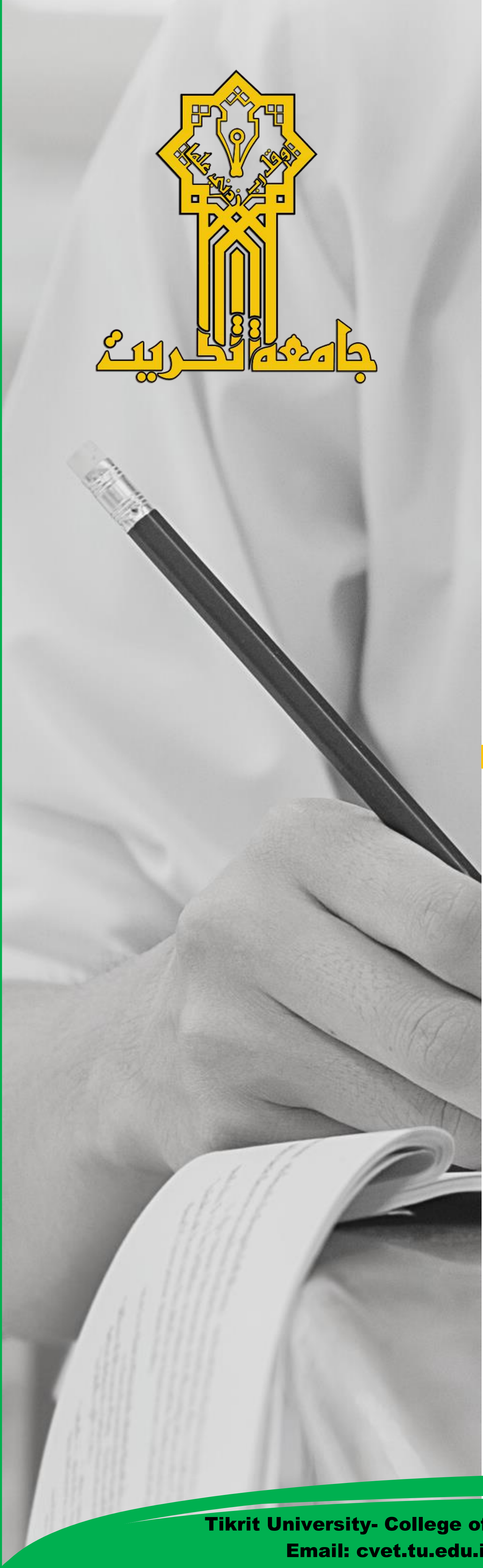

Tikrit University
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Nerves Physiology

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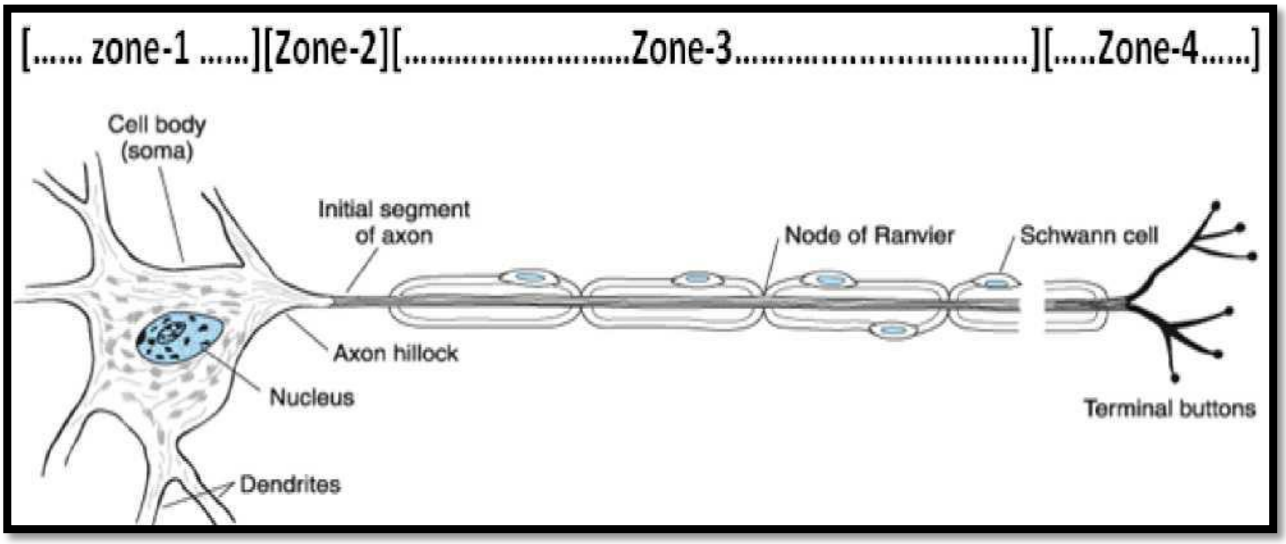
Nerves Physiology

