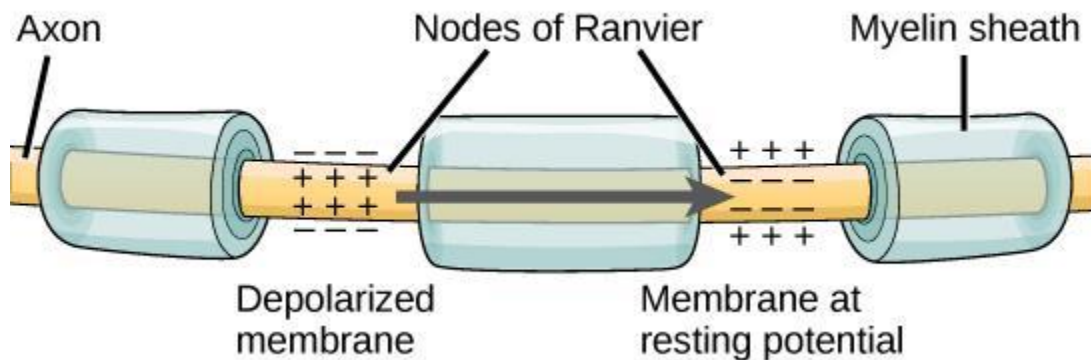


IB Biology

Revision

Topic 6.5 – Neurons & Synapses



Name:

Teacher: Mr Trent

1. [1 mark]

Which statement applies to an axon at rest?

- A. There is no electric potential difference between the external and internal surfaces of the plasma membrane.
- B. The external surface of the plasma membrane is positive relative to the internal surface.
- C. The external surface of the plasma membrane is negative relative to the internal surface.
- D. The internal surface of the plasma membrane has a much higher concentration of sodium ions.

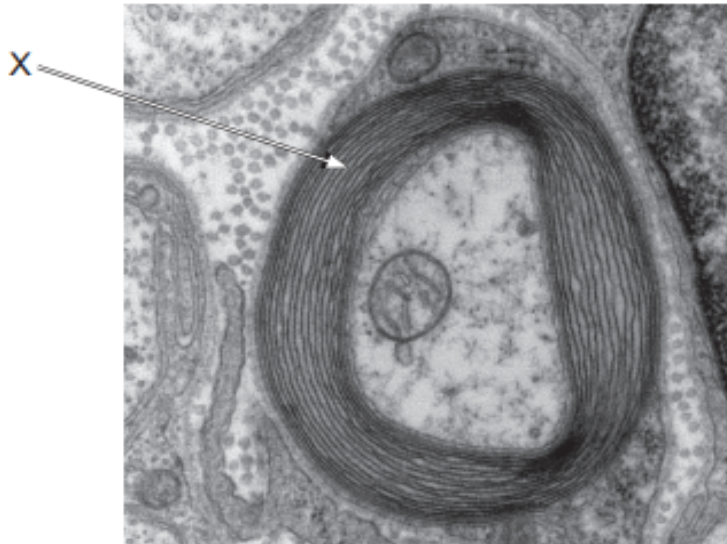
2. [1 mark]

Which structural feature enables saltatory conduction?

- A. Nodes of Ranvier between Schwann cells
- B. Na^+ channels under Schwann cells
- C. K^+ channels under Schwann cells
- D. Sodium–potassium pumps under Schwann cells

3. [1 mark]

The electron micrograph shows a transverse section through a myelinated neuron.



What process is facilitated by the presence of the structure labelled X?

