ACTION POTENTIALS

Foundational Understanding: Na+ is far more concentrated OUTSIDE of the cell; K+ is far more concentrated INSIDE the cell. The semi-permeable membrane does NOT allow these ions to move freely. The Na+/K+ ATPase pump sends 3 Na+ out for every 2 K+ brought it. This causes the inside of the cell to be relatively negative (compared to the outside) and it means Na+ is always more concentrated outside the cell (wants to come in if a channel opens) and K+ is always more concentrated inside (and wants to exit the cell if a channel opens).

Before AP, cell is polarized (at rest), charge is negative (-70mV), both Na+ and K+ channels are closed. Graded potentials are constantly arriving at the axon hillock. If the graded potential is large enough to raise the membrane potential to ~-55mV, then **threshold** is reached.

Threshold: enough Na+ channels are open to cause self-generated depolarization (approx. -55mV). This is the point of no return, if the membrane gets to this point, an action potential WILL be fired.

Parts of an Action Potential:

- **Resting Phase**: Na/K+ ATPase pump maintains the resting membrane potential before AP. This is an ATP driven pump that puts 3 Na+ ions out of the cell and brings 2 K+ ions into the cell with each "pump".
- **Graded Potentials**: May or may not reach threshold at the axon hillock. If one does, then depolarization will occur.
- **Depolarization**: Na+ channels open and Na+ rushes in; cell depolarizes, charge is positive (up to +30mV).
- **Repolarization**: K+ channels open, Na+ channels close. K+ leaves cell, causing membrane potential to move back toward -70mV.
- **Hyperpolarization**: K+ channels close *slowly*, so membrane potential actually dips below normal (extra negative) while positive K+ ions continue to leak out.
- **Resting Phase**: Na/K+ ATPase pump restores the resting membrane potential before next AP.

Absolute Refractory Period: No stimulus can generate an AP since all the Na+ channels are already opened.
Relative Refractory Period: A *very strong* stimulus can generate an AP since many Na+ channels are already opened.

Frequency: Number of APs generated in a given amount of time indicate the strength of the stimulus; increased frequency=stronger stimulus

Conduction Velocity: (2 mph—300 mph); based on two factors

1. Diameter of axon: bigger=faster, less resistance
2. Degree of myelination

Propagation of the Action Potential. The steps of an action potential repeat over and over again at each patch of membrane until the axon terminal is reached. If the axon is myelinated, then the propagation only has to happen at each Node of Ranvier. That's why myelinated neurons send signals faster and more reliably.

Why does propagation only occur at nodes? Because this is where the Na+ and K+ channels are concentrated, and where ions can pass through the membrane. Ions can't pass through the thick fat of the myelin sheath.