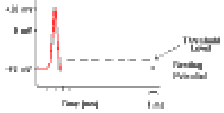
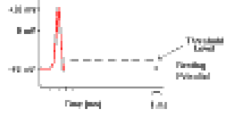
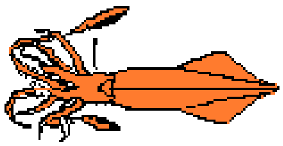


Lights, Camera, Action Potential!!



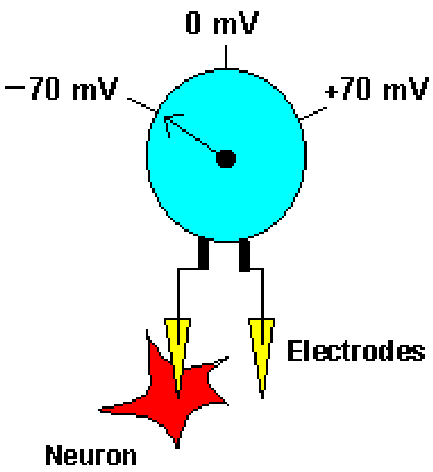
This page will describe the way that neurons work...I hope this explanation does not get too complicated, but it is important to understand how neurons do what they do. There are many details, but go slow and look at the figures.

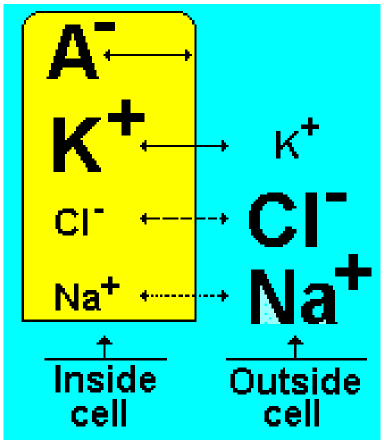


Much of what we know about how neurons work comes from experiments on the giant axon of the squid. This giant axon extends from the head to the tail of the squid and is used to move its tail. How giant is this axon? It can be up to 1 mm in diameter - easy to see with the naked eye.

Neurons send messages through an electrochemical process. This means that chemicals result in an electrical signal. Chemicals in the body are "electrically-charged" - when they have an electrical charge, they are called "ions". The important ions in the nervous system are sodium and potassium (both have 1 positive charge, +), calcium (has 2 positive charges, ++) and chloride (has a negative charge, -). There are also some negatively charged protein molecules. It is also important to remember that nerve cells are surrounded by a membrane that allows some ions to pass through while it blocks the passage of other ions. This type of membrane is called semi-permeable.

