



كلية المستقبل الجامعة
قسم الفيزياء الطبية
المرحلة الرابعة

Medical Physics

Neurophysics

Lecture 3

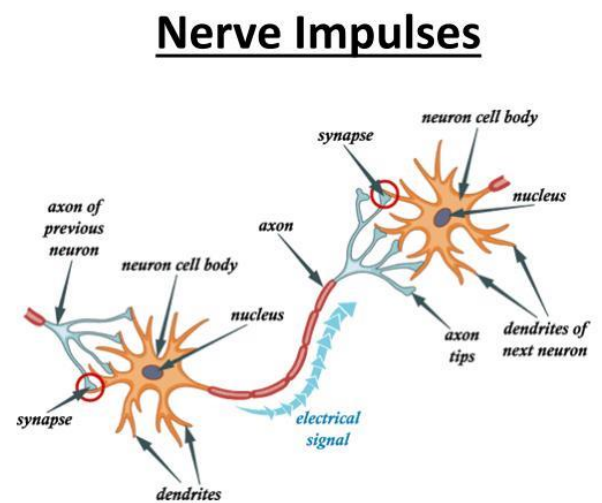
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Nerve Impulse :

The progressive physicochemical change in the membrane of a nerve fiber that follows stimulation and serves to transmit a record of sensation from a receptor or an instruction to act to an effector called also nervous impulse .

Medical Definition of Nerve Impulse :

An electrical signal that travels along a nerve fiber in response to a stimulus and serves to transmit a record of sensation from a receptor or an instruction to act to an effector, the propagation of an action potential along the length of a neuron .

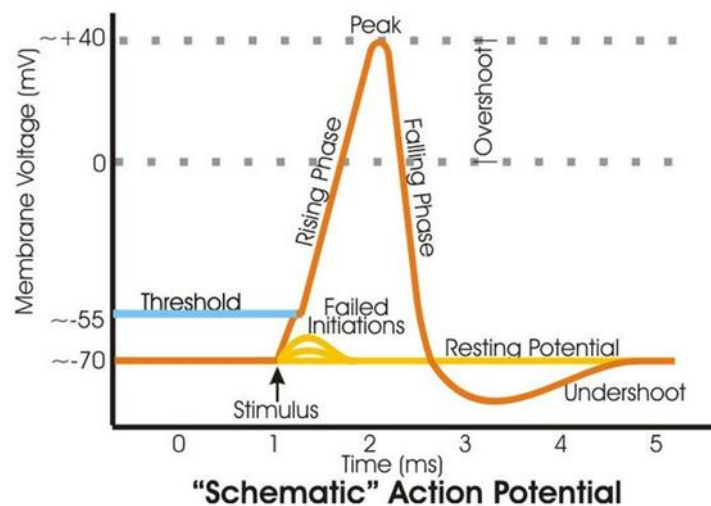


A nerve impulse : like a lightning strike, is an electrical phenomenon. A nerve impulse occurs because of a difference in electrical charge across the plasma membrane of a neuron .

Electricity Potential of Nerves :

Because electrical signals are the basis of information transfer in the nervous system, it is essential to understand how these signals arise .

The use of electrical signals as in sending electricity over wires to provide power or information presents a series of problems in electrical engineering .



A Fundamental Problem for Neurons :

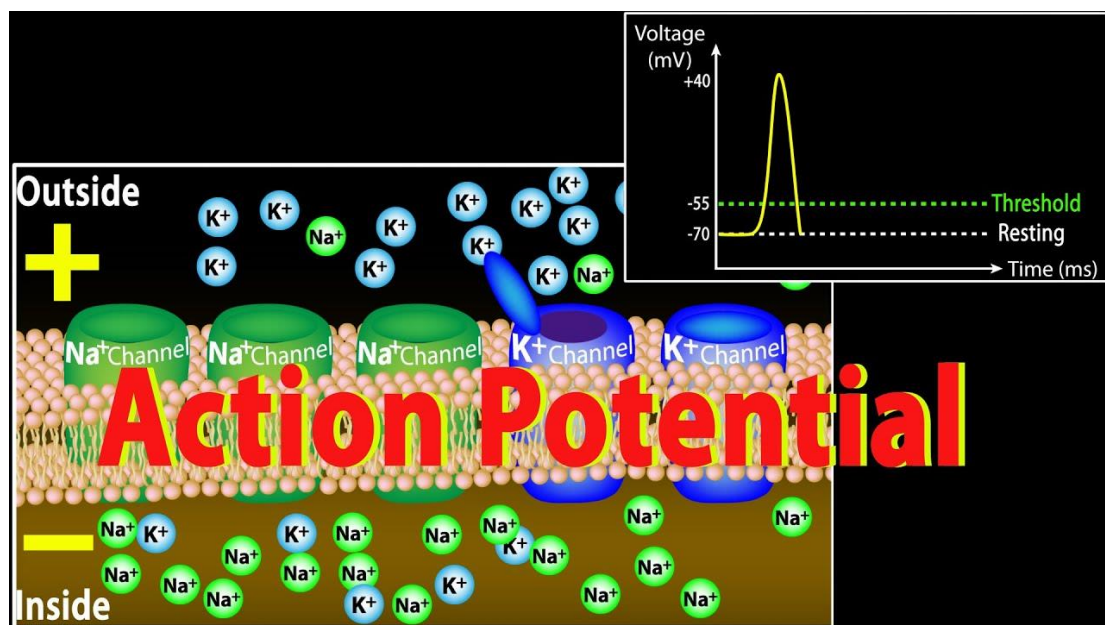
- 1- Their axons, which can be quite long (remember that a spinal motor neuron can extend for a meter or more) .
- 2- Neuron are not good electrical conductors.
- 3- Although neurons and wires are both capable of passively conducting electricity, the electrical properties of neurons compare poorly to even the most ordinary wire .

