

Impulses, synapses and receptors: practice questions

8 questions · 30 marks · mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 30

1 UNIT 5 STYLE

[1 mark]

Which statement describes habituation?

- A. ☐ A permanent increase in sensitivity to a repeated stimulus
- B. ☐ A decrease in response to a repeated stimulus that is harmless
- C. ☐ A reflex response that is unaffected by repeated stimulation
- D. ☐ A decrease in response because muscles run out of ATP

2 UNIT 5 STYLE

[5 marks]

The table shows the membrane potential of an axon measured at intervals after a stimulus was applied at 0.5 ms. (a) State the resting potential. (1) (b) Explain the change in membrane potential between 1.0 ms and 1.5 ms. (2) (c) Explain the change in membrane potential between 2.0 ms and 2.5 ms. (2)

Membrane potential of an axon after a stimulus	
Time / ms	Membrane potential / mV
0	-70
0.5	-70
1.0	-45
1.5	+30
2.0	-20
2.5	-75
3.0	-72
3.5	-70

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3 UNIT 5 STYLE

[2 marks]

An impulse travels along a myelinated motor axon of length 0.60 m in 6.0 ms. Calculate the speed of conduction, in m s^{-1} .

Answer = ...

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4

UNIT 5 STYLE

[4 marks]

Explain why an action potential is conducted faster along a myelinated axon than along an unmyelinated axon of the same diameter.

5

UNIT 5 STYLE

[5 marks]

Describe how a nerve impulse is transmitted across a cholinergic synapse.

6

UNIT 5 STYLE

[4 marks]

Explain how (a) lidocaine and (b) cobra venom alpha toxin prevent a response to a stimulus. (2 marks each)

7 UNIT 5 STYLE

[4 marks]

Explain how the pupil of the eye responds to a sudden increase in light intensity, and why this response is important.

8 UNIT 5 STYLE

[5 marks]

Explain how the absorption of light by a rod cell leads to the production of action potentials in an optic neurone.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B (1) Habituation is a decrease in response to a repeated, harmless stimulus; D describes fatigue.

2. [5]

- (a) -70 mV (1) units required
- (b) voltage-gated Na^+ channels open / permeability to Na^+ increases (1)
- (b) Na^+ diffuse into the axon down the electrochemical gradient, so the membrane depolarises / inside becomes positive (1)
- (c) Na^+ channels close and voltage-gated K^+ channels open / permeability to K^+ increases (1)
- (c) K^+ diffuse out of the axon (repolarisation); K^+ channels slow to close so the potential falls below the resting level / hyperpolarisation (1)

3. [2]

- $6.0 \text{ ms} = 6.0 \times 10^{-3} \text{ s}$, speed = $0.60 \div 6.0 \times 10^{-3}$ (1)
- 100 m s^{-1} (1) (credit the second mark for the correct answer with units, or by error carried forward from a wrong conversion)

4. [4]

- myelin acts as an insulator / prevents ions crossing the membrane except at nodes of Ranvier (1)
- depolarisation (Na^+ entry) only at nodes (1)
- local circuits carry the depolarisation from node to node / action potential jumps (saltatory conduction) (1)
- so fewer places have to depolarise and repolarise, which is quicker (than regenerating at every point) (1)
- Max 4. Accept less ATP is needed as fewer ions move (not a speed mark)

5. [5]

- action potential arrives at the presynaptic knob and opens voltage-gated Ca^{2+} channels / Ca^{2+} enter the knob (1)
- vesicles containing acetylcholine fuse with the presynaptic membrane and release ACh by exocytosis (1)
- ACh diffuses across the synaptic cleft (1)
- ACh binds to receptors on the postsynaptic membrane, opening Na^+ channels (1)
- Na^+ enter and depolarise the postsynaptic membrane, producing an action potential if threshold is reached (1)
- acetylcholinesterase breaks down ACh, so the response is not continuous (1)
- Max 5

6. [4]

- lidocaine blocks voltage-gated Na^+ channels in the axon membrane (1)
- so no depolarisation / action potentials are not conducted to the brain, so pain is not felt (1)
- alpha toxin binds to the acetylcholine receptors on the postsynaptic membrane (1)
- so ACh cannot bind / Na^+ channels do not open and the muscle is not depolarised, giving paralysis (1)

7. [4]

- receptors in the retina detect the light and send impulses (along the optic nerve) to the brain (1)
- impulses are sent along motor (parasympathetic) neurones to the iris (1)
- circular muscles contract and radial muscles relax / antagonistic muscles (1)
- pupil constricts, reducing the light that reaches the retina, protecting it from damage (1)
- Max 4

8. [5]

- light changes retinal from the cis to the trans form (1)
- rhodopsin splits / is bleached into opsin and retinal (1)
- cation channels / Na^+ channels in the rod membrane close (1)
- less Na^+ enters the rod, so the rod cell becomes hyperpolarised (1)
- less (inhibitory) transmitter released onto the bipolar neurone (1)
- bipolar neurone depolarised and releases transmitter, which depolarises the optic neurone to threshold, so action potentials form (1)
- Max 5