

**Q1.**

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

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**(3)**

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

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**(3)**

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

Explain why.

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(3)  
(Total 9 marks)

**Q2.**

Describe the sequence of events involved in transmission across a cholinergic synapse.

Do **not** include details on the breakdown of acetylcholine in your answer.

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(Total 5 marks)

**Q3.**

- (a) Dopamine is a neurotransmitter released in some synapses in the brain. The transmission of dopamine is similar to that of acetylcholine.

Dopamine stimulates the production of nerve impulses in postsynaptic neurones.

Describe how.

Do **not** include in your answer the events leading to the release of dopamine and the events following production of nerve impulses at postsynaptic neurones.

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(3)

- (b) Dopamine has a role in numerous processes in the brain including pain relief. The release of dopamine can be stimulated by chemicals called endorphins produced in the brain. Endorphins attach to opioid receptors on presynaptic neurones that release dopamine.

Morphine is a drug that has a similar structure to endorphins and can provide pain relief.

Explain how.

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(2)

- (c) GABA is a neurotransmitter released in some inhibitory synapses in the brain. GABA causes negatively charged chloride ions to enter postsynaptic neurones.

Explain how this inhibits postsynaptic neurones.

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(3)

(Total 8 marks)

**Q4.**

Alzheimer's disease (AD) is a non-reversible brain disorder that develops over a number of years. At the start of 2014 the number of Americans with AD was estimated to be 5.4 million. Every 30 seconds another person in America develops AD.

- 5 In the brain of a person with AD there is a lower concentration of acetylcholine. This affects communication between nerve cells and initially results in memory loss and confusion. Some of the symptoms of AD that are associated with communication between nerve cells are reduced by taking the drug donepezil. Donepezil inhibits the enzyme acetylcholinesterase.
- 10 A gene mutation called E280A found on chromosome 14 causes early-onset AD at a mean age of 49 years. The age at which the E280A mutation is expressed to cause AD varies.
- 15 Yaramul is a town in a historically isolated region of the Andes Mountains. The population of this town has the highest frequency of the E280A mutation in the world. The origin of the E280A mutation in this population has been traced back to a common ancestor in the 17th century. Natural selection has not reduced

the frequency of the E280A mutation in the population.

20 This autosomal dominant mutation involves a change in triplet 280 from GAA to GCA. Scientists analysed chromosome 14 from 102 individuals from Yaramul. They recorded a sample size of 204 and detected 75 E280A mutations but only 74 potential AD cases. The scientists identified individuals with the mutation by whole genome sequencing. They had decided that a DNA probe would not be a suitable method to detect the E280A mutation.

- (a) Assuming no one with AD died in 2014, calculate the annual percentage increase in AD cases in America for 2014 (lines 2–4).

Answer = \_\_\_\_\_ %

(2)

- (b) Explain how donepezil could improve communication between nerve cells (lines 7–9).

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(3)

**Q5.**

- (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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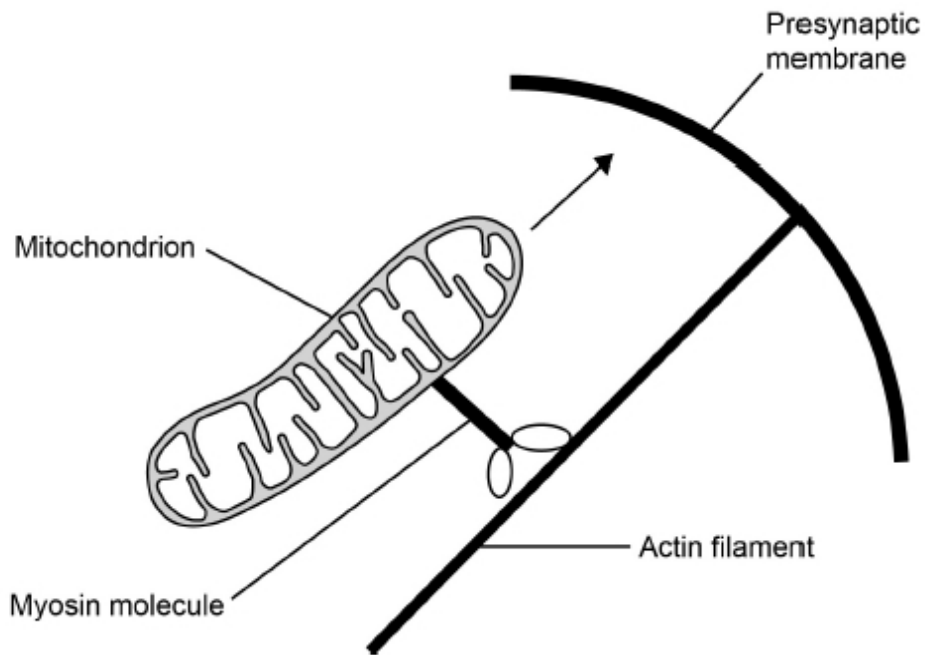


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(3)

(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.

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(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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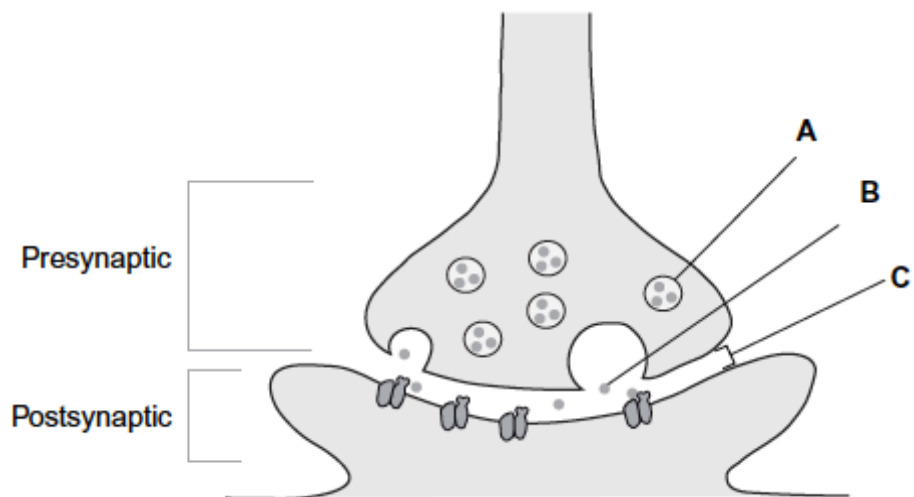


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(2)  
(Total 7 marks)

**Q6.**

The blink reflex involves synapses. Below is a diagram of a synapse.



Identify **A**, **B** and **C**.

**A** \_\_\_\_\_

**B** \_\_\_\_\_

**C** \_\_\_\_\_

(Total 3 marks)