- A. Repolarization of the nerve cell membrane
- B. Generation of an action potential
- C. Saltatory conduction
- D. Synaptic transmission

4. [1 mark]

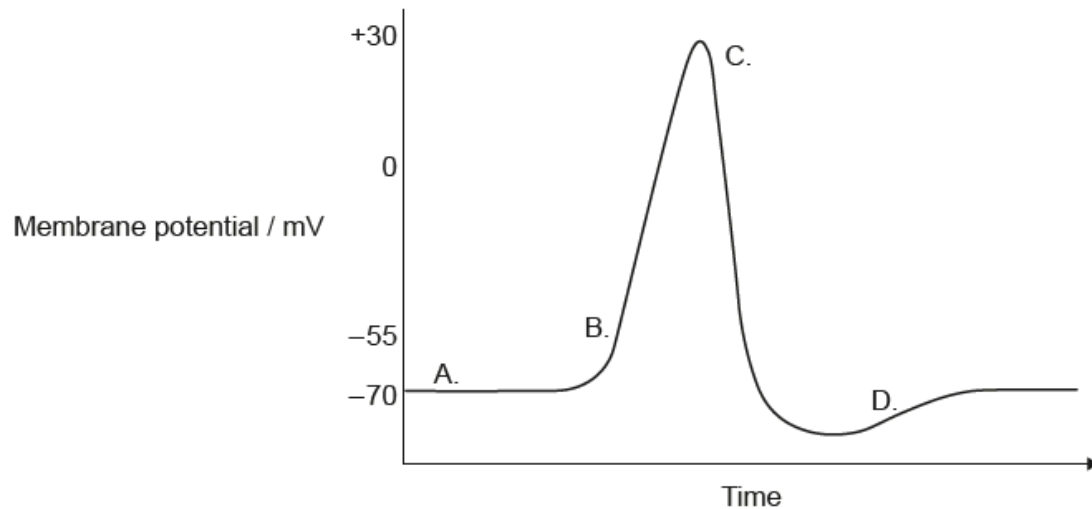
How do neonicotinoid pesticides cause paralysis and death in insects?

- I. Acetylcholine receptors are blocked.
- II. Cholinesterase fails to break down the pesticide.
- III. The pesticides bind to presynaptic receptors.

- A. I only
- B. I and II only
- C. I and III only
- D. I, II and III

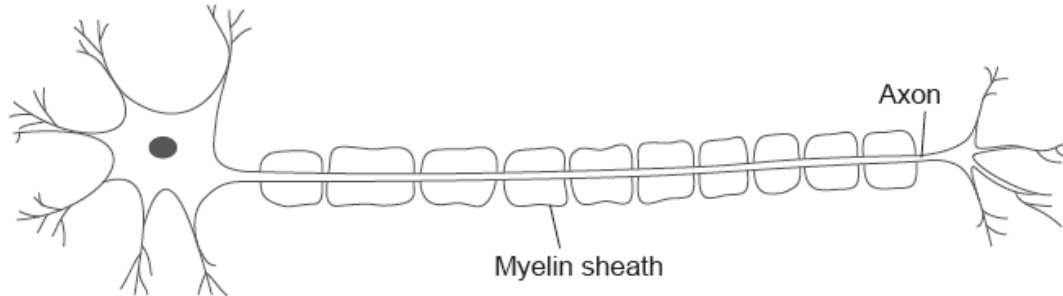
5. [1 mark]

The graph shows the changing membrane potential during a nerve impulse. Which letter indicates when the potassium channels open?



6. [1 mark]

The diagram shows a motor neuron.

