

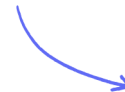
Structured Questions

Neural Signalling

Neurones: Function & Structure / Nerve Impulses / Nerve Impulses: Skills / Synapses

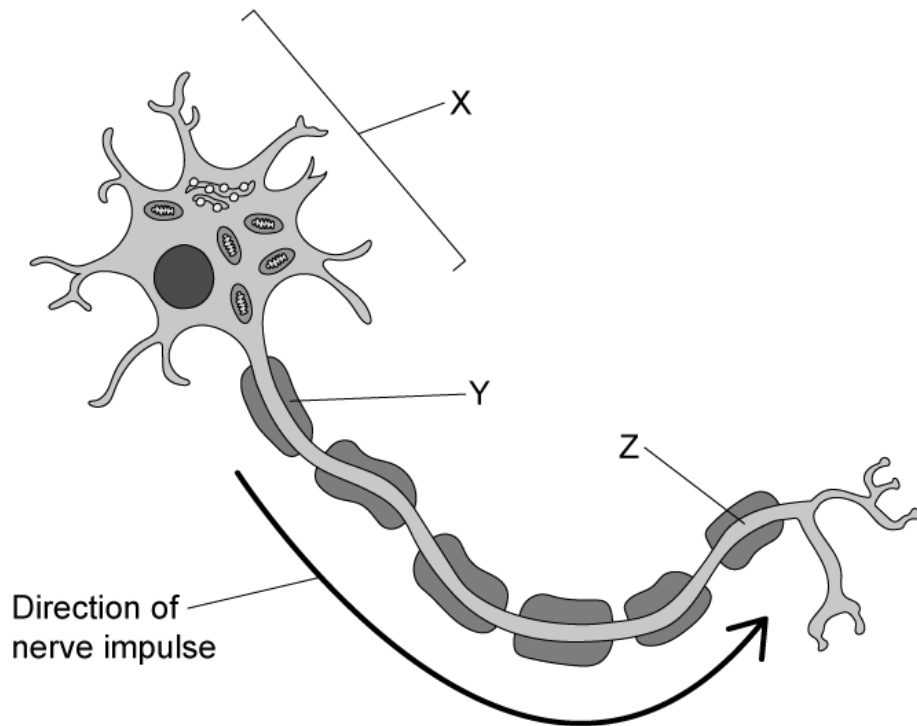
Easy (4 questions)	/22
Medium (4 questions)	/21
Hard (3 questions)	/28
Total Marks	/71

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Easy Questions

1 (a) The image shows a representation of a neurone.



Identify structures X-Z in the image.

(3 marks)

(b) Branching from structure X of the neurone in part a) are structures known as dendrites.

State the role of dendrites in the nervous system.

(1 mark)

(c) Describe the structure of Y from the image in part a).

