SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 35.

DEPARTMENT OF BIOMEDICAL ENGINEERING

UNIT 4

BRAIN AND THE NEURON

: Figure 1 depicts the major components of a typical nerve cell in the central nervous system. The membrane of neuron separates the intracellular plasma from the interstitial fluid external to the cell. The membrane is permeable to certain ionic species, and acts to maintain a potential difference between the intracellular fluid and the extracellular fluid. It accomplishes this task primarily by the action of a sodium-potassium pump. This mechanism transports sodium ions out of the cell and potassium ions into the cell. Other ionic species present are chloride ions and negative organic ions.

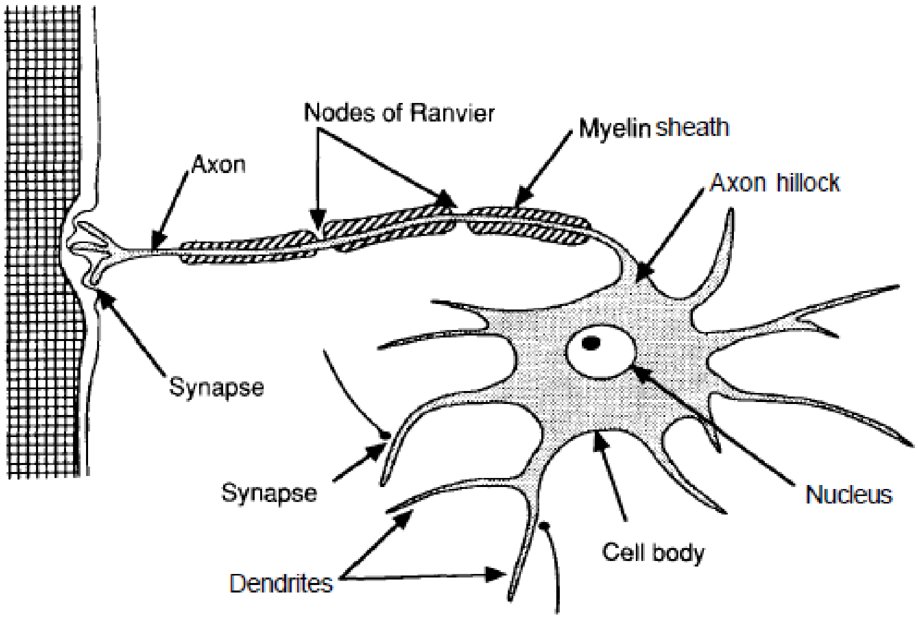

Figure 1 The major structures of a typical nerve cell include dendrites, the cell body, and a single axon. The axon of many neurons is surrounded by a membrane called the myelin sheath. Nodes of Ranvier interrupt the myelin sheath periodically along the length of the axon. Synapses connect the axons of one neuron to various parts of other neurons.

All the ionic species can diffuse across the cell membrane, with the exception of the organic ions, which are too large. Since the organic ions cannot diffuse out of the cell, their net negative charge makes chloride diffusion into the cell unfavorable; thus, there will be a higher concentration of chloride ions outside of the cell. The sodium-potassium pump forces a higher concentration of potassium inside the cell and a higher concentration of sodium outside the cell.

The cell membrane is selectively more permeable to potassium ions than to sodium ions. The chemical gradient of potassium tends to cause potassium ions to diffuse out of the cell, but the strong attraction of the negative organic ions tends to keep the potassium inside. The result of these opposing forces is that an equilibrium is reached where there are significantly more sodium and chloride ions outside the cell, and more potassium and organic ions inside the cell. Moreover, the resulting equilibrium leaves a potential difference across the cell membrane of about 70 to 100 millivolts (mV), with the intracellular fluid being more negative. This potential, called the **resting potential** of the cell, is depicted schematically in Figure 2.

