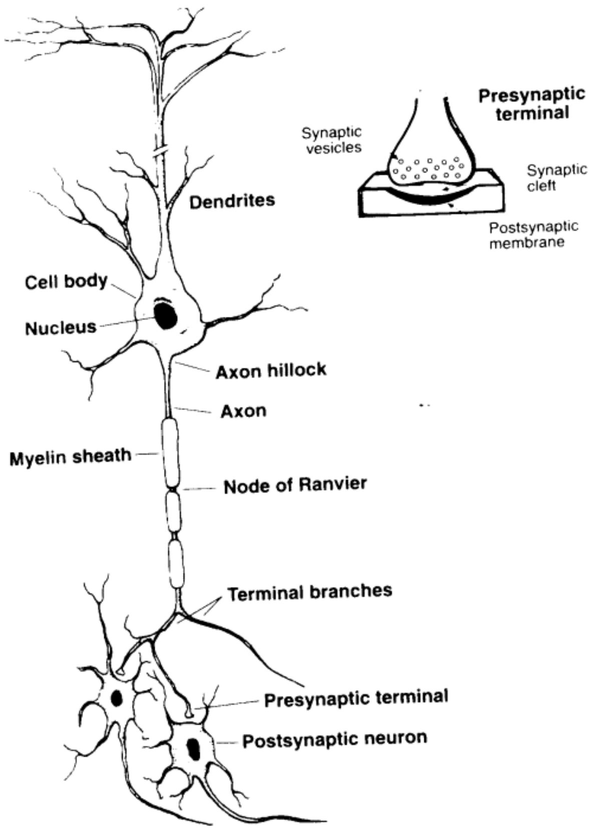
Neurones & the Action Potential

Neurones conduct impulses from one part of the body to another.

STRUCTURE



They have three distinct parts:

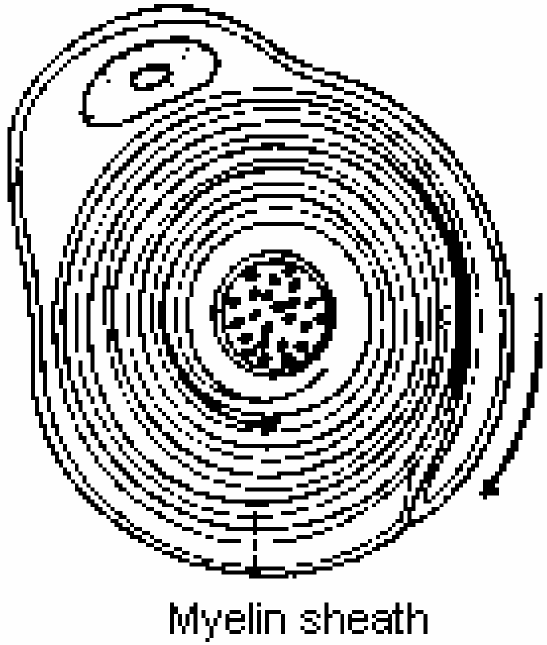
- (1) Cell body,
- (2) Dendrites, and
- (3) the Axon

The particular type of neuron that stimulates muscle tissue is called a motor neuron.

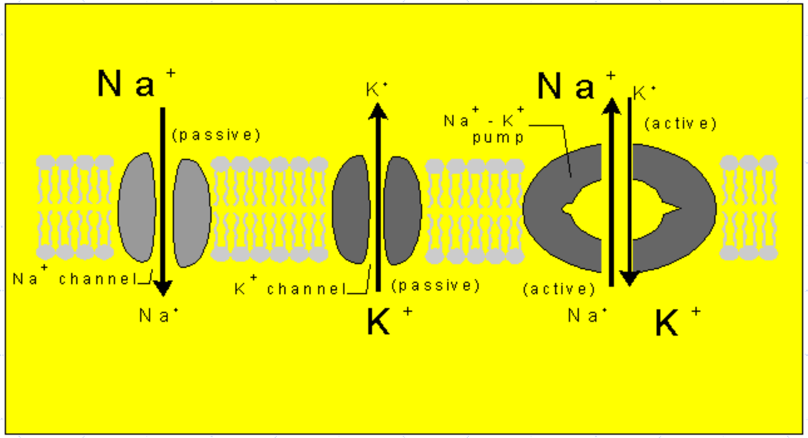
Dendrites receive impulses and conduct them toward the cell body.

Myelinated Axons

- The axon is a single long, thin extension that sends impulses to another neuron.
- They vary in length and are surrounded by a many-layered lipid and protein covering called the myelin sheath, produced by the schwann cells.