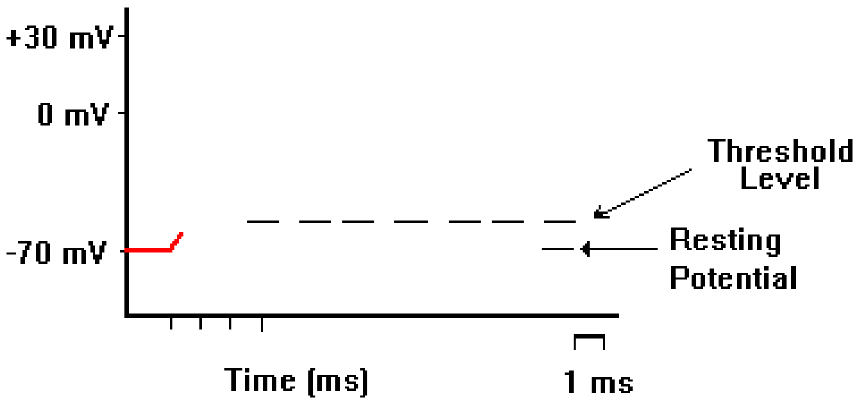
Resting Membrane Potential





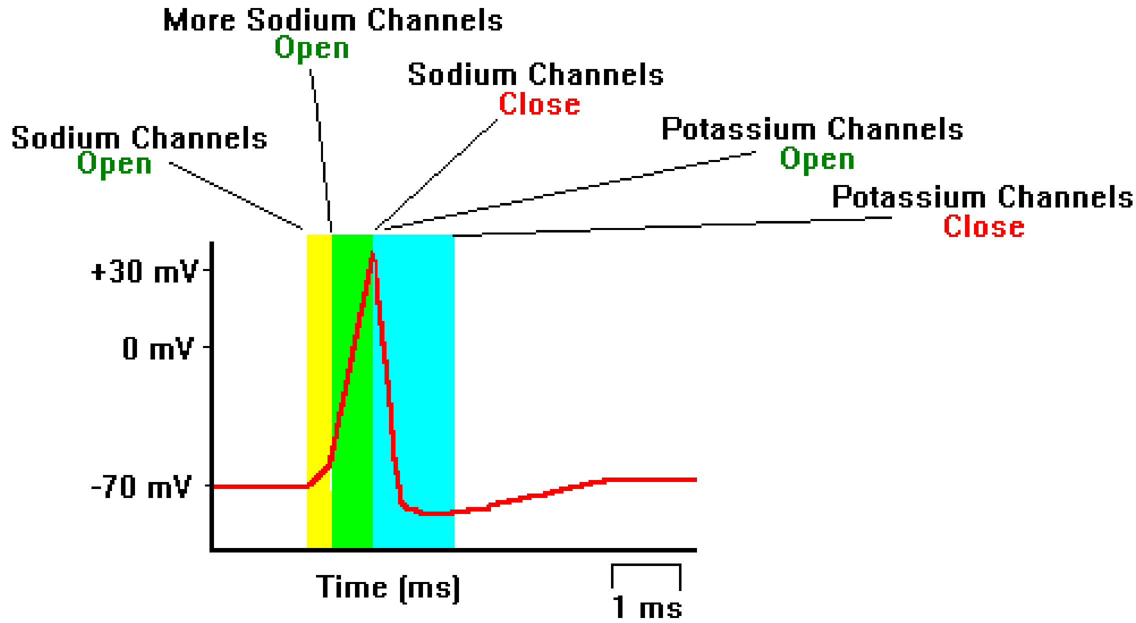
When a neuron is not sending a signal, it is said to be "at rest". When a neuron is at rest, the inside of the neuron is negative relative to the outside. While the concentrations of the different ions attempt to balance out on both sides of the membrane, they cannot because the cell membrane allows only some ions to pass through channels (ion channels). At rest, potassium ions (K^+) can cross through the membrane easily. Also at rest, chloride ions (Cl^-)and sodium ions (Na^+) have a more difficult time crossing. The negatively charged protein molecules (A^-) inside the neuron cannot cross the membrane. In addition to these selective ion channels, there is a pump that uses energy to move 3 sodium ions out of the neuron for every 2 potassium ions it puts in. Finally, when all these forces balance out, and the difference in the voltage between the inside and outside of the neuron is measured, you have the resting potential. The resting membrane potential of a neuron is about -70 mV (mV=millivolt) - this means that the inside of the neuron is 70 mV less than the outside. At rest, there are relatively more sodium ions outside the neuron and more potassium ions inside that neuron.

Action Potential



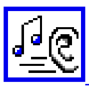
So the resting potential indicates what is happening with the neuron at rest. The action potential indicates what happens when the neuron transmits information from one cell to another. Neuroscientists use other words, such as a "spike" or an "impulse" to describe the action potential. The action potential is an explosion of electrical activity that is created by a depolarizing current. This means that some event (a stimulus) causes the resting potential to move toward 0 mV. When the depolarization reaches about -55 mV a neuron will fire an action potential. This is the threshold. If the neuron does not reach this critical threshold level, then no action potential will fire. Also, when the threshold level is reached, an action potential of a fixed sized will always fire...for any given neuron, the size of the action potential is always the same. There are no big or small action

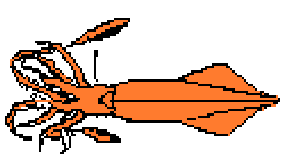
potentials in one nerve cell - all action potentials are the same size. Therefore, the neuron either does not reach the threshold or a complete action potential is fired - this is the "ALL OR NONE" principle.



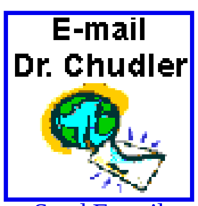
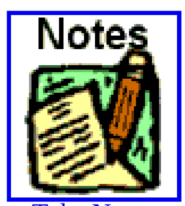
The "cause" of the action potential is an exchange of ions across the neuron membrane. A stimulus first results in the opening of sodium channels. Since there are a lot more sodium ions on the outside, and the inside of the neuron is negative relative to the outside, sodium ions rush into the neuron. Remember, sodium has a positive charge, so the neuron becomes more positive and becomes depolarized. It takes longer for potassium channels to open. When they do open, potassium rushes out of the cell, reversing the depolarization. Also at about this time, sodium channels start to close. This causes the action potential to go back toward -70 mV (a repolarization). The action potential actually goes past -70 mV (a hyperpolarization) since the potassium channels stay open a bit too long. Gradually, the ion concentrations go back to resting levels and the cell returns to -70 mV.

And there you have it...the **Action Potential**.

 **Hear some action potentials** **in the Sounds of Neuroscience gallery. See and hear more about the** **neuron membrane potential** **using virtual reality modeling language (VRML).**

Did you know? 	The giant axon of the squid can be 100 to 1000 times larger than a mammalian axon. The giant axon innervates the squid's mantle muscle. These muscles are used to propel the squid through the water.

BACK TO:	Exploring the Nervous System	Table of Contents

 Send E-mail	 Fill out survey	 Get Newsletter	 Search Pages	 Take Notes