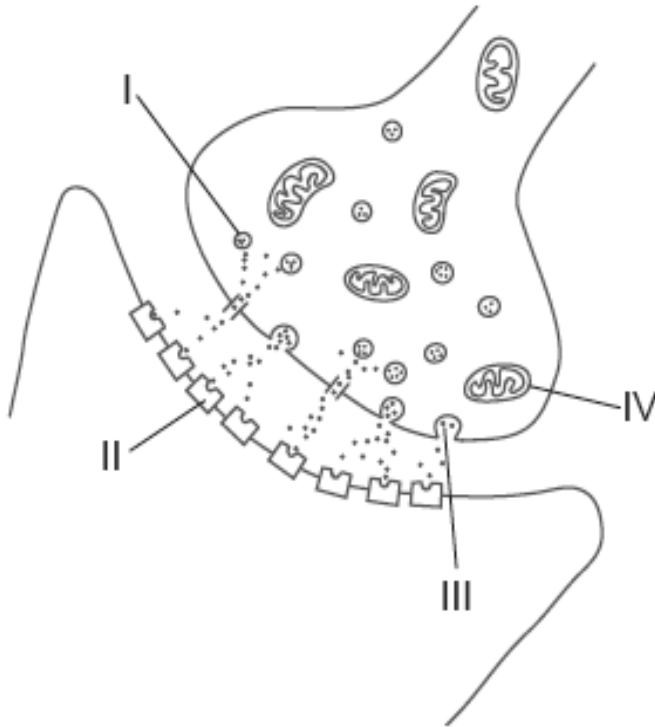


What are the biochemical nature and function of the myelin sheath?

- A. The myelin sheath is mainly protein which allows growth of the axon.
- B. The myelin sheath is mainly protein which acts as membrane carriers.
- C. The myelin sheath is mainly lipid which allows saltatory conduction.
- D. The myelin sheath is mainly lipid which provides an energy source.

7. [1 mark]

The diagram shows a neural synapse in the central nervous system of a honey bee (*Apis mellifera*).



How do neonicotinoid pesticides cause paralysis and death of honey bees?

- A. They destroy I.
- B. They bind to II.
- C. They inhibit the release of III.
- D. They block the activity of IV.

8. [1 mark]

Neurons transmit electrical impulses. Which statement describes part of this process?

- A. K^+ ions are pumped out of the cell to depolarize the membrane.
- B. Ion channels let K^+ diffuse into the cell to depolarize the membrane.

- C. Na^+ ions are pumped into the cell to repolarize the membrane.
- D. Ion channels let Na^+ diffuse into the cell to depolarize the membrane.

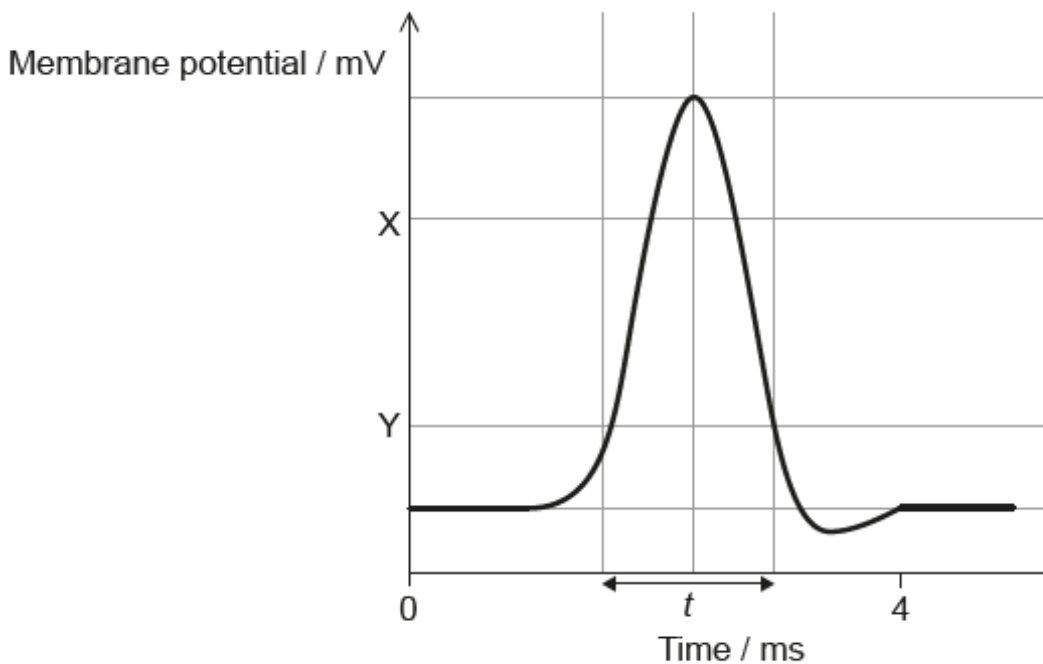
9. [1 mark]

What happens when an action potential reaches motor end plates?

