study / more data required;

4 max

[9] (a) (i) 1. Slower <u>diffusion</u>;

7

Accept description of diffusion eg 'movement down concentration gradient' but concept of slower is required

2. (Of) ions / Na^+ / K^+;

Reference to ions is required. Reject other named ions, eg calcium ions

Ignore references to synaptic transmission or rates of respiration

2

(ii) 1. Myelination / saltatory conduction;

Accept reference to presence of nodes of Ranvier

2. Axon diameter;

2

(b) Keep everything the same but not in bath / at room temperature / same clothing asfor immersion / sitting in empty bath / sitting in water at room temperature;

Accept 'normal' or 'comfortable' as equivalent to room temperature

Ignore reference to body temperature

1

(c) (i) (Find) the most common result / time / the result / time that occurs the most;

1

(ii) Highest and lowest result / time;

Accept 'difference between highest and lowest results / times'

1

(d) 1. (Which is based on) <u>mean</u> of 20 people / large (enough) sample;

This point is possible for students that suggest the difference is significant

2. (But) SE bars / confidence limits overlap;

This point applies whether 1 × SE or 2 × SE is used

3. Reference to 0.297 ± 0.0424 / 0.326 ± 0.0366 / confidence limits = 2 × SE;

This point rewards knowledge of use of 2 × SE (as per Students' Statistics Sheet)

4. (So) difference is **not** significant;

This point is only awarded after marking point 2 or marking point 3 has been given

3 max

[10] (a) 1. Causes sodium ion channels to open;

8

1. Reject if wrong sequence of events

2. Sodium ions enter (cell and cause depolarisation);

Reject sodium on its own only once

2

(b) 1. (If not removed) keeps binding (to receptors);

Accept answers based on what happens if it is transported out − ie what should happen

2. Keeps causing action potentials / depolarisation (in post-synaptic membrane);

2. Accept keeps Na^+ channels open(ing)

2

(c) 1. Movement in all groups (about) same before MDMA;

Q

2. MDMA increases movement in Group **L**;

*2. Accept normal mice for **L***

3. Group **K** shows MDMA causes movement;

*3. Accept **K** is a control*

4. No / little increase in mice without receptor / Group **M**;

3 max

[7]

(a) (Ion) channel proteins open, sodium in;

9

Changes membrane potential / makes inside of axon less negative / positive / depolarisation / reaches threshold;

More channels open / positive feedback;

Accept other phrases for ion channel proteins providing that it is clear that it is something through which ions pass. Reject carrier.

First marking point relates to opening.
Third point must relate to more (channels) opening.

3

(b) Potassium channels open;

Potassium out;

Sodium channels close;

Do not penalise candidate who refers to sodium or potassium. Ions are mentioned in question.
Reject pump

3

(c) Pump / active transport / transport against concentration gradient;

Of sodium from axon / sodium out / of potassium in;

Do not penalise candidate who refers to sodium or potassium. Ions are mentioned in question

2

[8]

10 (a) closed open closed;

closed closed open;

2

(b) active transport / pump of Na^+ out of axon; diffusion of K^+ out of axon / little diffusion of Na^+ into the axon;

2

(c) can not pass through phospholipid bilayer;because water soluble / not lipid soluble / charged / hydrophilic / hydrated;

2 **[6]**

11 (a) In table:

D	*All 3 correct = 2 marks;; 2 correct =*
B	*1 mark;*
C	*0 or 1 correct = 0 marks*

2

(b) (i) myelin insulates / prevents ion movement; saltation / describedre leaping node to node;

2

(ii) cat has higher body temperature; *ignore references to homoiothermy' / warm-blooded*
faster diffusion of ions / faster opening of ion pores / gates / channels;

2

(c) 1 increasing stimulus (potential) causes decrease in potentialdifference / rise in potential at P;

2 1 or 2 is sub-threshold / 1 or 2 does not give action potential / 3 or 4 is above threshold / 3 or 4 does give an action potential;

3 influx of Na^+ ions; *(not just Na / sodium)*

4 voltage-gated channels (in axon membrane) opens / opens Na^+ channels / membrane more permeable to Na^+
(NOT just Na / sodium);

