كلية المستقبل الجامعة
قسم الفيزياء الطبية
المرحلة الثالثة

Medical Physics

Lecture 4

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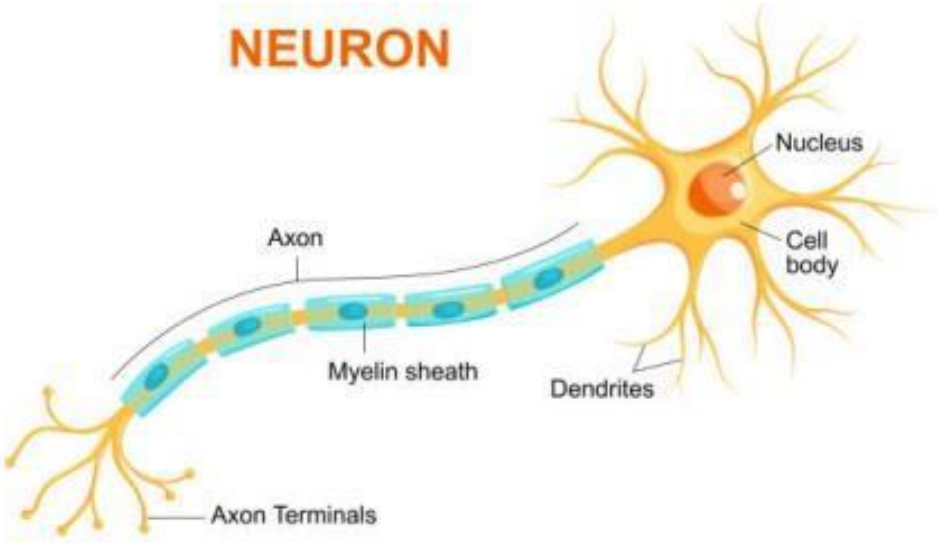
Electricity Potential of Nerves :

Nerves Cells :

Neurons are the information processing units of the brain which have a responsibility for sending, receiving, and transmitting electrochemical signals throughout the body .

Neurons, also known as nerve cells, are essentially the cells that make up the brain and the nervous system. Neurons do not touch each other, but where one neuron comes close to another neuron, a synapse is formed between the two .



Components of Central Nervous System :

1- The Brain .

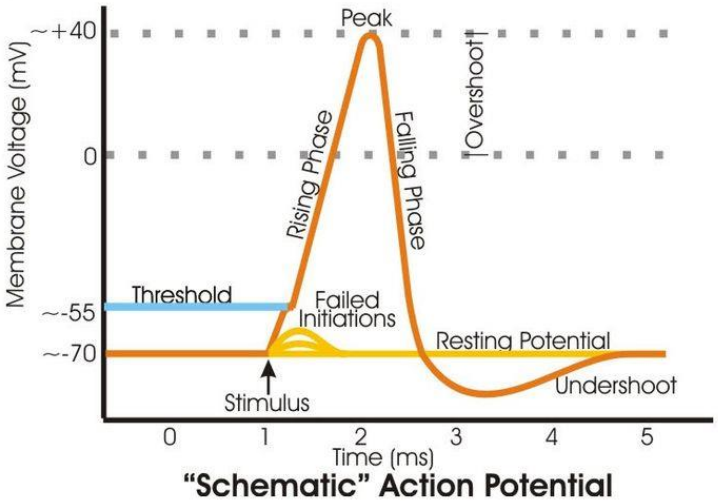
2- Spinal Cord .

3- Peripheral nervous system, which consists of sensory and motor nerve cells all contain these information processing neurons

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.

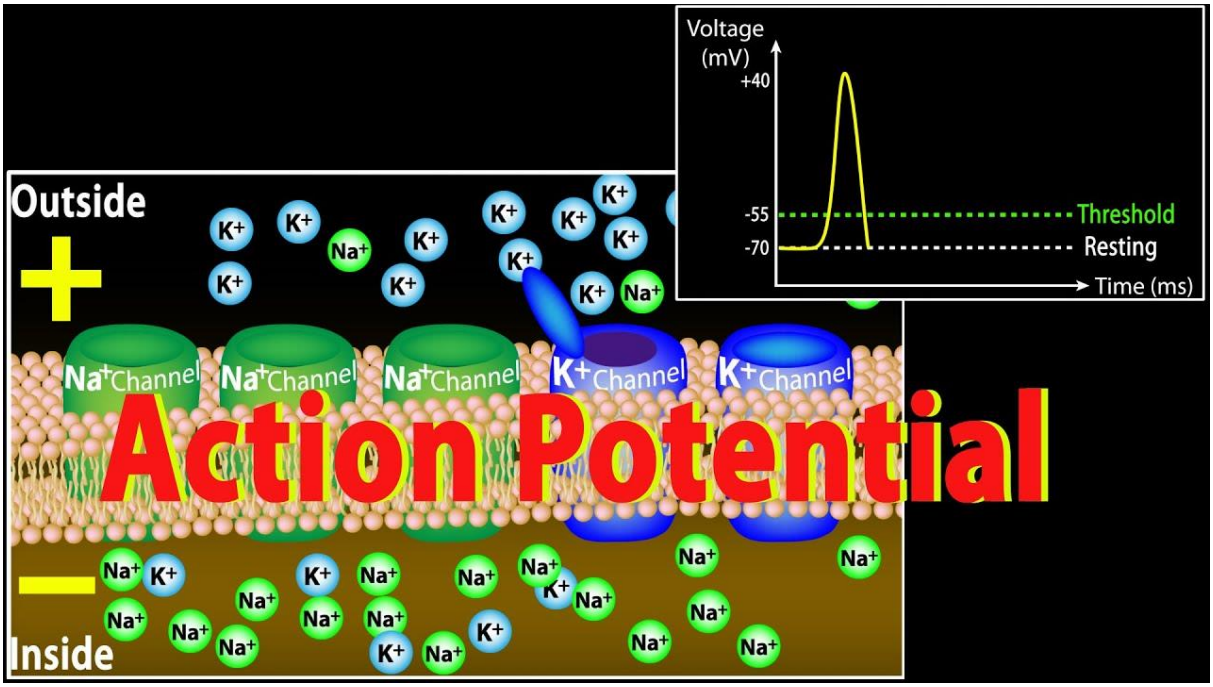
3- Although neurons and wires are both capable of passively conducting electricity, the electrical properties of neurons compare poorly to even the most ordinary wire.

