TOPIC 6.5: NEURONS & SYNAPSES

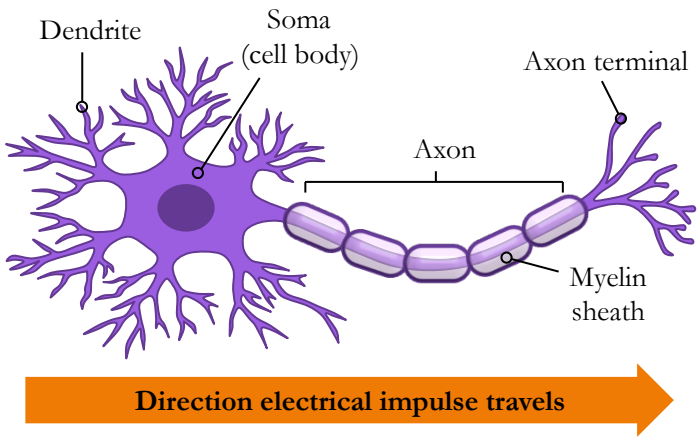
Nervous System

The nervous system consists of two main divisions:
- Central nervous system (CNS) = brain and spinal cord
- Peripheral nervous system (PNS) = peripheral nerves

The nervous system is composed of specialised cells called **neurons** that function to transmit electrical signals

The CNS coordinates sensory & motor signals from the PNS
- Sensory neurons send signals to the CNS *(afferent pathway)*
- Motor neurons send signals from the CNS *(efferent pathway)*
- Relay neurons (interneurons) send signals within the CNS

Structure of a Motor Neuron



Membrane Potentials

Neurons have a difference in charge across their membranes due to the distribution of positively-charged ions (Na^+ / K^+)

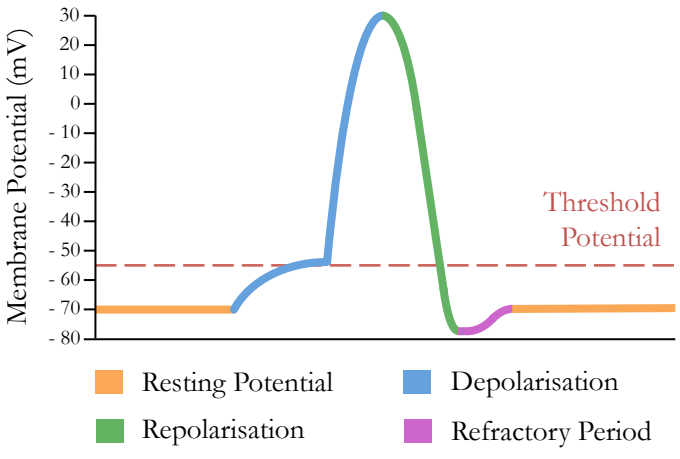
Electrical signals are created by changing membrane polarity
- Polarity of a neuron at rest is the *resting potential* (-70mV)
- Polarity of a firing neuron is the *action potential* (+30mV)

Nerve Impulses

The **resting potential** is maintained by a Na^+/K^+ pump
- It exchange sodium ions (3 out) and potassium ions (2 in) so that the membrane potential becomes slightly negative

An **action potential** changes the resting membrane potential
- The opening of sodium channels causes a sodium influx
- This creates a positive membrane potential *(depolarisation)*
- Opening potassium channels causes a potassium efflux
- This restores a negative membrane potential *(repolarisation)*

The ion distribution must be restored to original conditions before a neuron can fire again (this is the **refractory period**)



Myelination

Nerve impulses are action potentials propagated via axons
- Action potentials are *'all or none'* and are only propagated if a certain threshold potential is reached (~ -55mV)

In certain neurons, the axon is covered by a **myelin sheath**
- This enables saltatory conduction *(⬆ transmission speed)*
- The action potential 'hops' between gaps in the myelin sheath (called nodes of Ranvier) for faster transmission

Synaptic Transfer

Synapses are the physical junctions between two neurons
- Electrical impulses cannot cross these physical gaps

Neurons release **neurotransmitters** into the synapse cleft
- Depolarisation in axon terminals opens Ca^{2+} channels
- Ca^{2+} influx causes vesicles containing neurotransmitters to release their contents into the synapse (via *exocytosis*)
- Neurotransmitters bind receptors on post-synaptic cells and generate graded potentials (excitatory or inhibitory)
- The summation of these graded potentials determines if the post-synaptic neuron (or effector cell) is activated

Neonicotinoid Pesticides

Acetylcholine is a neurotransmitter used in CNS and PNS
- It is broken down in synapses by acetylcholinesterase
- This prevents the overstimulation of the receptors

Neonicotinoid pesticides irreversibly bind to acetylcholine receptors and cannot be digested by acetylcholinesterase
- Insects have higher levels of these types of receptors
- This makes neonicotinoids highly effective pesticides