AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.6.2.1 NERVE IMPULSES

SCORE	PERCENTAGE
/232	%

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(a) Explain how a resting potential is maintained across the axon membrane in a neurone. **1.**

(3)

(b) Explain why the speed of transmission of impulses is faster along a myelinated axon thanalong a non-myelinated axon.

(3)

(c) A scientist investigated the effect of inhibitors on neurones. She added a respiratoryinhibitor to a neurone. The resting potential of the neurone changed from –70 mV to 0 mV.

Explain why.

(3)

(Total 9 marks)

2. Guillain–Barré syndrome is a rare disease in which the immune system damages the myelin sheath of neurones. Myelin sheath damage can cause a range of symptoms, for example numbness, muscular weakness and muscular paralysis. Sometimes, neurones of the autonomic nervous system are affected, causing heart rate irregularities.

Huntington's disease is a disorder caused when a protein called huntingtin damages the brain. Huntingtin is produced because of a dominant, mutant allele.

The first successful drug trial to reduce concentrations of huntingtin in the human brain involved 46 patients. The patients received the drug for 4 10 months. The concentration of huntingtin was reduced in all the patients. The drug was injected at the base of the spine into the cerebrospinal fluid bathing the brain and spinal cord. The drug contains single-stranded DNA molecules. These single-stranded molecules inhibit the mRNA needed to produce huntingtin.

Symptoms of Huntington's disease can start at any time, but usually develop between 30 and 50 years of age. The likelihood and age when symptoms start are linked to the number of CAG base sequence repeats in the gene for Huntington's disease. However, recent studies have suggested that epigenetics may also affect the age when symptoms first start.

15 (a) Damage to the myelin sheath of neurones can cause muscular paralysis (lines 2–4).

Explain how.

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(3)

(b) Sometimes Guillain–Barré syndrome causes heart rate irregularities (lines 4–5).

Suggest and explain why.

(3)

(c) The first successful drug trial to reduce concentrations of huntingtin in the brain used single-stranded DNA molecules (lines 13–14).

Suggest and explain how this drug could cause a reduction in the concentration of the protein huntingtin.

(3)

(d) Scientists from the first successful drug trial to reduce concentrations ofhuntingtin (lines 9–11) reported that the drug is not a cure for Huntington's disease.

Suggest **two** reasons why the drug should not be considered a cure.
Do **not** include repeats of the drug trial in your answer.

1 _____

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2 _____

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(2)

(e) Suggest **two** reasons why people had the drug injected into the cerebrospinal fluid (lines 12–13) rather than taking a pill containing the drug.

1 _____

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2 _____

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(2)

(f) Suggest and explain **one** way epigenetics may affect the age when symptoms of Huntington's disease start.

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(2)

(Total 15 marks)

3. (a) When a nerve impulse arrives at a synapse, it causes the release of neurotransmitter from vesicles in the presynaptic knob.

Describe how.

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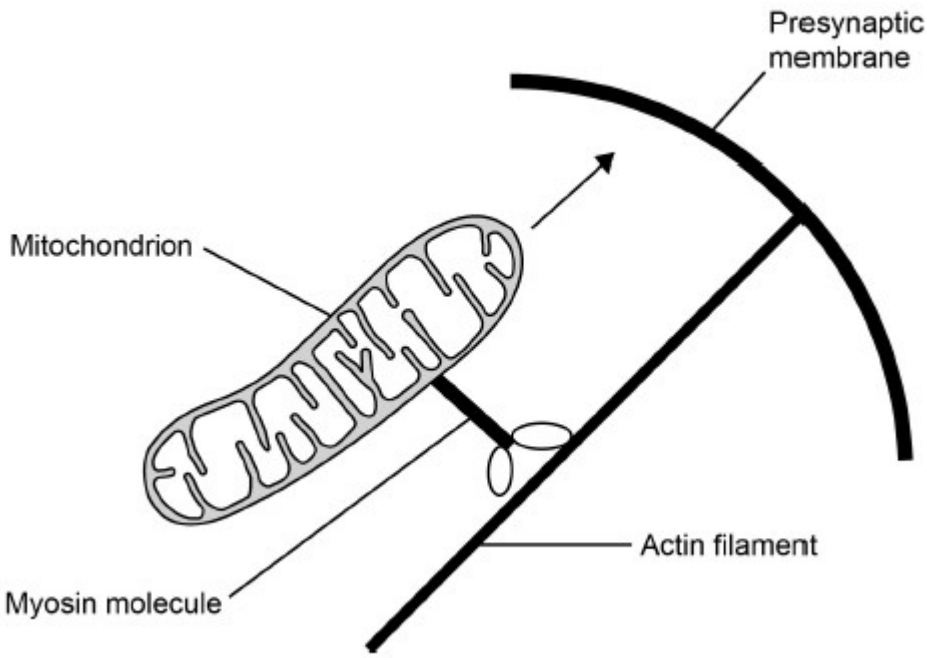
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(3)

(b) The presynaptic knob contains actin filaments and myosin molecules.

The myosin molecules can attach to mitochondria and move them towards the presynaptic membrane, as shown in the diagram.



Use your knowledge of how myosin and actin interact to suggest how the myosin molecule moves the mitochondrion towards the presynaptic membrane.

Do **not** include the roles of calcium ions and tropomyosin in your answer.

(2)

(c) This movement of mitochondria happens when nerve impulses arrive at the synapse.

Suggest and explain **one** advantage of the movement of mitochondria towards the presynaptic membrane when nerve impulses arrive at the synapse.

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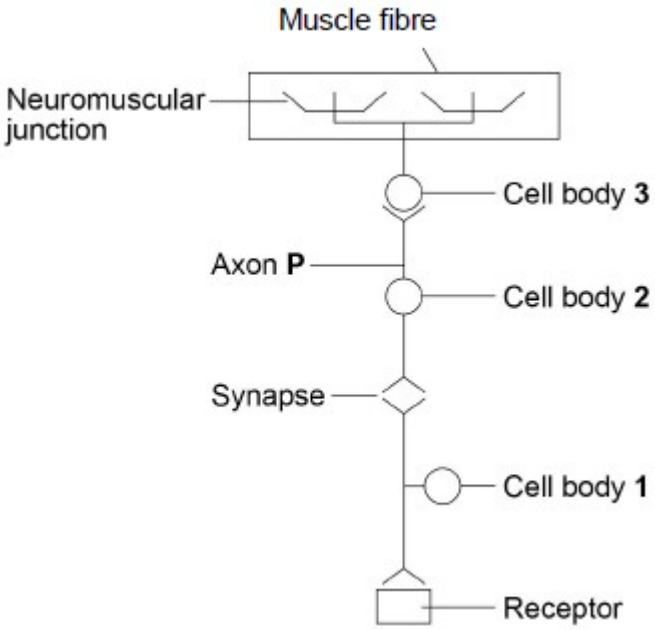
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(2)

(Total 7 marks)

4. The diagram below shows a nerve pathway in an animal.



(a) The nerve pathway shown in the diagram may be regarded as a simple reflex arc.