- A. Calcium ions are absorbed by the muscle fibres.
- B. The sarcomeres relax.
- C. Neurotransmitter is released.
- D. Action potential is passed to the neuron.

10a. [1 mark]

The graph shows the change in the membrane potential of an axon during an action potential.



State the approximate value of the membrane potential at X.

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10b. *[1 mark]*

Y is the threshold potential. State what happens when the threshold potential is reached.

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10c. *[2 marks]*

Describe the movements in ions that occur during time t .

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10d. *[3 marks]*

Explain how a nerve impulse is passed on to other neurons.

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11c. *[3 marks]*

Explain the propagation of nerve impulses along the membrane of a neuron.

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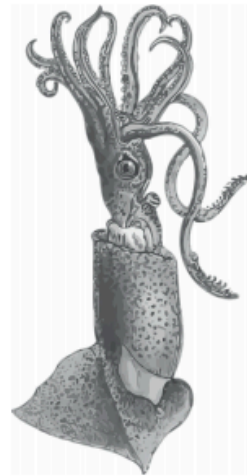
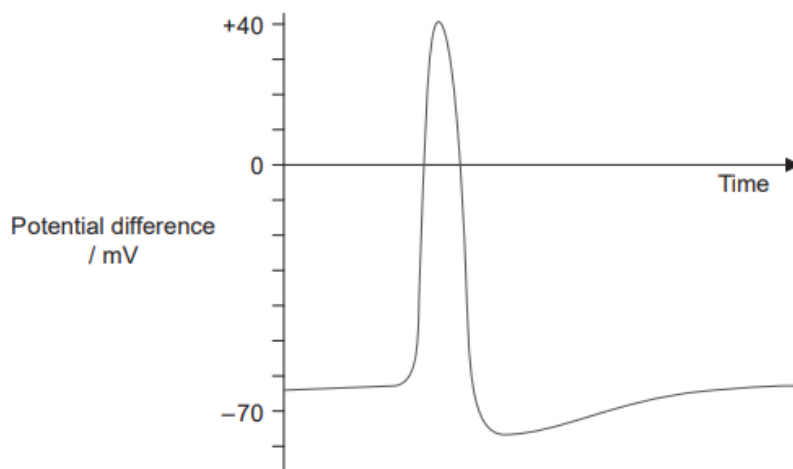
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12a. *[1 mark]*

Squid have been used for research on nerve impulses. The mechanism of nerve transmission in these animals is the same as that in humans. The image shows an oscilloscope trace from a nerve impulse in a squid’s giant axon.



[squid] Pixabay.

Estimate the resting potential for this axon.

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12b. [2 marks]

Outline the role of the sodium–potassium pump in maintaining the resting potential.

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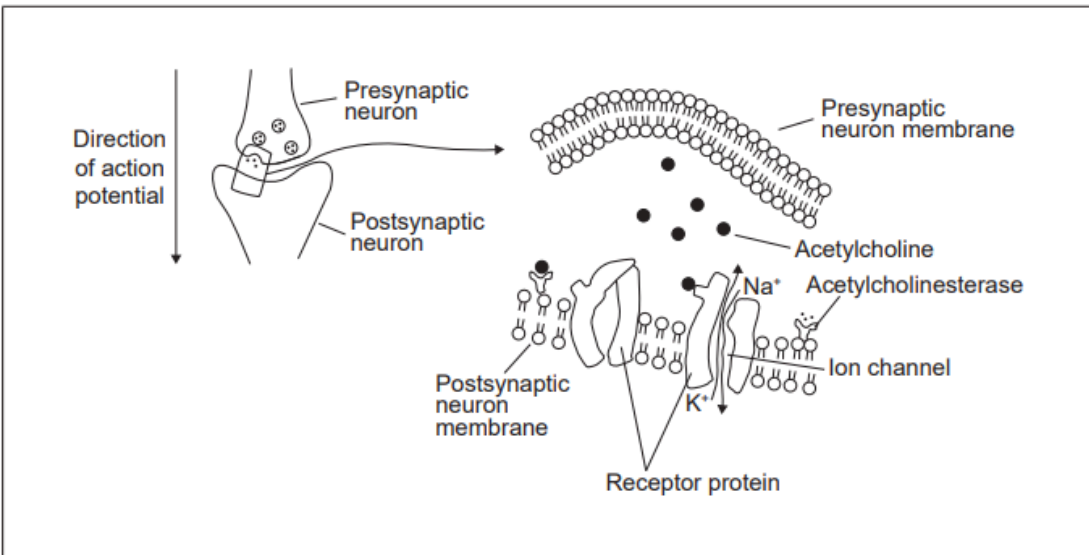
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13a. [1 mark]

