Difference Between Depolarization and Repolarization

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Key Difference - Depolarization vs Repolarization

Our brain is connected to the rest of the organs and muscles in our body. When our hand is moving the brain sends signals through the nerve cells to the muscles in hand to contract. The nerve cells send a lot of electrical impulses telling the muscles in hands to contract. These electrical impulses in nerve cells are known as action potential. The action potential arises as a result of the concentration gradient of ions (Na^+, K^+ or Cl^-). Three main triggering events in an action potential are: depolarization, repolarization and hyperpolarization. In depolarization, the Na^+ ions gates are opened. It brings inflow of Na^+ ions into the cell and hence, the neuron cell is depolarized. The action potential passes through the axons. In repolarization, cell comes back to resting membrane potential again by stopping the inflow of Na^+ ions. The K^+ ions are flowing out the neuron cell in repolarization. When action potential passes through the K^+ gated channels for too long, the neuron looses more K^+ ions. This means the neuron cell gets hyperpolarized (more negative than resting membrane potential). The **key difference** between depolarization and repolarization is that, **depolarization causes the action potential due to Na^+ ions going inside the axon membrane through Na^+/K^+ pumps while in repolarization, K^+ go out the axon membrane through Na^+/K^+ pumps causing the cell to come back to resting potential.**

What is Depolarization?

Depolarization is a triggering process that takes place in the neuron cell which changes the polarization of it. The signal is coming from the other cells that are connected to the neuron. The positively charged Na^+ ions flow into the cell body through “m” voltage gated channels. The specific chemicals known as neurotransmitters are binding to these ion channels that make them open at the right time. The incoming Na^+ ions bring the membrane potential closer to “zero”. That is described as **depolarization** of the neuron cell.

If the cell body gets a stimulus which passes the threshold potential it can trigger the Sodium channels in the axon. Afterwards, the action potential or electrical impulses will be sent. This lets the positively charged Na^+ ions to flow into negatively charged axons. And it depolarizes the surrounding axons. Here, when one channel opens and lets the positive ions in, it triggers the other channels to do the same down the axons.

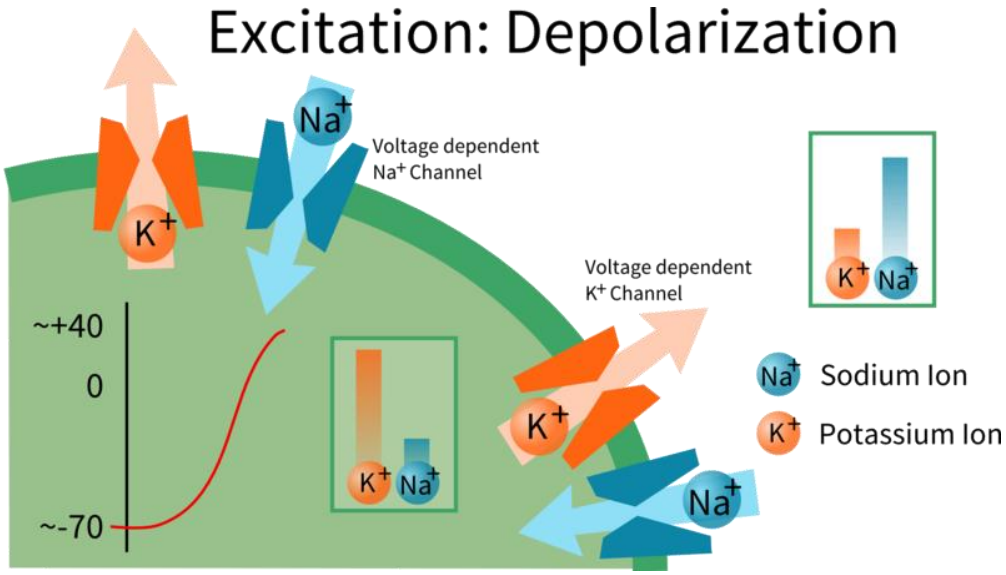

Figure 01: Depolarization

As the action potential passes through the neuron swings, it passes the equilibrium and becomes positively charged quickly. Once the cell becomes positively charged, the depolarization process completes. When the neuron gets depolarized the "h" voltage gates are shut down and blocks the Na^+ ions entering the cell. This initiates the next step which is known as repolarization which brings the neuron to its resting potential.

What is Repolarization?

The process of repolarization brings back the neuron cell to the membrane resting potential. The inactivation process of sodium gated channels will make them close up. It stops the inward rush of positive Na^+ ions into the neuron cell. At the same time, potassium channels known as "n" channels are opened. There is a lot of K^+ ions concentration inside the cell than the outside cell. Hence, when these K^+ channels are opened, more potassium ions flow out the membrane than when they are coming in. The cell loses its positive ions. Hence the cell returns back to the resting stage. This entire process is described as **repolarization.**

In neuroscience it is defined as the change in membrane potential to the negative value again just after the depolarization phase of action potential. This is usually known as the falling phase of an action potential. There are several other K^+ channels that contribute to the repolarization process such as, A-type channels, delayed rectifiers and Ca^{2+} activated K^+ channels.