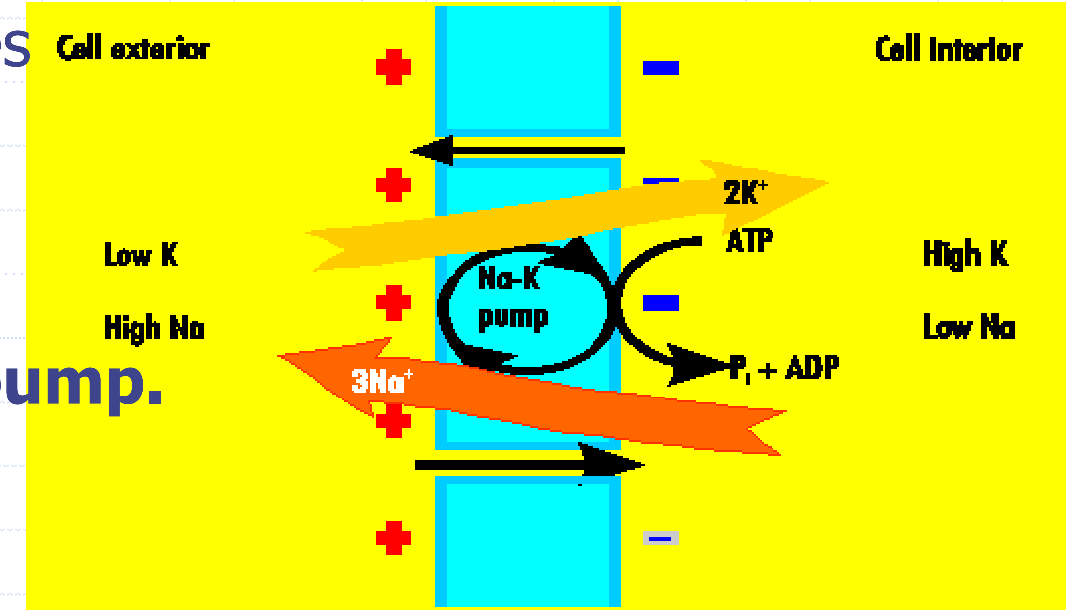
Resting Potential



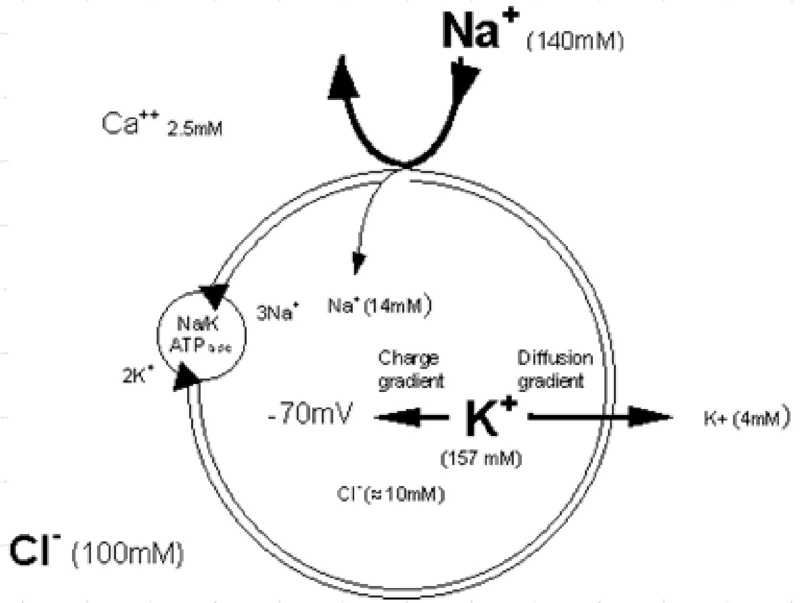
In a resting neuron (one that is not conducting an impulse), there is a difference in electrical charges on the outside and inside of the plasma membrane. The outside has a positive charge and the inside has a negative charge.

Contribution of Active Transport – Factor 1

There are different numbers of potassium ions (K^+) and sodium ions (Na^+) on either side of the membrane. Even when a nerve cell is not conducting an impulse, for each ATP molecule that's hydrolysed, it is **actively transporting** 3 molecules Na^+ out of the cell and 2 molecules of K^+ into the cell, at the same time by means of the **sodium-potassium pump.**



Contribution of facilitated diffusion



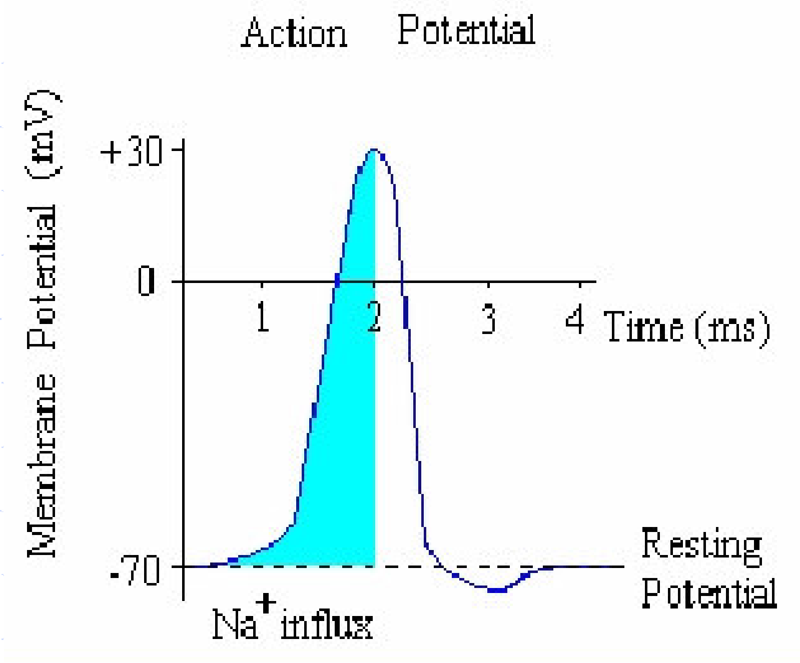
The sodium-potassium pump creates a concentration and electrical gradient for Na^+ and K^+, which means that K^+ tends to diffuse ('leak') out of the cell and Na^+ tends to diffuse in. BUT, the membrane is much more permeable to K^+, so K^+ diffuses out along its concentration gradient much more slowly.

