

# **Biosignals recording system**

- Electrical biosignals, or bioelectrical time signals, usually refers to the change in electric current produced by the sum of an electrical potential difference across a specialized tissue, organ or cell system like the nervous system. Thus, among the best-known bioelectrical signals are:
  - Electroencephalogram (EEG)
  - Electrocardiogram (ECG)
  - Electromyogram (EMG)
  - Mechanomyogram (MMG)
  - Electrooculogram (EOG)
  - Galvanic skin response (GSR)
  - Magnetoencephalogram (MEG)

## Biosignals

- An electroencephalogram (EEG) is a test used to evaluate the electrical activity in the brain. Brain cells communicate with each other through electrical impulses. An EEG can be used to help detect potential problems associated with this activity.
- An EEG tracks and records brain wave patterns. Small flat metal discs called electrodes are attached to the scalp with wires.
- The electrodes analyze the electrical impulses in the brain and send signals to a computer that records the results.

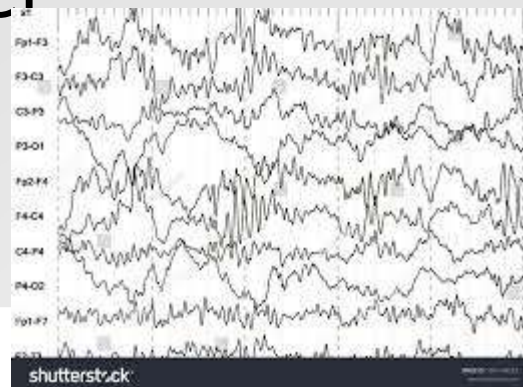


During an EEG, electrodes are placed on your child's scalp so the electrical activity of the brain can be recorded.

## Electroencephalogram (EEG)

# The EEG measurement including:

- Seizure disorders (such as epilepsy)
- Head injury
- Encephalitis (inflammation of the brain)
- Brain tumor
- Encephalopathy (disease that causes brain dysfunction)
- Memory problems
- Sleep disorder
- Stroke
- Dementia

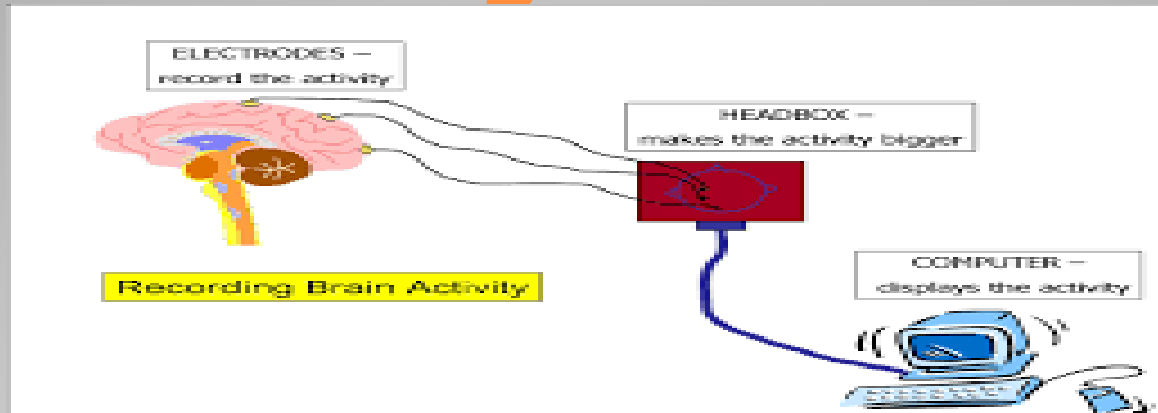


Before the test, you should take the following steps:

- Wash your hair the night before the EEG, and don't put any products (like sprays or gels) in your hair on the day of the test.
- Ask your doctor if you should stop taking any medications before the test. You should also make a list of your medications and give it to the technician performing the EEG.
- Avoid eating or drinking anything containing caffeine for at least eight hours before the test.
- Your doctor may ask you to sleep as little as possible the night before the test if you have to sleep during the EEG. You may also be given a sedative to help you relax and sleep before the test begins.
- After the EEG is over, you can continue with your regular routine