Use the diagram to explain why.

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_____

(1)

(b) Suggest **two** advantages of simple reflexes.

1. _____

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2. _____

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(2)

(c) In the nerve pathway in the diagram, synapses ensure that nerve impulses only traveltowards the muscle fibre.

Explain how.

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(2)

(d) Axon **P** was found to conduct impulses much faster than other axons in the nerve pathway shown in the diagram.

Describe and explain **one** feature of axon **P** that might cause this difference.

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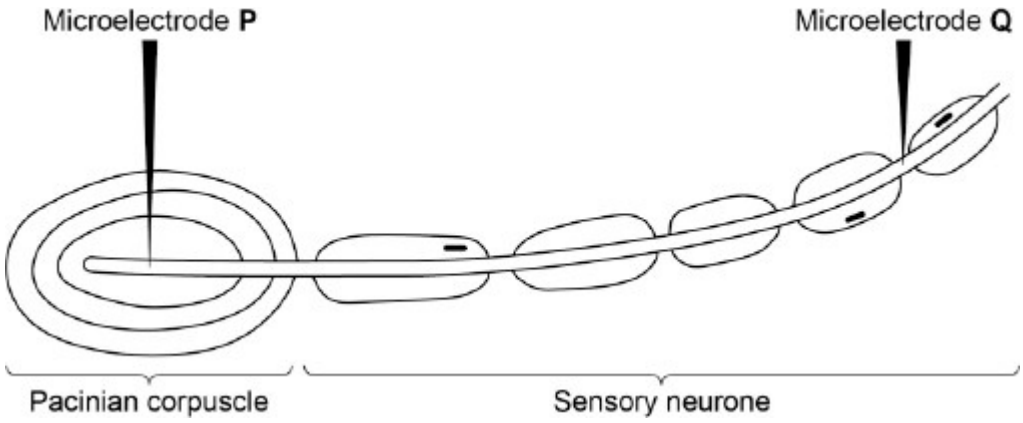
(2)

(Total 7 marks)

5. A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip.

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**.

(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)

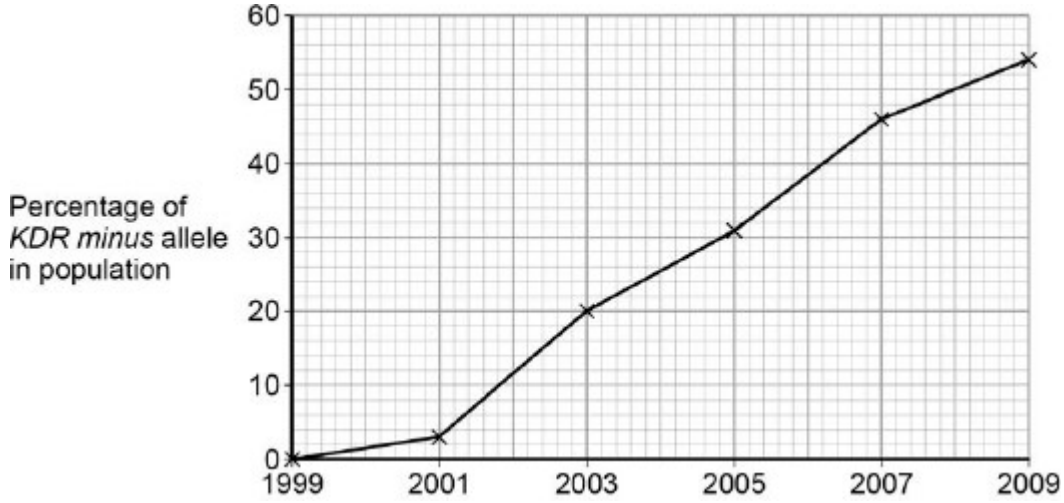
(Total 9 marks)

6. 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.

_____

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(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)

7.

(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 _____

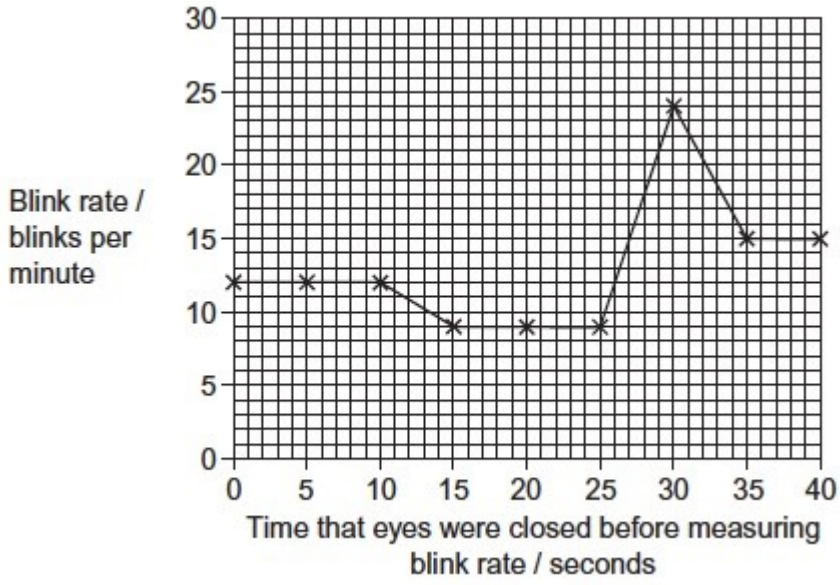
2 _____

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(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 _____

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_____

2 _____

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(2)

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

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(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)

8. (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.

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(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.

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_____

(1)

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

(2)
(Total 6 marks)

9. 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 contractionof muscles.

Suggest **one** reason why.

(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.

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(4)

(d) Cannabinoids include substances found in cannabis that can enter brain tissue. Scientistsare 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.

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(2)

(Total 9 marks)

10.

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

Explain this difference.

