Electrocardiography (ECG)

Physiology Lab-7

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Cardiac conductivity

- The heart is a muscle regarding as the strongest muscle in our body. skeletal muscle can contract 70 times every minute, for 60 minutes every hour, 24 hours each day, 365 days each year, for 70 or 80 years.

- The intrinsic conduction system (nodal system) of the heart that sets its basic rhythm occurs as a result of polarization and depolarization events in the heart tissue

Impulse conduction

Sinoatrial node (SA) node

↓

Atrioventricle node (AV) node

↓

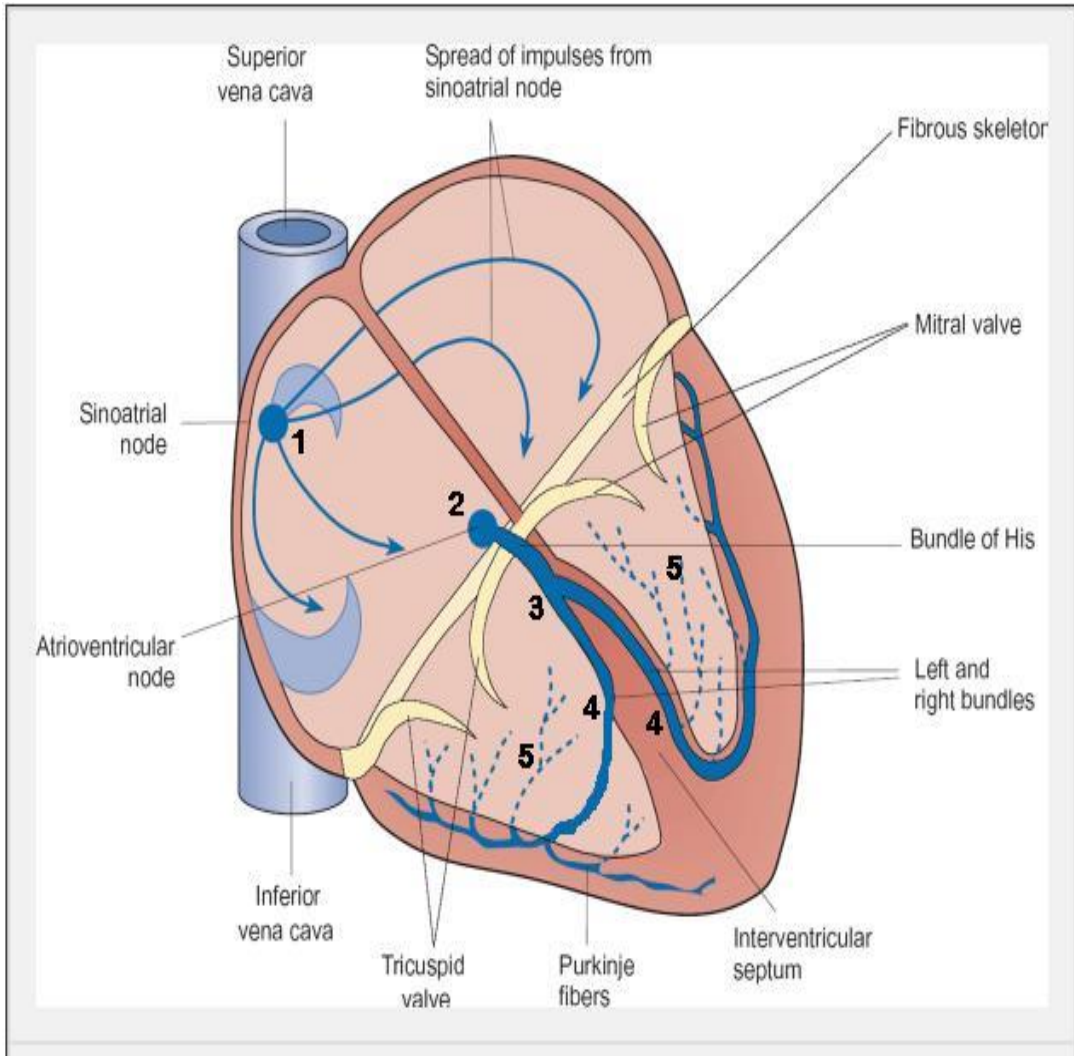
Bundle of His

↓

Bundle branches

↓

Purkunje fibers

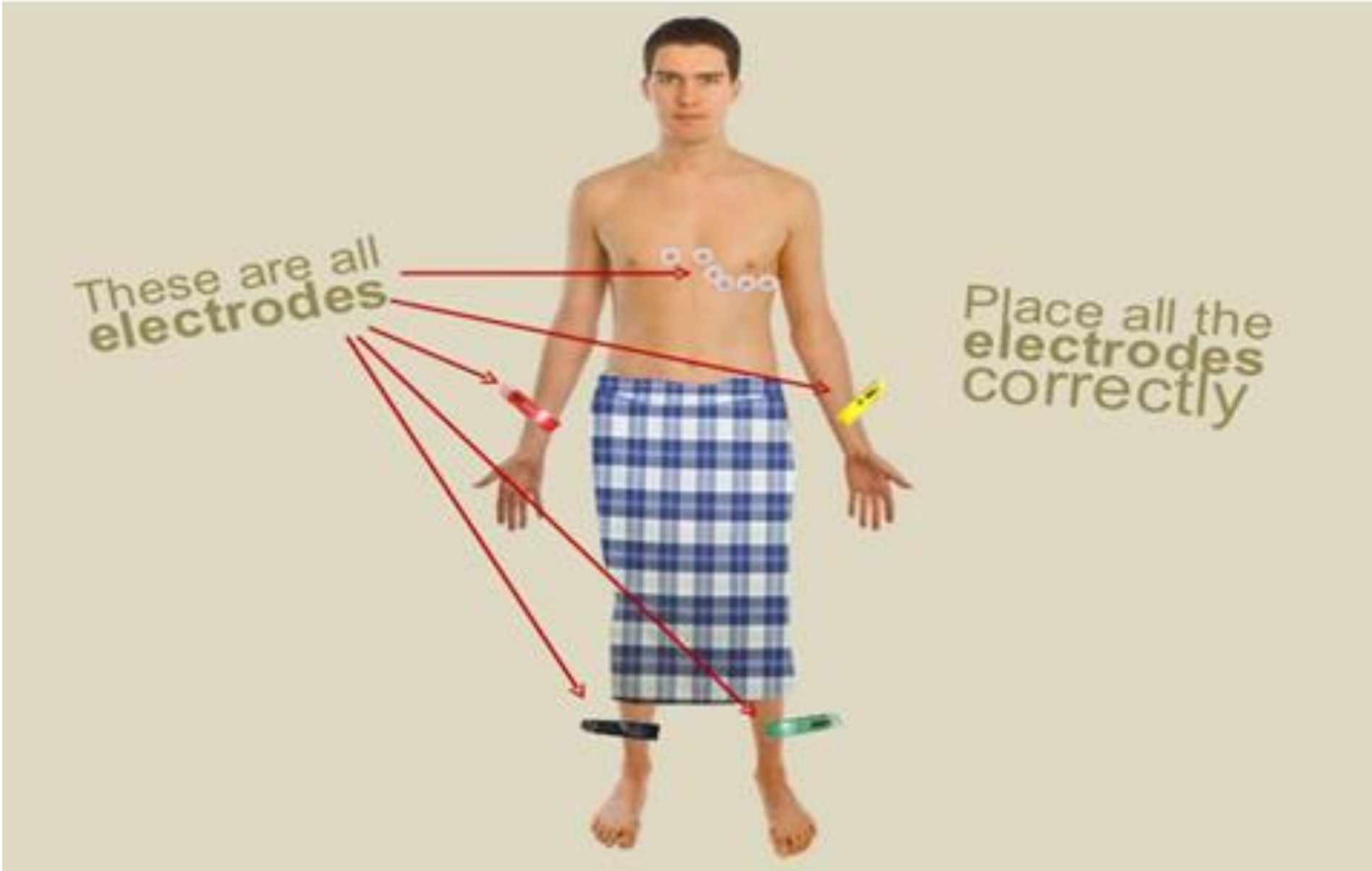


What is an electrocardiogram (ECG)?

- Electrocardiography (ECG or EKG) is the process of recording the electrical activity of the heart over a period of time using electrodes (electrical sensing device) placed on a patient's body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle depolarizing during each heartbeat.

- ECG electrodes are attached to the body while the patient lies flat on a bed or table. Electrodes are attached to each extremity (4 totals) and to 6 pre-defined positions on the front of the chest.

Electrodes


These are all
electrodes
Place all the
electrodes
correctly

Electrodes and leads

There is a careful distinction between "electrode" and "lead.“

Electrode:- electrical sensing device placed on the body.