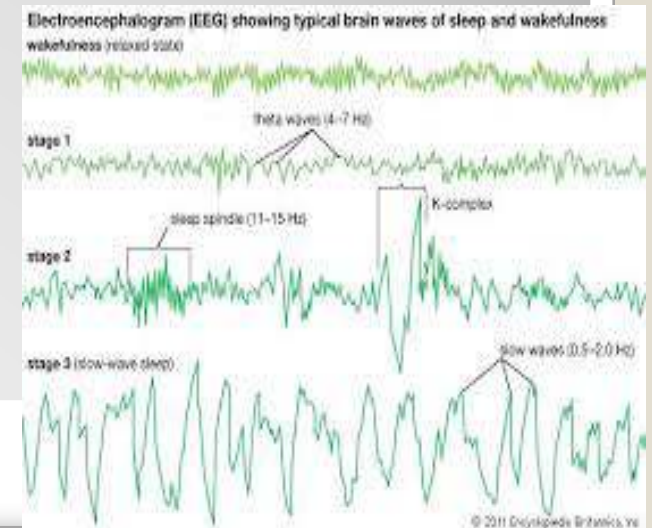
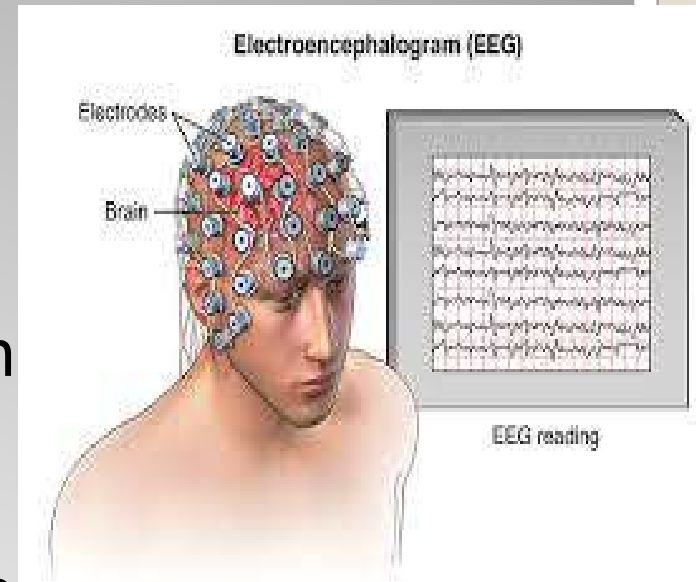
## EEG recording preparation

# EEG recording

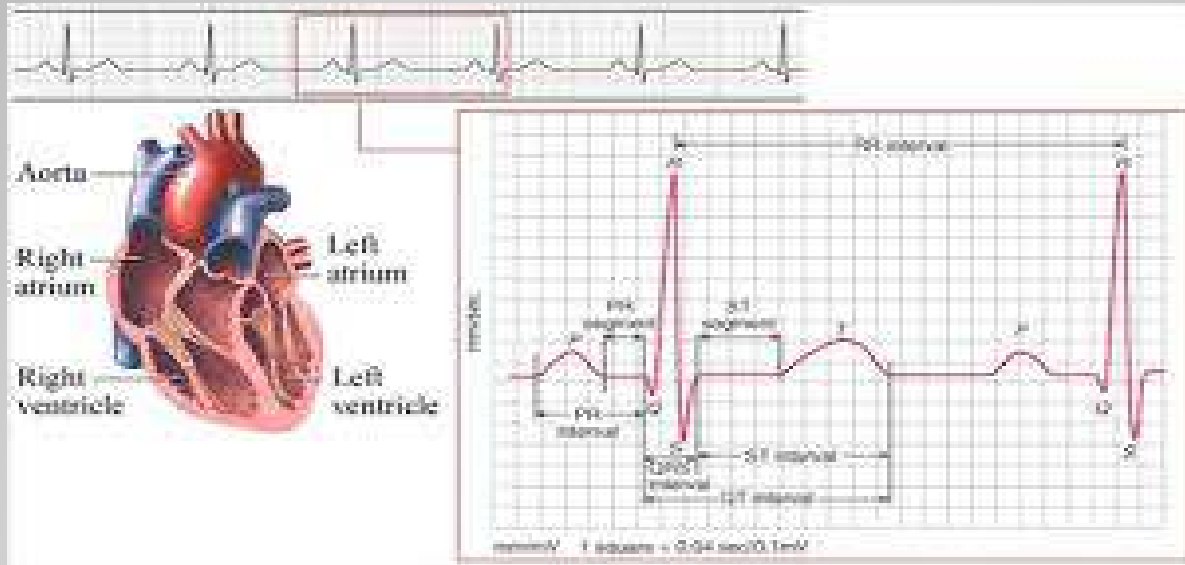


- An EEG measures the electrical impulses in your brain by using several electrodes that are attached to your scalp. The electrodes transfer information from your brain to a machine that measures and records the data.
- The test usually takes 30 to 60 minutes to complete.
- You'll lie down on your back in a reclining chair or on a bed.
- The technician will measure your head and mark where to place the electrodes. These spots are scrubbed with a special cream that helps the electrodes get a high-quality reading.
- The technician will put a sticky gel adhesive on 16 to 25 electrodes, and attach them to spots on your scalp.

