Medical Physics

Electricity within the body

Lecture Seven

Nervous System & the Neuron:-

Nervous system can be divided into two parts.

1. Central nervous system: consist of brain, spinal cord and the peripheral nerves.

Nerve fibers (neuron): that transmit sensory information to brain or spinal cord are **"afferent nerves".**

Nerve fibers: that transmit information from brain or spinal Cord to the appropriate muscles and glands are **"efferent nerves".**

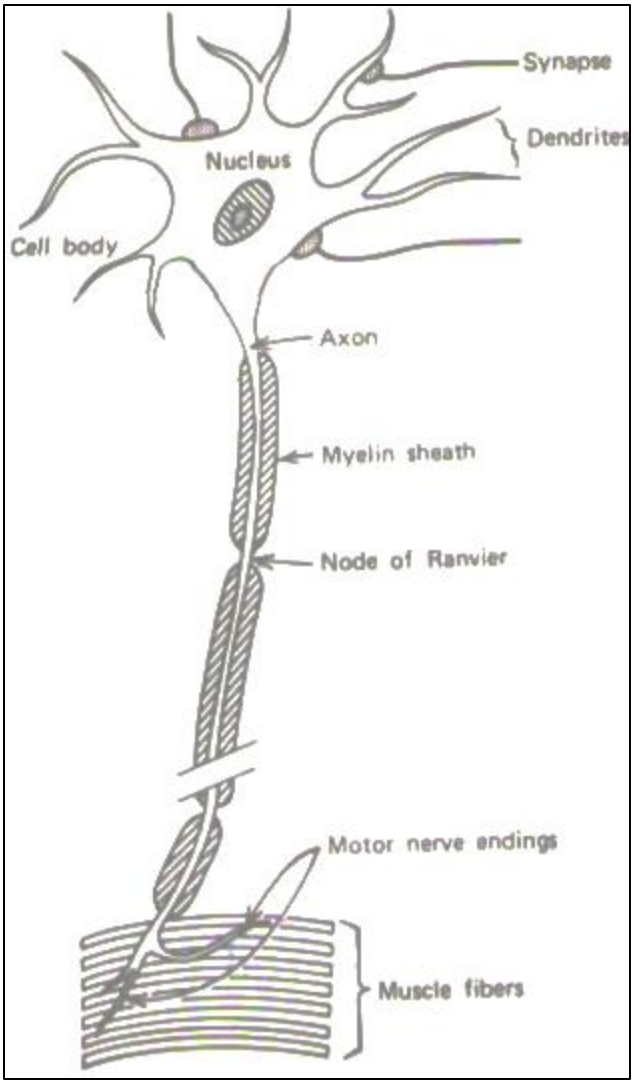
2. **Autonomic nervous system**: controls various internal organs such as heart, intestines and glands ((the control here is essentially involuntary)).

Neuron: is the basic structure unit of nervous system, which is specialized for reception and transmission of electrical signals.

Contents of neuron (nerve cell)

1. **Cell body:** receives electrical massages from other neurons through contacts called "synapses", which are located on the "dendrites". **Dendrites**: are the part of the neuron specialized for receiving information from other cells, or stimulus.

2. **Axon**: (or nerve fibers) this carries the electrical signal to muscles, glands, or other neurons.



Electrical Potentials of Nerves

Across the surface or membrane of every neuron is an electrical potential (voltage) difference due to the presence of more “negative ions" on the inside of the membrane than the outside.

A polarization neuron is mostly inside negative than the outside, 60 to 90 mV it has polarized. This potential difference is called "Resting potential "of the neuron.

When the neuron is simulated, a momentary charge will happen from positive to negative; this potential change is called "Action potential".