To Compensate for This Deficiency : neurons have evolved a “booster system” that allows them to conduct electrical signals over great distances despite their intrinsically poor electrical characteristics. The electrical signals produced by this booster system are called action potentials (which are also referred to as “spikes” or “impulses) .

Action Potential :

An action potential is a rapid rise and subsequent fall in voltage or membrane potential across a cellular membrane with a characteristic pattern .

Sufficient current is required to initiate a voltage response in a cell membrane; if the current is insufficient to depolarize the membrane to the threshold level, an action potential will not fire. Examples of cells that signal via action potentials are neurons and muscle cells .

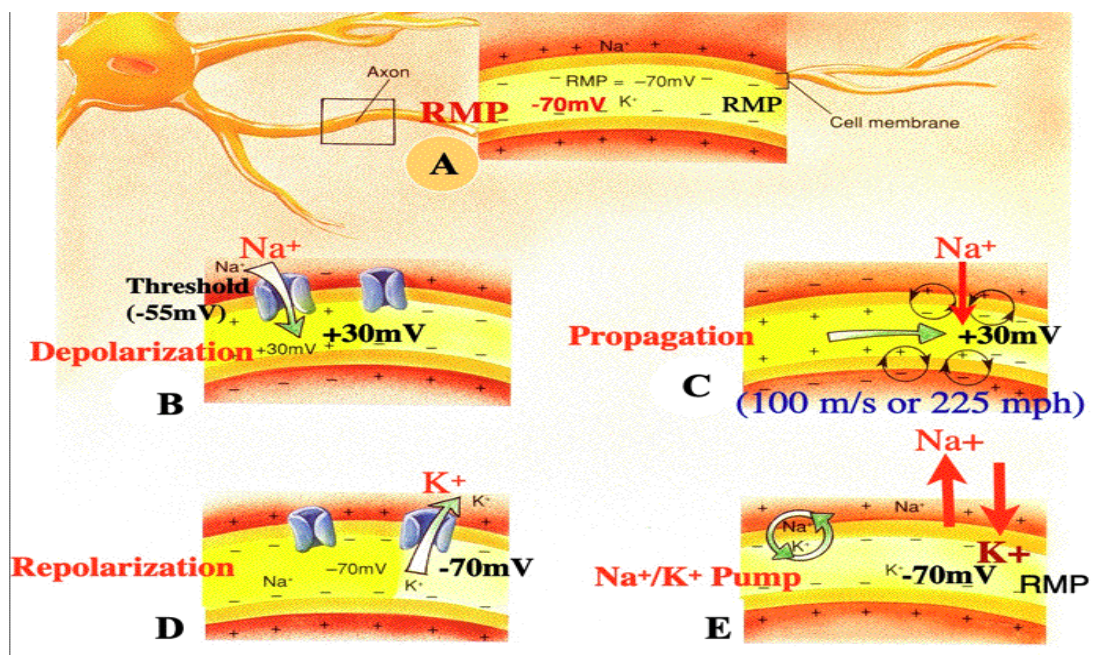


For a long time, the process of communication between the nerves and their target tissues was a big unknown for physiologists .

With the development of electrophysiology and the discovery of electrical activity of neurons, it was discovered that the transmission of signals from neurons to their target tissues is mediated by action potentials .

How Can Generated Neuron Impulse :

A nerve impulse is generated when the stimulus is strong. This stimulus triggers the electrical and chemical changes in the neuron. There are different ions on either side of the cell membrane. The exterior side has sodium ions that are positively charged and are more in number. The interior side of the cell is negatively charged with more potassium ions. Due to this difference in the charges, there is an electrochemical difference .



When a nerve impulse is generated, there is a change in the permeability of the cell membrane. The sodium ions flow inside and potassium ions flow outside, causing a reversal of charges. The cell is now depolarized. This depolarization results in an action potential which causes the nerve impulse to move along the length of the axon. This depolarization of the membrane occurs along the nerve. A series of reactions occur where the potassium ions flow back into the cell and sodium ions move out of the cell. This whole process again results in the cell getting polarized, with the charges being restored .

Neurotransmitters and Receptors :

There are more than a hundred known neurotransmitters, and more than one type of neurotransmitter may be released at a given synapse by a presynaptic cell . Many neurotransmitters also have multiple types of receptors to which they can bind. Receptors , can be divided into two general groups:

1- Chemically Gated Ion Channels :

When a chemically gated ion channel is activated, it forms a passage that allows specific types of ions to flow across the cell membrane.

Depending on the type of ion, the effect on the target cell may be :

- **Excitatory** : A neurotransmitter that will have excitatory effects on the neuron, meaning it will increase the likelihood that a neuron will fire an action potential .

- **Inhibitory** : A neurotransmitter that decreases the likelihood that a neuron will fire an action potential .

2- Second Messenger Systems :

When a second messenger system is activated, it starts a cascade of molecular interactions inside the target cell. This may ultimately produce a wide variety of complex effects, such as increasing or decreasing the sensitivity of the cell to stimuli

