UNDERSTANDING MEMBRANE POTENTIAL CHANGES IN TERMS OF NERNST POTENTIALS:
For seeing how a change in conductance to ions affects the membrane potential, follow these steps:
1. Make a graph with membrane potential on the vertical axis (-100 to +55) and time on the horizontal axis.
2. Draw dashed lines indicating the standard Nernst potential (equilibrium potential) for each ion:
Na^+ = +55 mV, K^+ = -90mV, Cl^- = -65 mV.
3. Draw lines below the horizontal axis showing the increased conductance to individual ions.
4. Start plotting the membrane potential on the left. Most graphs will start at resting potential (-70 mV)
5. When current injection (Stim) is present, move the membrane potential upward to Firing threshold.
6. For the time during which membrane conductance to a particular ion increases, move the membrane potential toward the Nernst potential for that ion.
7. During the time when conductance to a particular ion decreases, move the membrane potential away from the Nernst potential of that ion, toward a position which averages the conductances of the other ions.
8. When conductances return to their original value, membrane potential will go to its starting value.
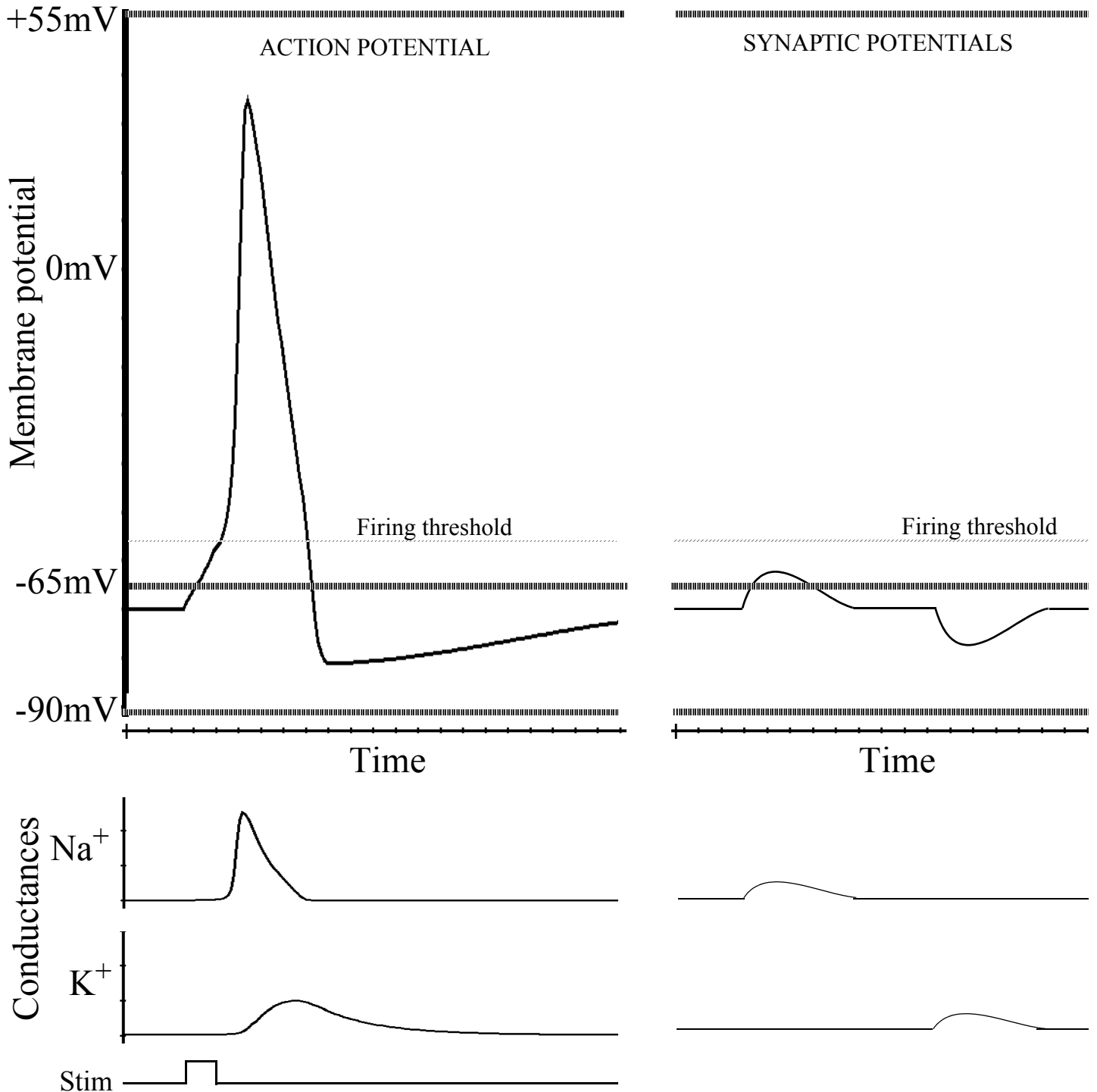
The membrane potential of a neuron can be measured with an intracellular electrode. This provides a measurement of the voltage difference between the inside of the cell and the outside.