The nervous system consists of nerve cells (neurons) and supporting cells. Neuron is the structural and functional unit of the nervous system. A typical neuron consists of the soma or cell body and two types of processes: the axon and dendrites. These cells functionally divided to four zones:

1. **Receptor Zone**: It is the body cell and its dendrites. Dendrites provide a receptive area that transmits electrical impulses to the cell body.
2. **Impulse origin zone:** it is the axon hillock, the origin of the axon near the cell body. Here, the nerve impulses originate.
3. **Impulse transmission zone**: it is the reign extends from the axon hillock to the telodendria, the nerve ending. The nerve impulses transmit to synaptic buttons.
4. **Neurotransmitter secretion zone:** it is telodendria and its synaptic buttons which responsible to transmit the impulses to other cell by secret the neurotransmitters.



Nerve fibers:

The nerve fibers divided to myelinated and unmyelinated. The myelin sheath formed by oligo dendrocytes. All myelinated axons are surrounded by myelin sheath except Ranvier's nodes, which have 2000-12000 Na chanals, while in the first one of axone 350-500, in the cell body 50.75, in the myelin sheath 25, in the end of axon 20-75, and in the unmyelinated axons 110. Unmyelinated are smaller than 2pm in diameter, whereas those that are larger are likely to by myelinated. Myelinated axons conduct impulses more rapidly than unmyelinated.

Resting membrane potential (RMP):

An electrical potential difference, or membrane potential, can be recorded across the plasma membrane of living cells. The potential of unstimulated cells, or resting potential, amounts to -9 to 100mV depend of the type of cell. A resting potential is caused by a slightly unbalanced distribution of ions between intracellular fluid (ICF) and extracellular fluid (ECF).

RMP: it is the potential difference across the cell membrane during rest, without stimulation between the inner side and the outer side, and it is relatively –ve inside.

Measurement of RMP: (using voltmeter).

Normal Values: -70 in medium sized nerves and -90 mv in large nerve fibers.

(Inside the fiber is 90 times more negative) During rest, the membrane is polarized (the membrane is a wall between the positive outside and negative inside).