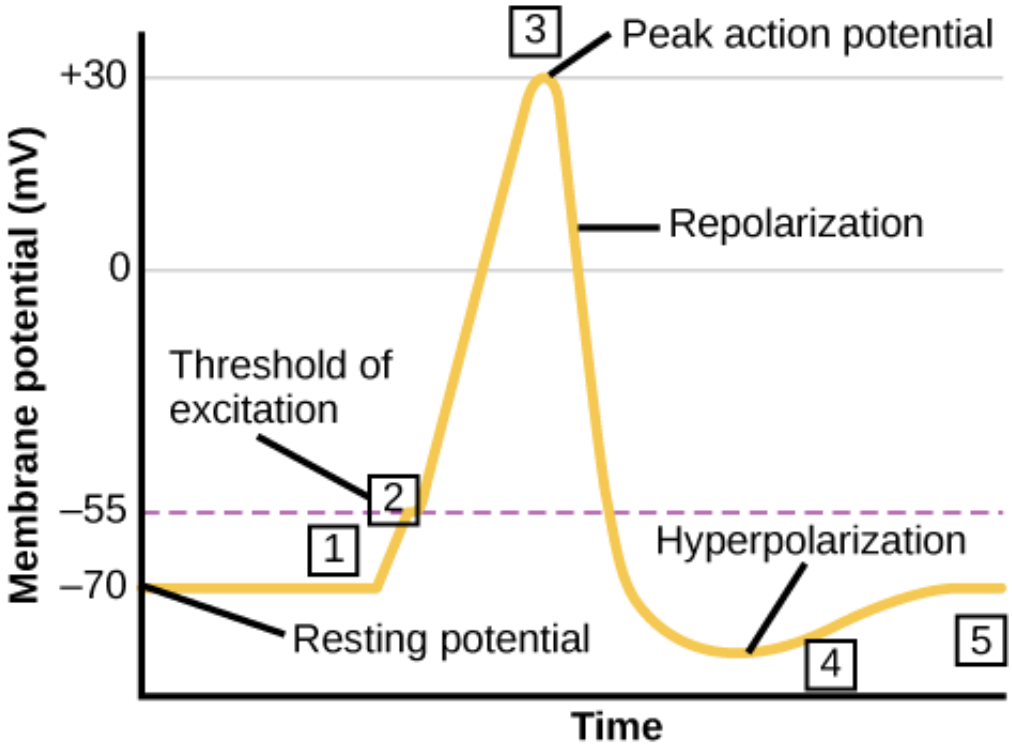

Figure 02: Repolarization

The repolarization ultimately results in the hyperpolarization stage. In this case, the membrane potential gets too negative than the resting potential. The hyperpolarization is normally due to the efflux of K^+ ions from K^+ channels or influx of Cl^- ions from Cl^- channels.

What are the Similarities Between Depolarization and Repolarization?

- Both are stages of the action potential.
- Both are very important to maintain neuron membrane potential.
- Both are initiated due to concentration gradient of ions in and out of the neuron cell (Na^+, K^+)
- Both are initiated due to inflow and outflow of the ions through the voltage gated channels in the neuron cell membrane.

What is the Difference Between Depolarization and Repolarization?

Depolarization vs Repolarization

Depolarization is the process which initiates inflow of Na^+ ions into the cell and creates action potential in the neuron cell.	Repolarization is the process which returns the neuron cell into its resting potential after depolarization by stopping the inflow of Na^+ ions into the cell and sending more K^+ ions out of the neuron cell.
Net Charge	
In depolarization, the neuron cell body has a positive charge.	In repolarization, the neuron cell body has a negative charge.
Inflow and Outflow of Ions	
More positively charged Na^+ ions inflow to the neuron cell happens in depolarization.	More positively charged K^+ ions outflow of the neuron cell happens in repolarization.
Channels Used	
In depolarization, Sodium **"m"** voltage gated channels are used.	In repolarization, Potassium **"n"** voltage gated channels and other potassium channels are used (A-type channels, delayed rectifiers and Ca^{2+} activated K^+ channels).
Neuron Cell Polarization	
In depolarization there is less polarity in the neuron cell.	In repolarization there is more polarity in the neuron cell.
Resting Potential	
In depolarization resting potential does not get restored.	In repolarization resting potential is restored.
Mechanical Activity	
Depolarization triggers a mechanical activity.	Repolarization does not trigger a mechanical activity.

Summary - Depolarization vs Repolarization

The electrical impulses that are initiated in nerve cells are known as **action potential**. The action potential arises based on the concentration gradient of ions (Na^+, K^+ or Cl^-) across the axon membrane. Three main triggering events in an action potential are described as: depolarization, repolarization and hyperpolarization. During the depolarization, an action potential is created due to the influx of Na^+ into the axon via sodium channels located in the membrane. Depolarization is followed by repolarization. Repolarization process brings the depolarized axon membrane into its resting potential by opening potassium channels and sending K^+ ions out the axon membrane. This is the difference between depolarization and repolarization.

Reference:

1.Neuron action potentials: The creation of a brain signal." Khan Academy. Available here
2.Depolarization." Wikipedia, Wikimedia Foundation, 5 Nov. 2017. Available here

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2.'Figure 35 02 03'By CNX OpenStax (CC BY 4.0) via Commons Wikimedia

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