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(3)

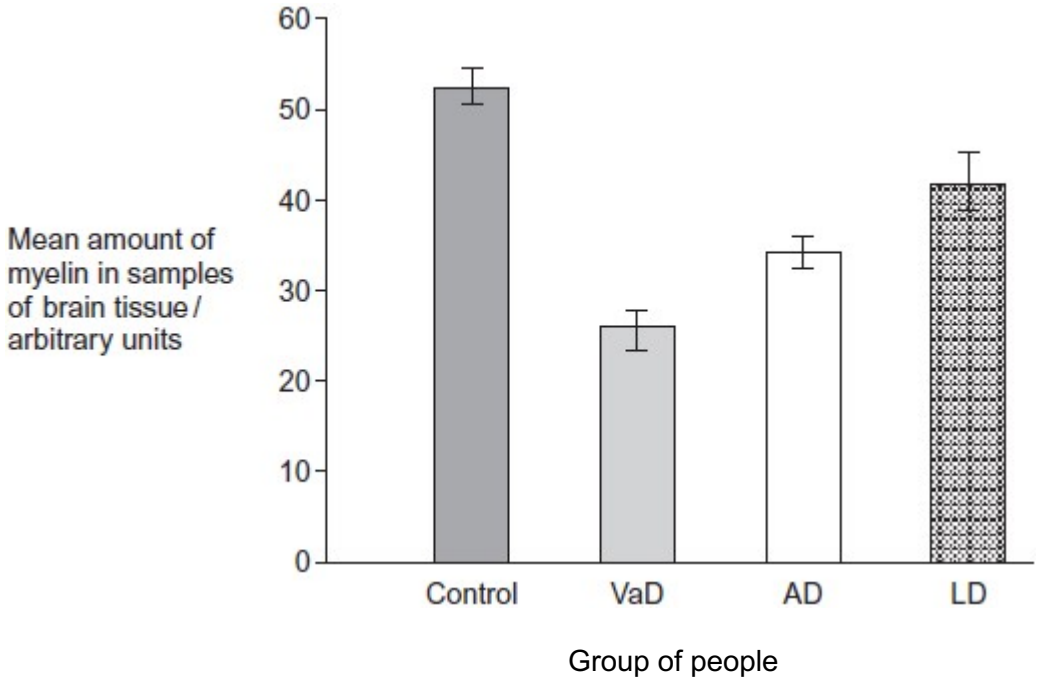
Doctors investigated the relationship between myelin in brain tissue and different types of dementia. All types of dementia involve loss of mental ability.

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.

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_____

_____

(4)

(Total 9 marks)

11. 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.

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(3)

(Total 10 marks)

12. 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.

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(2)

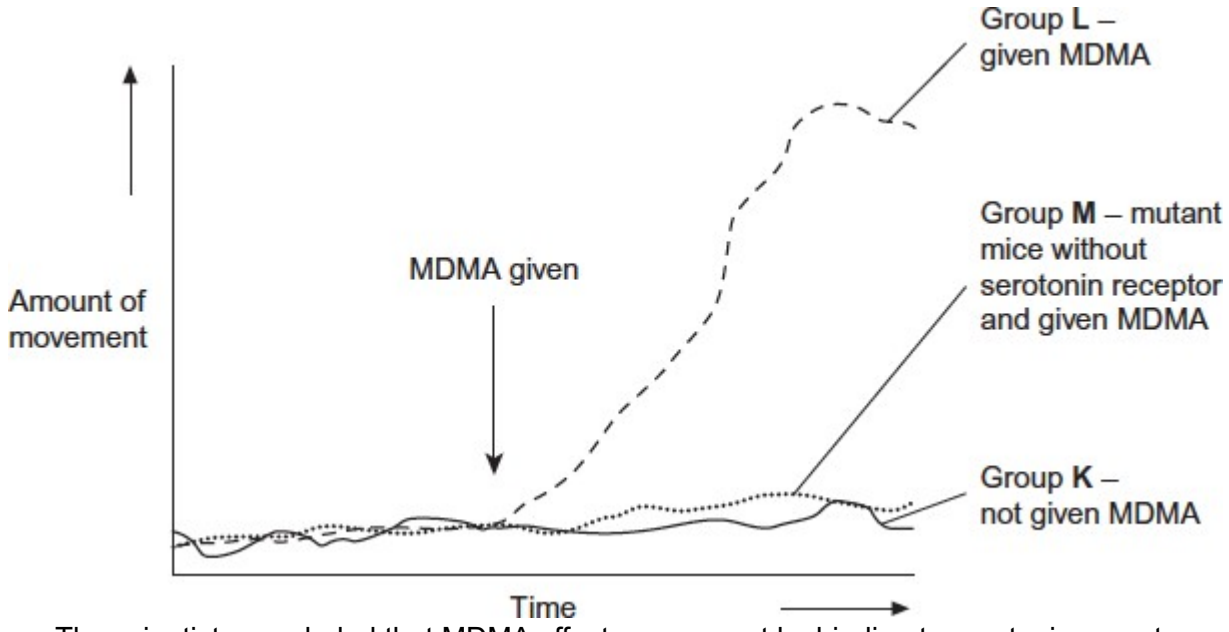
(b) It is important that a neurotransmitter such as serotonin is transported back out ofsynapses. Explain why.

(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.

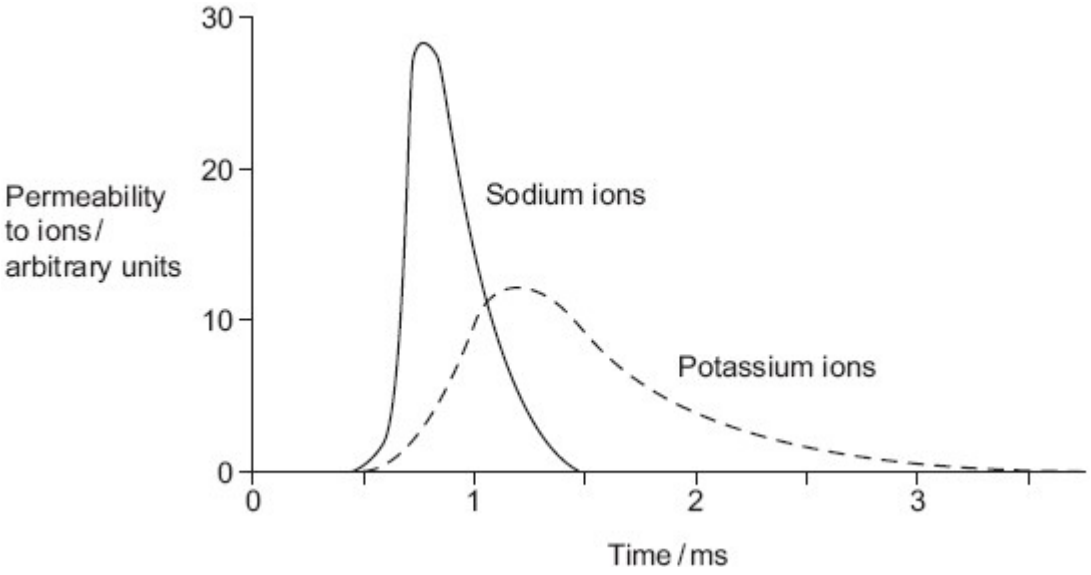
How do these results support this conclusion?

