Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

it insulates the axon; so the impulse jumps between the nodes of Ranvier and travels faster (saltatory conduction)

2.2

the impulse reaches the axon terminal and acetylcholine is released into the gap; acetylcholine binds to receptors on the muscle fibre membrane, which depolarizes and starts an impulse, so the fibre contracts; acetylcholine is then broken down by acetylcholinesterase, so the signal stops

2.3

nervous signals are electrical (and chemical at synapses); hormones are chemicals carried in the blood; nervous control is very fast; hormonal control is slower; nervous effects are short and precise; hormonal effects last longer and can affect many organs

2.4

(a) $t = \dfrac{1.2}{60} = \mathbf{0.02}$ s

(b) hearing the gun and processing it in the brain, deciding and starting the response; delays at synapses and the time for the muscle to be activated and produce force

3.1

(a) one motor neuron and all the muscle fibres it supplies

(b) more motor units are recruited; small units first, then larger, more powerful ones (size principle); motor neurons fire at a higher frequency, so twitches add together (summation)

3.2

(a) muscle spindle

(b) the tap stretches the quadriceps and the muscle spindle; a sensory neuron carries an impulse to the spinal cord; it connects to a motor neuron, which carries the impulse back so the quadriceps contracts

(c) the pathway goes through the spinal cord only, not the brain; it has fewer synapses and no conscious decision, so less delay

3.3

(a) any three: heart rate and force of contraction rise; airways (bronchioles) widen; glycogen is broken down to glucose; blood is redirected to muscles; alertness rises

(b) before: the sympathetic system raises heart rate and breathing, preparing the body (anticipatory rise); after: the parasympathetic system lowers heart rate and breathing back towards rest; the two work against each other to control the heart

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(c) adrenaline is carried in the blood and stays there until it is broken down; a nerve impulse lasts milliseconds and the transmitter is removed quickly