- Once the test begins, the electrodes send electrical impulse data from your brain to the recording machine. This machine converts the electrical impulses into visual patterns that appear on a screen. A computer saves these patterns.
- The technician may instruct you to do certain things while the test is in progress. They may ask you to lie still, close your eyes, breathe deeply, or look at stimuli (such as a flashing light or a picture).
- After the test is complete, the technician will remove the electrodes from your scalp.



- Electrocardiography (**ECG** or EKG) is the process of recording the electrical activity of the heart over a period of time using electrodes placed over the skin.



## Electrocardiogram (ECG)



# Basic structure of the heart.

Event	Characteristics	Duration at 75 bpm (0.8 second cycle)
<b>Atrial diastole</b> <b>Ventricular diastole</b>	<b>AV valves opened.</b> <b>Semilunar valves close.</b> <b>Ventricular filling.</b>	<b>0.4 seconds</b>
<b>Atrial systole</b> <b>Ventricular diastole</b>	<b>AV valves open.</b> <b>Semilunar valves closed.</b> <b>Ventricular filling.</b>	<b>0.1 seconds</b>
<b>Atrial diastole</b> <b>Ventricular systole</b>	<b>AV valves closed.</b> <b>Semilunar valves open.</b> <b>Blood pumped into aorta and pulmonary artery.</b>	<b>0.3 seconds</b>

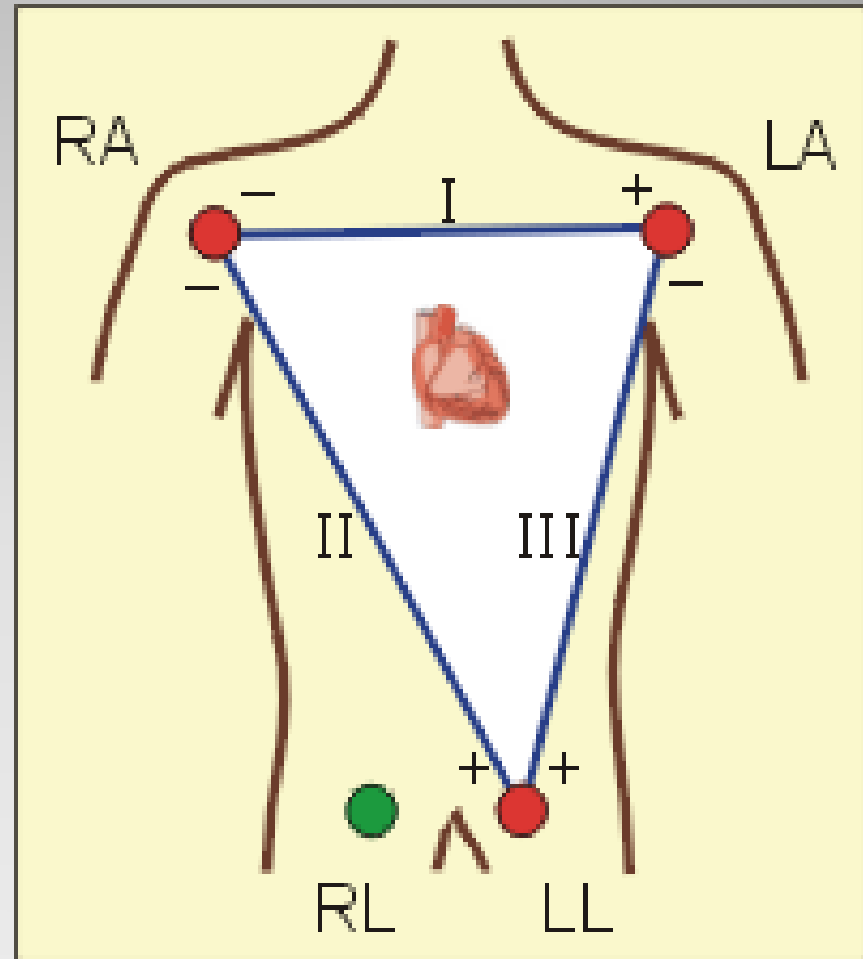
Duration and characteristics of each major event in the cardiac cycle.

