

6.5 Neurones & Synapses

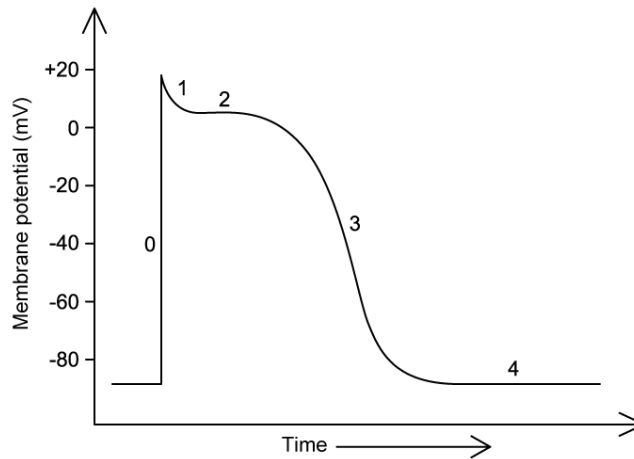
Question Paper

Course	DP IB Biology
Section	6. Human Physiology
Topic	6.5 Neurones & Synapses
Difficulty	Hard

Time allowed: 70
Score: /55
Percentage: /100

Question 1a

a)
The graph below shows the changes in membrane potential that occur during a cardiac (heart) action potential.



Stage 0 occurs more quickly in a cardiac action potential than the equivalent stage in a regular action potential.

Suggest **two** possible explanations for the increased rate at which stage 0 takes place in a cardiac action potential.

[2 marks]

[2 marks]

Question 1b

b)
Compare and contrast the changes in membrane potential that occur during the cardiac action potential in part a) with the changes that occur during a regular action potential.

Note that no credit will be given for describing the difference already noted in part a).

[4 marks]

[4 marks]

Question 1c

c)

A group of heart conditions known as arrhythmias involves problems with the co-ordination or speed of the heart beat. Potassium channel blockers are a group of drugs used to treat some types of arrhythmia.

i)

Sketch on the graph in part a) the effect that you would expect a potassium channel blocker to have on the cardiac action potential.

[1 mark]

ii)

Suggest how potassium channel blockers have the effect predicted in part i).

[2 marks]

[3 marks]

Question 1d

d)

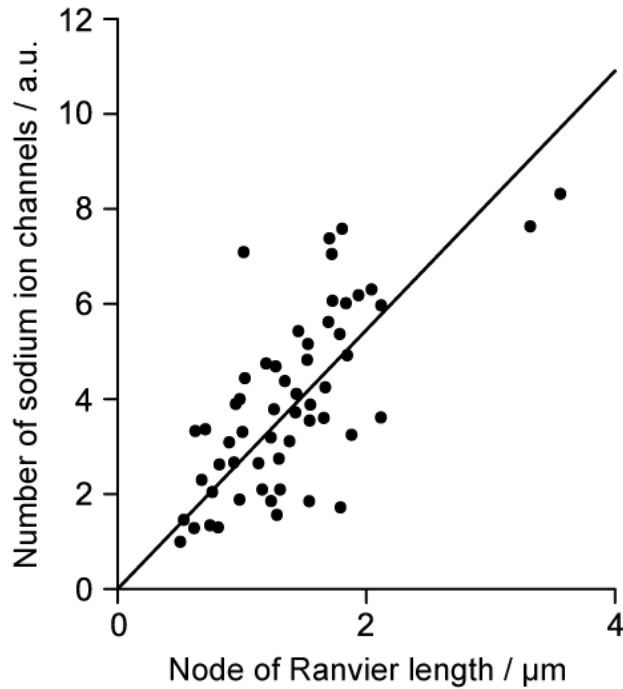
Suggest, with a reason, the type of arrhythmia that potassium channel blockers might be used to treat.

[2 marks]

[2 marks]

Question 2a

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.