When there is no external input, the membrane potential will usually remain at a value called the resting potential. For mammalian cortical neurons, resting potential is around -70 millivolts (mV).
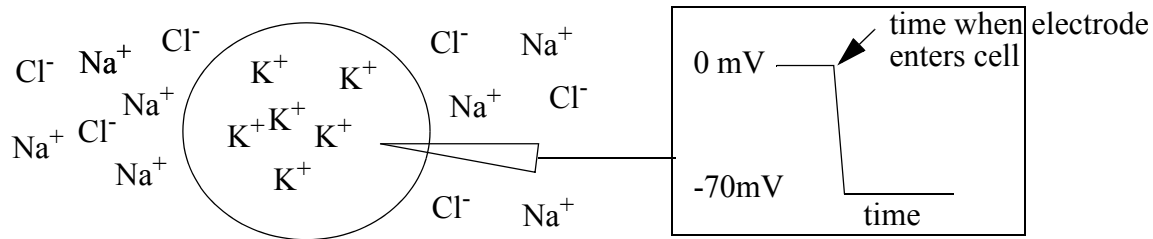
Resting potential results from differences in the chemical concentration of ions inside and outside the neuron. Sodium ions (Na^+) and chloride ions (Cl^-) are at a high concentration outside of neurons. Potassium ions (K^+) are at a high concentration inside of neurons.

The membrane potential can change over time, allowing signals to be transmitted. These changes in membrane potential are caused by particular ion channels opening and closing, and thereby changing the conductance of the membrane to the ions. You can understand the changes in membrane potential by using the Nernst potential for each ion.

For this course you should MEMORIZE THREE STANDARD NERNST POTENTIALS:
Nernst potential for Na^+ = +55mV,
Nernst potential for Cl^- = -65mV,
Nernst potential for K^+ = -90mV.
(The Nernst potential is the voltage which would balance out the unequal concentration across the membrane for that ion. For example, a positive voltage (+55) inside the neuron would keep the high concentration of positive Na^+ ions outside the cell. A large negative voltage (-90mV) would hold the positive K^+ ions inside the cell. Opposites attract, similar charges repel each other).

MEMORIZE THE FOLLOWING RULE: When the membrane conductance increases for a particular ion, the membrane potential will move toward the Nernst potential for that ion.

For example, if the neuron is at resting potential (-70mV) and the conductance to sodium increases, the membrane potential will be depolarized (it will move toward +55mV). When the conductance to sodium goes back to its original value, the membrane potential will return to the resting potential. If the neuron is at resting potential (-70mV) and the conductance to potassium increases, the membrane potential will be hyperpolarized (it will move toward -90mV).

Transmission along the axon of a neuron occurs due to sequential activation of voltage-sensitive sodium and potassium channels. These cause large but brief changes in membrane potential which are referred to as action potentials (spikes).

Neurons communicate with other neurons by releasing transmitters which change the conductance of other neurons to various ions. The changes induced by this synaptic input are called synaptic potentials.