(3)

(Total 7 marks)

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

13. 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)

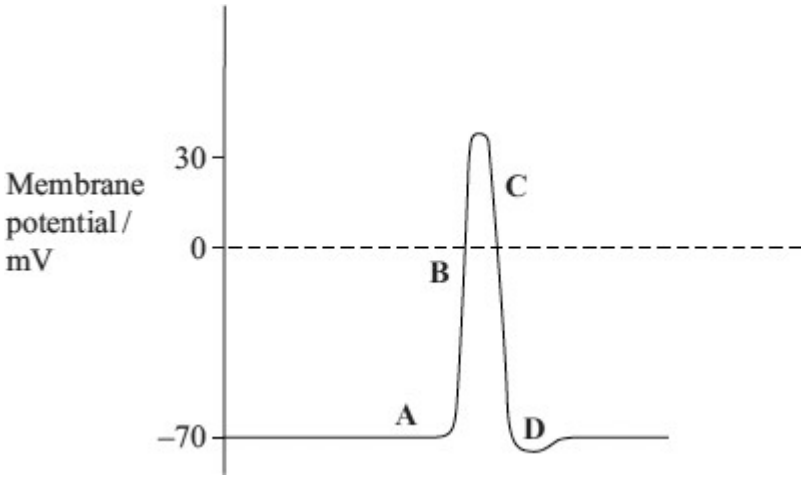
(c) After exercise, some ATP is used to re-establish the resting potential in axons. Explain howthe resting potential is re-established.

(2)

(Total 8 marks)

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

Figure 1



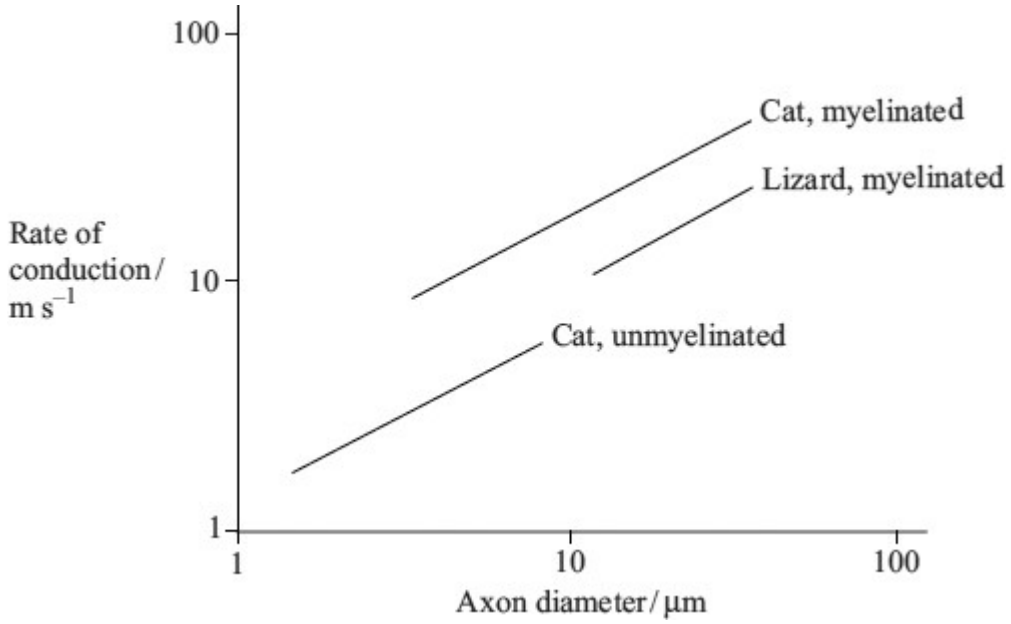
The changes shown in **Figure 1** are due to the movement of ions across the axon membrane. Complete the table by giving the letter (**A** to **D**) that shows where each process is occurring most rapidly.

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.

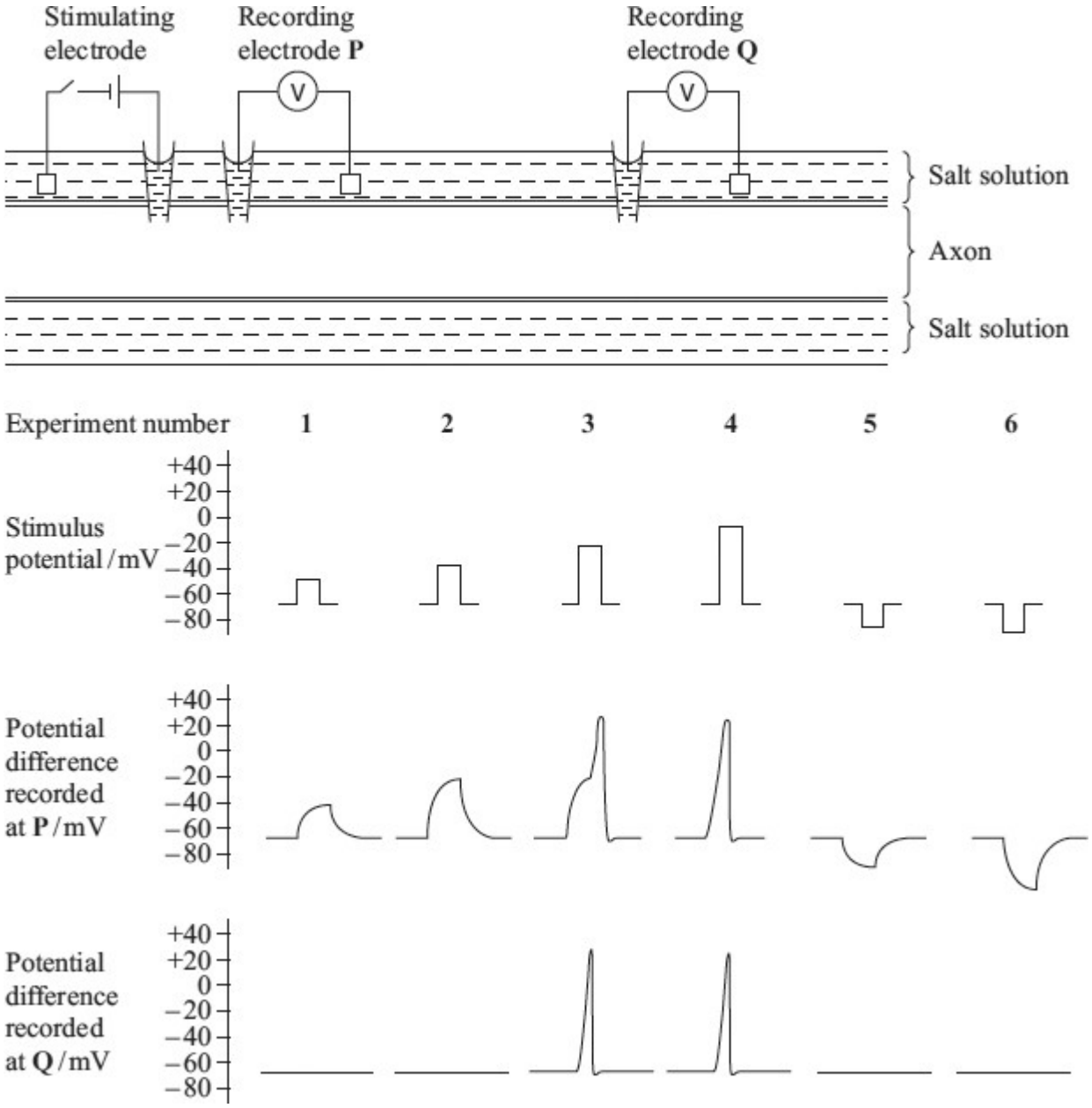
(2)