Leads:- the electrical activity or (voltage differences) between electrodes. Two types:

1- limbs leads (3 standared+3 augmented)

2-chest leads (6 leads)

Types of limb Leads

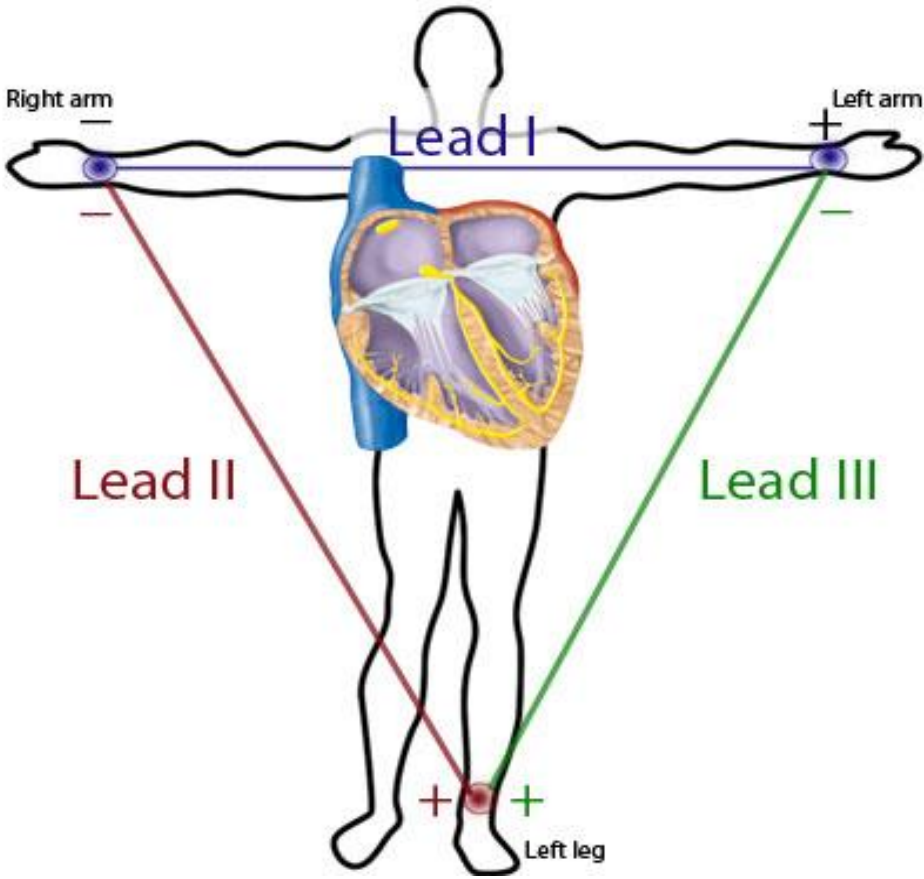
- **1. (Standard Limb Leads)**
- **(Bipolar leads)** I , II , III Leads :- record the electrical activity between electrode placed on the wrists and left ankle (with right ankle acting as the earth).

- **2. (augmented limb lead)**
- **(Unipolar leads) aVL , aVR , aVF** record the electrical activity between a single electrode placed on the body surface and an electrode that is maintained at zero potential (earth) that is a combination of readings from other leads.

Standard limb leads (bipolar)

- **Lead I** is formed using the right arm electrode as the negative electrode and the left arm electrode as the positive.
- **Lead II** is formed using the right arm electrode as the negative electrode and the left leg electrode as the positive.
- **Lead III** is formed using the left arm electrode as the negative electrode and the left leg electrode as the positive.