5 sufficient for stimulation of adjacent region of axon therefore impulse propagated(from P to Q);

5

(d) 1 X / Acetylcholine → opening of Na^+ channels / increases Na^+ permeability and Na^+ ion entry into Z;

2 Y / Cl^- entry - lowers potential / increases potential difference / makes potential more negative;

3 X stimulates and Y inhibits (Z);

4 balance of impulses from X and Y determines whether Zfires action potential / determines whether potential rises above threshold;

4

[15] (a) action potential arrives / depolarisation occurs;

12

calcium ions enter synaptic knob; vesicles
fuse with membrane; acetylcholine diffuses
(across synaptic cleft); binds to receptors;

4 max

(b) inside becomes more negatively charged /
hyperpolarised; stimulation does not reachthreshold
level / action potential not produced;
depolarisation does not occur / reduces effect of sodium ions entering;

3

(c) (i) inhibits enzyme (which breaks down
GABA);more GABA available (to inhibit neurone);

OR

binds to (GABA) receptors;
inhibits neuronal activity / chloride ions enter (neurone);

2 max

(ii) receptors have different tertiary / 3D structure / shape not complementary;
GABA cannot bind; inhibition of neuronal activity does not occur / chloride ions
do not enter;

3

(d) motor area;left cerebral hemisphere;

2

[14] (a) Transports Na^+ and K^+ ;

13

By active transport / pump / against concentration gradient;
Restores ion balance after an action potential;
[*reject* K^+ out and Na^+ in]

2

(b) (i) each protein has a specific tertiary structure / shape;
because the ions have different sizes / shape / charge;
[*reject* receptors binding]

2

(ii) fewer protein B molecules, which transport sodium ions / more
protein A molecules, which transport potassium ions;

1

[5] (a) 1. automatic (adjustments to changes in environment) / involuntary;

14

2. reducing / avoiding damage to tissues / prevents injury / named injury e.g. burning;
3. role in homeostasis / example;
4. posture / balance;
5. finding / obtaining food / mate / suitable conditions;
6. escape from predators;

(ignore 'danger' or 'harm' unless qualified)

3 max

(b) (i) 1. (impulse causes) calcium ions / Ca^{++} to enter axon;
2. vesicles move to / fuse with (presynaptic) membrane;
3. acetylcholine (released);
4. (acetylcholine) diffuses across synaptic cleft / synapse;
5. binds with receptors on (postsynaptic) membrane;

(reject active sites, disqualify point)

6. sodium ions / Na^{+} enter (postsynaptic) neurone;
7. depolarisation of (postsynaptic) membrane;
8. if above threshold nerve impulse / action potential produced

6 max

(ii) neurone to neurone and neurone to muscle; action potential in neurone and no action potential in muscle / sarcolemma; no summation in muscle; muscle response always excitatory (never inhibitory); some neuromuscular junctions have different neurotransmitters; *(penalise 'nerve' once)*

2 max

[11]

15 (a) sodium gates or channels open / increase in permeability of axon membrane to sodium ion;

sodium ions enter axon;

2

(c) non-myelinated – next section of membrane depolarised / whole membrane;
myelinated – depolarisation / ion movement only at nodes;
impulse jumps from node to node / saltatory conduction;

3

[5] (a) (epithelial cell) of tubule cells carry out active transport;

16

transport chloride / sodium ions out (of filtrate); against concentration gradient; into surrounding tissue / tissue fluid;

creates / maintains water potential gradient for water reabsorption; countercurrent multiplier;

5 max

(b) if water potential of blood falls, detected by receptors in hypothalamus;leads to ADH released from pituitary gland;
ADH makes cells of collecting duct / distal convoluted tubule permeable to water;

(accept DCT)

water leaves filtrate by osmosis;
smaller volume of urine produced;

(accept converse if water potential of blood rises)

4 max

(c) (autonomic reflex),autonomic ganglion involved; extra synapse outside the spinal cord; inhibitory rather than excitatory neurone; more neurones involved;

2 max

[11]