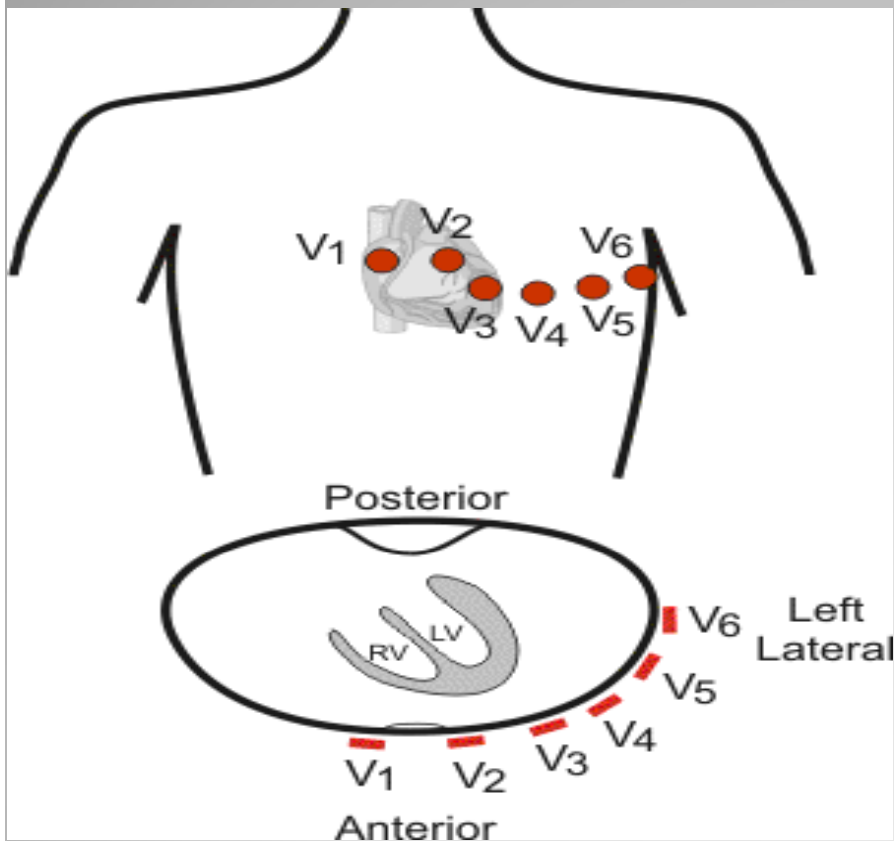
- Heart attack within the last 5 days
- Heart muscle inflammation
- Acute lung embolism
- Acute coronary syndrome
- Severely elevated blood pressure
- Certain ventricular arrhythmias
- Severe angina pectoris (chest tightness)
- Narrowing of the aorta

**ECG measurement not includes**

- Standard limb leads (bipolar leads).
  - Record potential difference between two electrodes.
  - Lead I (+ive electrode left arm and -ive on right arm).
  - Lead II (+ive electrode left leg and -ive on right arm)
  - Lead III (+ive electrode on left leg and -ive on left arm).
  - Einthoven Triangle - equilateral triangle with heart at centre.

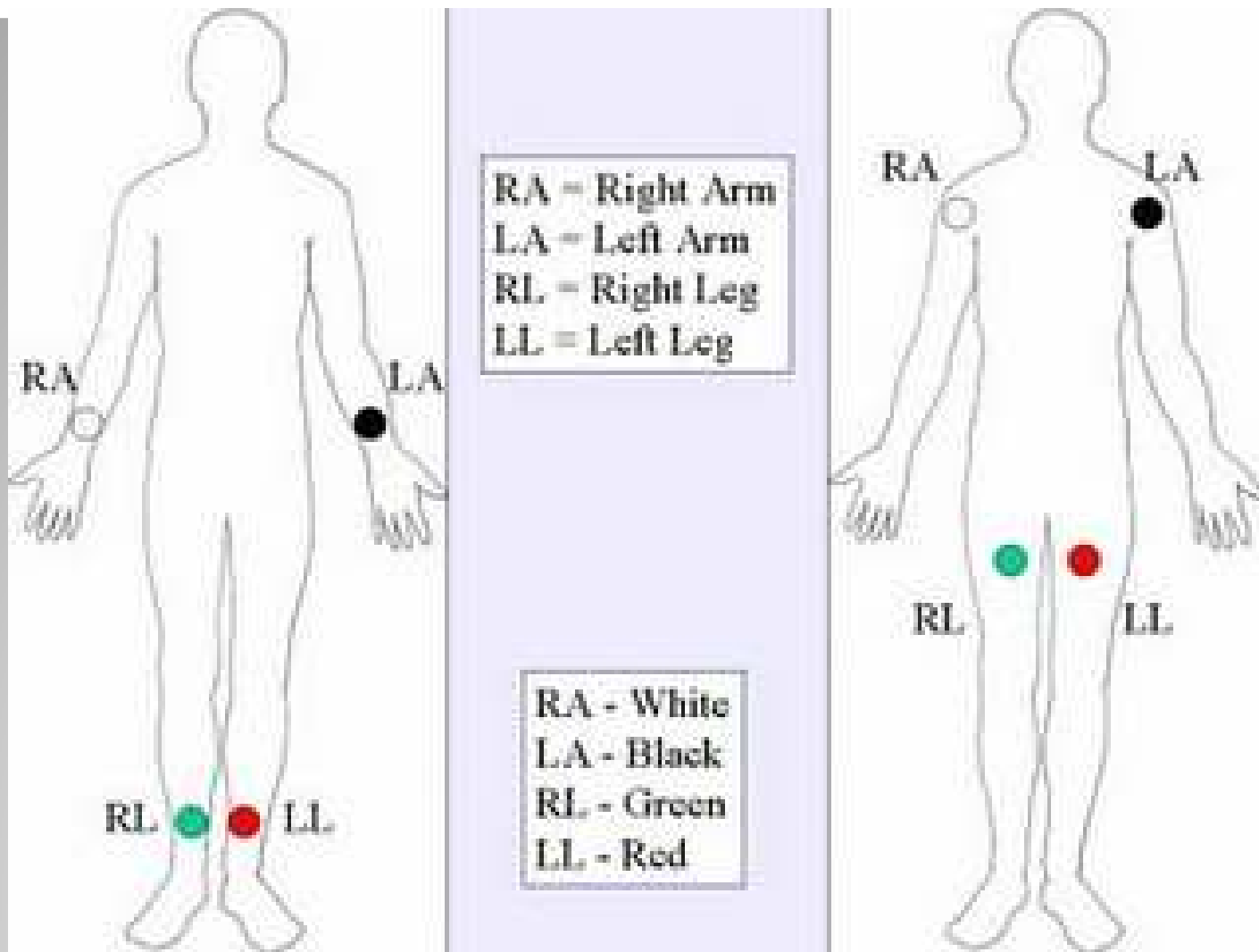
## Recording a 12 lead ECG.



