SHP Neuroscience

Lecture 2: Electrical Properties of Neurons September 28, 2013

Learning Objectives:

(1) Know the basic parts of a neuron.
(2) Know the relative concentrations of ions on either side of the neuron membrane, and predict the direction of ion flow from the electrochemical gradient.
(3) Know which ion/channel is moving/active during each phase of the action potential.
(4) Understand the meaning of the following terms in the context of the action potential:
    Resting potential
    Threshold
    Depolarization
    Hyperpolarization

(5) Understand the basic principles of ion channel function.

Supplement:

Ion concentrations of a healthy neuron

	Outside (mM)	Inside (mM)
Na^+	145	12
K^+	4	140
Ca^{2+}	2	<0.0002
Mg^{2+}	2	0.5-1
Cl^-	115	4
X^-	138	10

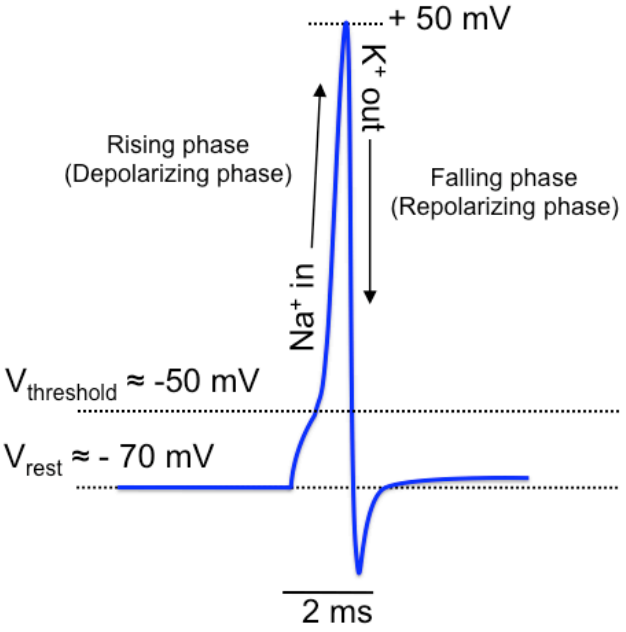
(X: proteins and other small molecules)

Cerebrospinal Fluid: clear aqueous solution that is produced from the blood, flows over the brain and spinal cord and through the ventricles, and provides an isotonic extracellular environment for neurons, with a consistent ionic composition (see above).

Resting Potential: the membrane potential, or voltage, across the cell membrane when it is not generating action potentials or receiving synaptic inputs. This voltage is mainly produced by the action of the Na^+/K^+ pump, which uses ATP to pump K^+ into the cell while pumping slightly more Na^+ out of the cell (usually thought of as $3Na^+$ out for every $2K^+$ in). The typical resting potential (V_{rest}) for neurons is -70 to -60 mV.

Action Potential: an instantaneous (<2ms) change in the membrane potential. The action potential is often called “all-or-none”, meaning that each action potential is generally the same amplitude and time course.

Threshold: the voltage at which the influx of Na^+ ions leads to sufficient depolarization to trip the voltage gate in sodium channels in the overlying membrane, forming a positive feedback loop that leads to explosive and rapid influx of more Na^+ ions (action potential). The threshold for most neurons is typically about -50 mV to -40 mV.



Depolarization: when the membrane potential becomes more positive (less negative), and is more likely to fire an action potential; also referred to as "excitation".

Hyperpolarization: when the membrane potential becomes more negative, and is less likely to fire an action potential; also referred to as "inhibition".