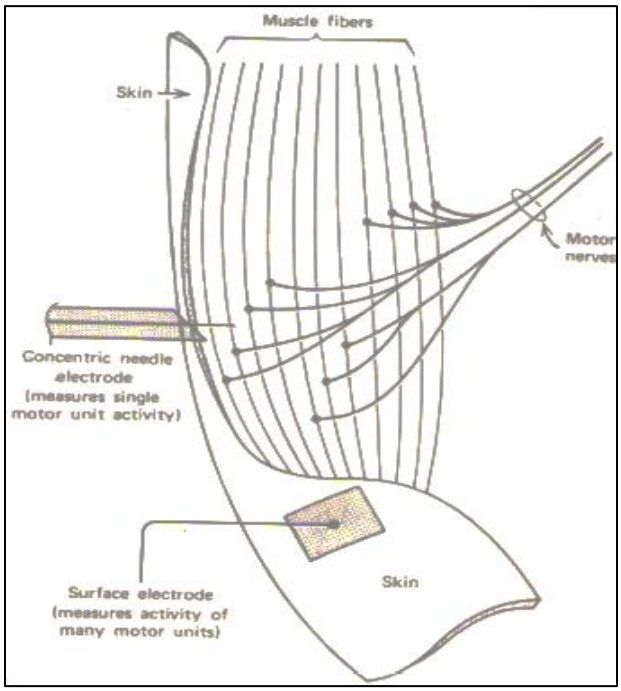
Electrical Signals from Muscles - EMG

The record of potentials from muscles during movement is called EMG (electromyogram).

EMG Electrodes:-

1. Surface electrode attached to the skin measures the electrical signals from many motor units.

2. Concentric needle electrode inserted under the skin measures single motor unit activity.



Action potential of EMG

Action potential appears in EMG after a latency period **(time between stimulation and the beginning of the response)**

EMGs of symmetrical muscles of the body are compared to each other, or to those of normal individuals to determine the action potential and latency periods.

The conduction velocity for sensory nerves can be measured by simulating of one site and recording at several locations that are known distance from the point of stimulation. Many times nerve damage may results in decreased in conduction velocity.

Typical velocities are 40 to 60 m/sec. velocity slow 10 m/sec would indicate a problem.

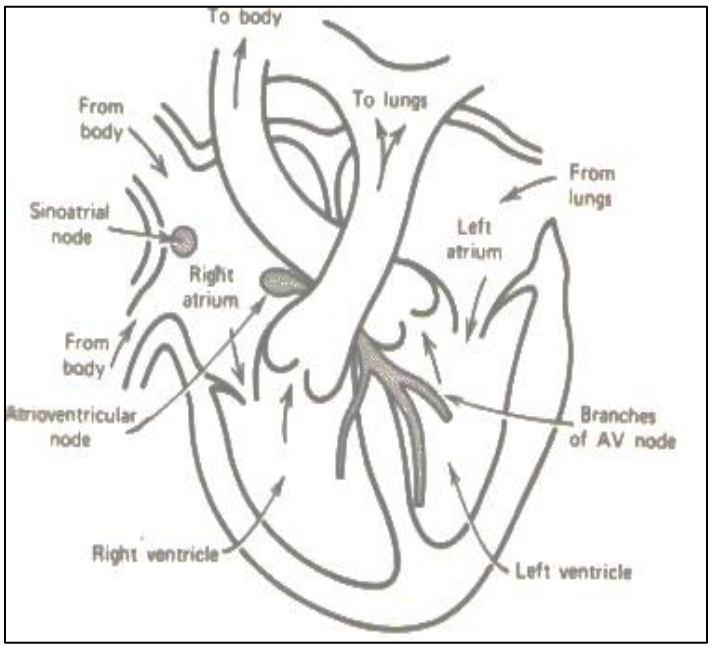
Electrical Signal from the heart - ECG

The action of the heart is controlled by an electrical signal initiated by "Sinoatrial (SA) Node" which is spontaneous stimulation of special muscle cells located in the right atrium.

SA node controls the pulse rate (72 pulse per min); it decreases or increases the pulse rate according to the demands of body to the blood.

The electrical signal from SA node initiate depolarization of nerves and muscles of both atria, causing the atria to contract and pump blood into ventricles. Repolarization of atria follows:

Electrical signal passes into the atrioventricular (AV) Node, which initiates depolarization of right and left ventricle, causing them contract and force blood into the two systems (pulmonary and general circulation), then ventricles are repolarize and so forth.



Measuring ECG:-

Surface electrodes for obtaining ECG are most commonly located in left arm (LA), right arm (RA) and left leg (LL).

ECG graphing contains 12 section:-

(6) of them are in the frontal plane

Other (6) are in the transverse plane in each section an electrode is located.

