



AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Bio-Electronics Design Lab

BME 515

Lecture 4

- Electrocardiogram (ECG) -

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Electrocardiogram (ECG)

Al- Mustaqbal
University College





Electrocardiograph

ECCG

Electro

cardio

graph



Biopotential

ECG



EEG



EMG



Electrocardiogram (ECG) Function



Electrocardiogram (ECG) Monitoring



One common way to help *diagnosis for heart diseases*

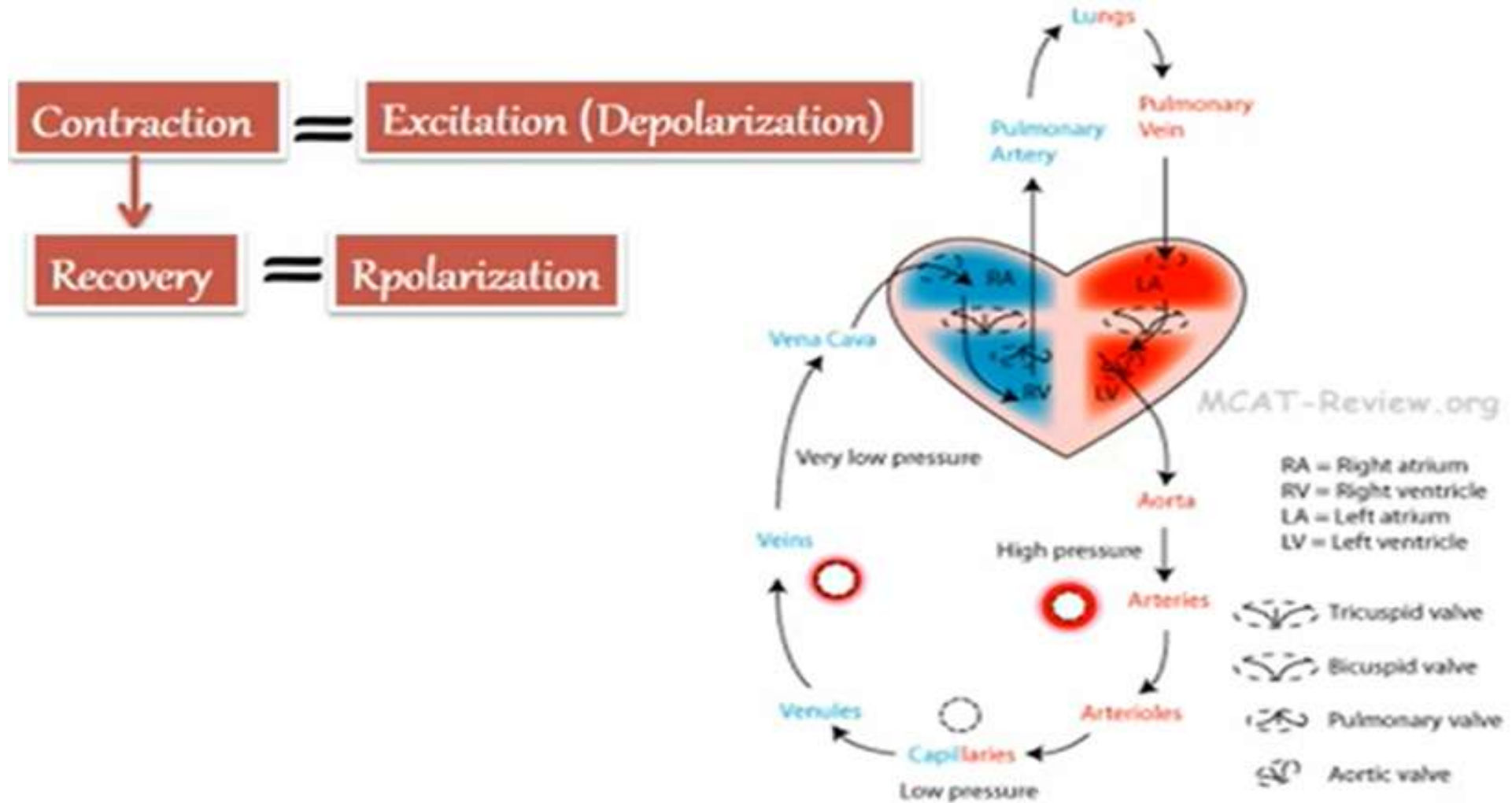


Records the electrical activity of the heart

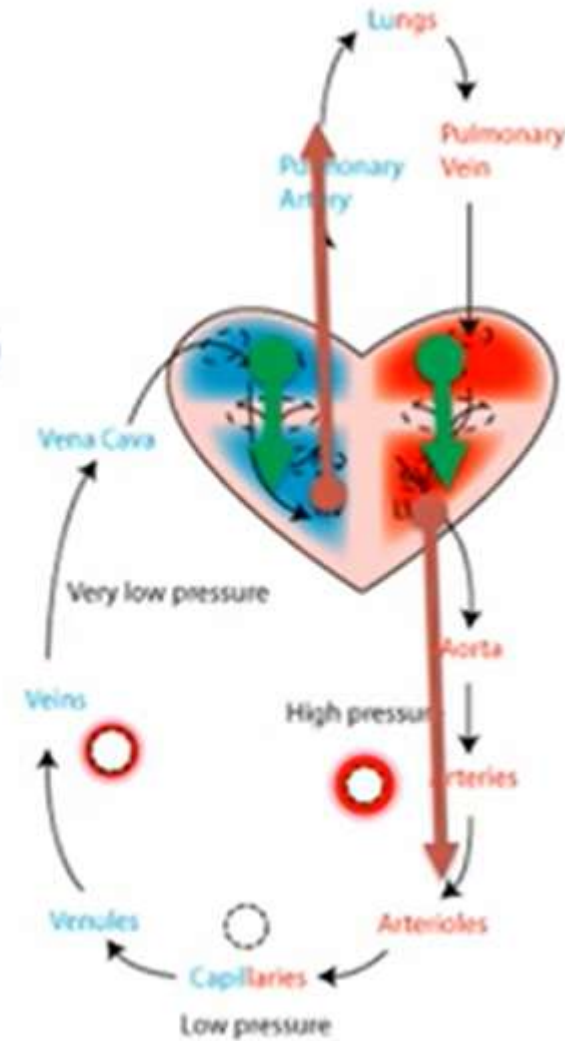
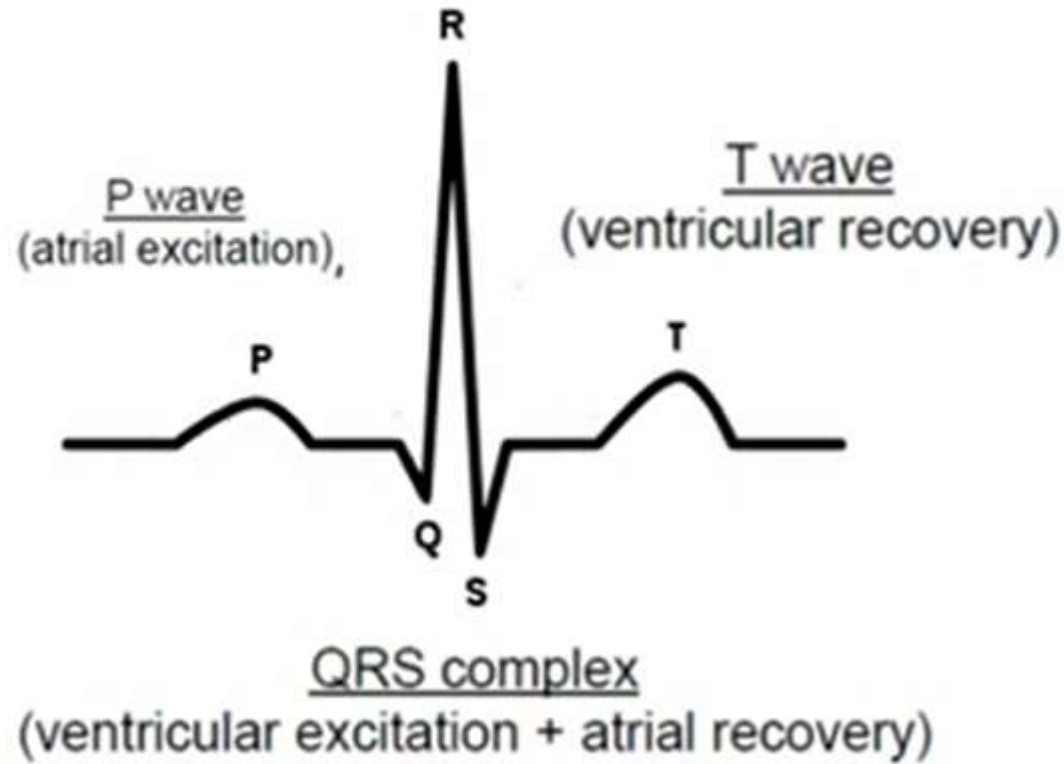