Cholinergic synapses use acetylcholine as their neurotransmitter. They are widespread in the body, passing on signals to muscle cells. These synapses are affected by neonicotinoid pesticides.

The diagrams, which are not drawn to scale, show the synapse between two neurons and a detail of the synaptic cleft.



On the diagrams, label with a letter H the hydrophilic end of a phospholipid.

13b. [1 mark]

On the diagrams, label with a letter E a vesicle involved in exocytosis.

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13c. [1 mark]

On the diagrams, label with a letter P a location where a neonicotinoid pesticide could bind.

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13d. *[2 marks]*

Outline how depolarization of the membrane of an axon occurs.

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13e. *[2 marks]*

Explain how acetylcholine initiates an action potential in a postsynaptic membrane.

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13f. *[1 mark]*

State the action of the enzyme acetylcholinesterase.

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13g. *[3 marks]*

Explain what happens to an enzyme if there is a change of pH.

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14. *[7 marks]*

Every cell is surrounded by a cell surface membrane which regulates the movement of materials into and out of the cell.

Explain the events that occur during a nerve impulse and how the impulse is propagated along an axon.

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15. [4 marks]

Outline how neurons generate a resting potential.

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1. [1 mark]

B

2. [1 mark]

A

3. [1 mark]

C

4. [1 mark]

B

5. [1 mark]

C

6. [1 mark]

C

7. [1 mark]

B

8. [1 mark]

D

9. [1 mark]

C

10a. [1 mark]

Markscheme

0 mV; (accept answers in the range of – 10 mV to +10 mV) (Units required)

10b. [1 mark]

Markscheme

sodium channels (start to) open

OR

depolarization/axon begins to depolarize

OR

action potential occurs;

Reject pumping of ions.

10c. [2 marks]

Markscheme

Na^+ /sodium ions diffuse into the axon (in the first part/half of t);

K^+ /potassium ions diffuse out of the axon (in the second half/part of t)

Do not accept the name of the element without indication that it is an ion.

10d. [3 marks]

Markscheme

- a. impulses pass to another neuron at a synapse/across synaptic gap/cleft;
 - b. (depolarization causes) Ca^{2+} /calcium ions to diffuse into the (presynaptic) neuron/axon;
 - c. depolarization (of presynaptic neuron) causes release of a neurotransmitter
- OR**
- neurotransmitters diffuse across the synapse;
 - d. (neurotransmitters) bind to receptors on postsynaptic neuron/membrane;
 - e. (if the threshold potential is reached) an action potential occurs/sodium gates open (in the postsynaptic neuron);

11c. [3 marks]

Markscheme

- a. depolarization of part of axon/membrane triggers/causes depolarization of next part;
- b. local currents;
- c. diffusion of sodium ions between depolarized part and next/polarized part (of axon);
- d. resting potential reduced/polarization of membrane becomes less /change from -70 to -50mV;
- e. sodium channels open when -50mV/threshold potential reached;
- f. entry of sodium ions causes depolarization;
- g. saltatory conduction in myelinated neurons/axons;

Allow answers in an annotated diagram

12a. [1 mark]

Markscheme

−65 mV ✓

Unit required; minus sign required. Accept answers from −62mV to −65mV.