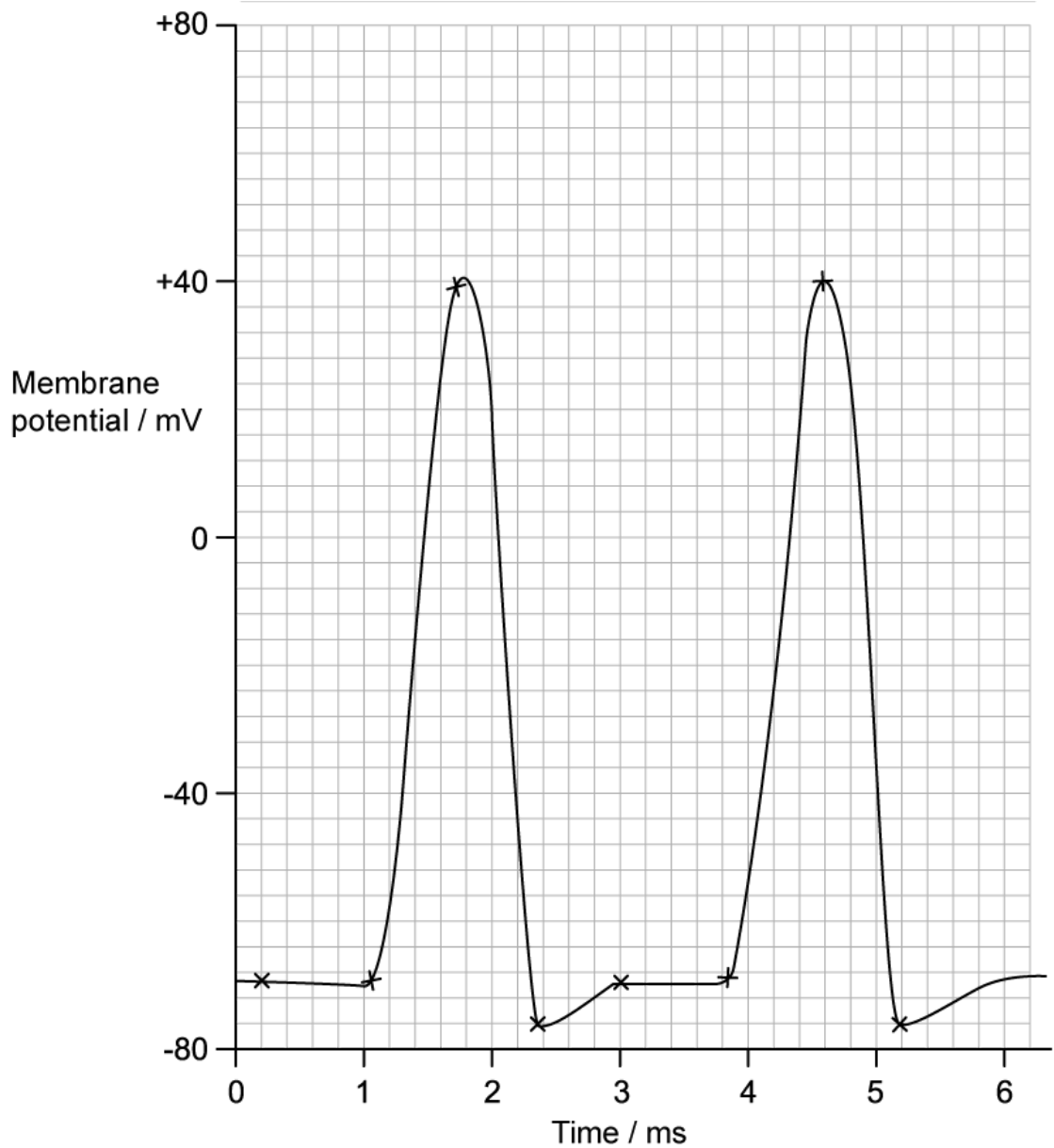
(2 marks)

- (d) It has been estimated that a neurone **without** structure **Y** present can conduct nerve impulses at speeds of 0.5 m s^{-1} whereas a neurone **with** structure **Y** present can conduct impulses at speeds of 150 m s^{-1} .

Calculate how many times faster impulse conduction is in the presence of structure **Y** than without structure **Y**.

(2 marks)

- 2 The graph below shows changing membrane potential in an axon within a human leg.



At 0.5 ms:

(i) Identify the type of membrane potential present in the axon.