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

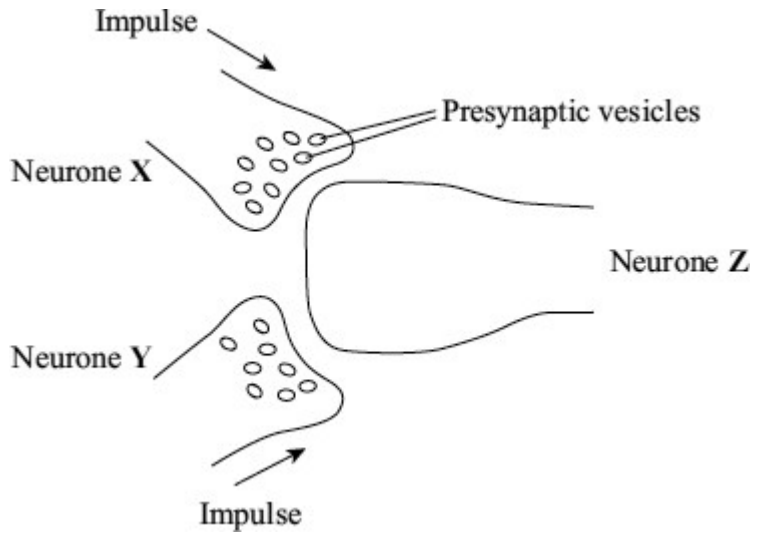


(c) Explain the results of experiments **1** to **4**.

(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)

15.

(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 ionsacross the membrane.

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_____

_____

(2)

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

Explain why.

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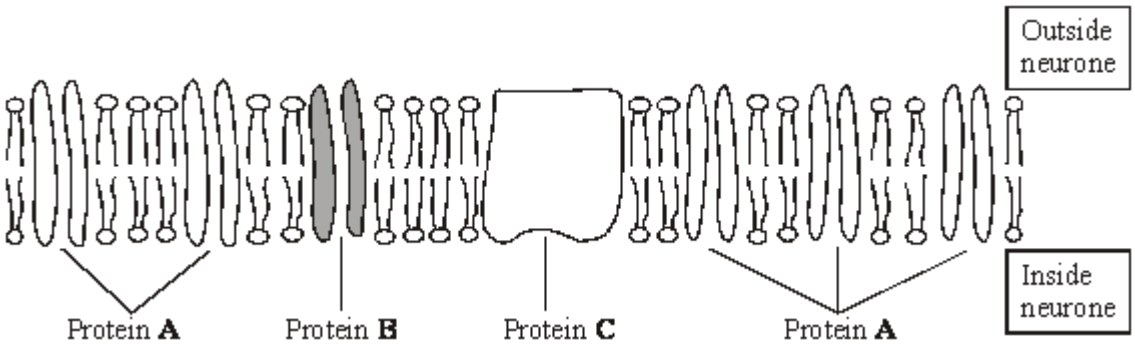
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(2)

(Total 6 marks)

16. 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**.

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_____

_____

_____

(2)

(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.

_____

_____

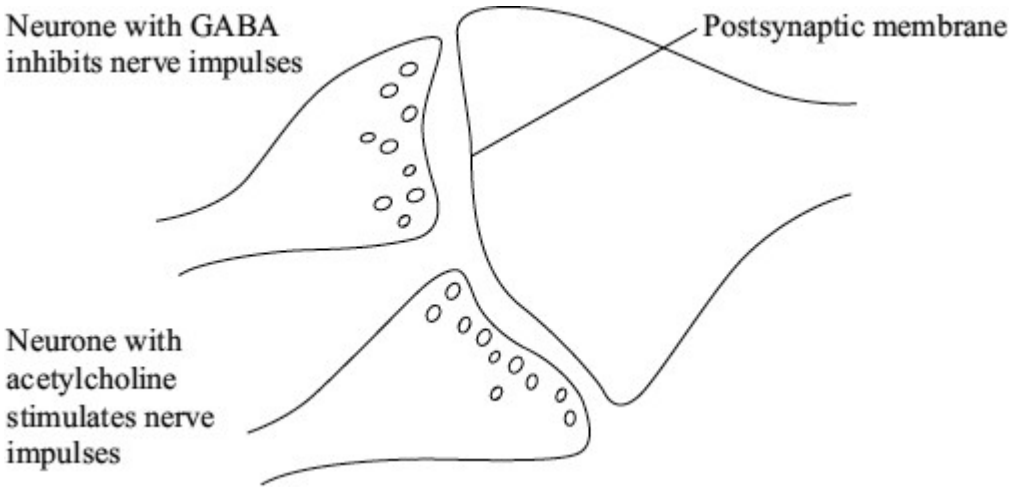
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(1)

(Total 5 marks)

17. 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.