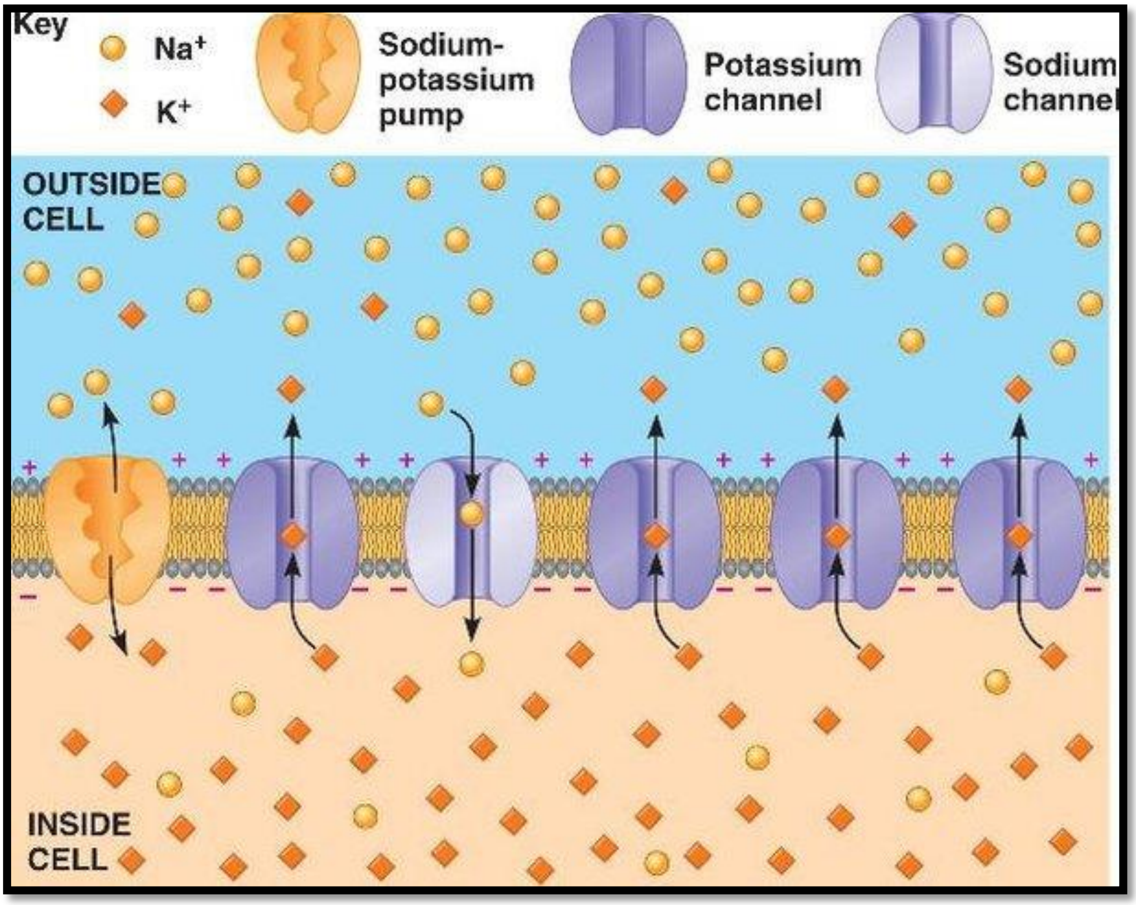
There are high molecules of K+ inside the cell and high molecules of Na+ outside the cell.

Causes (Origin) of Resting Membrane Potential (RMP):

The important factors in the establishment of the normal resting membrane potential of -90 millivolts

1- Contribution of K+ diffusion potential:- • The cell membrane has tendency to pump potassium (K) (positive charge) out, from high to low, causing –ve charge inside, through K leak channels, down its concentration gradient.
2- Result: Electro-positivity outside and electro-negativity inside.
3- RMP is 100 times more permeable to K+ than Na+. (These K+ leak channels may also leak sodium ions slightly but are far more permeable to potassium than sodium)

4- K diffusion contributes far more to resting membrane potential. (most important)



Resting Membrane Potential (RMP)

Membrane Action Potential (MAP):

Nerve signals are transmitted by action potentials, which are rapid changes in the membrane potential that spread rapidly along the nerve fiber membrane. Each action potential begins with a sudden change from the normal resting negative membrane potential to a positive potential and ends with an almost equally rapid change back to the negative potential.

Action Potential: a sudden reverse of membrane polarity (of charges) produced by a stimulus to produce a physiological effect such as: o Transmission of impulse along nerve fibers (transmission of nerve signals) o Release of neurotransmitters o Muscle contraction or

Activation or inhibition of glandular secretion } Only Excitable tissue (Nerve and muscles) respond to action potential.

The excitation of nerve has four periods:

1. **Latent (resting) period:** in this period the membrane potential is stile -70mV (resting potential) to a short or long time according the microelectrodes position.

2. **Depolarization period:** large numbers of Na+ channels are activated, and the influxing Na+ accelerates depolarization. As a result, the membrane potential is slowly decreased from -70 to -55mV, which called **threshold** or firing level. After that, the membrane potential is rapidly decreased to (0mV), which called **isopotential**. The membrane potential temporarily reaches positive levels (+35mV).

