SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF BIOMEDICAL ENGINEERING

19BMB302 - BIOMEDICAL SIGNAL PROCESSING

III YEAR/ V SEMESTER

Unit IV : BIOSIGNALS AND THEIR CHARACTERISTICS

- Source of Bioelectric potential
- Resting and action potential
- Propagation of action potentials in nerves
- Characteristics of biomedical signals
- The ECG-Cardiac electrophysiology
- Relation of ECG components to cardiac events
- Clinical applications

Propagation of action potentials in nerves

- The human central nervous system (CNS) contains about 100 billion neurons.
- 40% of the human genes participate, at least to a degree, in its formation.

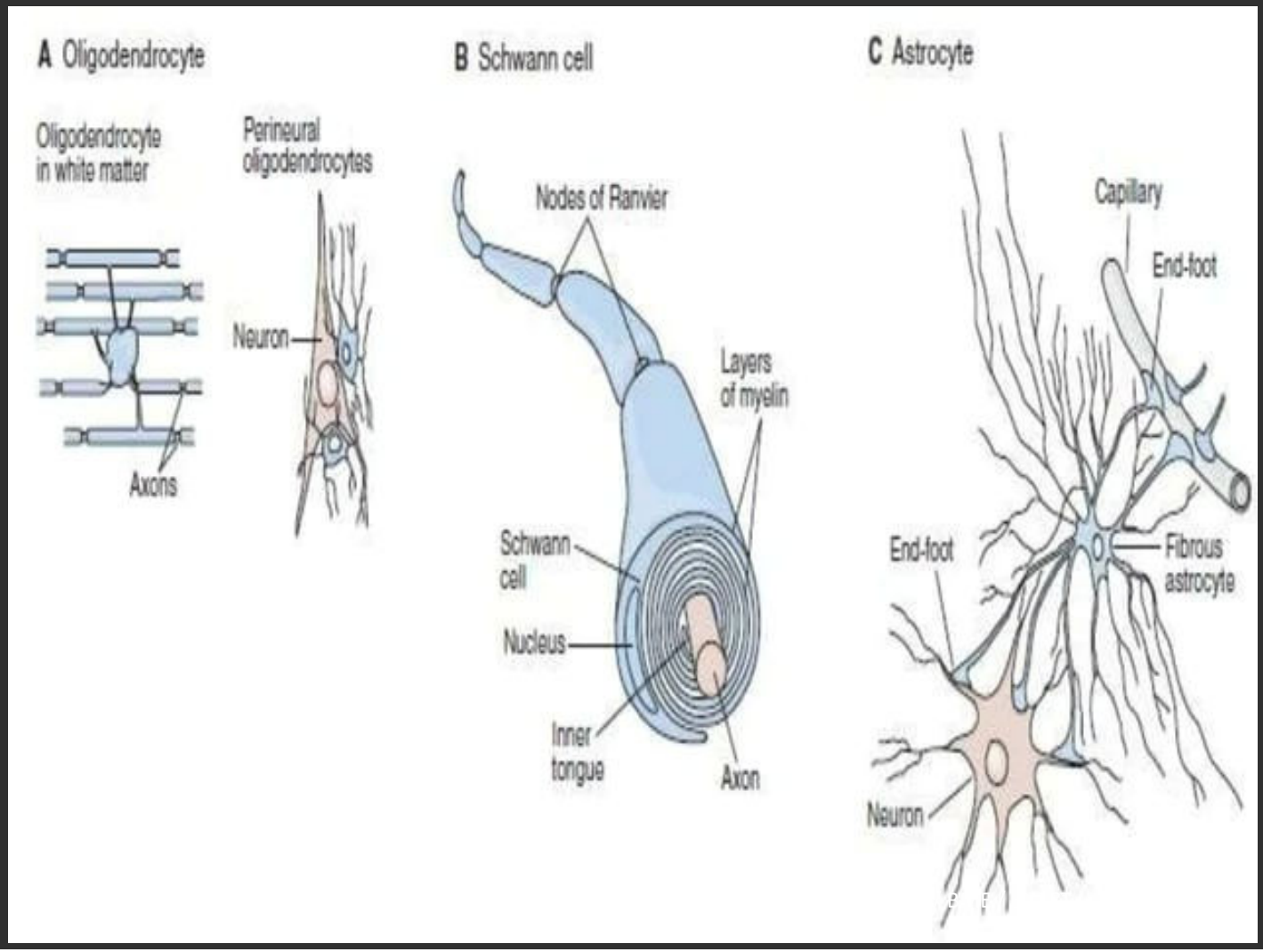
CELLULAR ELEMENTS IN THE CNS

- **GLIAL CELLS**
- the word *glia is* Greek for *glue.*
- *Theses cells are recognized for* their role in communication within the CNS in partnership with neurons.
- Unlike neurons, glial cells continue to undergo cell division in adulthood and their ability to proliferate is particularly noticeable after brain injury (eg, stroke).

- two major types of glial cells in the vertebrate nervous system:
- **microglia and macroglia**
- Microglia are scavenger cells that resemble tissue macrophages and remove debris resulting from injury, infection, and disease.

- three types of macroglia:
- **oligodendrocytes,**
- **Schwann cells,**
- **astrocytes .**
- **Oligodendrocytes** and **Schwann cells are involved in myelin formation around** axons in the CNS and peripheral nervous system, respectively.

- Astrocytes, which are found throughout the brain, are of two subtypes.
- **Fibrous astrocytes, which contain many** intermediate filaments, are found primarily in white matter.
- **Protoplasmic astrocytes are found in gray matter and have a** granular cytoplasm.
- Both types send processes to blood vessels, where they induce capillaries to form the tight junctions making up the **blood–brain barrier.**


A Oligodendrocyte
Oligodendrocyte in white matter
Perineural oligodendrocytes
Neuron
Axons
B Schwann cell
Nodes of Ranvier
Layers of myelin
Schwann cell
Nucleus
Inner tongue
Axon
C Astrocyte
Capillary
End-foot
End-foot
Fibrous astrocyte
Neuron

EXCITATION & CONDUCTION

- Nerve cells respond to electrical, chemical, or mechanical stimuli.
- Two types of physicochemical disturbances are produced:

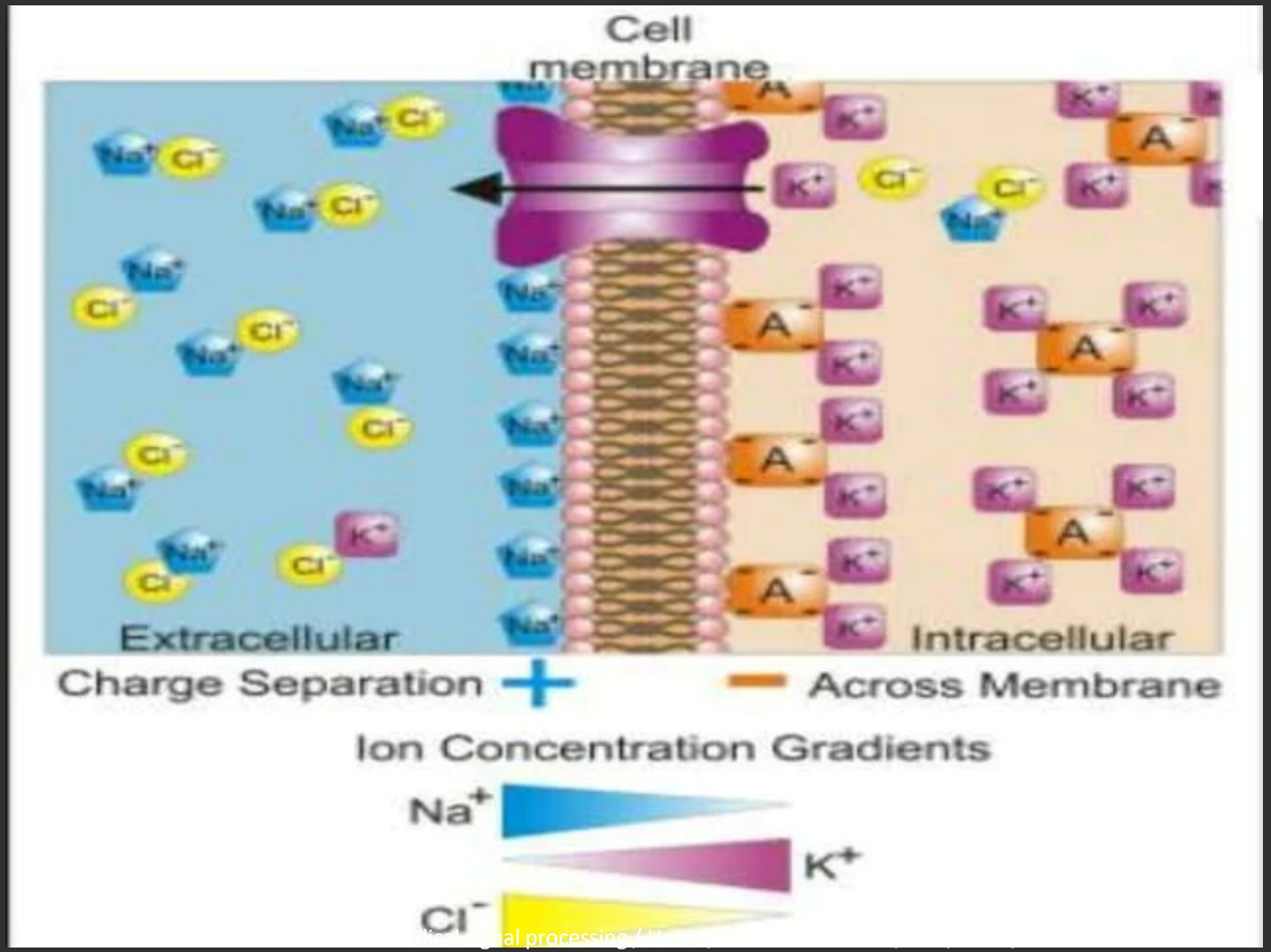
- local, nonpropagated potentials called, depending on their location, **synaptic, generator, or electrotonic potentials;**

