How the Neuron Works

The axon of the neuron sends a wave of depolarization along its length.

Depolarization is the result of the movement of two positive ions, Na^+ and K^+ from one side of the axon's cell membrane to the other.

The Resting Potential:

Normally the outside of the cell membrane is positively charged and the inside is negatively charged. This is due to a number of factors:

- outside the cell there are high [Na^+] and low [K^+], Cl^- is the dominant negative ion
- inside the cell there are high [K^+] and low [Na^+]. Other negative ions are also found inside, like some amino acids, phosphates and sulfates.
- the cell membrane has special gateways for the $Na^+$and K^+ and the larger anions are trapped inside the cell
- the movement of Na^+ and K^+ is what causes a wave of depolarization. At rest, the cell membrane is much more permeable to K^+ than to Na^+ (about 50x)
- when Na^+ is moving into the cell there is more K^+ moving out of the cell. Remember all those big negatively charged ions are trapped inside.
- Active transport keeps more positive ions on the outside by the **Na^+/K^+ pump**
- This pump pulls three Na^+ outside and only two K^+ inside
- This results in a cell that is relatively negative inside and relatively positive outside

All of this requires a constant supply of oxygen and glucose to the mitochondria of the cell body. The aerobic metabolism uses this to produce ATP, which releases energy when it breaks into ADP. This provides the energy for the pump.

The Nerve Impulse:

A neuron will only trigger an impulse along its axon when it has been stimulated. The stimulus has to be strong enough to send a wave of depolarization along the axon, beyond the neuron's threshold.
It cannot send a mild or strong response. Either it sends a response or it doesn't; there are no degrees of stimulation. (Like the trigger of a gun, either there is enough pressure to fire the gun or not. You can't affect the gun by pulling harder on the trigger)

Depolarization:

- Depolarization occurs when the gates of the K^+ close and the gates of the Na^+ open.
- The Na^+ moves to the inside of the cell, causing the inside to become positive and the outside to become negative. This change in charge is called the **action potential**.
- Depolarization of any one part of the axon causes the gates of the neighbouring Na^+ channels to open , so the depolarization ripples along the entire length of the neuron.

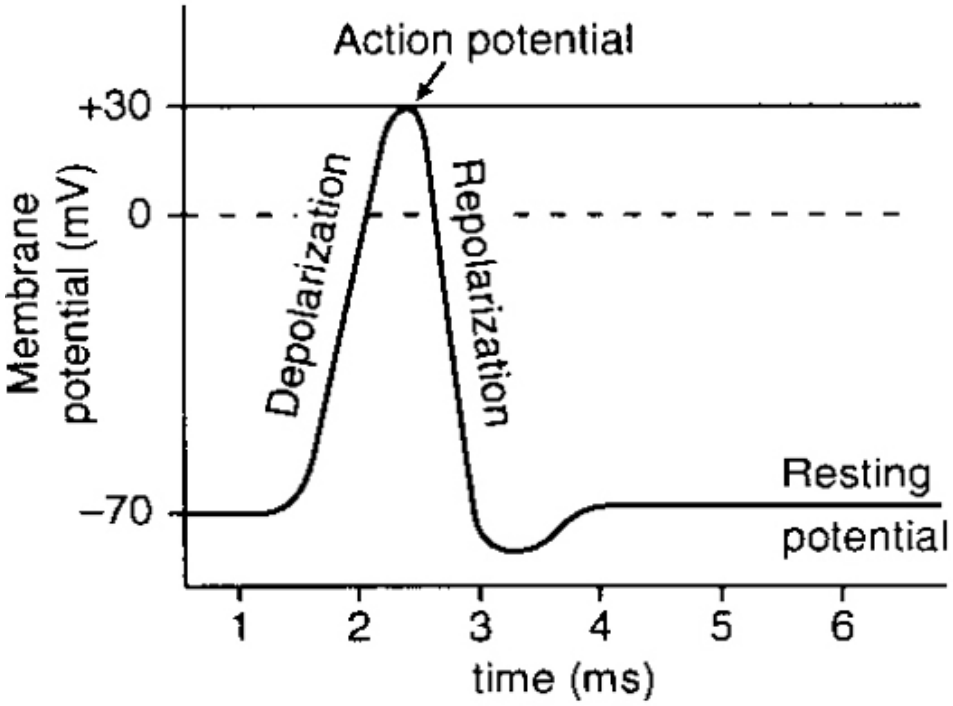
Repolarization:

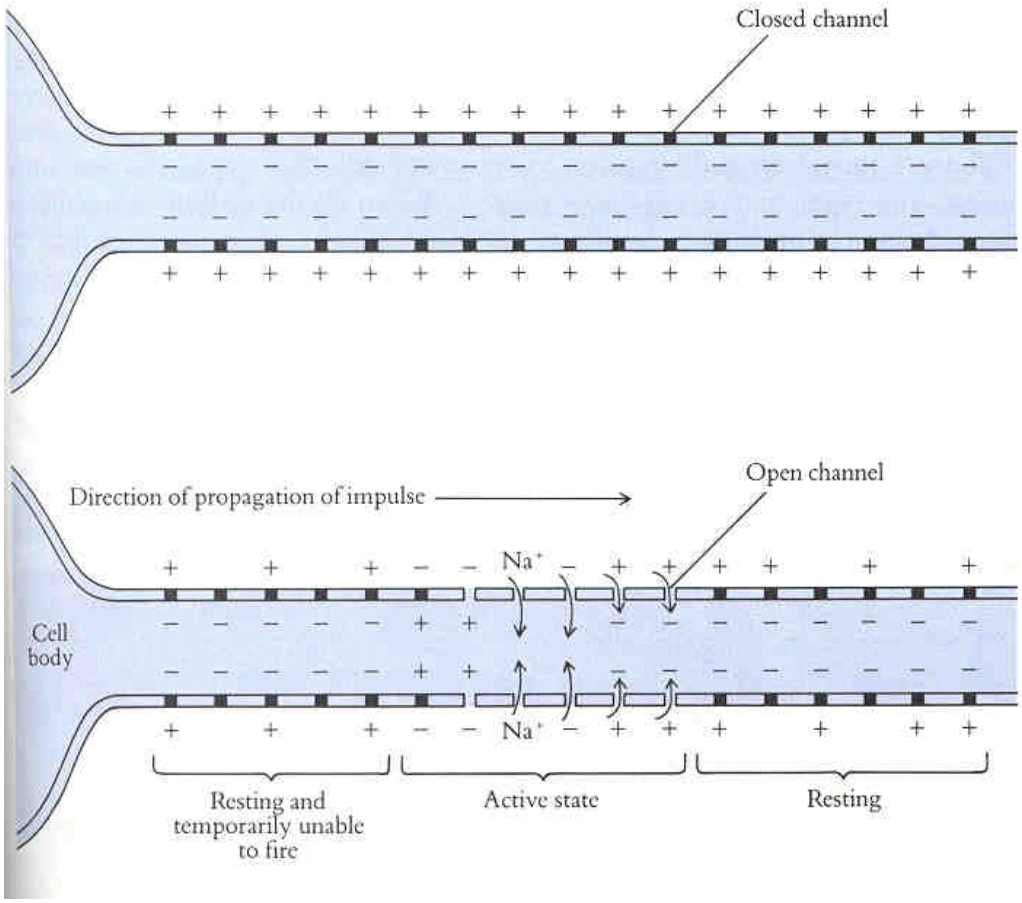
Depolarization only occurs for a small fraction of a second.

Right after the sodium channels open to cause depolarization -

- the gates of the K^+ channels re-open
- the potassium ions move out
- the Na^+ channels close
- there is rapid active transport of the Na^+out of the axon by the Na^+/K^+ pump
- polarity is re-established

The time between an impulse and the next time the axon may be available for another impulse is called the **refractory period** (about 0.001 s)




Closed channel
Direction of propagation of impulse
Open channel
Na+
Na+
Cell body
Resting and temporarily unable to fire
Active state
Resting