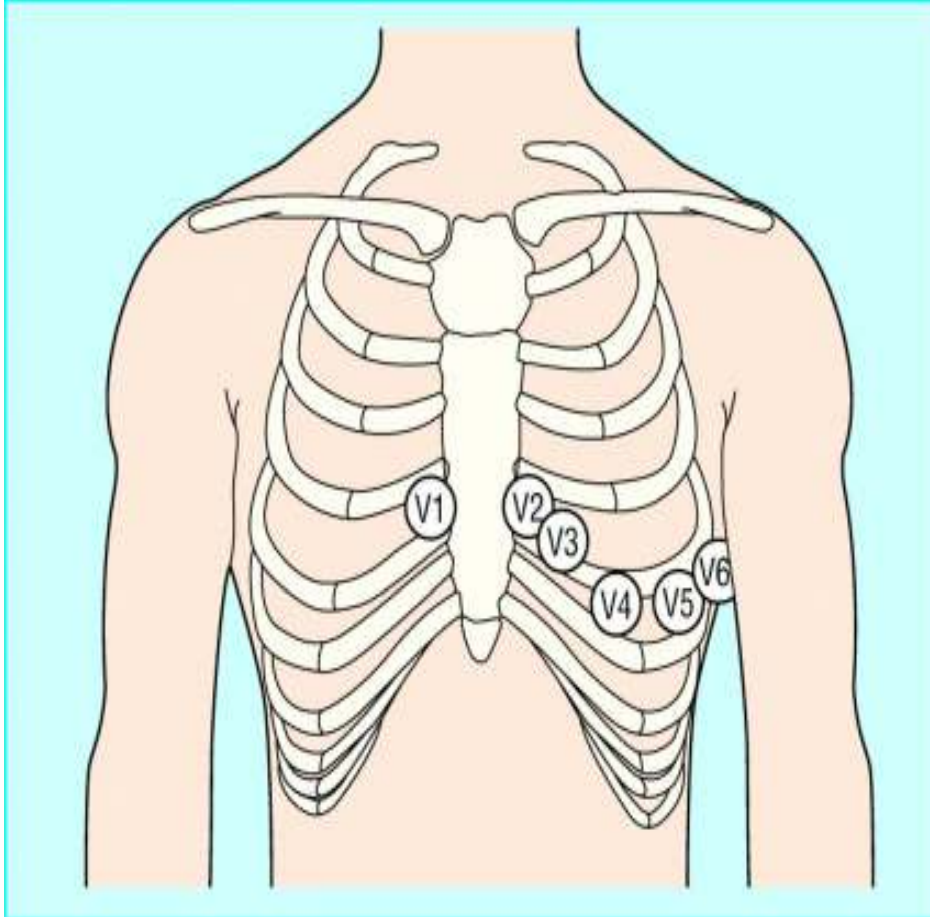


- Leads V1 and V2 view antero-septal region.
- V3 and V4 view antero-apical region.
- V5 and V6 view antero-lateral region.

