PROPERTIES OF NERVE FIBERS

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- Excitability
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- **EXCITABILITY:**

Excitability is defined as the **physiochemical change** that occurs in a tissue when stimulus is applied. Stimulus is defined as an external agent, which produces excitability in the tissues.

Response Due to Stimulation of Nerve Fiber

When a nerve fiber is stimulated, based on the strength of stimulus, two types of response develop:

1. Action potential or nerve impulse
2. Electrotonic potential or local potential

1. Action potential or nerve impulse:

Action potential develops in a nerve fiber when it is stimulated by a stimulus with adequate strength. Adequate strength of stimulus, necessary for producing the action potential in a nerve fiber is known as **threshold or minimal stimulus. Action potential is propagated.**

2. Electrotonic potential or local potential:

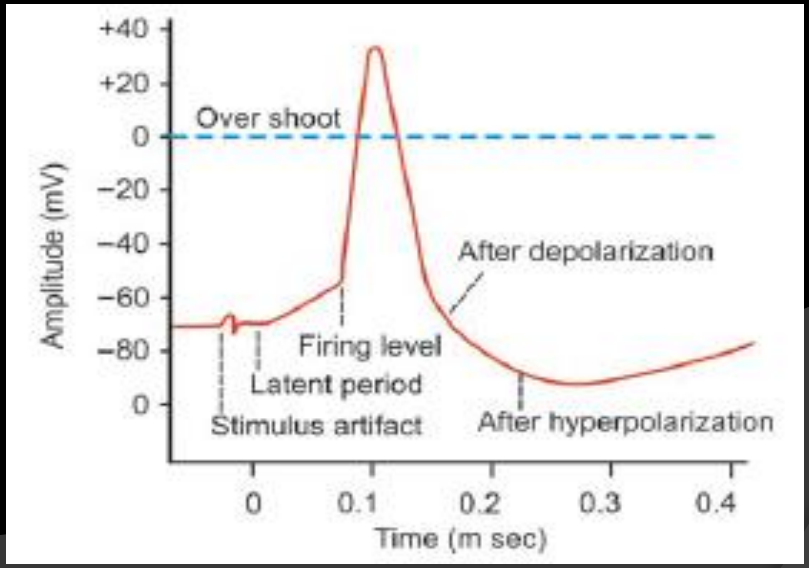
When the stimulus with **subliminal strength is applied,** only electrotonic potential develops and the action potential does not develop. Electrotonic potential is nonpropagated.

ACTION POTENTIAL OR NERVE IMPULSE

Action potential in a nerve fiber is similar to that in a muscle, except for some minor differences.

Resting membrane potential in the nerve fiber is –70 mV. The firing level is at –55 mV. Depolarization ends at +35 mV. Usually, the action potential starts in the initial segment of nerve fiber.

Event	Nerve fiber	Skeletal muscle fiber
Resting membrane potential	–70 mV	–90 mV
Firing level	–55 mV	–75 mV
End of depolarization	+35 mV	+55 mV



- **ELECTROTONIC POTENTIAL OR LOCAL POTENTIAL:**

Electrotonic potential or local potential is a non-propagated **local response that develops in the nerve fiber** when a subliminal stimulus is applied.

Subliminal or sub-threshold stimulus does not produce action potential. But, it alters the resting membrane potential and produces **slight depolarization for about 7 mV.**

This slight depolarized state is called electrotonic potential.

- **VOLTAGE CLAMPING**

The term 'voltage clamping' refers to an experimental method that uses electrodes to alter and control the membrane potential.

It is used to measure the ionic current across the membrane of nerve fiber by fixing the membrane potential at a desired voltage.

Equipment for Voltage Clamping

Voltage clamp equipment has three units:

1. Recording amplifier
2. Current generator
3. Feedback amplifier.

- **CONDUCTIVITY**

Conductivity is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas. Action potential is transmitted through the nerve fiber as nerve impulse.

Normally in the body, the action potential is transmitted through the nerve fiber in only one direction.

However, in experimental conditions when, the nerve is stimulated, the action potential travels through the nerve fiber in either direction.

- **MECHANISM OF CONDUCTION OF ACTION POTENTIAL:**

  Depolarization occurs first at the site of stimulation in the nerve fiber. It causes depolarization of the neighbouring areas. Like this, depolarization travels throughout the nerve fiber. Depolarization is followed by repolarisation.