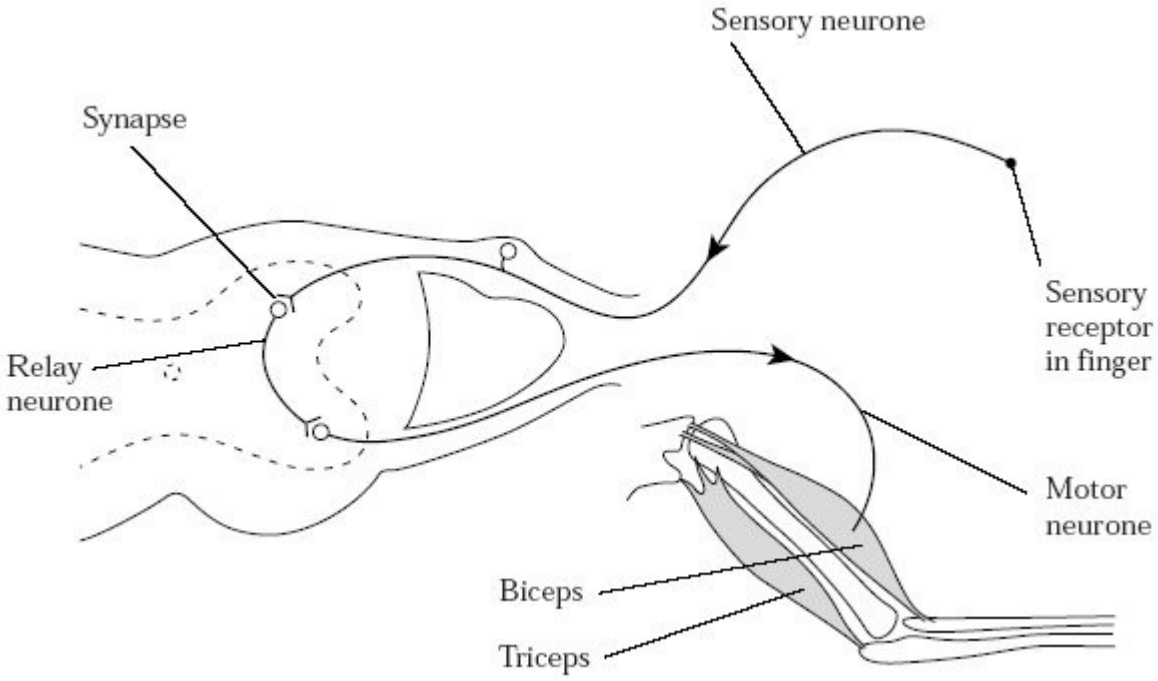
(3)

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

(2)

(Total 14 marks)

18. 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.

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(6)

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

1. _____

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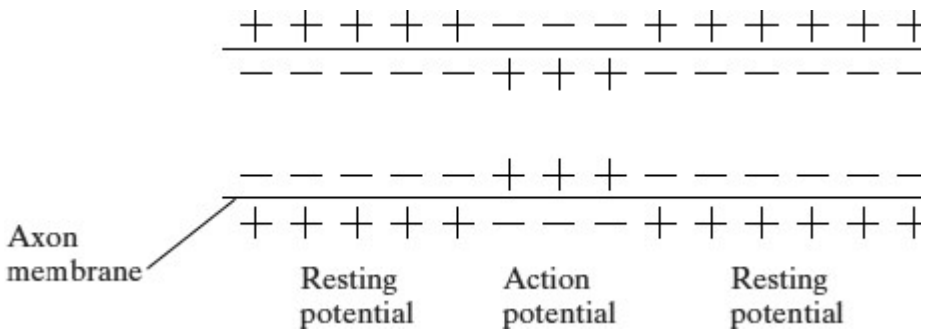
2. _____

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(2)

(Total 11 marks)

19. 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.

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_____

(2)

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

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(3)

(Total 5 marks)

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

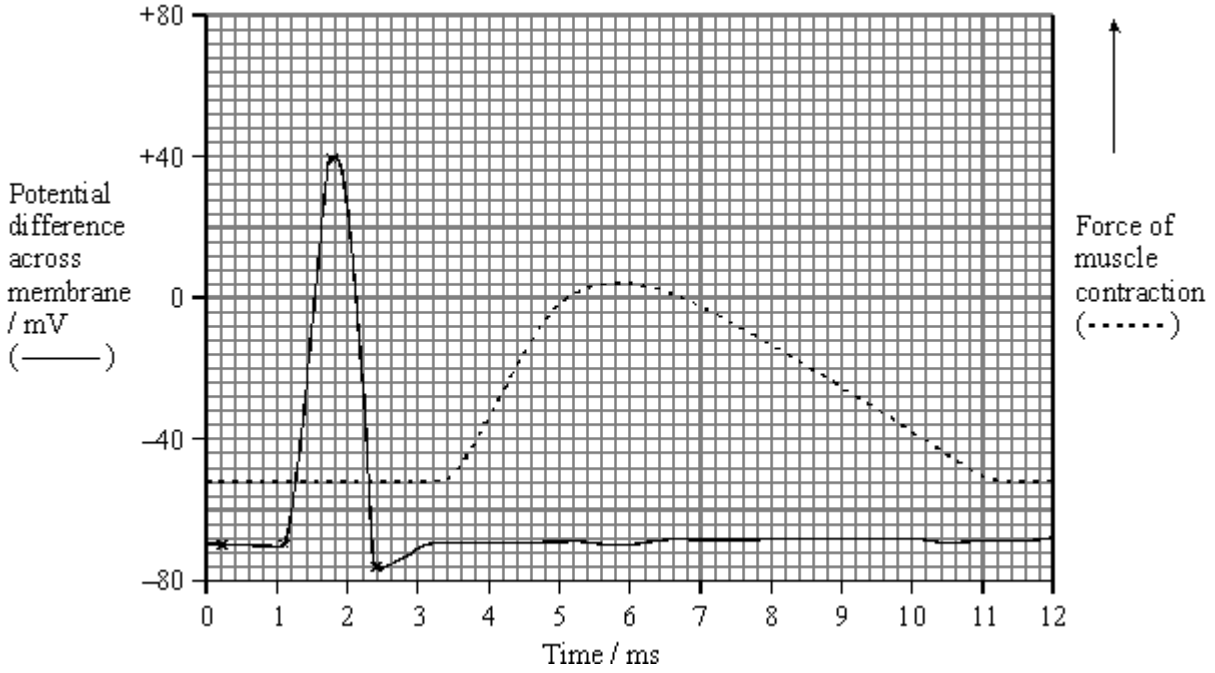
20.

(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.

_____

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_____

_____

_____

_____

(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)

Answers should be written in continuous prose, where appropriate.

21.

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.

