

24.1 Neural signalling: impulses and synapses

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

KEY WORDS action potential • synapse

Objective

Neural signalling: impulses and synapses. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

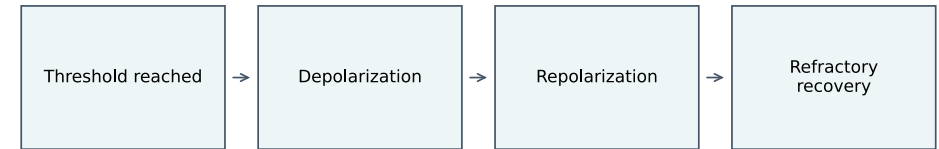
1 Key knowledge and worked examples

■ What would explain this observation?

- A stronger stimulus can increase impulse frequency while each **action potential** remains a similar size.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ 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.



■ 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.
- 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

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: 30 impulses occur in 0.50 s. $\text{Frequency} = \text{count/time} = 30/0.50 = 60 \text{ Hz}$. This is impulse frequency, not an estimate of propagation speed.

Example:

24 impulses occur in 0.40 s. Find impulse frequency. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ 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.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A stronger stimulus always makes each action potential larger. This claim is false: 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.

Key:

Neural signalling: impulses and synapses: 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.

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]

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]

Solutions

2.1 A 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.

2.2 $\text{frequency} = \text{count} / \text{time} = 24 / 0.40 = 60 \text{ Hz}$.

2.3 False. 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.

2.4 action potential. action potential means A brief propagating change in membrane potential.

3.1 60 and 30 Hz. Frequency is count per time; speed requires propagation distance and delay between locations. These are different measured quantities.