Provides information about *wide range of cardiac disorders*

Heart Structural



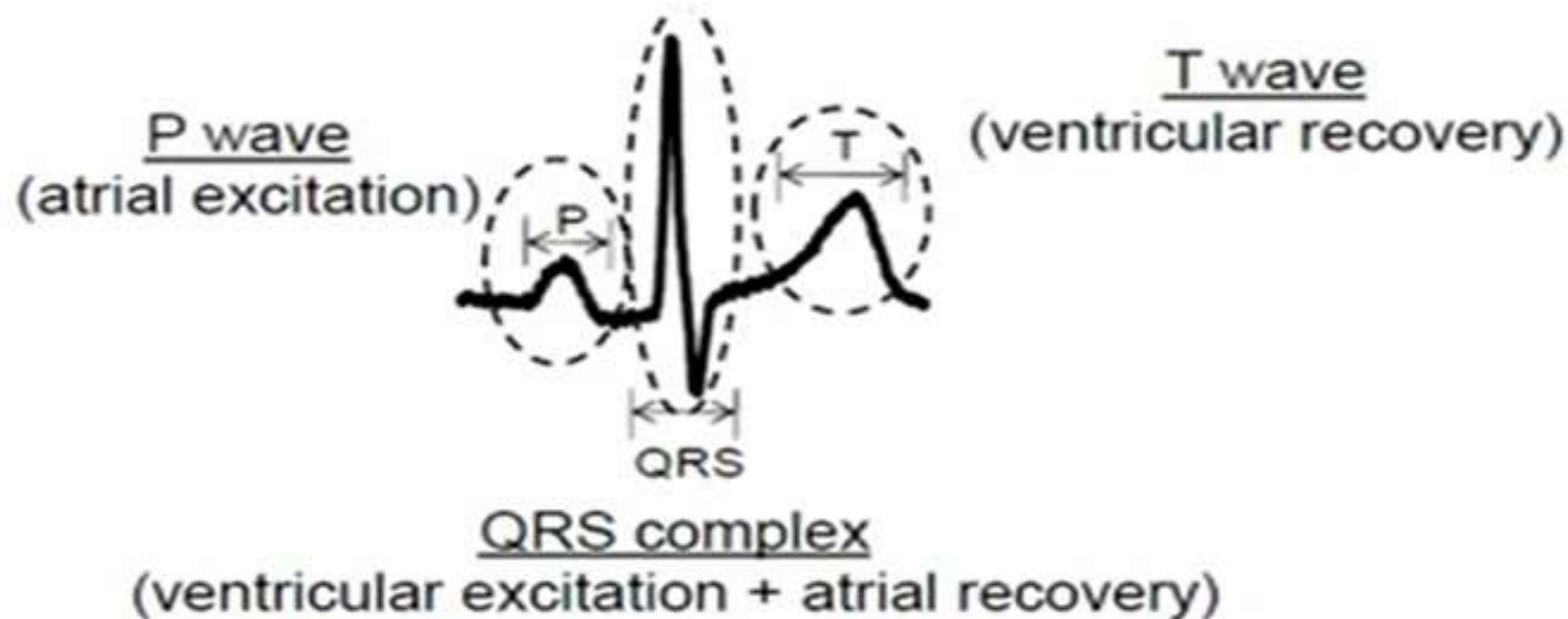
Signal components & Waveform



ECG Waveform Characteristics



- Three major waves: **P wave**, **QRS complex**, and **T wave** .
- Signal Amplitude : 0.1 to 4 mV
