

Solutions

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

2.1

- any two: nervous uses electrical impulses vs hormones; along neurones vs in the blood; fast vs slow; short-lived vs longer-lasting

2.2

(a)

- sodium (Na^+)

(b)

- potassium (K^+)

2.3

- About -70 mV; the pump actively transports 3 Na^+ out for every 2 K^+ in, so more positive ions leave than enter and the inside becomes negative relative to the outside

2.4

- Below the threshold potential no action potential is produced at all; at or above it the action potential is always the same size, however strong the stimulus; a stronger stimulus is represented by a higher frequency of impulses

2.5

- The nodes of Ranvier; saltatory conduction

3.1 B

- The sodium channels are temporarily unable to reopen

3.2 B

- The impulse jumps between nodes of Ranvier (saltatory conduction)

3.3

(a)

- a pump moves sodium ions out and potassium ions in; the membrane is more permeable to potassium, so the inside is negative

(b)

- sodium channels open and Na^+ rushes in, depolarising the membrane to about $+40$ mV; then K^+ channels open and K^+ leaves, repolarising it

3.4

- speed = $\frac{0.60}{0.012} = 50 \text{ m s}^{-1}$

3.5

(a)

- The stimulus opens voltage-gated sodium channels and Na^+ enters, depolarising the membrane; once the threshold of about -55 mV is reached, all the voltage-gated Na^+ channels open; the rapid influx of Na^+ raises the potential to about $+40$ mV

(b)

- The Na^+ channels close and voltage-gated K^+ channels open; K^+ leaves the axon, repolarising the membrane; the K^+ channels are slow to close, so the potential briefly falls below the resting value — hyperpolarisation — before the sodium–potassium pump restores it

(c)

- Any two of: impulses are kept discrete and separate; the maximum frequency of impulses is limited; the impulse can only travel in one direction, because the region behind is still refractory

(d)

- The myelin sheath insulates the axon, so depolarisation can only occur at the nodes of Ranvier; the impulse jumps from node to node, which is saltatory conduction; this is much faster than the continuous depolarisation of the whole membrane in an unmyelinated axon

(e)

- Any three of: nervous is electrical along neurones, hormonal is chemical in the blood; nervous is very fast, hormonal slower; nervous effects are short-lived, hormonal longer-lasting; nervous is targeted at specific effectors, hormonal reaches all cells with the right receptor