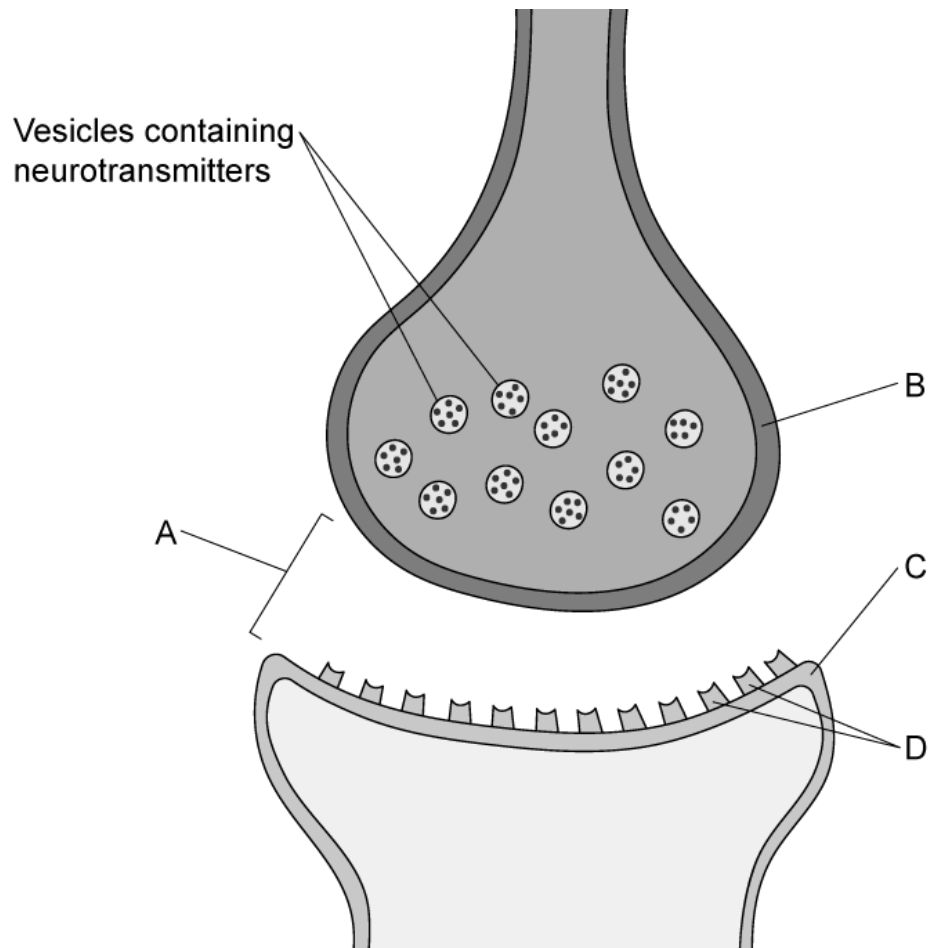
[1]

(ii) Explain how this membrane potential has been achieved.

[2]

(3 marks)

3 (a) The image below shows a representation of a junction between two neurones.



Identify structures **A-C**.

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(3 marks)

(b) Part a) shows that the junctions between neurones contain molecules known as neurotransmitters.

Outline how neurotransmitters interact with the structures labelled **D** to bring about an action potential in the new neurone.

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(2 marks)

- (c)** Once its role is complete the neurotransmitter needs to be broken down and recycled in order for the junction between neurones to continue functioning.

Identify an enzyme that is involved with the breakdown of neurotransmitter molecules.

(1 mark)

- 4** Draw a labelled diagram of a neurone.

(5 marks)

Medium Questions

- 1 (a) Describe and explain **one** way in which an axon may be adapted to conduct impulses at a faster rate in the nervous system.

(1 mark)

- (b) The presence of myelin around an axon can help speed up a nerve impulse.

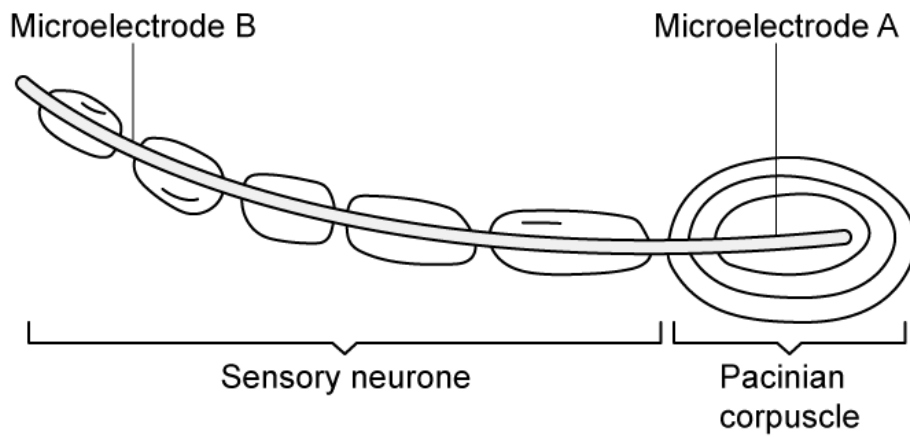
Explain how.

