PHYSIOLOGY

Q3 – Action Potential in a Nerve

Ans : 1 – Answer

Introduction

Action potential is a rapid electrical event that occurs in nerve fibers and forms the basis of nerve impulse transmission. It enables communication between different parts of the body by allowing signals to travel along nerves with high speed and fidelity.

Definition

An action potential is defined as a rapid, transient, and reversible change in the membrane potential of a nerve fiber that occurs when the membrane is depolarized beyond its threshold level.

Resting Membrane Potential

At rest, a nerve fiber maintains a resting membrane potential of approximately –70 mV. This potential difference is maintained due to unequal distribution of sodium and potassium ions across the membrane, selective membrane permeability, and the activity of the sodium–potassium pump.

Phases of Action Potential

The action potential consists of depolarization, repolarization, and hyperpolarization phases. Depolarization occurs due to opening of voltage-gated sodium channels and rapid influx of sodium ions. Repolarization follows with closure of sodium channels and opening of potassium channels, leading to efflux of potassium ions. Hyperpolarization occurs due to delayed closure of potassium channels.

Threshold Potential and All-or-None Law

Threshold potential is the minimum level of depolarization required to initiate an action potential, usually around –55 mV. Action potential follows the all-or-none law, meaning that once threshold is reached, a full-sized action potential occurs regardless of stimulus strength.

Refractory Period

The refractory period consists of an absolute refractory period, during which no new action potential can be generated, and a relative refractory period, during which a stronger stimulus is required. This ensures unidirectional propagation of impulses and limits the frequency of nerve firing.

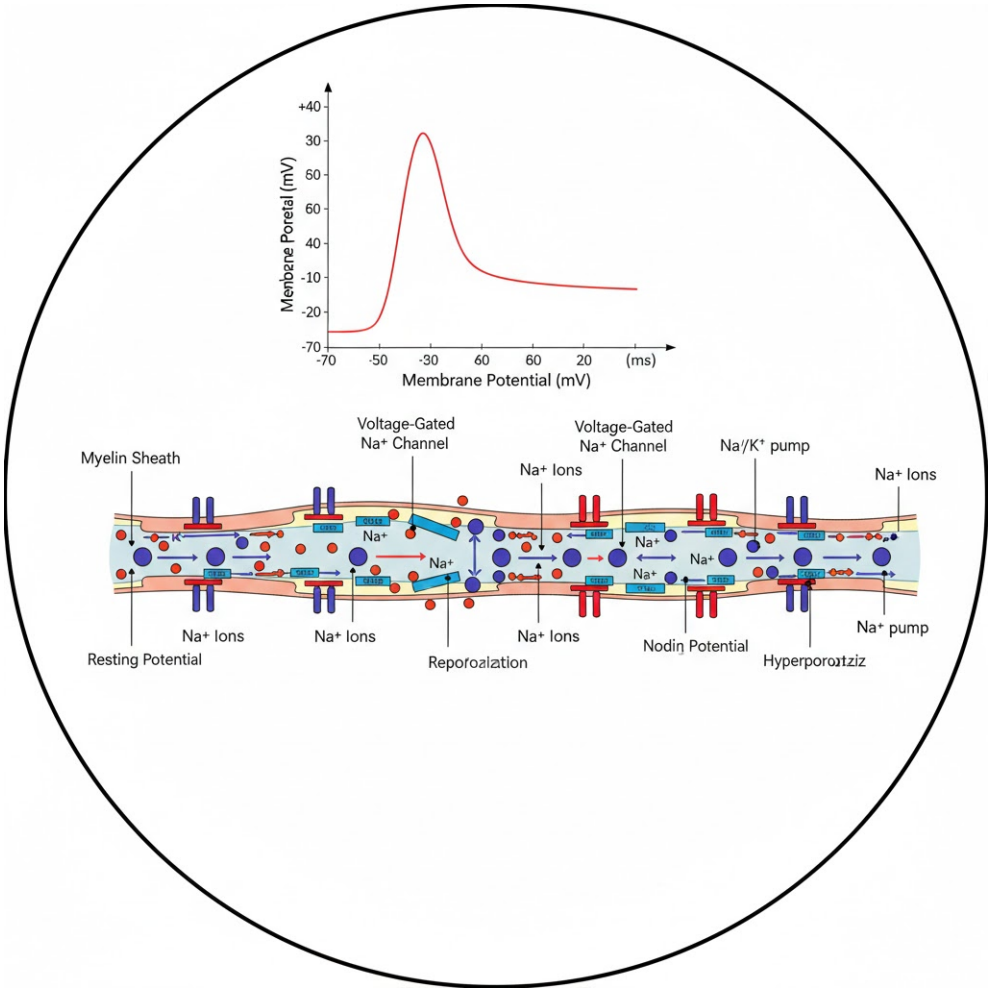
Propagation of Action Potential

In non-myelinated nerve fibers, action potential propagates by continuous conduction. In myelinated fibers, saltatory conduction occurs, where impulses jump from one node of Ranvier to another, greatly increasing conduction velocity.

Clinical Importance

Local anesthetics block voltage-gated sodium channels, preventing generation of action potentials and resulting in loss of sensation. Demyelinating diseases reduce conduction velocity, while electrolyte imbalances affect nerve excitability.

Diagram – Action Potential in a Nerve



Conclusion

Action potential is the fundamental mechanism by which nerve impulses are generated and conducted along nerve fibers. Its precise ionic basis and regulated propagation ensure efficient communication within the nervous system, which is essential for normal sensory, motor, and integrative functions.