13.1 Neurons, synapses and brain systems: evidence and transfer

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

KEY WORDS all-or-none principle • reuptake

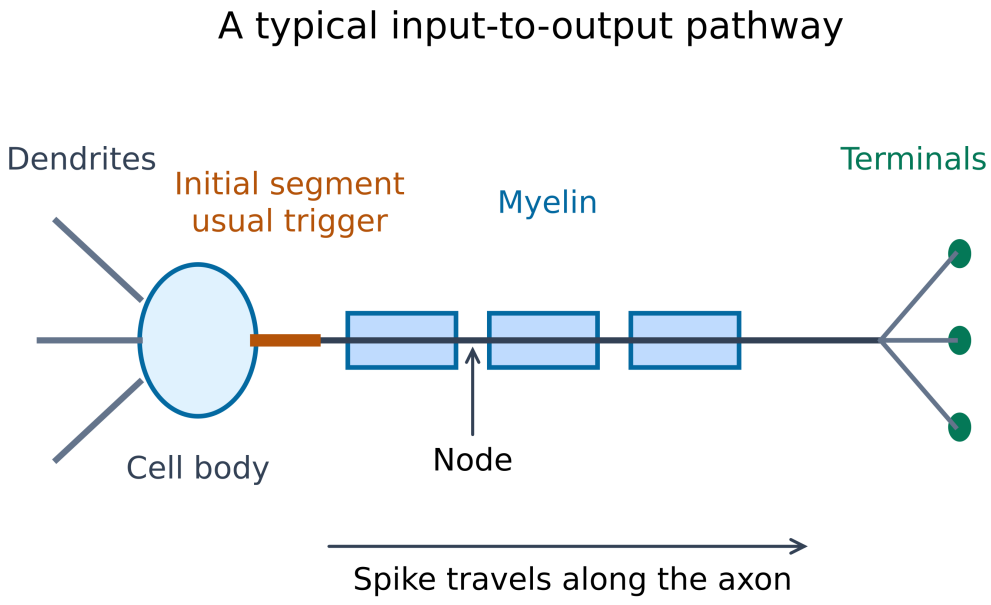
Objective

Trace the action potential from trigger to synaptic release; Relate major brain structures to their behavioural functions; Distinguish neurotransmitter and drug actions at the synapse. Original practice and authored marking guidance.

1 Key knowledge and worked examples

all-or-none principle : Once threshold is reached a neuron fires a complete spike; stronger stimuli raise rate, not spike size. **reuptake** : Reabsorption of neurotransmitter into the presynaptic cell, ending its action.

Graded input can vary in size and combine at the trigger region; a propagated action potential is all-or-none. Stronger input can change firing frequency and recruitment, rather than making every spike taller. At a chemical synapse, arrival opens calcium channels, vesicles release transmitter and receptors alter the receiving cell. An agonist increases a receptor-related action; an antagonist blocks it. Effects depend on receptor and circuit, not just the transmitter's name.



Worked case. A fictional substance blocks receptors without activating them. Another slows transmitter reuptake. Predict their immediate actions with qualifications.

The receptor blocker acts as an antagonist at the stated receptor. Slower reuptake can prolong or increase transmitter availability in the cleft. Neither description establishes an overall behavioural effect: receptor subtype, feedback and affected pathways matter. Do not infer a drug recommendation.

2 Practice

2.1 The action potential is triggered at which part of the neuron? [1]

A. dendrite B. cell body C. axon hillock D. terminal button E. dendritic spine

2.2 The myelin sheath around an axon serves to: [1]

A. protect the axon from overheating B. supply the axon with nutrients C. increase the speed of impulse conduction D. store neurotransmitter vesicles E. generate new action potentials

2.3 Revisit the worked case. State one conclusion its evidence supports and one stronger conclusion it does not support. Explain the difference. [2]

3 Exam-style questions

3.1 A stronger stimulus produces more spikes of unchanged height. A pupil calls this evidence against all-or-none firing. Correct the inference. Give the interpretation, supporting reasoning, a relevant alternative or limitation, and an appropriate check. [4]

Solutions

2.1 Answer: C. Graded potentials sum at the axon hillock; crossing threshold there launches the spike. The other options do not satisfy the stated defining conditions.

2.2 Answer: C. Myelin enables saltatory conduction between nodes of Ranvier, speeding the impulse. Compare the exact process, design or evidence, rather than an associated keyword.

2.3 Use the worked case evidence to support a bounded claim and explain why a causal, universal or stronger claim needs additional evidence. The claim must fit the specific design and observed process.

3.1 Unchanged spike amplitude fits all-or-none action potentials. Firing rate can carry information about input strength, and more neurons may also be recruited. Separate spike amplitude from number of spikes per second and population activity. A diagram must label which quantity is plotted before being interpreted. Award B1 each (authored) for the interpretation, its reasoning, a relevant limitation/alternative and an appropriate check, up to four points. Accept a different justified answer satisfying these demands.