(3 marks)

- (c) Pacinian corpuscles are one of many receptors found in the skin. They detect changes in pressure.

A scientist wanted to research the effects of different pressures on the magnitude of membrane potentials generated. They investigated this effect by connecting multiple microelectrodes to the end of a toe and applying different pressures to the toe. The microelectrodes measured the maximum membrane potential of the pacinian corpuscle and its associated neurone, called a sensory neurone, when different pressures were applied.

The diagram below shows the structure of the Pacinian corpuscle, along with its sensory neurone and the position of the microelectrodes.



The table below shows the results.

Pressure applied to the end of the toe	Membrane potential at A (mV)	Membrane potential at B (mV)
None	-70	-70
Light	-45	-70
Medium	+35	+40
Heavy	+40	+40

Explain how the sensory neurone within the Pacinian corpuscle maintains a resting potential when no pressure is applied.

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(2 marks)

2 (a) Body temperature can affect the speed of an action potential. Research has found that reaction time is slower when body temperature falls. This is because nerve impulse conduction is slower.

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

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(2 marks)

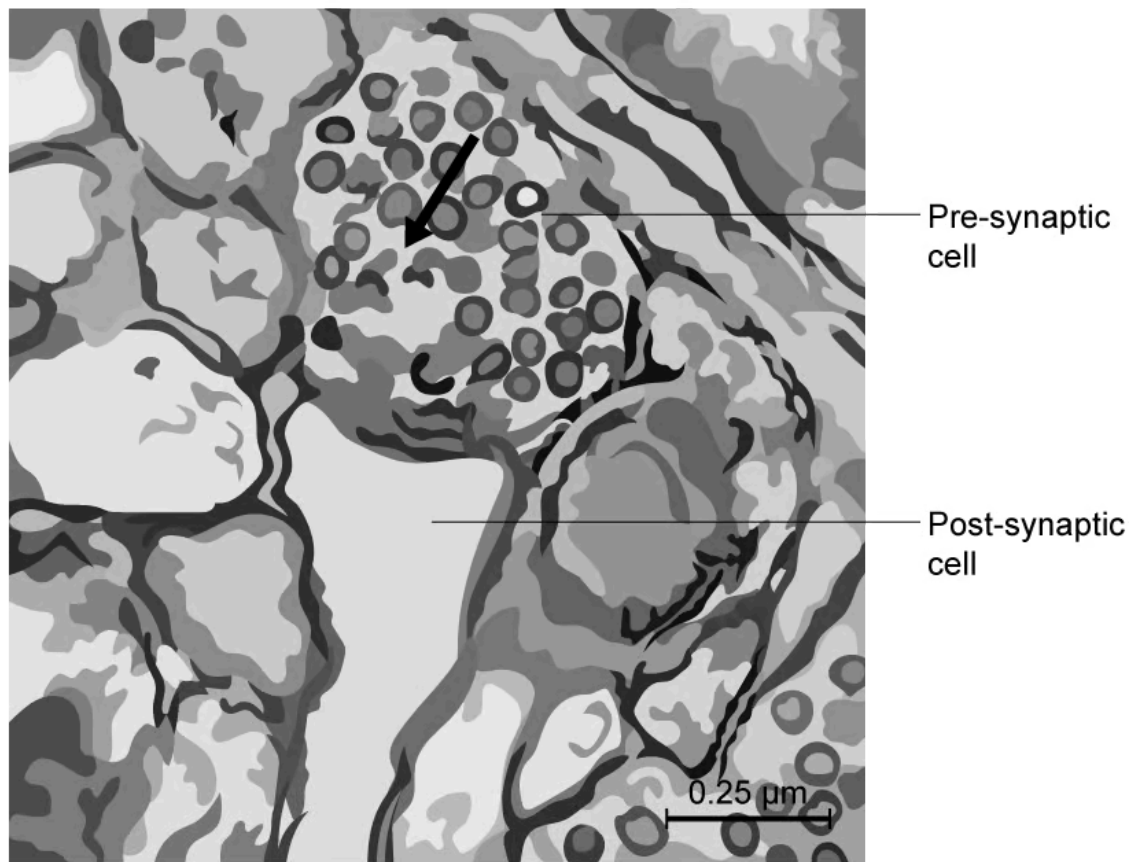
(b) After exercise, ATP is required for the resting potential to be re-established in axons. Explain how this occurs.