ECG Leads (Electrodes)

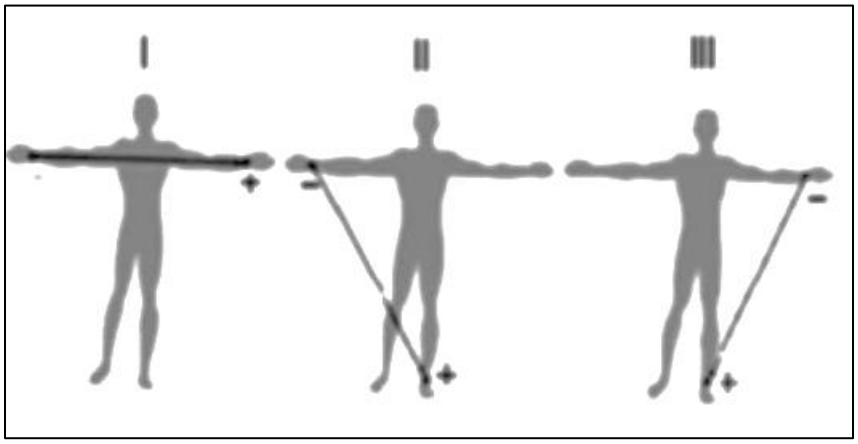
To measure the electric activity of the heart in the frontal plane, the limb leads and augmented lead should be used:

Limb leads:

1. Lead I : measure the potential between RA and LA

2. Lead II : measure the potential between RA and LL

3. Lead III : measure the potential between LA and LL

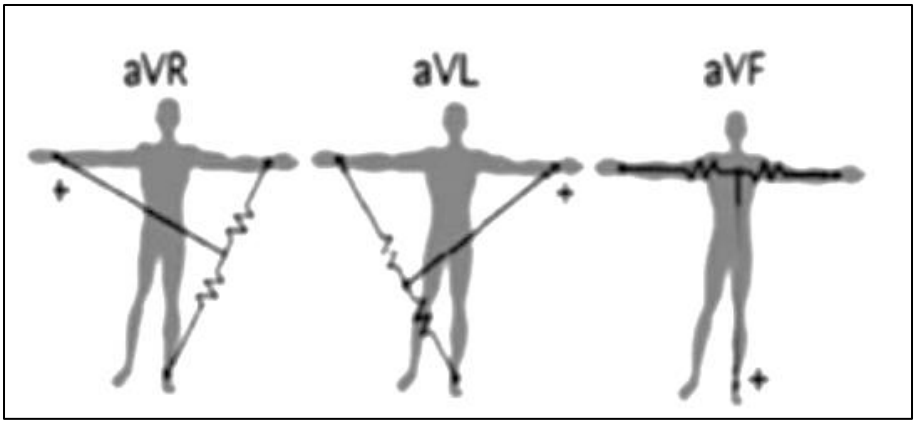


Augmented lead:

1. aV_R lead: (RA – center of LL and LA)

2. aV_L lead: (LA – center of RA and LL)

3. aV_F lead: (LL – center of RA and LA)

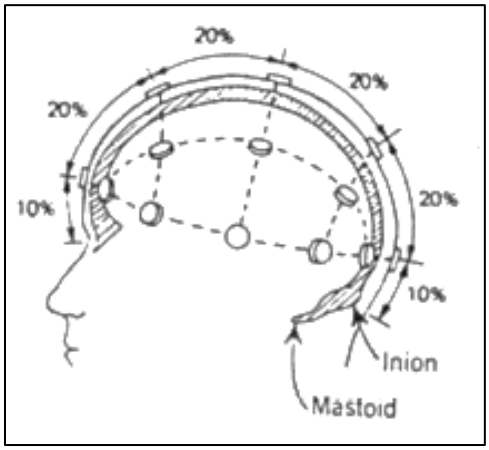


Electrical Signals from the Brain - EEG

The recording of the signals from the brain is called electroencephalogram or (EEG), which are due to primarily to the electrical activity of the neurons in the cortex of the brain.

Electrode are small discs made of AgCl, these are attached to the head at locations that depend upon the part of brain to be studied.

These electrodes out on the head at some areas, we record only the potential difference response to that area.



Asymmetrical activity is often an indication of brain disease the right signals compared to the left one.

The external noise is controlled, the potentials of muscle activity, such as eye movement, can cause artifacts in the record.

The frequencies of EEG signals are depend on the metal activity of the subject .e.g. relaxed person frequency is from 8 to 13 Hz (α wave), while frequency of person in action is > 13 Hz (β wave), Delta δ or slow 0.5 to 3.5 Hz, Theta θ or intermediate 4 to 7 Hz.