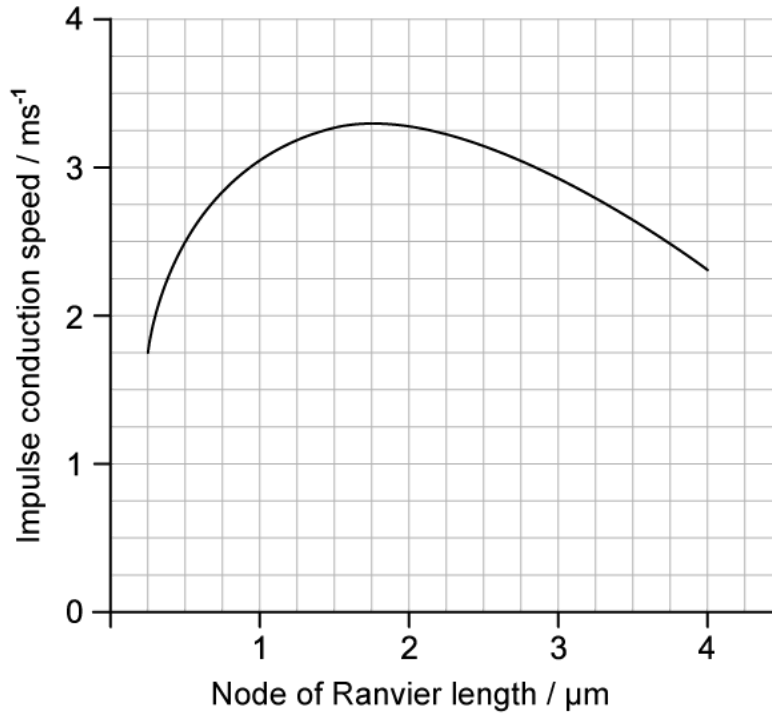
[2 marks]

[2 marks]

Question 2b

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 $1.5 \mu\text{m}$.

[2 marks]

[2 marks]

Question 2c

c)

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

[3 marks]

[3 marks]

Question 2d

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.

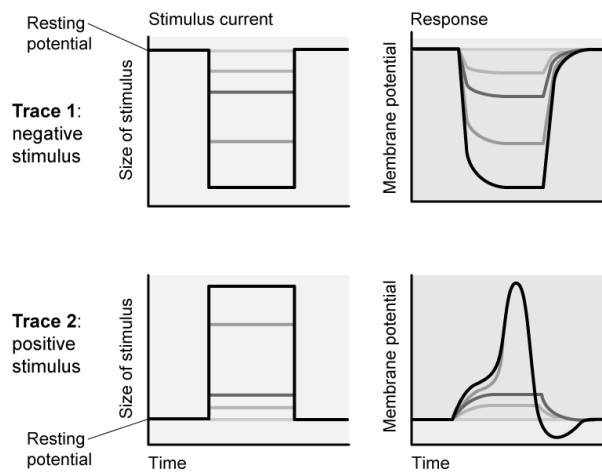
[2 marks]

[2 marks]

Question 3a

a)

The graphs below show the effect of applying different electrical stimuli to a neurone on its membrane potential.



Compare and contrast the response of the membrane to the negative stimulus in trace 1 and the positive stimulus in trace 2.

[3 marks]

[3 marks]

Question 3b

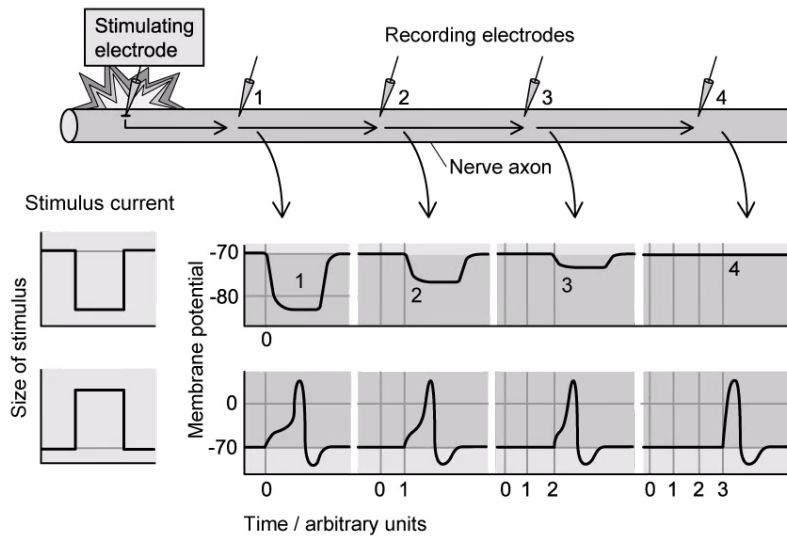
b) Suggest an explanation for the changes in membrane potential shown in trace 1 in part a).