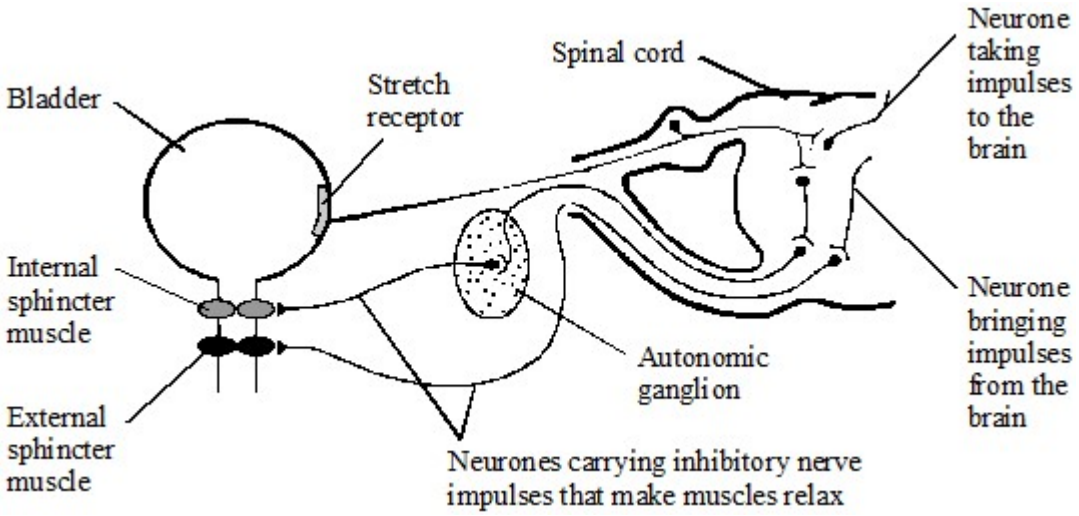
(a) Explain how the loop of Henle maintains the gradient of ions which allows water to be reabsorbed from filtrate in the collecting duct.

(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;

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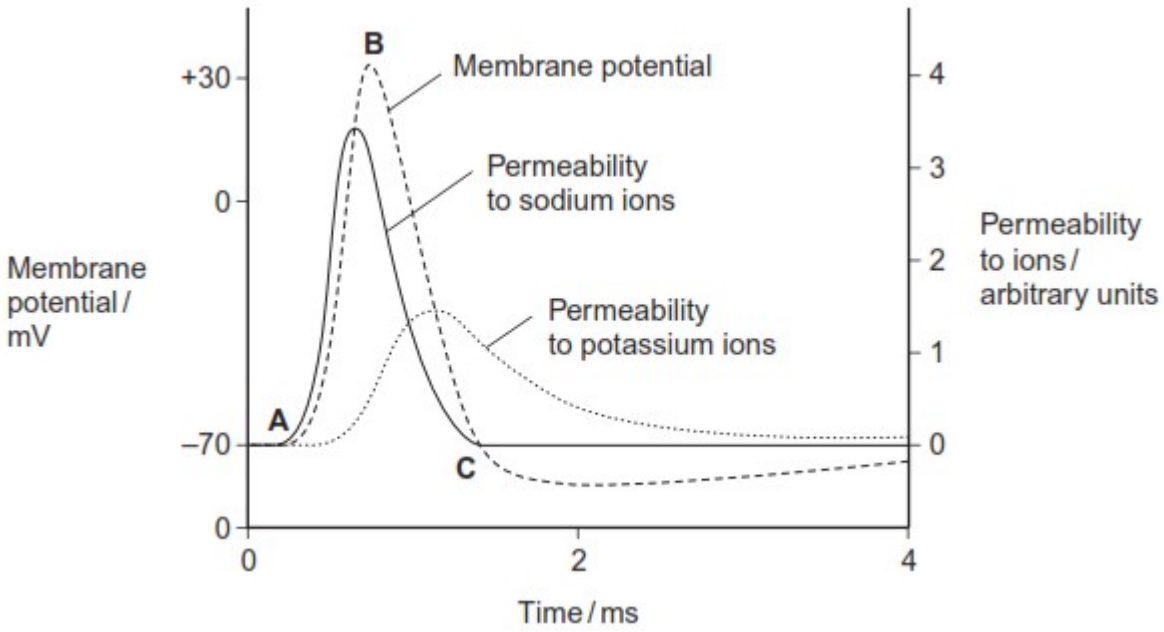
_____

(2)

(Total 11 marks)

22. 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)

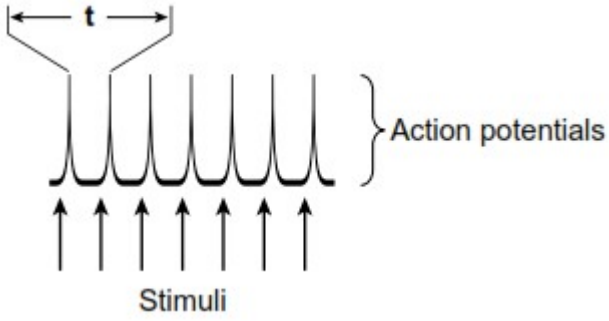
(3)

(Total 7 marks)

23. 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.

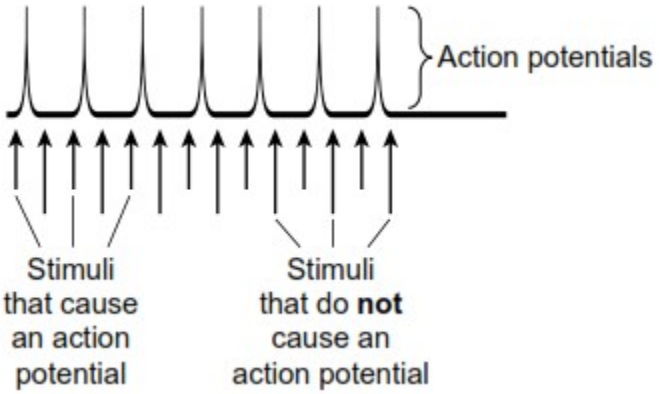
Show your working.

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.

_____

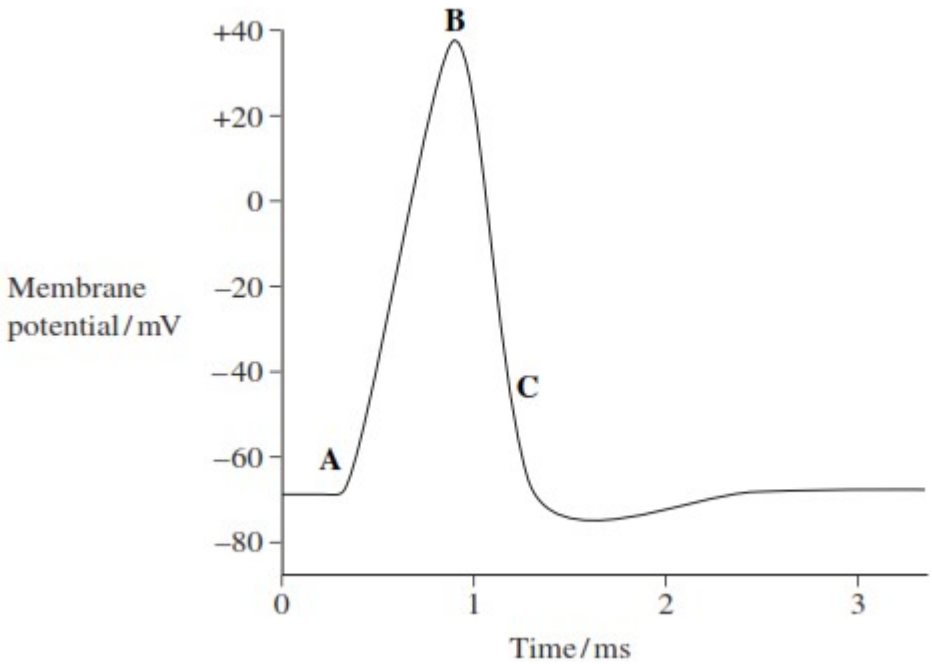
(Extra space) _____

(3)

(Total 5 marks)

24. **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**.