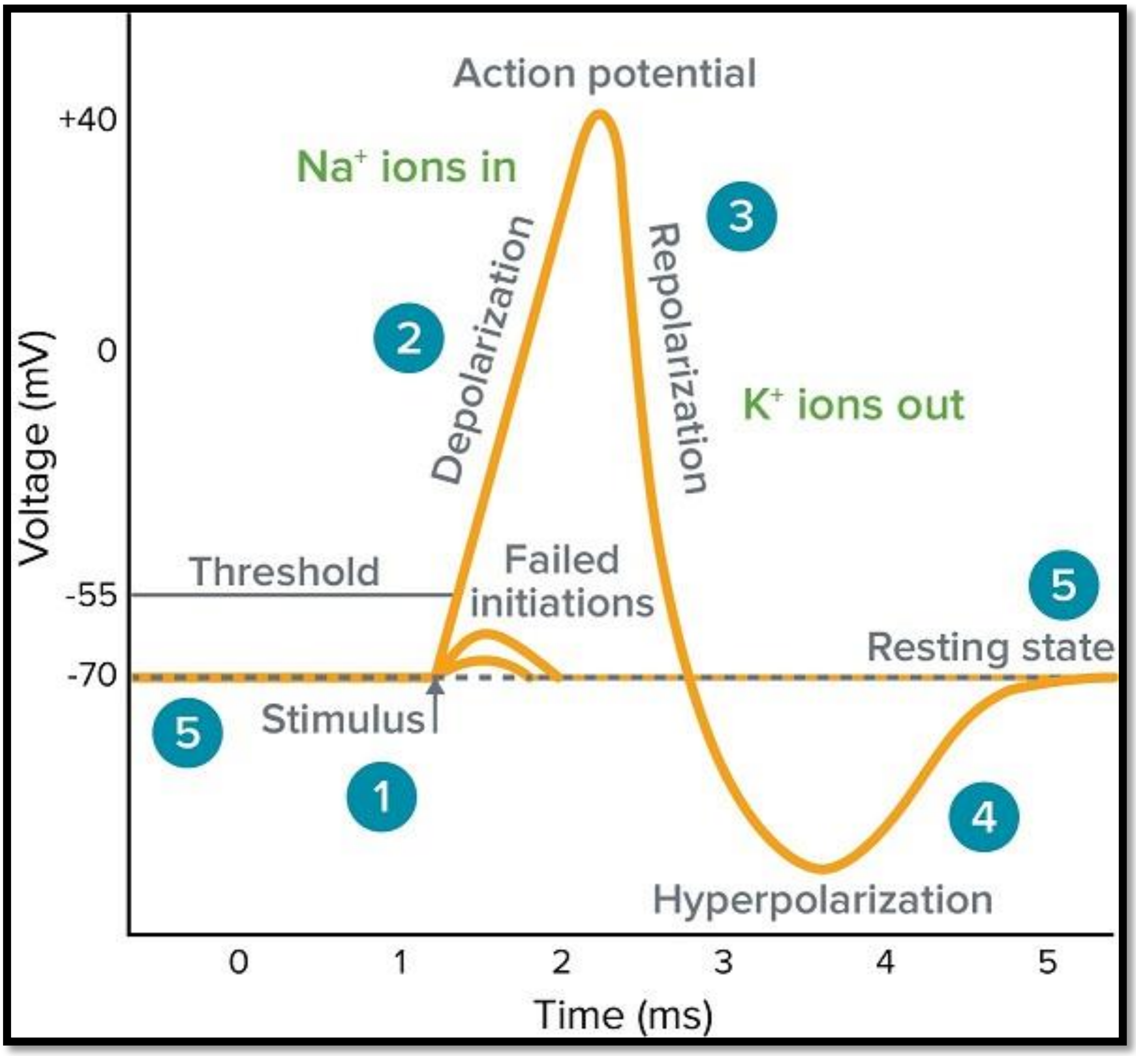
There are two types of stimuli:

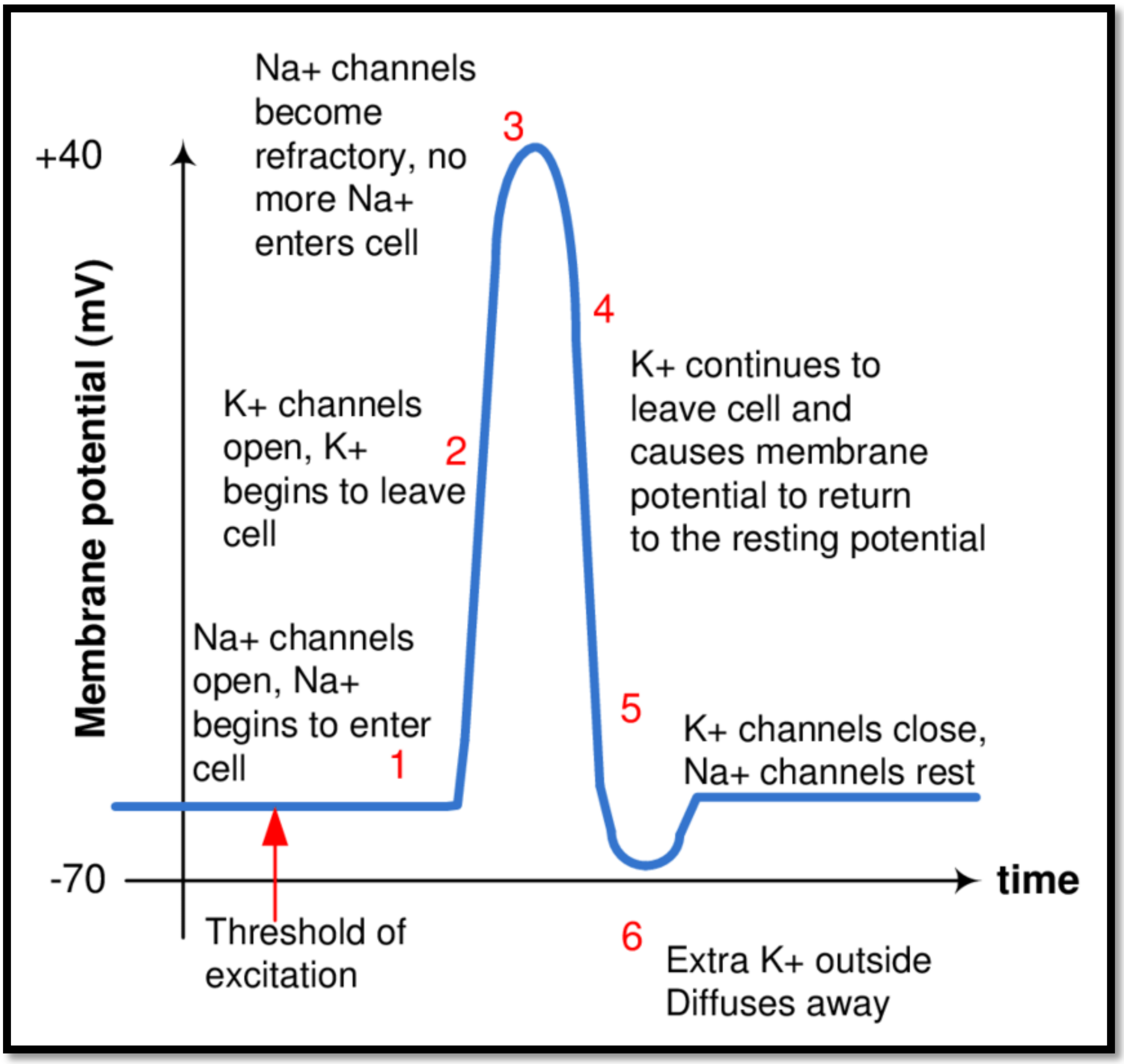
Threshold stimuli: it is successful to produce active potential, which its intensity is more than 15mV (-70mV, RMB, -55, threshold=15)

Sub-threshold stimuli: its intensity is less than 15mV, which cannot reach the threshold so it cannot produce active potential.

3. **Repolarization period:** because the Na+ channels are inactivated, the potential reverses, and restoration of the resting potential, the repolarization phase of the action potential, begins. Depolarization has increased the open-probability of voltage gated K+ channels. This has increased the potassium conductance, thereby accelerating repolarization.

4. **Hyperpolarization period:** in many cases, potassium conductance is still increased after the original resting potential has been restored, resulting in a hyperpolarization after potential. Increased Na+-K+ ATPase pumping rates can contribute to this after-potential.