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.

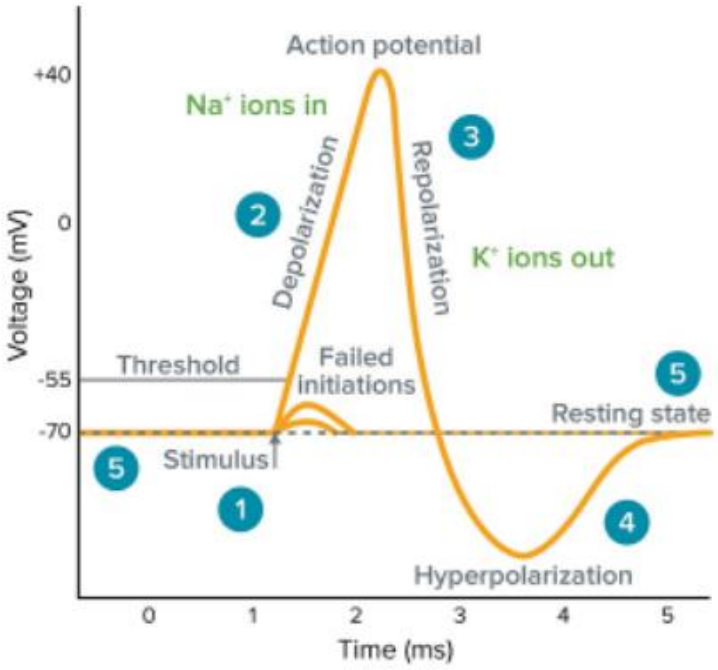
With the development of electrophysiology and the discovery of electrical activity of neurons, it was discovered that the transmission of signals from neurons to their target tissues is mediated by action potentials

How Can Generated Action Potential :

1- Stimulus starts the rapid change in voltage or action potential. In patch-clamp mode, sufficient current must be administered to the cell in order to raise the voltage above the threshold voltage to start membrane depolarization .

2- Depolarization is caused by a rapid rise in membrane potential opening of sodium channels in the cellular membrane, resulting in a large influx of sodium ions .

3- Membrane Repolarization results from rapid sodium channel inactivation as well as a large efflux of potassium ions resulting from activated potassium channels .



4- Hyperpolarization is a lowered membrane potential caused by the efflux of potassium ions and closing of the potassium channels .

5- Resting state is when membrane potential returns to the resting voltage that occurred before the stimulus occurred .

Electrical Nature of Nerves :

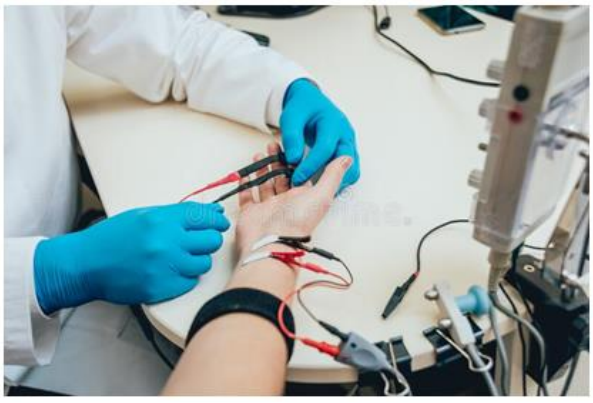
1- Neurons use electrical signals to communicate with other neurons, muscles and glands.

2- When microelectrodes are placed on either side of the membrane of an inactive neuron, measurements from a voltmeter indicate an electrical potential difference of -70mV (millivolts) .

3- The charge of the inside of the neuron cell is negative in relation to the outside .This charge separation across the membrane is known as the membrane potential .

Electromyogram (EMG) :

Electromyography (EMG) measures muscle response or electrical activity in response to a nerve's stimulation of the muscle. The test is used to help detect neuromuscular abnormalities . An audio-amplifier is used so the activity can be heard. EMG measures the electrical activity of muscle during rest, slight contraction and forceful contraction.



Muscle tissue does not normally produce electrical signals during rest. When an electrode is inserted, a brief period of activity can be seen on the oscilloscope, but after that, no signal should be present .