Signaling in the Nervous System

Nerve impulses are caused by changes in resting membrane potential (RMP). These changes can be **Graded Potentials** (GP's) or **Action Potentials** (AP's).

GRADED POTENTIAL

- a GP is the prelude to the AP and is often considered as part of the beginning of an AP
- when the end of a neuron (ie. dendrite or receptor) encounters a **stimulus** (ie. pressure, light), that stimulus causes a small # of **Na+ ions** to enter the neuron through **leak channels**
- the entry of positive charge causes a slight **depolarization** (shift to more **positive** value) of RMP

    1. GP's can be **excitatory** (caused by depolarization) or **inhibitory** (caused by hyperpolarization)

    2. GP's can **vary in size** (amplitude)
        - a GP is a change in RMP proportional to the stimulus intensity (increase intensity = bigger GP)

    3. GP's are conducted **decrementally**
        - they don't travel far down an axon because they fade away

    4. GP's can be **summed** together
        - temporal vs. spatial summation

- when a GP occurs between 2 neurons (ie. at a synapse) it is called a **synaptic potential**; when it occurs where the neuron is connected to a receptor it is called a **receptor potential**
- if the depolarization is great enough (ie. **enough Na+ enters**), the RMP will reach a value called **threshold** and an AP will occur

ACTION POTENTIAL

- the major form in which impulses are transmitted in the nervous system
- a brief (~ 3 msec) change in RMP which can move down a neuron
- threshold MUST be reached for an AP to fire

- at threshold, numerous **voltage-gated Na+ channels** open allowing a rapid **influx** (entry) of Na+ into the neuron down the concentration gradient causing gain of +'ve charge
- this greatly depolarizes the neuron and leads to the **upstroke** (**depolarization**) on the AP curve

- < 1 ms later, **voltage-gated K+ channels** open allowing a rapid **efflux** (exit) of K+ from the neuron causing loss of +'ve charge
- this causes the **downstroke** (**repolarization**) on the AP curve as the potential moves back towards RMP
- the volt.-gated Na+ channels also **close** restricting Na+ entry

- the potential briefly goes **more negative** than normal (**hyperpolarization**) and then the **Na+/K+ pump** kicks in and pumps Na+ out and K+ into the neuron, restoring ion [ ]'s and RMP