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(2 marks)

3 (a) Below is a micrograph of a synapse. The arrow shows the direction of the nerve impulse.



Label on the diagram the synaptic vesicles and the synaptic cleft.

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(2 marks)

(b) Dopamine is a neurotransmitter that plays a vital role in areas of the brain responsible for muscle control. It is transported back out of the synaptic cleft by a transporter protein located within the presynaptic membrane. Dopamine diffuses across the synaptic gap and binds to a receptor on the postsynaptic membrane.

Describe how this results in the depolarisation of the postsynaptic membrane.

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(2 marks)

(c) Explain why it is essential that neurotransmitters like dopamine are transported back out of synapses.

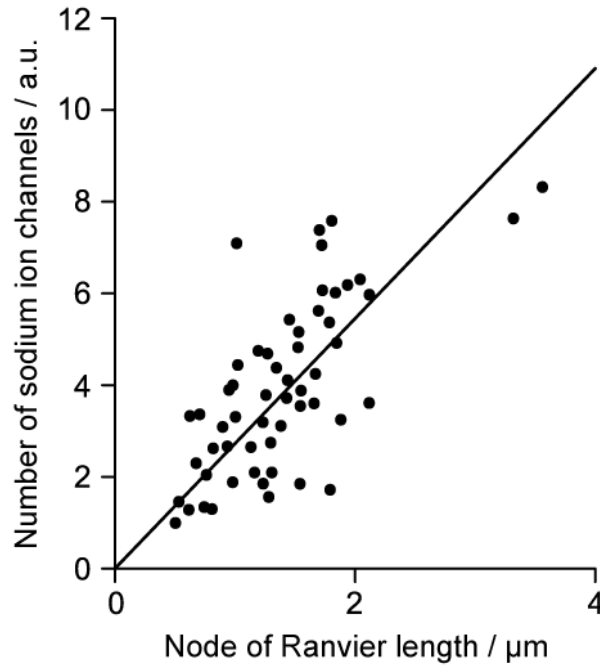
(2 marks)

4 Describe the mechanism which allows information to pass across a synapse.

(5 marks)

Hard Questions

- 1 (a) A study was carried out into the impact of a node of Ranvier length on nerve transmission. The graph below shows the relationship between the node of Ranvier length and the number of sodium ion channels at each node.

