



# **A-Level Biology**

## **Synaptic Transmission**

### **Question Paper**

**Time available: 60 minutes**

**Marks available: 43 marks**

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1.

(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)**

2.

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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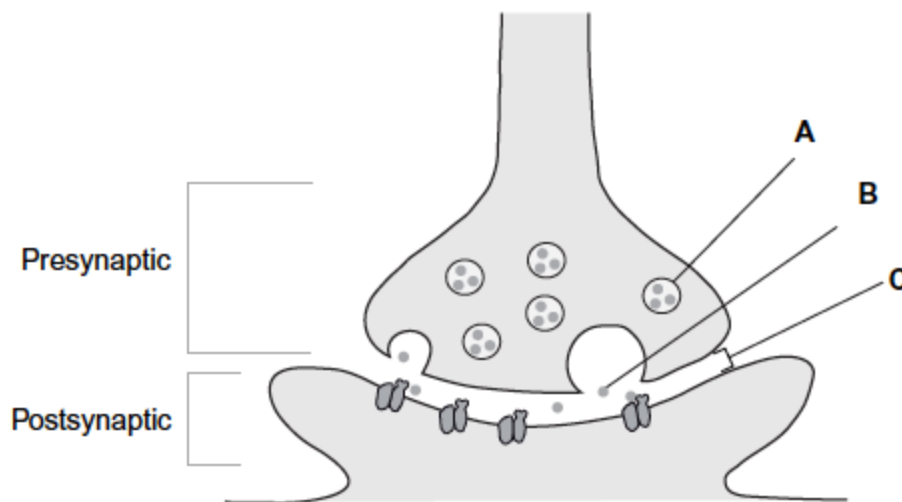


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(Total 5 marks)

3.

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



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

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

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

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

(Total 3 marks)

4.

The blink reflex can be affected by anaesthetics. Local anaesthetics are used to stop people feeling pain but do not make them unconscious. General anaesthetics make people unconscious and stop them feeling pain.

Doctors investigated two ways of measuring the effect of general anaesthetics.

They gave:

- anaesthetic **S** to 18 people
- anaesthetic **Q** to 29 people

They recorded how long it took for the people to stop blinking.

The doctors then repeated the investigation. This time, they used a machine that measures brain activity to decide when a person was unconscious, rather than when blinking stopped. For each person, they recorded how long it took for the machine's readings to show that the person was unconscious.

Their results are shown in the table. A value of  $\pm 2 \times \text{SD}$  from the mean includes over 95% of the data.

Anaesthetic	Mean time taken to stop blinking / minutes ( $\pm 2 \times \text{SD}$ )	Mean time taken for machine to show that person was unconscious / minutes ( $\pm 2 \times \text{SD}$ )
<b>S</b>	0.24 ( $\pm 0.01$ )	0.48 ( $\pm 0.11$ )
<b>Q</b>	0.28 ( $\pm 0.02$ )	0.44 ( $\pm 0.07$ )

- (a) Blinking involves cholinergic synapses. Anaesthetic **S** is a similar shape to acetylcholine. Suggest how anaesthetic **S** stops the transmission across the synapse.

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(3)

- (b) Should time taken to stop blinking be used as an indicator of when to start surgery?  
Explain your answer.

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(2)

- (c) Each person was given the same volume of anaesthetic per kg of body mass.  
Suggest why.

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(1)

(Total 6 marks)

5.

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-synaptic membrane.

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 of synapses. Explain why.