- Frequency Range : 0.01 to 150 Hz Skin electrodes (For monitoring, a bandwidth of **1 to 40 Hz**)



ECG Electrodes type



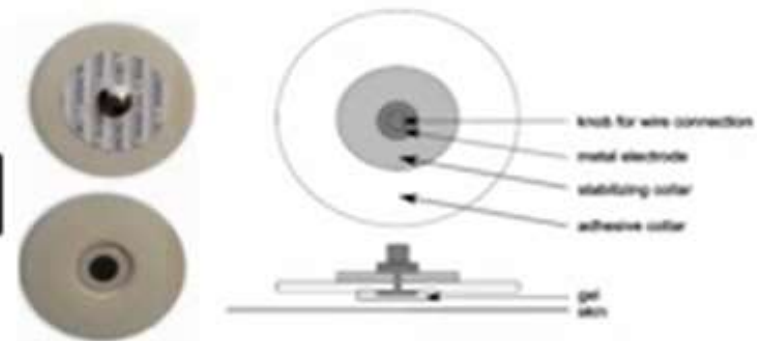
- ✓ A typical **Skin surface electrode** used for ECG recording is made of **Ag/AgCl**



Reusable



Disposable



ECG leads placements

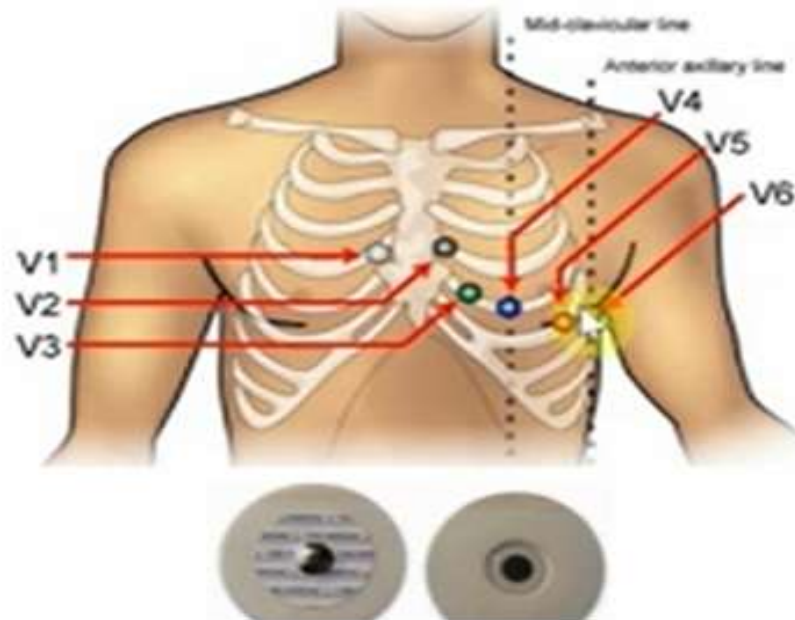
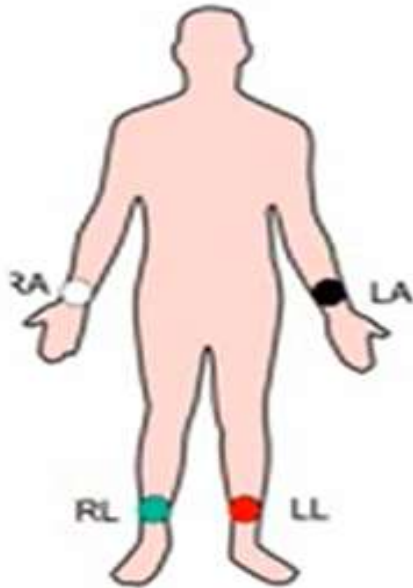


