

Q1. 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.

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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.

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- (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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(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.

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Q2.(a) Describe the roles of calcium ions and ATP in the contraction of a myofibril.

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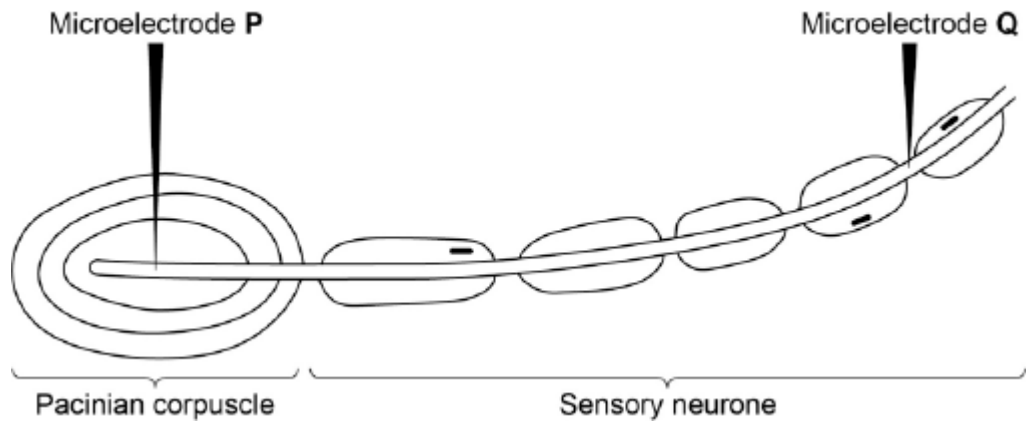
(b) ATP is an energy source used in many cell processes. Give **two** ways in which ATP is a suitable energy source for cells to use.

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(Total 7 marks)

Q3.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 no pressure is applied.

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- (b) Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode P.

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

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

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(Total 9 marks)

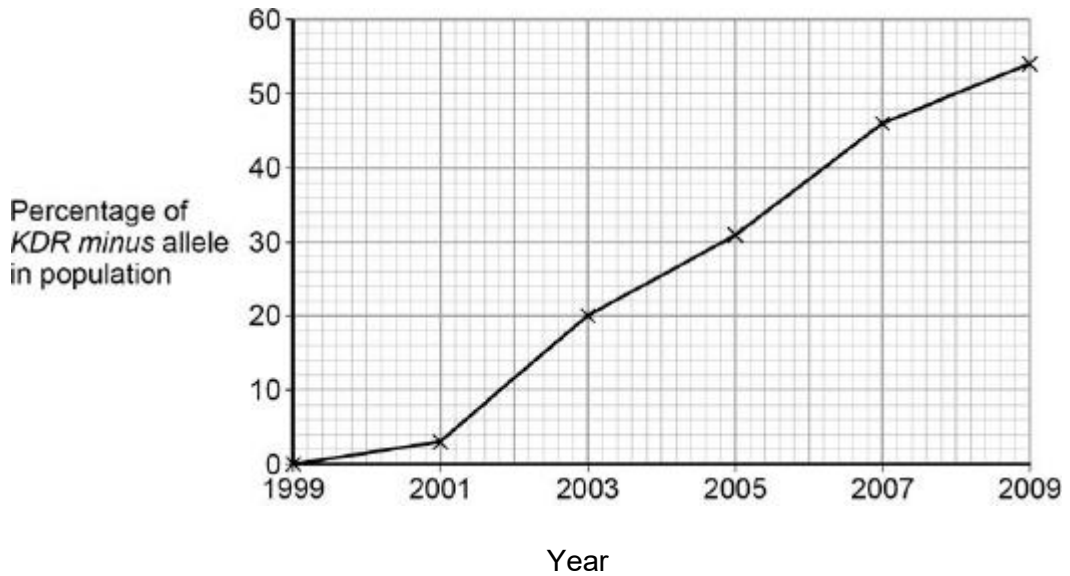
Q4. Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

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 heterozygous for the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003

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

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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.

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

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(Total 10 marks)

Q5. 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 because nerve impulse conduction is slower. Explain how a lower temperature leads to slower nerve impulse conduction.

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

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

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(1)

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

(i) the mode

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(ii) the range

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

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(Total 10 marks)