## Chest Lead Position Related to Heart.



**Position of Limb ECG Electrodes.**

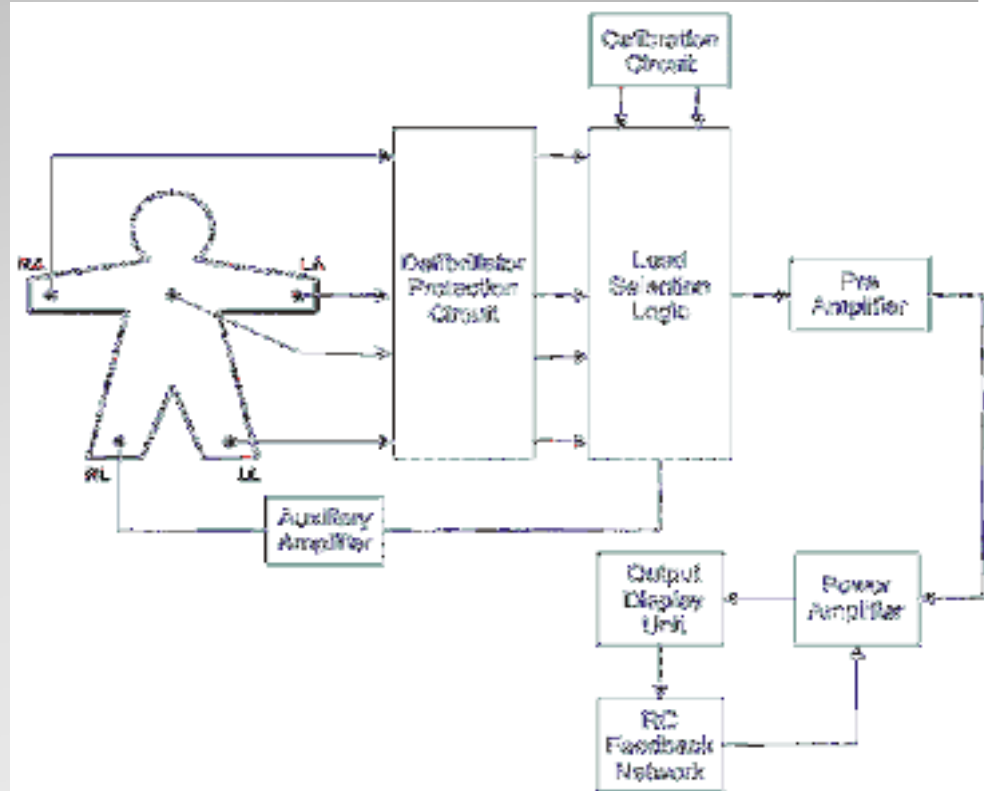


- V1** – fourth intercostal space at the right sternal edge
- V2** – Fourth intercostal space at the left sternal edge
- V3** – Midway between V2 and V4.
- V4** – Fifth intercostal space in the mid-clavicular line
- V5** – Left anterior axillary line at the same horizontal level as V4
- V6** – Left mid-axillary line at the same horizontal level as V4 and V5

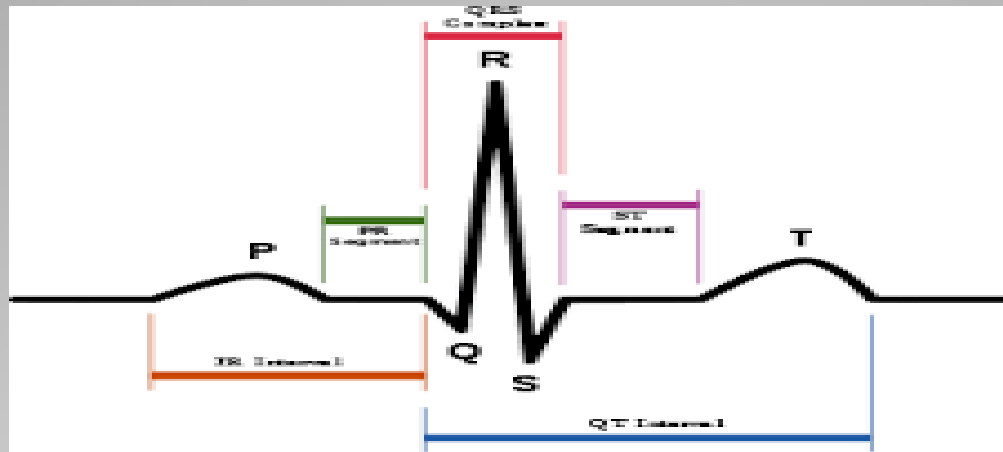
## **Chest Lead Electrode Position.**

➤ In a conventional 12-lead **ECG**, ten electrodes are placed on the patient's limbs and on the surface of the chest.