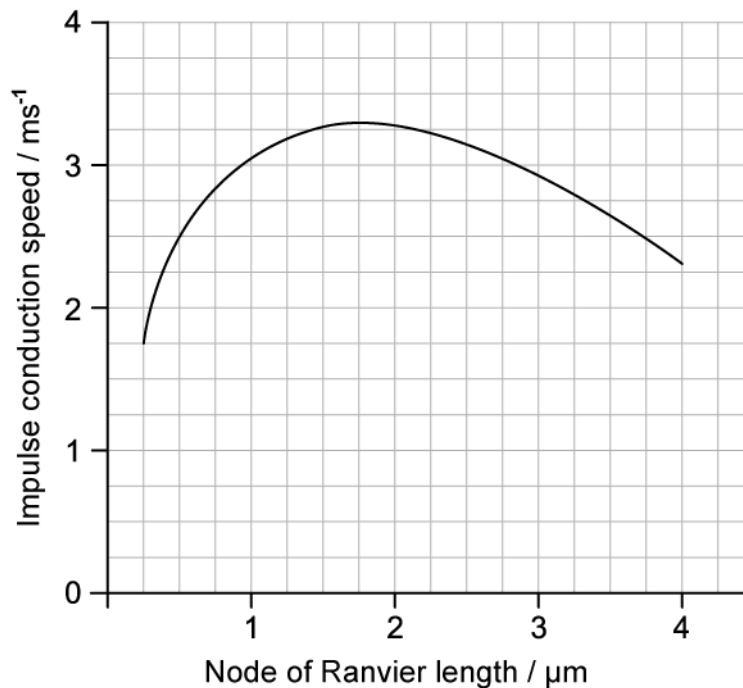


A student concluded from the graph that there will be more sodium ion channels at longer nodes of Ranvier.

Evaluate the student's conclusion.

(2 marks)

- (b) The study also looked at the impact of node of Ranvier length on the speed of impulse conduction in axons. The graph below shows some of the results.



Calculate the percentage change in impulse conduction speed when the node of Ranvier length increases from $0.5 \mu\text{m}$ to $1.5 \mu\text{m}$.

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(2 marks)

- (c) Suggest an explanation for the change in conduction speed for nodes of Ranvier lengths between 0.25 and $1.75 \mu\text{m}$.

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(3 marks)

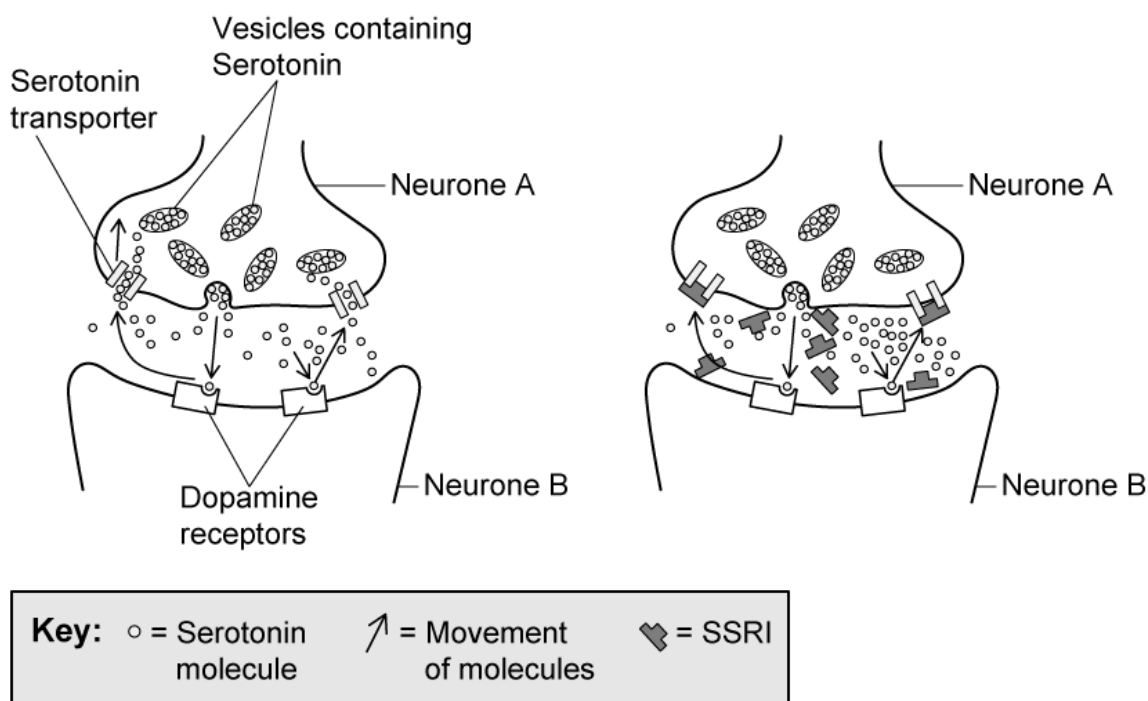
- (d) The study looked at nodes of Ranvier length in mice and found that an individual mouse could have some axons with longer nodes of Ranvier and some axons with short nodes of Ranvier.