12b. [2 marks]

Markscheme

a. sodium/potassium pump pumps sodium ions Na^+ out of axon and pumps potassium ions/ K^+ in ✓

b. requires energy/ATP/against concentration gradients/active transport ✓

c. three sodium ions pumped out for every two potassium ions pumped in ✓

d. results in charge difference between inside and outside where outside is positive relative to inside ✓

13a. [1 mark]

Markscheme

hydrophilic end of phospholipid shown ✓

For 2a, i, ii and iii, accept letters written on the structure even if a line is not drawn.

Award the mark if the full word is used to label the structure. Labels must be unambiguous.

13b. [1 mark]

Markscheme

an exocytic vesicle shown ✓

For 2 a, i, ii and iii, accept letters written on the structure even if a line is not drawn.

Award the mark if the full word is used to label the structure. Labels must be unambiguous.

Accept any of the three intact circles or the exocytosis shown within the box.

13c. [1 mark]

Markscheme

any receptor protein on post synaptic membrane marked ✓

For 2 a, i, ii and iii, accept letters written on the structure even if a line is not drawn.

Award the mark if the full word is used to label the structure.

Must unambiguously be pointed to a receptor on the synapse side. Accept labels of acetylcholinesterase.

13d. [2 marks]

Markscheme

a. (local depolarization) causes ion / sodium / voltage gated channels to open ✓

b. altering membrane permeability to sodium ions/ Na^+ /positive ions / Na^+ diffuses into the cytoplasm ✓

c. membrane potential (of the axon) changes from negative to positive ✓

d. a threshold potential is reached and an action potential is generated ✓

Do not accept sodium pumps.

Mp b requires evidence that the student recognizes sodium is an ion.

Numerical values indicating change from -70 to $+30/+40/+55$ can be accepted.

13e. [2 marks]

Markscheme

a. acetylcholine binds to the receptor protein ✓

b. (causing a) change in tertiary structure / conformation of protein ✓

c. diffusion/entry of ions / Na^+ through the receptor/channel protein allowed ✓

13f. [1 mark]

Markscheme

breaks down acetylcholine (to acetyl and choline) ✓

13g. [3 marks]

Markscheme

a. change in pH can cause a change in the tertiary structure of the enzyme

OR

enzyme denatured ✓

b. causing a change in the active site / substrate not able to bind ✓

c. the enzyme will not work as efficiently / decreased rate of reaction ✓

d. (may no longer be) the optimum/optimal pH for enzyme activity ✓

Allow answer in the form of a graph.

14. [7 marks]

Markscheme

a. nerve impulses are action potentials propagated along axons of neurons

b. resting potential is -70 mV

OR

relatively negative inside in comparison to the outside

c. Na^+/K^+ pumps maintain/re-establish «the resting potential»

d. more sodium ions outside than inside «when at the resting potential»

OR

more potassium ions inside than outside «when at the resting potential»

e. action potential stimulates «wave of» depolarization along the membrane/axon

f. «when neuron is stimulated» if threshold potential is reached Na^+ channels open

g. sodium ions diffuse/move in

h. « Na^+ move in» causing depolarization / inside of the neuron becomes more positively charged than the outside of the neuron

i. potassium ion channels open

OR

potassium ions diffuse/move out

j. « K^+ move out» causing repolarization

k. local currents

OR

description of Na^+ ion diffusion between depolarized region and next region of axon to depolarize

l. myelination increases propagation speed/allows saltatory conduction

Accept any of the points clearly explained in an annotated diagram.

15. [4 marks]

Markscheme

a. sodium-potassium pump

b. sodium /Na⁺ out and potassium /K⁺ in

OR

sodium/Na⁺ concentration higher outside and potassium/K⁺ higher inside

c. three Na⁺ pumped for every two K⁺ (hence negative inside)

OR

inside of axon holds negative ions/Cl⁻ ions/negatively charged proteins/organic anions (hence negative inside)

d. by active transport / using ATP

e. inside (of axon/neuron) is negative in comparison to outside

OR

electrochemical concentration/charge difference (across the membrane) is the resting potential

f. resting potential is -70 mV