17 (a) membrane relatively impermeable / less permeable to sodium ions / gated channels are closed / fewer channels; sodium ions pumped / actively transported out; by sodium ion carrier / intrinsic proteins; inside negative compared to outside / 3 sodium ions out for two potassium ions in;

(if sodium mentioned but not in context of ions, negate 1 mark)

4

(b) (i) 1.6;

1

(ii) 18 ÷ 1.6 = 11.25;multiply by 1000 to convert from ms to s / 11 250;

(correct method = 1 mark, i.e. $\frac{distance}{time}$ *or × 1000)*

(correct answer based on (b)(i) = 2 marks)

2

(iii) time for transmission / diffusion across the neuromuscular junction / synapse;time for muscle (fibrils) to contract;

1 max

(c) movement by diffusion;binding to receptors on (post-synaptic) membrane; causing sodium channels to open / sodium ions to move in to muscle (cell);

3

(d) (i) toxin binds to / competes for / blocks the acetylcholine receptors;acetylcholine can not depolarise the membrane / the toxin does not cause depolarisation;

(allow references to generating action potentials instead of depolarisation, do not allow references to impulses in muscles)

2

(ii) acetylcholinesterase is unable to breakdown acetylcholine;acetylcholine still available to depolarise the membrane / generate action potentials in the membrane;

2

[15]

18

(a) Correct answer: 6 / 6.25 / 6.3;

Ignore working

Allow 1 mark if decimal point in wrong position

OR

$\frac{1000}{160}$ / $\frac{1}{160}$

Allow 1 mark

2

(b) Ref. to '<u>refractory period</u>' ;

Requires greater stimulation;
To reach threshold / threshold cannot be reached / to cause depolarisation;

K^+ channels are open / more negative potential than resting potential / membrane is hyperpolarised;

Na^+ channels are inactive/are closed / sodium channels will not open;

3 max

[5]

19

(a) (i) <u>A to B</u>:

Mark (i) and (ii) as a whole

Sodium channels open / membrane more permeable to sodium (ions);

Max 3 for each section

Sodium ions enter;
By diffusion / from high to low concentration;

Allow 'diffusion' point ONCE only

Ref. sodium ions have positive charge / cause change from negative to positive potential; *Accept refs to sodium and potassium*

(ii) After B:

Sodium channels close;
Potassium channels open / membrane more permeable to potassium ions;
Potassium ions leave;
By diffusion / from high to low concentration (ONCE only);

4 max

(b) (More) respiration;

Reject anaerobic respiration

(More) energy supplied / (more) ATP supplied;

Reject 'produce' energy

For active transport of ions / 'sodium (-potassium) pump' / pumping out sodium ions / for neurotransmitter synthesis / for vesicle movement; *Accept named e.g.*

3

[7]

20

(a) Potassium channels open (and K^+ ions diffuse out);

Accept references to sodium channels opening;

Sodium channels close (and stops Na^+ ions diffusion in);

Leading to depolarisation;

Accept sodium pump (starts) to pump out sodium ions

2

(b) (Absolute) refractory (period);

1

(c) (i) Causes them to contract;

And relax;

Rapidly/twitch;

2 max

(ii) Cause continuous muscle contraction;

Accept a reasonable suggestion of harm – linked to muscle contraction

At high force;

Causing failure to breathe/heart stops pumping/ damage to bones or joints;

2 max

[7]

21 (a) Cocaine (binding) changes shape of transporter/prevents dopamine binding;

Reject references to active site

Transporter cannot move (bound) dopamine (through membrane / protein / into cell);
Dopamine remains / builds up in synapses (leading to feelings of pleasure);

3

(b) (i) Polymerase chain reaction / PCR;

1

(ii) Single-stranded DNA;

Reject reference to a single strand of DNA

Bases / sequence complementary to DNA / gene to be identified;

(Radioactively / fluorescent) labelled so that it can be detected;

2 max

(c) Mutation changes base sequence of gene / DNA;

Accept references to active site

(Thus) changing amino acid sequence;
Changes tertiary structure / shape of protein/transporter;
Cocaine binding site changes/cocaine cannot bind;
Dopamine can still bind (and be transported);

3 max

[9]