Suggest why it might be advantageous to have axons with varying nodes of Ranvier length.

(2 marks)

- 2 (a)** Serotonin is a neurotransmitter found in the brain. Low serotonin levels are thought to contribute to symptoms of clinical depression. One commonly used treatment for depression involves a group of drugs called SSRIs.

The diagram below shows a serotonin synapse in the brain both before (left) and after (right) treatment with SSRIs.



Suggest how SSRIs might be effective at treating the symptoms of depression.

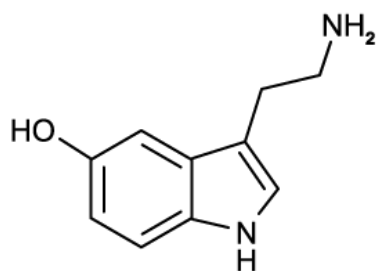
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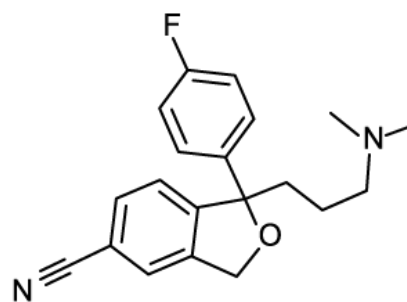
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(3 marks)

- (b)** The image below shows the chemical structures of serotonin and an SSRI called Citalopram. Citalopram is commonly prescribed for depression due to its limited side effects, but it does sometimes cause some nausea and sleep disturbance during the first few weeks.



Serotonin

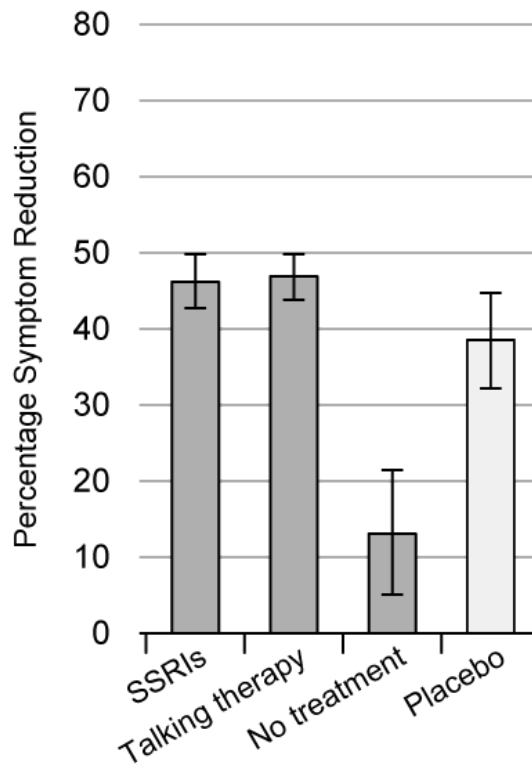


Citalopram

Use the image to suggest how Citalopram can have the effect shown in part a) while also having some side effects.

(3 marks)

- (c) Although the use of SSRIs has increased significantly in recent years there is still controversy over their effectiveness in the treatment of depression, along with some concern surrounding withdrawal symptoms at the end of treatment. One group of researchers analysed the results of around 300 studies involving treatment for depression; some of their results are shown in the graph below.



The placebo in this case was a pill identical in appearance to an SSRI but containing no active chemical ingredients.

Suggest the role of a placebo in a study of this type.

(2 marks)

(d) State what can be concluded about the effectiveness of SSRIs in the treatment of depression from the information provided in part c). Note that the error bars in the graph represent standard deviation.

(3 marks)

3 Describe how a nerve impulse is transmitted from one neurone to another.

(8 marks)