10 Leads

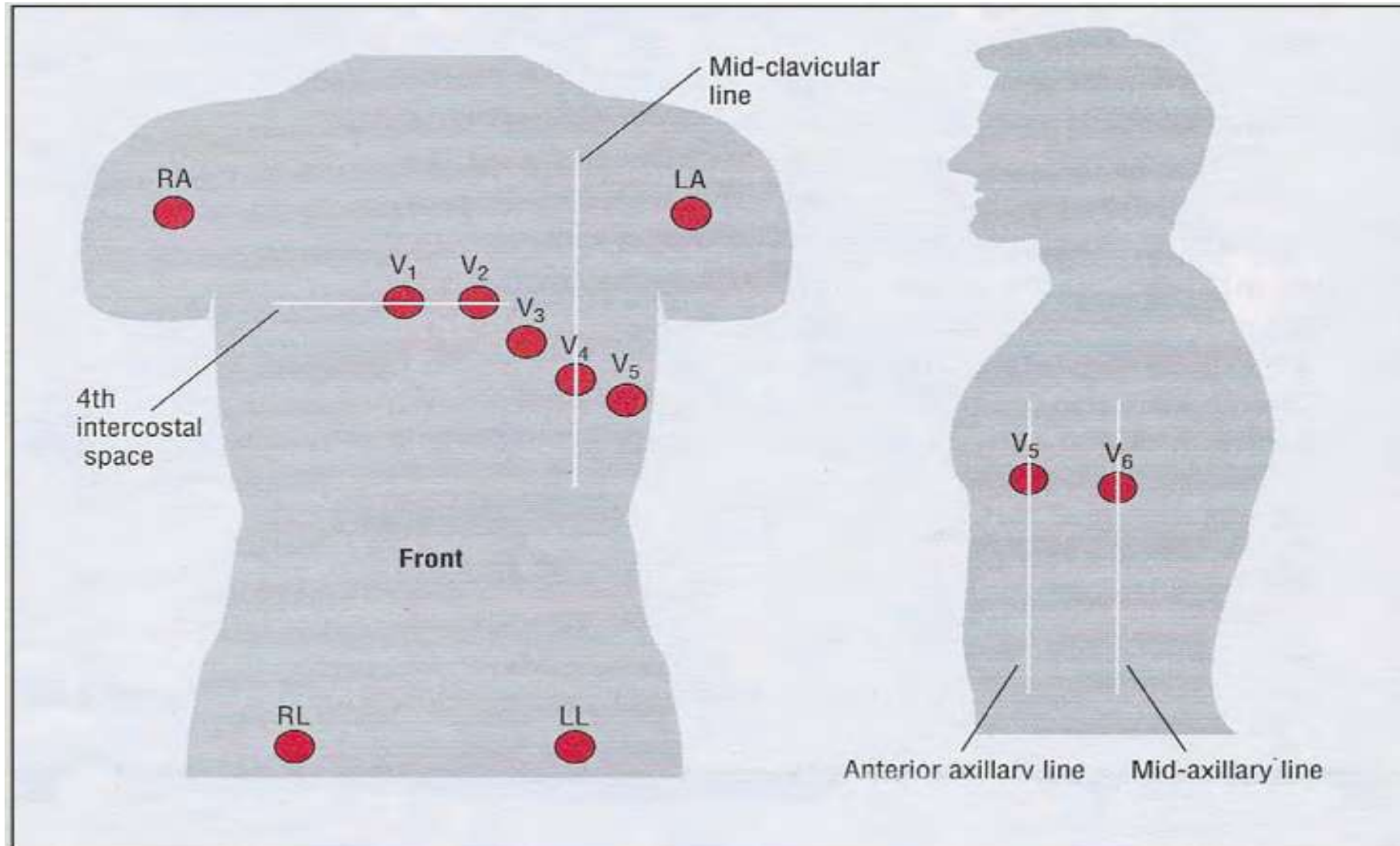
4 limb electrodes

6 chest electrodes

RA = Right Arm
LA = Left Arm
RL = Right Leg
LL = Left Leg

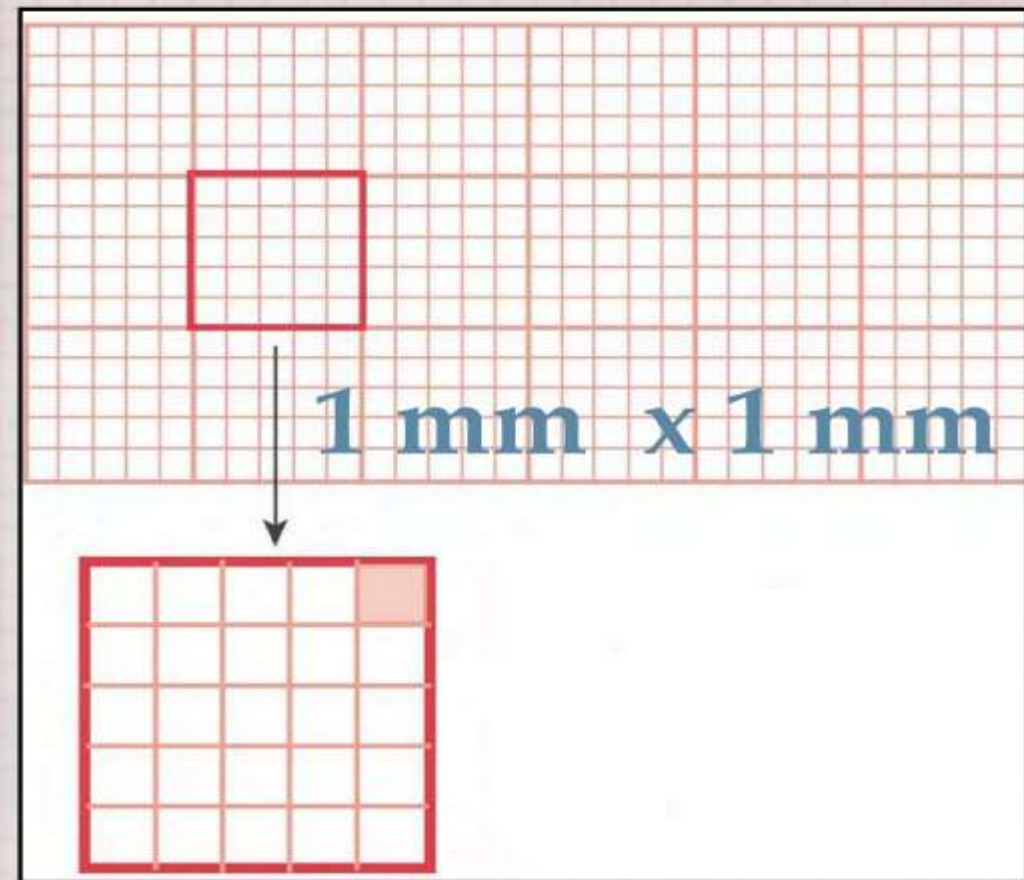


Lead Placement





Height = millivolts
Width = Time



Calibration



Vertical Axis
'y'

1 Small Square = 1 mm (0.1 mV)

1 Large Square = 5 mm (0.5 mV)

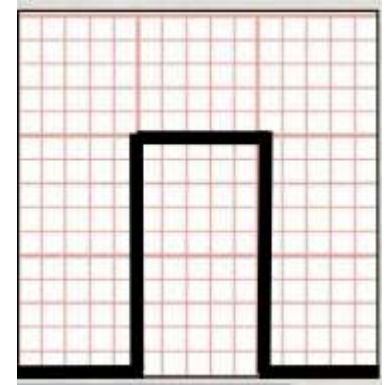
2 Large Squares = 10 mm (1 mV)

