InkBiology

ANSWER BOOK

The synapse: transmission, and why it runs one way

Nervous coordination, receptors, muscles and behaviour · Unit B14

AQA 3.6.2.2 · OCR A 5.1.3 · Edexcel A Topic 8.10 · CAIE 15.1.6–15.1.8

6 questions · 21 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** the neurotransmitter is acetylcholine. **B1** the enzyme is acetylcholinesterase, which hydrolyses it into choline and ethanoic acid. [2]

SECTION B · Standard, 3 to 5 marks

B1 **B1** the arriving action potential depolarises the membrane of the knob, so voltage-gated calcium channels open and calcium ions diffuse in. **B1** the influx of calcium causes vesicles of acetylcholine to move to the presynaptic membrane and fuse with it, releasing their contents by exocytosis. **B1** acetylcholine diffuses across the 20 nm cleft down its concentration gradient and binds to receptor sites on the postsynaptic membrane. **B1** the receptors are sodium channels, so binding opens them, sodium ions diffuse into the postsynaptic neurone and depolarise it, and a new action potential begins if threshold is reached. **A1** acetylcholinesterase in the cleft hydrolyses the acetylcholine, and the products are reabsorbed into the knob and recombined using ATP from its mitochondria. [5]

B2 **B1** the receptors at an inhibitory synapse open chloride channels, letting negative chloride ions in, or potassium channels, letting positive potassium ions out. **B1** either movement makes the inside of the postsynaptic membrane more negative, so it is hyperpolarised rather than depolarised. **B1** a larger excitatory input is now needed to bring the membrane to the threshold of about -55 mV. **A1** this lets a postsynaptic neurone weigh positive against negative inputs, so signals are sharpened, unwanted movements are suppressed and the whole network does not fire at once. [4]

B3 **B1** calcium ions could not diffuse into the synaptic knob when an action potential arrived. **B1** without the calcium influx the vesicles would not move to the presynaptic membrane and fuse with it, so no acetylcholine would be released into the cleft. **B1** no receptors on the postsynaptic membrane would be occupied, so no sodium channels would open, the muscle fibre membrane would not depolarise and the muscle would be paralysed. **A1** injected acetylcholine would bind and depolarise the fibre, but the amount present would no longer depend on the impulses arriving, so the contraction could not be graded or timed by the nervous system. [4]

B4 **B1** vesicles of acetylcholine are found only in the presynaptic knob, so the neurotransmitter can only be released on that side. **B1** receptors complementary to acetylcholine are found only on the postsynaptic membrane, so it can only be detected on the other side. **A1** an impulse arriving at the postsynaptic side would find nothing to release and nothing on the far side to detect it, so a reflex arc runs reliably from receptor to effector and never backwards. [3]

B5 **B1** spatial summation adds inputs arriving at the same time from several different presynaptic neurones, whereas temporal summation adds impulses arriving in quick succession from a single presynaptic neurone. **B1** in spatial summation the depolarisations are produced at different points on the membrane at once, whereas in temporal summation the transmitter from the first impulse has not yet been hydrolysed when the second arrives. **B1** both reach threshold by adding small excitatory postsynaptic potentials together, and neither could be reached by one impulse at one synapse acting alone. [3]