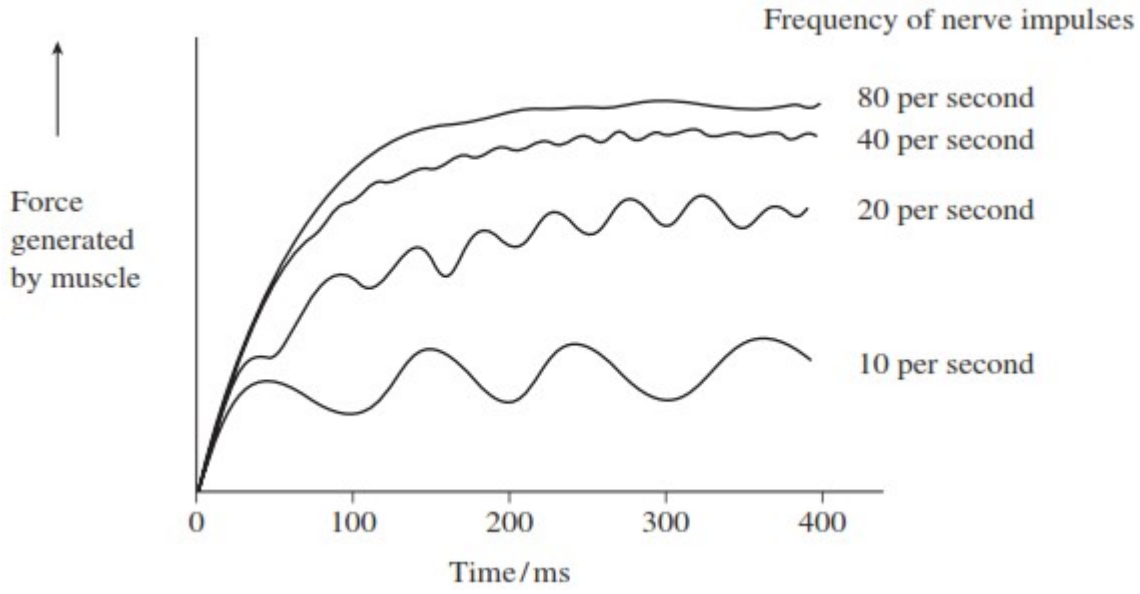
What is the name given to the period between times **A** and **C**?

_____

(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.

_____

_____

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_____

(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.

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(2)

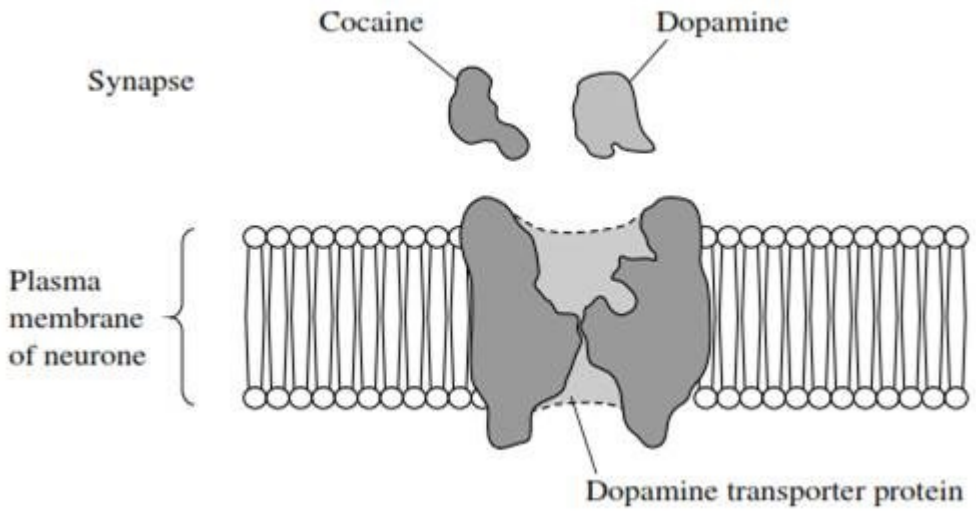
(Total 7 marks)

25. 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.

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_____

_____

_____

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_____

(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?

_____

_____

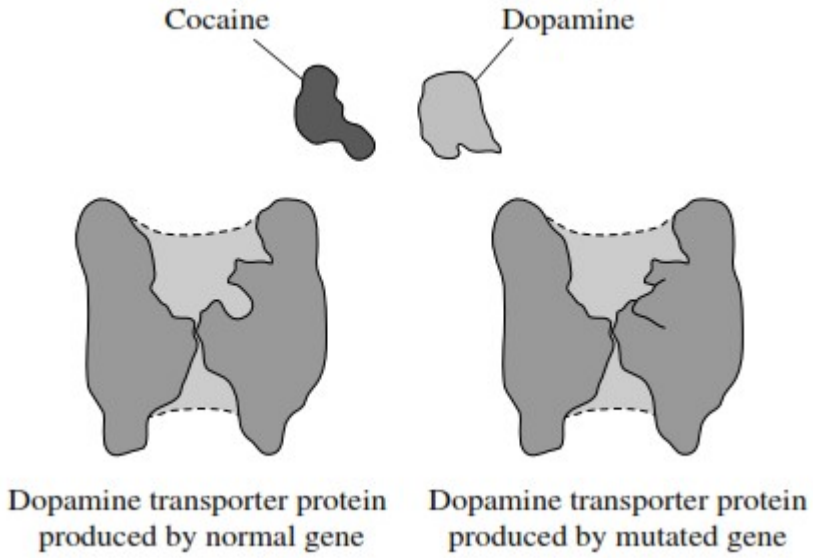
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_____

(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.

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_____

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(Extra space) _____