➤ The overall magnitude of the heart's electrical potential is then measured from twelve different angles ("leads") and is **recorded** over a period of time (usually ten seconds).



## ECG Recording Setup



O is the origin or datum point preceding the cycle

P is the atrial systole contraction pulse

Q is a downward deflection immediately preceding the ventricular contraction

R is the peak of the ventricular contraction

S is the downward deflection immediately after the ventricular contraction

T is the recovery of the ventricles

U is the successor of the T wave but it is small and not always observed

## ECG RESULTS



- Muscle contraction due to a change in the relative sliding of thread-like molecules or filaments
  - Actin and Myosin
- Filament sliding is triggered by electrical phenomenon (**ACTION POTENTIAL, AP**)
- The recording of muscle APs is called electromyography (EMG)
  - The record is known as an electromyogram

**What is EMG**

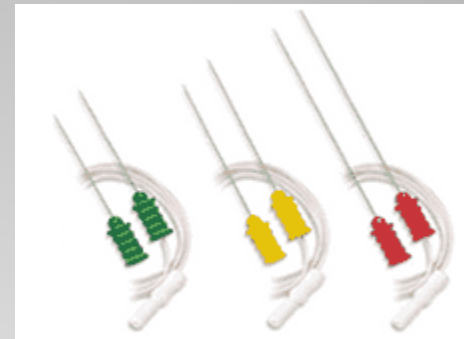
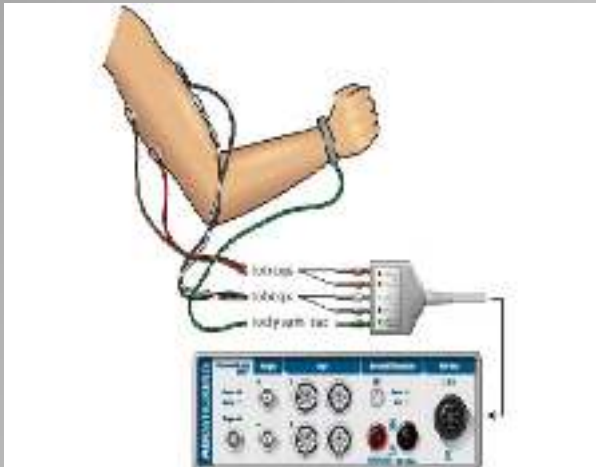
# Action Potential (AP)

- Cell membrane separates intracellular from extracellular space, diffusion barrier which restricts ION flow. Concentration of ions different inside vs. outside of cell membrane, results in an electrical potential difference known as a MEMBRANE POTENTIAL.
- Typical magnitude of membrane potential is -60 and -90 mV (interior of cell is negatively charged compared to the outside) when the muscle cell is in resting state.
- When sufficient neurotransmitters are deposited at the motor endplate, it opens up Na<sup>+</sup> gates, causing an influx of Na<sup>+</sup> ions, causing a rapid depolarization of the membrane near the motor end plate.
- The membrane potential can change to +20 to +50 mV at the motor endplate within a fractions of a second, which starts (all or none) a cascade of events.

- **Amplitude & Frequency**
- More MU → more amplitude, more spikes and more turns in signal
- Change in firing rate → change in frequency content of EMG
- Change in muscle fiber type → change in AP velocity, change in EMG frequency.
- EMG is spatial and temporal summation of APs

