

Electrochemical Impulse

- It has long been known that electrical impulses are present in living organisms, but it is only within the last century that we have understood how and why neurons transmit electricity
- These impulses are generated using uneven concentrations of ions inside the neuron compared to the intermembrane spaces
- Negatively charged ions play a minimal role in this, because they are mostly large ions and cannot move across the membrane in comparison to the smaller sodium (Na^+) and potassium (K^+) ions

The Generation of Electrical Impulse (follow along with Fig.4, p.420)

1. The resting membrane is more permeable to potassium than to sodium. Potassium ions diffuse out of the nerve cell faster than sodium ions diffuse into the nerve cell. The outside of the nerve cell becomes positive relative to the inside, this is called a polarized membrane.
2. A strong electrical disturbance moves across the cell membrane. The disturbance opens sodium ion gates, and sodium ions rush into the nerve cell. The membrane becomes depolarized, where the charge is reversed (action potential).
3. Depolarization causes the sodium gates to close, while the potassium gates are opened once again. Potassium follows the concentration gradient and moves out of the nerve cell by diffusion. Adjoining areas of the nerve membrane become permeable to sodium ions, and the action potential moves away from the site of origin.
4. The electrical disturbance moves along the nerve membrane in a wave of depolarization. The membrane is restored, as successive areas once again become more permeable to potassium. The sodium-potassium pump restores and maintains the polarization of the membrane by actively pumping potassium ions in and sodium ions out of the cell. The time required for the nerve cell to become repolarized is called the refractory period.

Threshold Level and All-or-None Response

- In order for a nerve cell to trigger a response, there needs to be a certain amount of stimulus
- The critical intensity is known as the threshold level
- Stimuli below the threshold level do not initiate a response
- Stimuli above the threshold level do not initiate an increased response, the intensity of the nerve impulse and speed of transmission remain the same (all-or-none response)
- The neurons either fire maximally or not at all

Synaptic Transmission

- Small spaces between neurons (or between neurons and effectors) are known as synapses
- Chemicals called neurotransmitters are stored and released from the end plates of axons
- An impulse moves along the axon and releases neurotransmitters from the endplate (called the presynaptic neuron)

- The neurotransmitters diffuse across the synaptic cleft, creating a depolarization of the dendrites of the postsynaptic neuron
- Diffusion is much slower than nerve impulses, so transmission slows at the synapse
- Complex responses generally require more different neurons, have more synapses, and take more time than simpler responses

- Some neurotransmitters are excitatory, and cause depolarization, causing the neuron to fire (ex/ acetylcholine)
- These neurotransmitters need to degrade over time, or be broken down, or else the postsynaptic neuron would be in a constant state of depolarization
- The enzyme cholinesterase destroys acetylcholine, allowing sodium channels to close, enabling them to recover

Homework

p.426 # 1, 3-10