Horizontal Axis
'x'

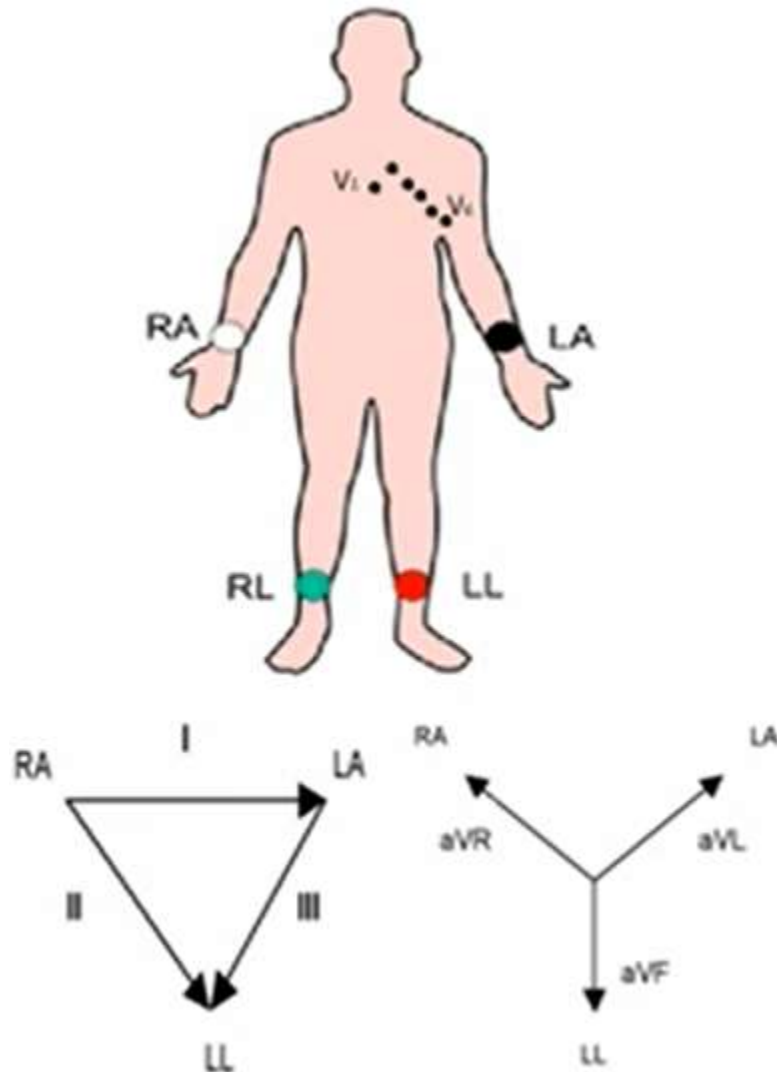
1 Small Square = 0.04 sec

1 Large Square = 0.2 sec

5 Large Squares = 1 sec



Standard 12-lead Electrode Placement



Lead	Type	Calculation
I	Bipolar limb leads	$LA - RA$
II		$LL - RA$
III		$LL - LA$
aVR	Augmented limb leads	$RA - (LA + LL) / 2$
aVL		$LA - (RA + LL) / 2$
aVF		$LL - (RA + LA) / 2$
V ₁	Unipolar chest leads	$V_1 - (RA + LA + LL) / 3$
V ₂		$V_2 - (RA + LA + LL) / 3$
V ₃		$V_3 - (RA + LA + LL) / 3$
V ₄		$V_4 - (RA + LA + LL) / 3$
V ₅		$V_5 - (RA + LA + LL) / 3$
V ₆		$V_6 - (RA + LA + LL) / 3$

Standard 12-lead Electrode Placement