RESULTS IN:

→ a net positive charge outside & a net negative charge inside. Such a membrane is **POLARISED**

Action Potential

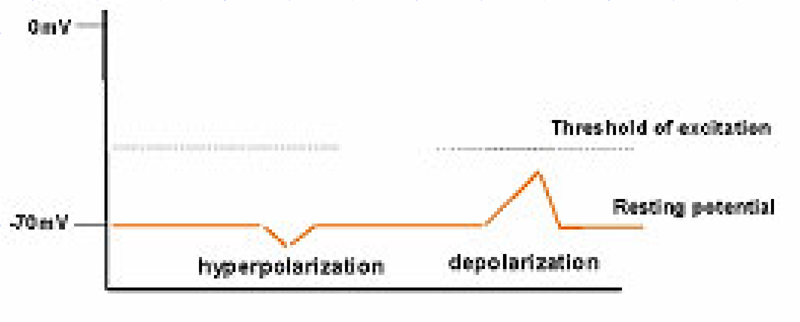
- When the cell membranes are stimulated, there is a change in the permeability of the membrane to sodium ions (Na^+).



- The membrane becomes more permeable to Na^+ and K^+, therefore sodium ions diffuse into the cell down a concentration gradient. The entry of Na^+ disturbs the resting potential and causes the inside of the cell to become more positive relative to the outside.

DEPOLARISATION

In order for the neuron to generate an action potential the membrane potential must reach the **threshold of excitation.**



As the outside of the cell has become more positive than the inside of the cell, the membrane is now **DEPOLARISED**.

When enough sodium ions enter the cell to depolarise the membrane to a critical level (**threshold level**) an action potential arises which generates an impulse.

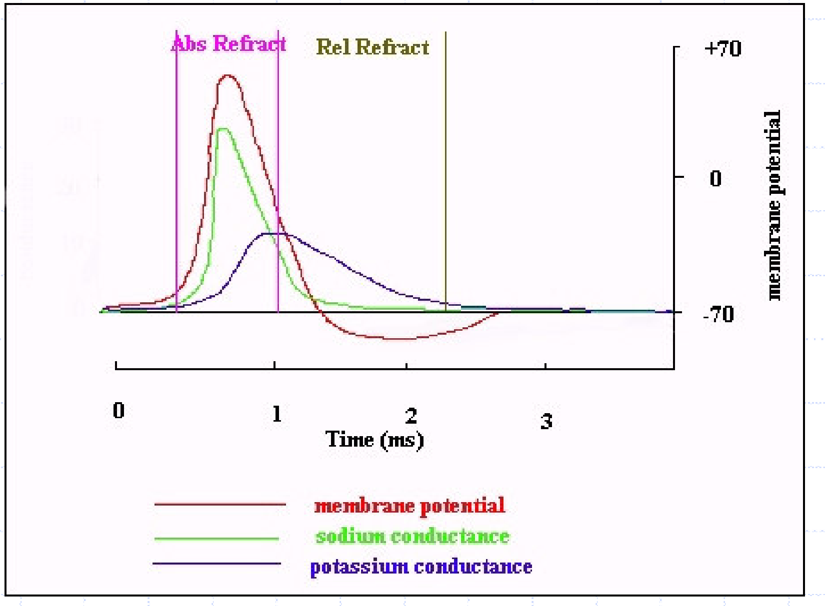
All-or-None Principle

Throughout depolarisation, the Na+ continues to rush inside until the action potential reaches its peak and the sodium gates close.

If the depolarisation is not great enough to reach **threshold**, then an action potential and hence an impulse are not produced.

This is called the **All-or-None Principle.**

Refractory Period



There are two types of refractory period:

Absolute Refractory Period – Na+ channels are inactivated and no matter what stimulus is applied they will not re-open to allow Na+ in & depolarise the membrane to the threshold of an action potential.

Relative Refractory Period - Some of the Na+ channels have re-opened but the threshold is higher than normal making it more difficult for the activated Na+ channels to raise the membrane potential to the threshold of excitation.

Speed of Nerve Impulses

Impulses travel very rapidly along neurones. The presence of a myelin sheath greatly increases the velocity at which impulses are conducted along the axon of a neuron. In unmyelinated fibres, the entire axon membrane is exposed and impulse conduction is slower.

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