Action potential
+40
0
-55
-70
Voltage (mV)
Na+ ions in
K+ ions out
Depolarization
Repolarization
Threshold
Failed initiations
Resting state
Stimulus
Hyperpolarization
1
2
3
4
5
5
0
1
2
3
4
5
Time (ms)



Nerve Impulse: Nerve impulse is an electrochemical phenomenon which includes:

1. Electrical, The movement of active potential by stimuli from stimulation point on the long nerve fiber. This is like electrical flows through a cable when voltage is applied.
2. Chemical, neurotransmitter is released by regulated exocytosis of synaptic vesicles when the action potential reached it to stimulate the adjacent cells.

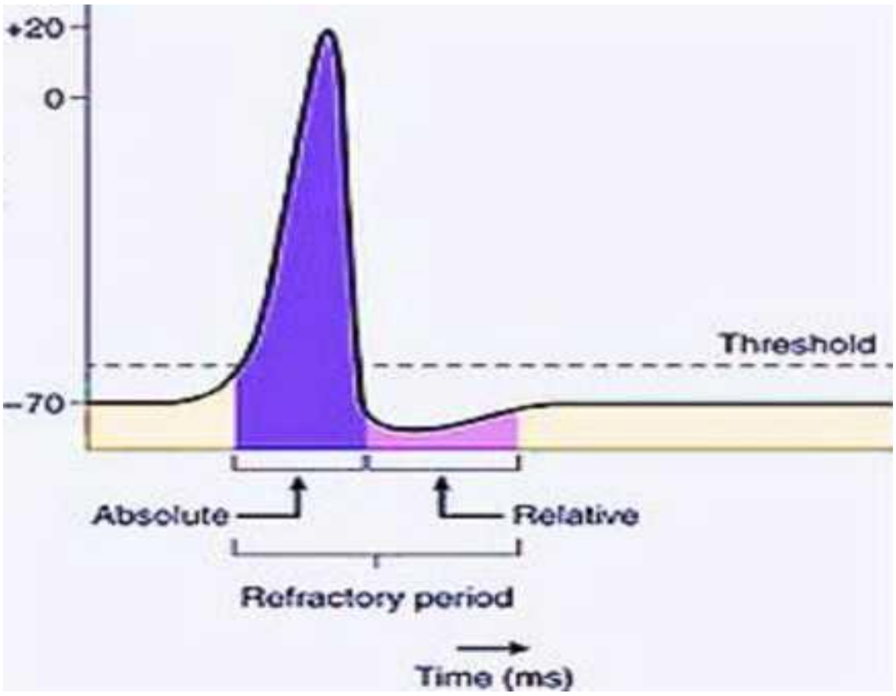
Nerve impulse characteristics are:

1. All or None Low:

Action potential producing depends on intensity of stimulus and duration of stimulation. All stimuli, which have threshod intensity and enough duration of stimulation, are success to produce action potential. But none, which its intensity is less than threshold, can produce action potential whatever its duration.

2. Refractory period:

During an action potential, the cell remains unresponsive to further stimuli. In absolute refractory period, from firing point to repolarization period no other action potential can be triggered, even by extremely strong stimuli, since Na+ channels in depolarized membranes cannot be activated. This is flowed by a relative refractory period during which only action potentials of smaller amplitudes and rates or rise can be generated, even by strong stimuli. The refractory period ends once the membrane potential returns to its resting value.



3. Impulse conduction:

The start of an action potential is accompanied by a brief influx of Na+ into the nerve fiber. The cell membrane that previously was inside negative now becomes positive, thus a longitudinal potential difference with respect to adjacent, still unstimulated nerve segments. This is followed by a passive electrotonic withdrawal of charge from the adjacent segment of the nerve fiber, causing its depolarization. If it exceeds threshold, another action potential is created in the adjacent segment dissipates.

4. **Velocity of conduction: The conduction velocity depends on:**

a. Myelination: the conduction velocity of such myelinated nerve fiber is much higher than that of unmyelinated nerve fibers.

b. Diameter: the conduction velocity increases with the diameter of nerve fiber.