- **Propagated** potentials, the **action potentials (or nerve impulses).**

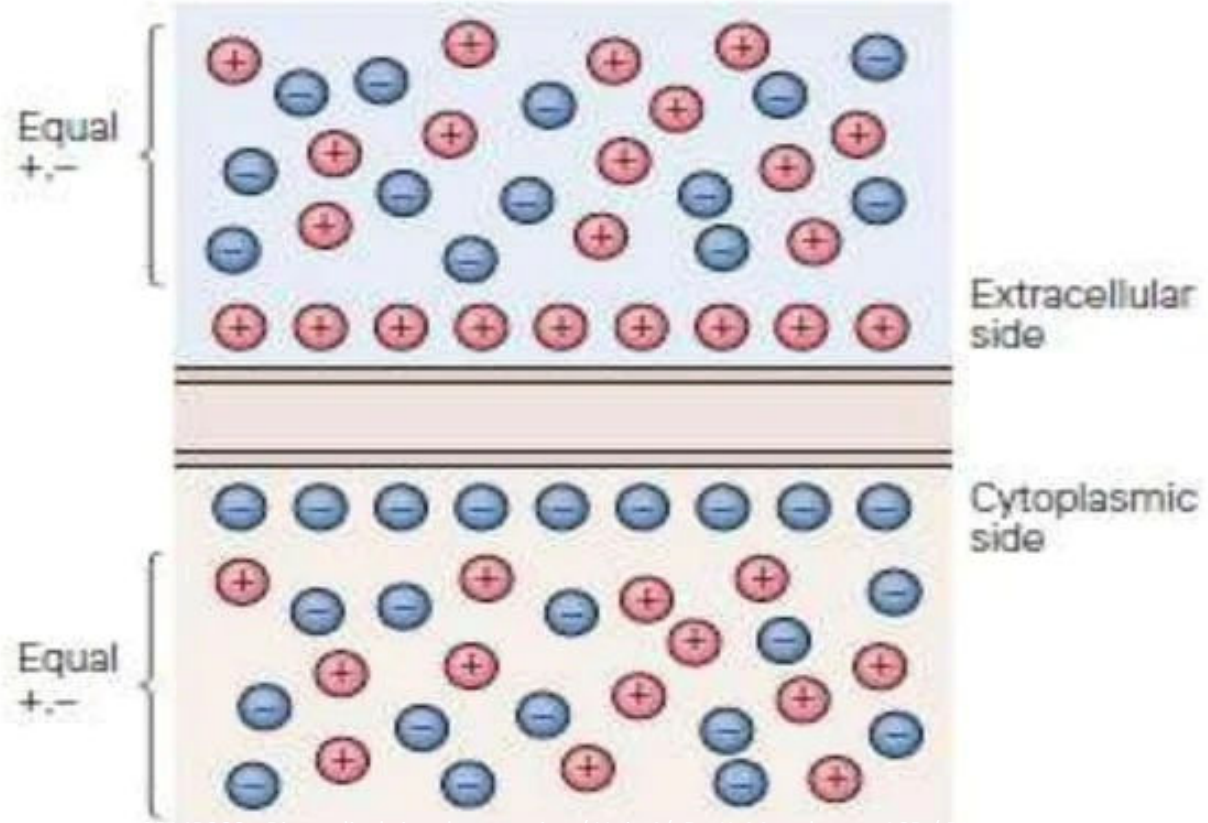
RESTING MEMBRANE POTENTIAL

- **Resting Membrane Potential** (RMP) is the voltage (charge) difference across the cell **membrane** when the cell is at **rest**.
- In neurons, the **resting membrane potential is usually** about –70 mV, which is close to the equilibrium potential for K+.
- **Because there are more open K+** channels than Na + channels at rest, the membrane permeability to K+ is greater.

- The resting membrane potential represents an equilibrium situation at which the driving force for the membrane-permeant ions down their concentration gradients across the membrane is equal and opposite to the driving force for these ions down their electrical gradients.


Cell membrane
Extracellular
Intracellular
Charge Separation
Across Membrane
Ion Concentration Gradients
Na+
K+
Cl-

A membrane potential results from separation of positive and negative charges across the cell membrane.



Action Potential

- A momentary change in electrical potential associated with the passage of an impulse along the membrane of a muscle cell or nerve cell.
- An **Action potential** is the neurons way of transporting electrical signals from one cell to the next.

- Action potentials are the primary electrical responses of neurons and other excitable tissues, and they are the main form of communication within the nervous system.
- They are due to changes in the conduction of ions across the cell membrane.
- The electrical events in neurons are rapid, being measured in **milliseconds (ms) ; and the potential changes are small, being** measured in **millivolts (mV).**

How an action potential is generated?