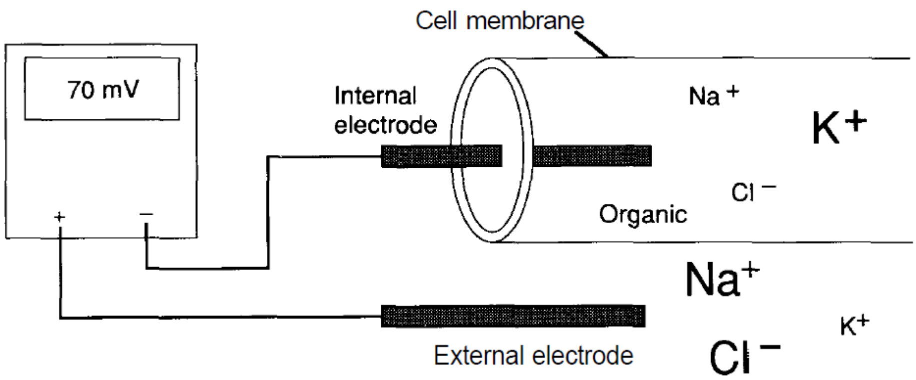

Figure 2 This figure illustrates the resting potential developed across the cell membrane of a neuron. The relative sizes of the labels for the ionic species indicate roughly the relative concentration of each species in the regions internal and external to the cell.

Figure 3 illustrates a neuron with several incoming connections, and the potentials that occur at various locations. The figure shows the axon with a covering called a **myelin sheath.** This insulating layer is interrupted at various points by the **nodes of Ranvier.**

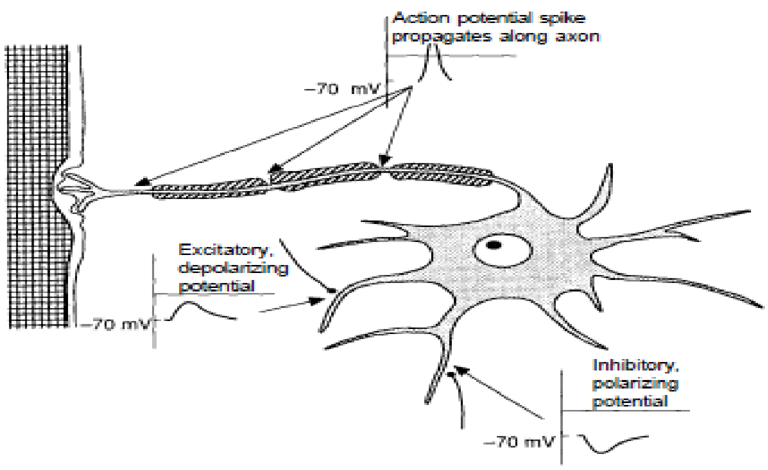

Figure 3 Connections to the neuron from other neurons occur at various locations on the cell that are known as synapses. Nerve impulses through these connecting neurons can result in local changes in the potential in the cell body of the receiving neuron. These potentials, called graded potentials or input potentials, can spread through the main body of the cell. They can be either excitatory (decreasing the polarization of the cell or inhibitory (increasing the polarization of the cell). The input potentials are summed at the axon hillock. If the amount of depolarization at the axon hillock is sufficient, an action potential is generated; it travels down the axon away from the main cell body.

Excitatory inputs to the cell reduce the potential difference across the cell membrane. The resulting depolarization at the **axon hillock** alters the permeability of the cell membrane to sodium ions. As a result, there is a large influx of positive sodium ions into the cell, contributing further to the depolarization. This self-generating effect results in the **action potential.**

Nerve fibers themselves are poor conductors. The transmission of the action potential down the axon is a result of a sequence of depolarizations that occur at the nodes of Ranvier. As one node depolarizes, it triggers the depolarization of the next node. The action potential travels down the fiber in a discontinuous fashion, from node to node. Once an action potential has passed a given point, that point is incapable of being reexcited for about 1 millisecond, while it is restored to its resting potential. This **refractory period** limits the frequency of nerve-pulse transmission to about 1000 per second.