24.1 Neural signalling: impulses and synapses

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS action potential • synapse

Objective

Neural signalling: impulses and synapses. Original classroom practice for IB HL; not an official IB paper.

1 Key knowledge and worked examples

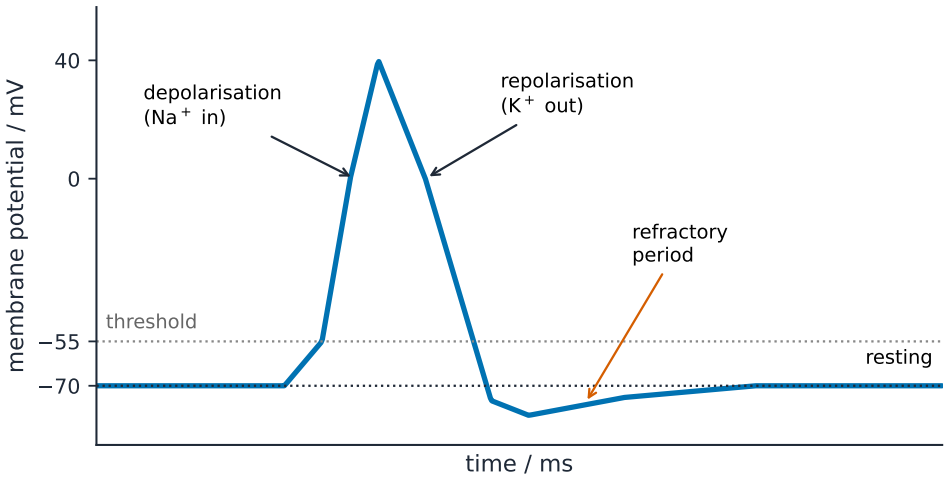
What would explain this observation?

- A stronger stimulus can increase impulse frequency while each **action potential** remains a similar size.

Build the model

- An action potential is a brief change in membrane potential involving voltage-gated ion channels.
- Depolarization followed by repolarization propagates along a neuron.
- At a chemical **synapse** , transmitter release can alter the next cell membrane potential.
- action potential: A brief propagating change in membrane potential.
- synapse: A junction for communication between cells.

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all-or-nothing: once threshold is reached, a full spike fires (no partial APs)

Choose evidence that can test it

- The all-or-none principle applies to an individual action potential.
- Stimulus information can be encoded by frequency and recruitment.
- Myelination permits saltatory conduction between nodes rather than making ions move freely through myelin.

In the lab: Interpret supplied voltage-time traces and compare time intervals. Identify threshold, rising phase and recovery before explaining ions. Use classroom models rather than electrical stimulation of people.

Work from known quantities

- Known: 30 impulses occur in 0.50 s.
- Frequency = count/time = 30/0.50 = 60 Hz.
- This is impulse frequency, not an estimate of propagation speed.

Your turn: 24 impulses occur in 0.40 s. Find impulse frequency.

Check the conclusion and its limits

- A neurotransmitter diffuses across the synaptic cleft; an action potential does not jump intact through the liquid gap.
- Excitatory input does not guarantee the postsynaptic cell reaches threshold.

Not true: A stronger stimulus always makes each action potential larger. Action potentials are all-or-none: once threshold is reached, the impulse has a fixed size set by the ion gradients. A stronger stimulus raises the frequency of impulses, not their amplitude.

Key:

- An action potential is a brief change in membrane potential involving voltage-gated ion channels.
- The all-or-none principle applies to an individual action potential.
- Watch for: A neurotransmitter diffuses across the synaptic cleft; an action potential does not jump intact through the liquid gap.

■ **Write from an impulse frequency of 70 per second**

- 21 impulses occur in 0.30 s.
- Find the frequency. This is not the propagation speed.

2 Practice

2.1 How can stimulus intensity affect an all-or-none signalling system? Choose one answer.

- **A** Through impulse frequency or recruitment
- **B** By giving every impulse unlimited amplitude
- **C** By removing all ion gradients [1]

2.2 24 impulses occur in 0.40 s. Find impulse frequency. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: A stronger stimulus always makes each action potential larger. [2]

2.4 A brief propagating change in membrane potential: write the technical term. [1]

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3 Exam-style questions

3.1 Two records have 30 impulses in 0.5 s and 30 impulses in 1.0 s. Compare frequency. Would either observation determine nerve conduction speed? [4]

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