## **Analyzing the EMG Signal**

# EMG Electrodes



Fine wire



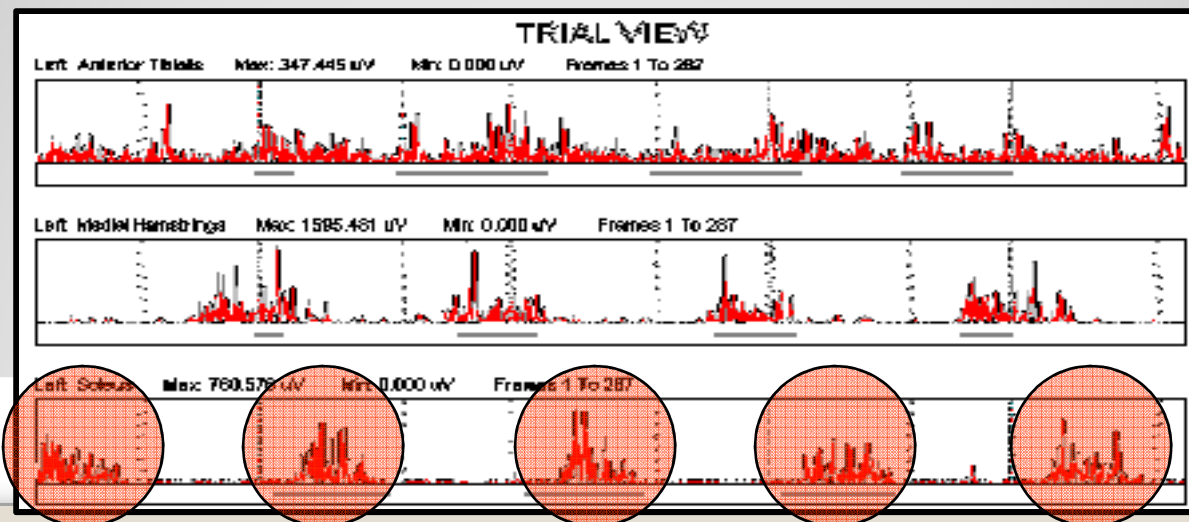
Surface Electrodes



Needle electrode

# Recording Methodology

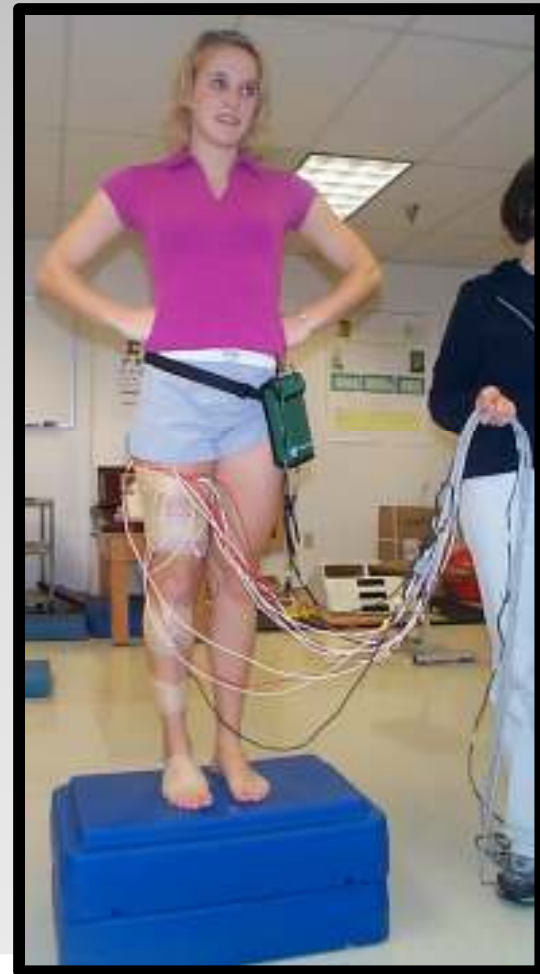
- Sweep of AP → similar to a wave
- Height of wave and the density of the wave can be recorded
- Represented graphically → electromyogram



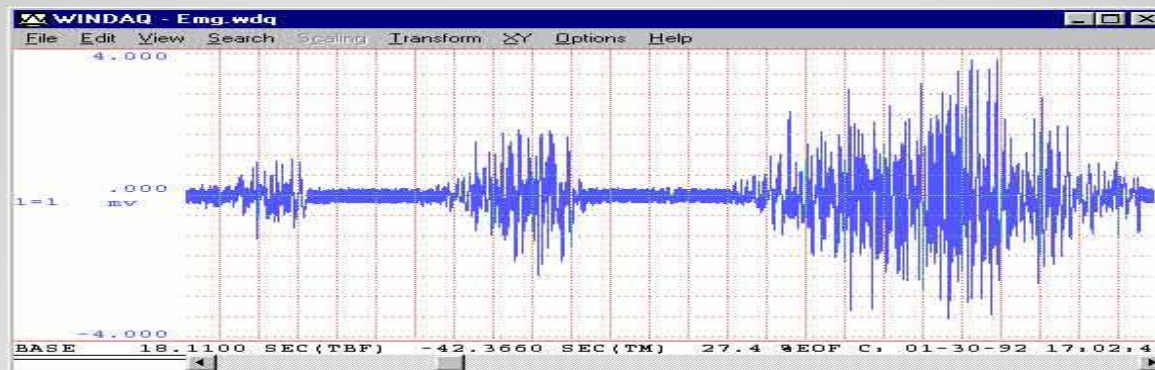
# Recording Methodology

## *(continued)*

- Electrical potential difference measured between two points → bipolar electrode configuration used
- Bipolar Electrode Types
  - Fine Wire
  - Needle
  - Surface
    - Most common, less invasive
    - Silver-silver chloride electrodes
- Electrode Placement
  - Overlying the muscle of interest in the direction of predominant fiber direction
  - Subject is **GROUNDED** by placing an electrode in an inactive region of body



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**Analyzing the EMG Signal**