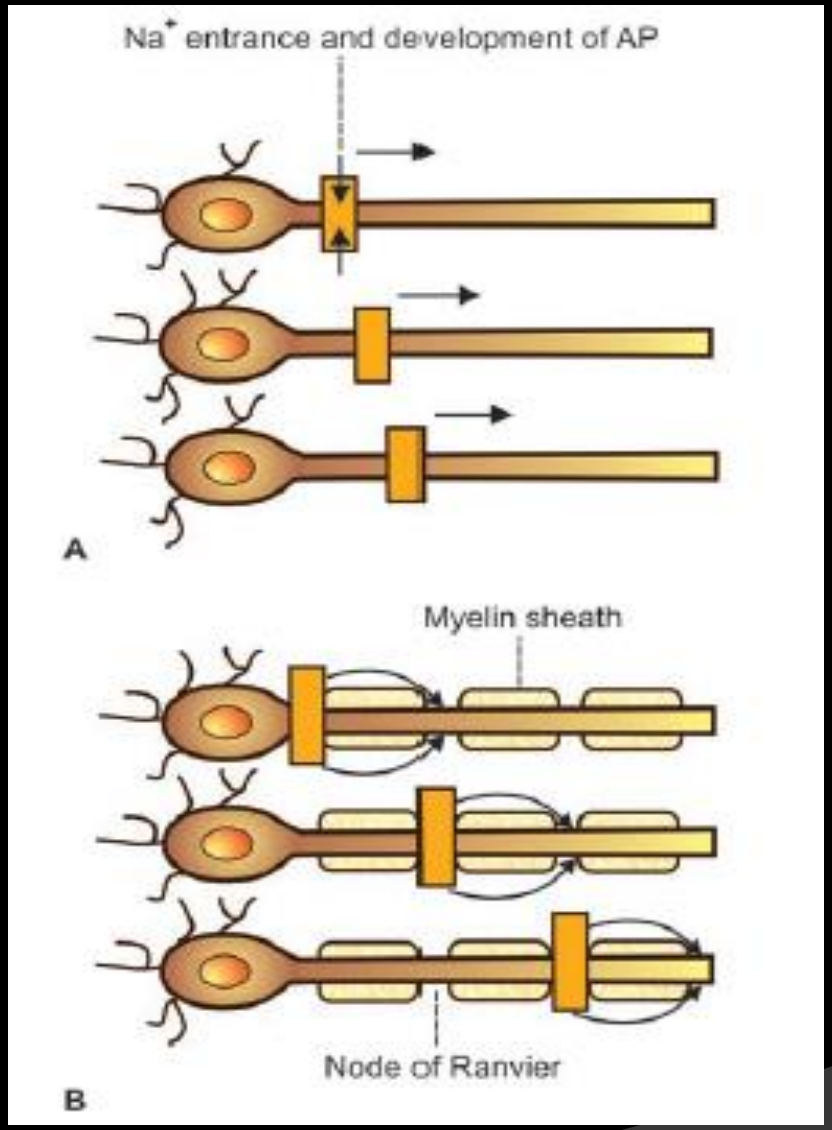
- **CONDUCTION THROUGH MYELINATED NERVE FIBER – SALTATORY CONDUCTION:**

Saltatory conduction is the form of conduction of nerve impulse in which, the impulse jumps from **one node to another. Conduction of impulse through a myelinated** nerve fiber is about 50 times faster than through a nonmyelinated fiber. It is because the action potential jumps from one node to another node of Ranvier instead of travelling through the entire nerve fiber

Mechanism of Saltatory Conduction

Myelin sheath is not permeable to ions. So, the entry of sodium from extracellular fluid into nerve fiber occurs only in the node of Ranvier, where the myelin sheath is absent. It causes depolarization in the node and not in the internode. Thus, depolarization occurs at successive nodes.

So, the action potential jumps from one node to another. Hence, it is called saltatory conduction (saltare = jumping).


Na+ entrance and development of AP
A
Myelin sheath
Node of Ranvier
B

REFRACTORY PERIOD

Refractory period is the period at which the nerve does not give any response to a stimulus.

- **TYPES OF REFRACTORY PERIOD**

Refractory period is of two types:

1. ***Absolute Refractory Period***

Absolute refractory period is the period during which the nerve does not show any response at all, whatever may be the strength of stimulus.

2. ***Relative Refractory Period***

It is the period, during which the nerve fiber shows response, if the strength of stimulus is increased to maximum.

- **SUMMATION**

When one subliminal stimulus is applied, it does not produce any response in the nerve fiber because, the subliminal stimulus is very weak.

However, if two or more subliminal stimuli are applied within a short interval of about 0.5 millisecond, the response is produced.

It is because the subliminal stimuli are summed up together to become strong enough to produce the response. This phenomenon is known as summation.

- **ADAPTATION**

While stimulating a nerve fiber continuously, the excitability of the nerve fiber is greater in the beginning. Later the response decreases slowly and finally the nerve fiber does not show any response at all. This phenomenon is known as adaptation or **accommodation.**

Cause for Adaptation

When a nerve fiber is stimulated continuously, depolarization occurs continuously. Continuous depolarization inactivates the sodium pump and increases the efflux of potassium ions.

- **INFATIGABILITY**

  Nerve fiber cannot be fatigued, even if it is stimulated continuously for a long time. The reason is that nerve fiber can conduct only one action potential at a time. At that time, it is completely refractory and does not conduct another action potential.

- **ALL-OR-NONE LAW**

  All-or-none law states that when a nerve is stimulated by a stimulus it gives maximum response or does not give response at all.