[2 marks]

[2 marks]

Question 3c

c) The graphs below shows the effect of changing the type of stimulus on the propagation of a nerve impulse along an unmyelinated axon.



Suggest an explanation for the difference between the transmission of the impulses shown in the top and bottom graphs.

[2 marks]

[2 marks]

Question 3d

d)

In an extension to the investigation shown in part c), electrodes were inserted into a fully myelinated axon of the same diameter before applying a positive stimulus at the stimulating electrode. Electrodes 1, 2, and 4 were inserted into sections of the axon surrounded by myelin while electrode 3 was inserted into a node of Ranvier.

Suggest, each with a reason, **two** ways in which the results would look different to those in the bottom graph shown in part c).

[4 marks]

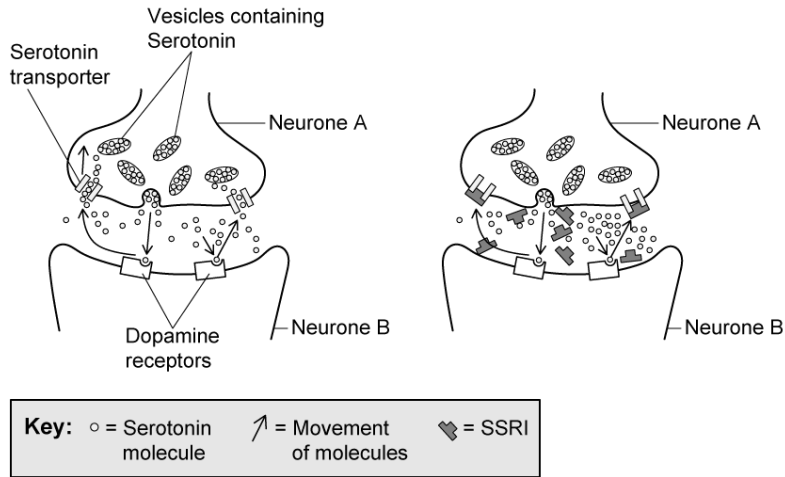
[4 marks]

Question 4a

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.

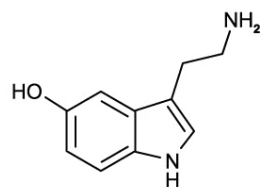
[3 marks]

[3 marks]

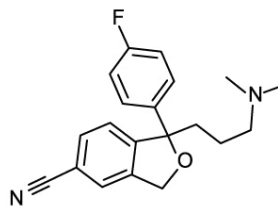
Question 4b

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.

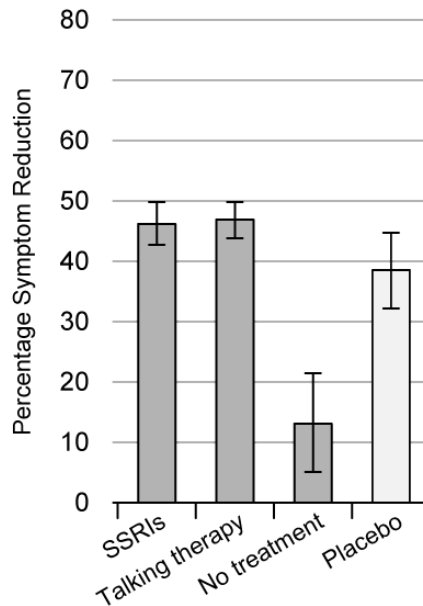
[3 marks]

[3 marks]

Question 4c

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]

[2 marks]

Question 4d

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 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a)

Draw an annotated diagram of an oscilloscope trace of an action potential.

[5 marks]

[5 marks]

Question 5b

b)

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

[8 marks]

[8 marks]