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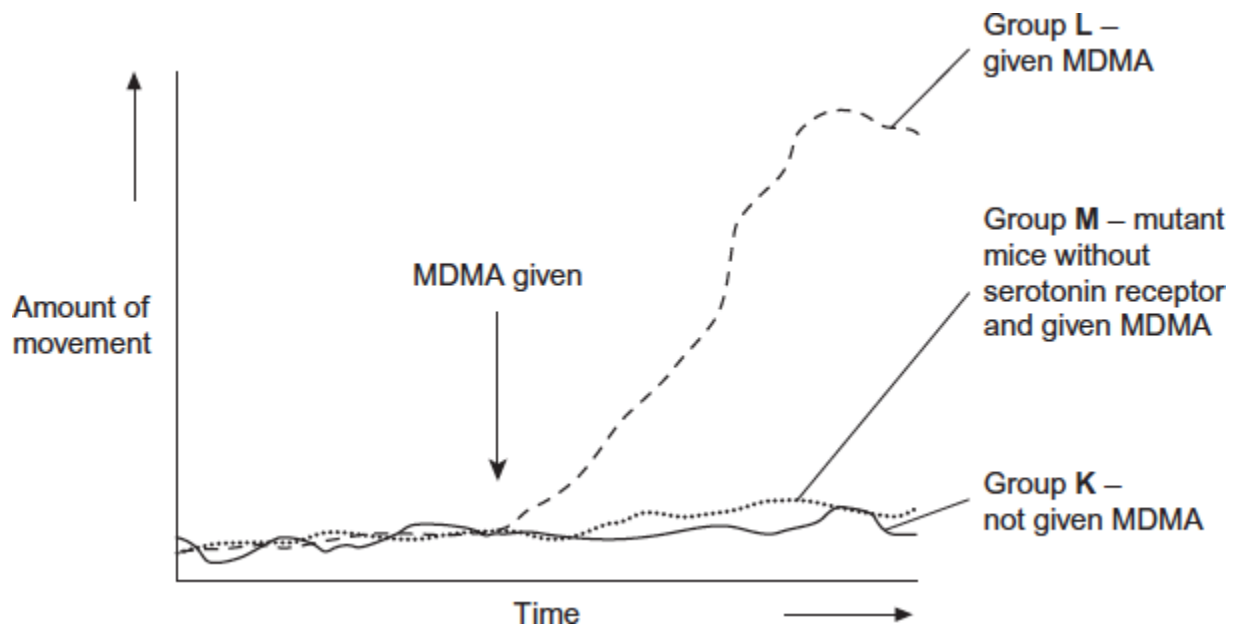
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(2)

(c) Scientists investigated the effect of a drug called MDMA on movement of mice. They measured 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?

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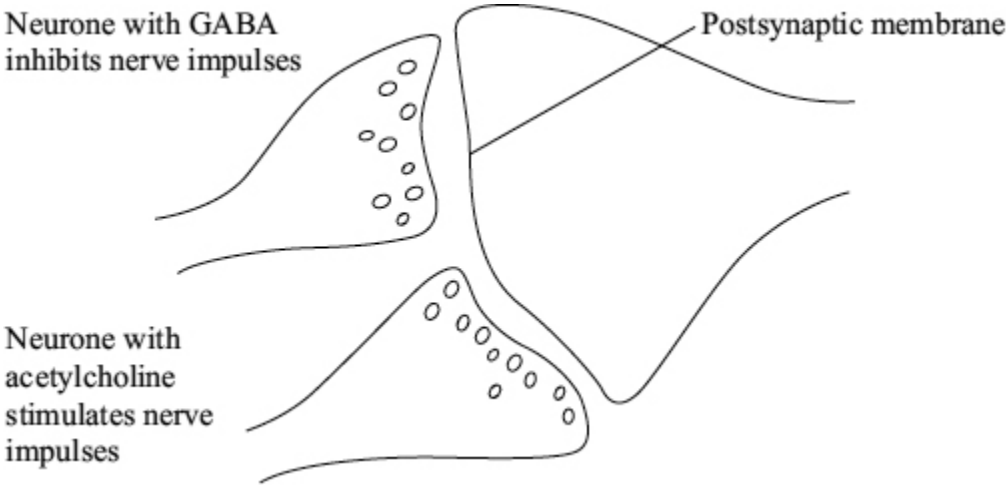
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**(3)**  
**(Total 7 marks)**



6.

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 to the postsynaptic membrane.

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(4)

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

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**(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 the postsynaptic 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.

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**(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.

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**(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?

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**(2)**

**(Total 14 marks)**