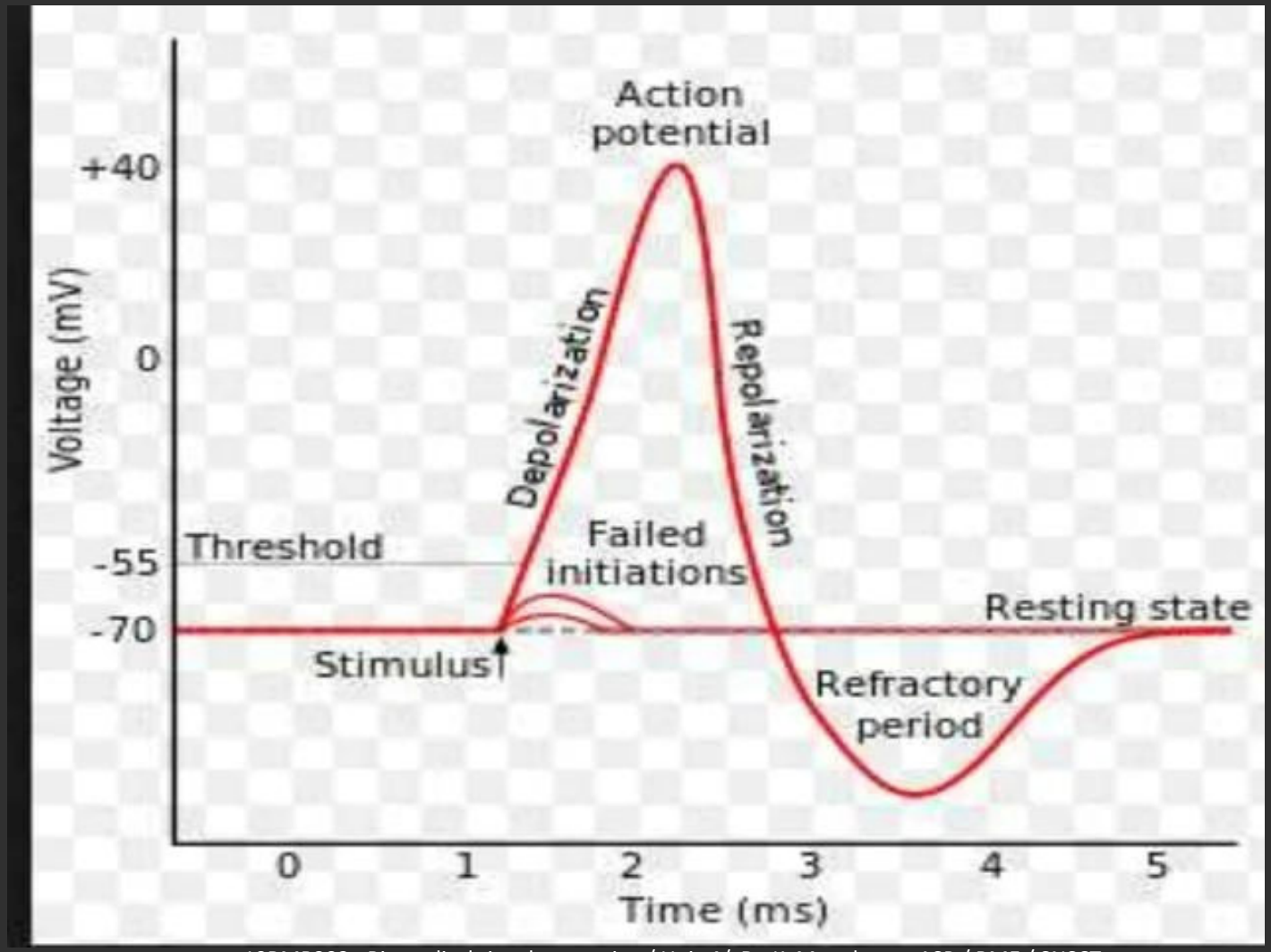
- A neuron that emits an **action potential** is often said to "fire".
- **Action** potentials are **generated** by special types of voltage-gated ion channels embedded in a cell's plasma membrane. ..
- The rapid influx of sodium ions causes the polarity of the plasma membrane to reverse, and the ion channels then rapidly inactivate.
- Thus, the sodium channel activation moves in a wave-like fashion: .

How an action potential is propagated?

- The **action potential** is **propagated** down the length of the neuron, from its input source at the dendrites, to the cell body, and then down the axon to the synaptic terminals

How does a stimulus trigger an action potential?

- The **stimulus triggers an action potential** in the cell membrane of the nerve cell, and that **action potential** provides the **stimulus** for a neighboring segment of the cell membrane.


Action potential
+40
0
-55
-70
Voltage (mV)
Depolarization
Repolarization
Threshold
Failed initiations
Resting state
Stimulus
Refractory period
0
1
2
3
4
5
Time (ms)