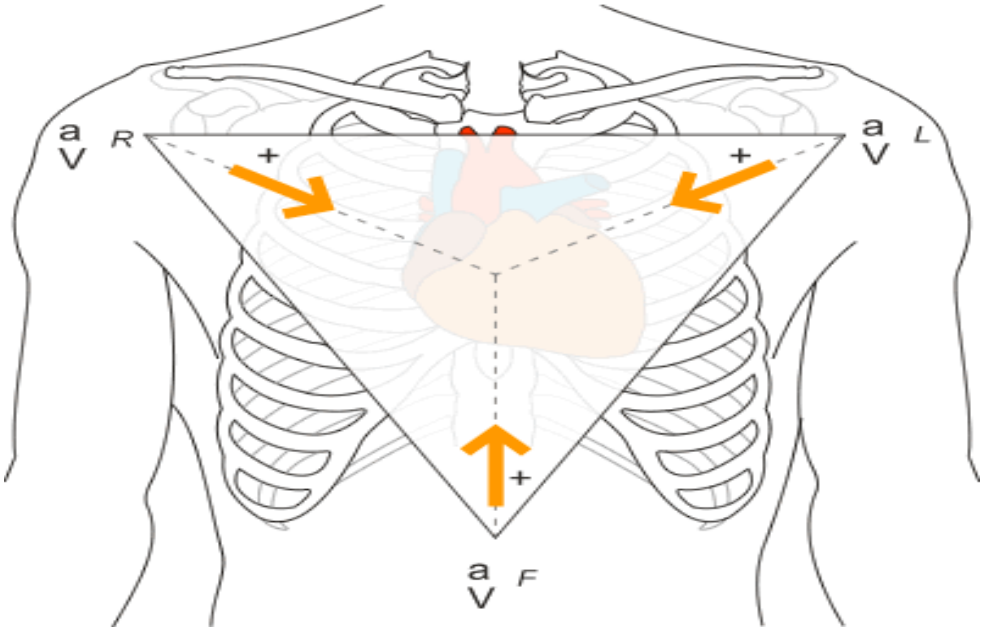
Einthovens triangle



Augmented limb leads(unipolar leads)

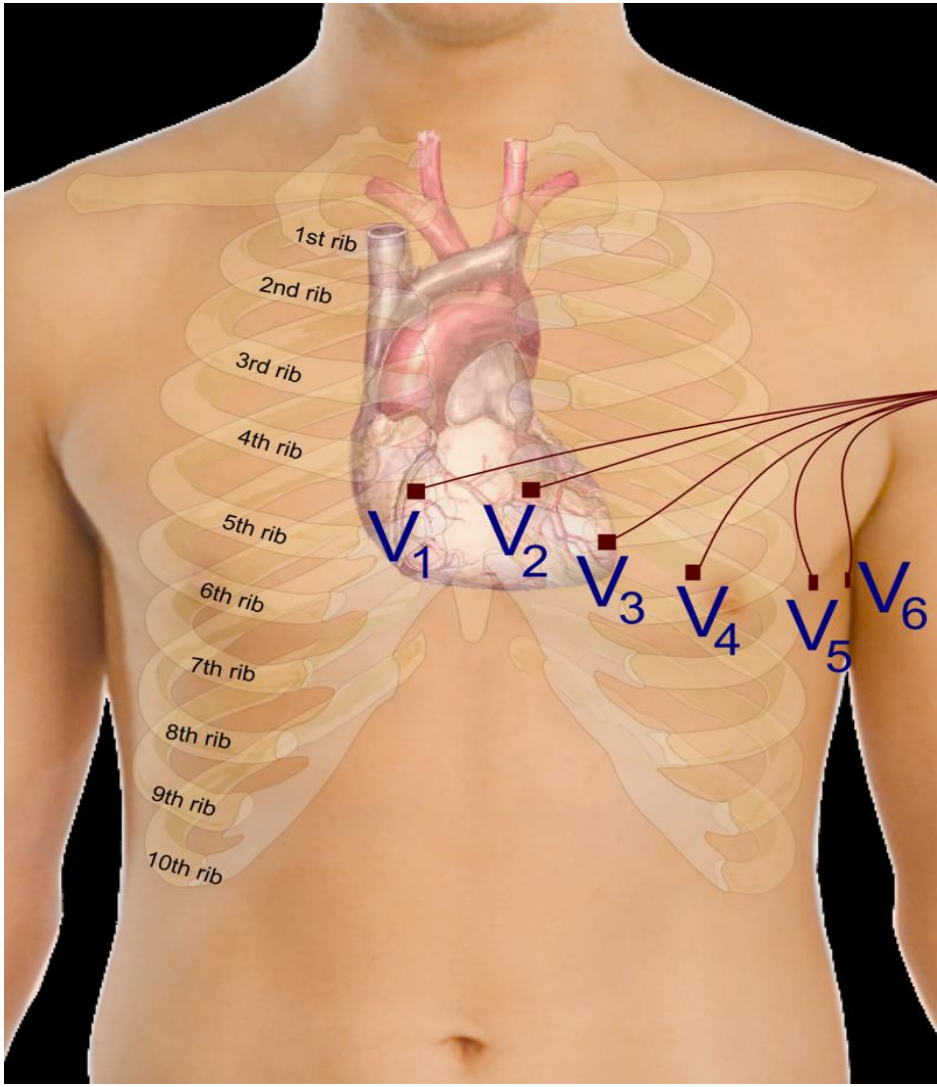
- aVL, aVF and aVR are composite leads, computed using the information from the other leads.

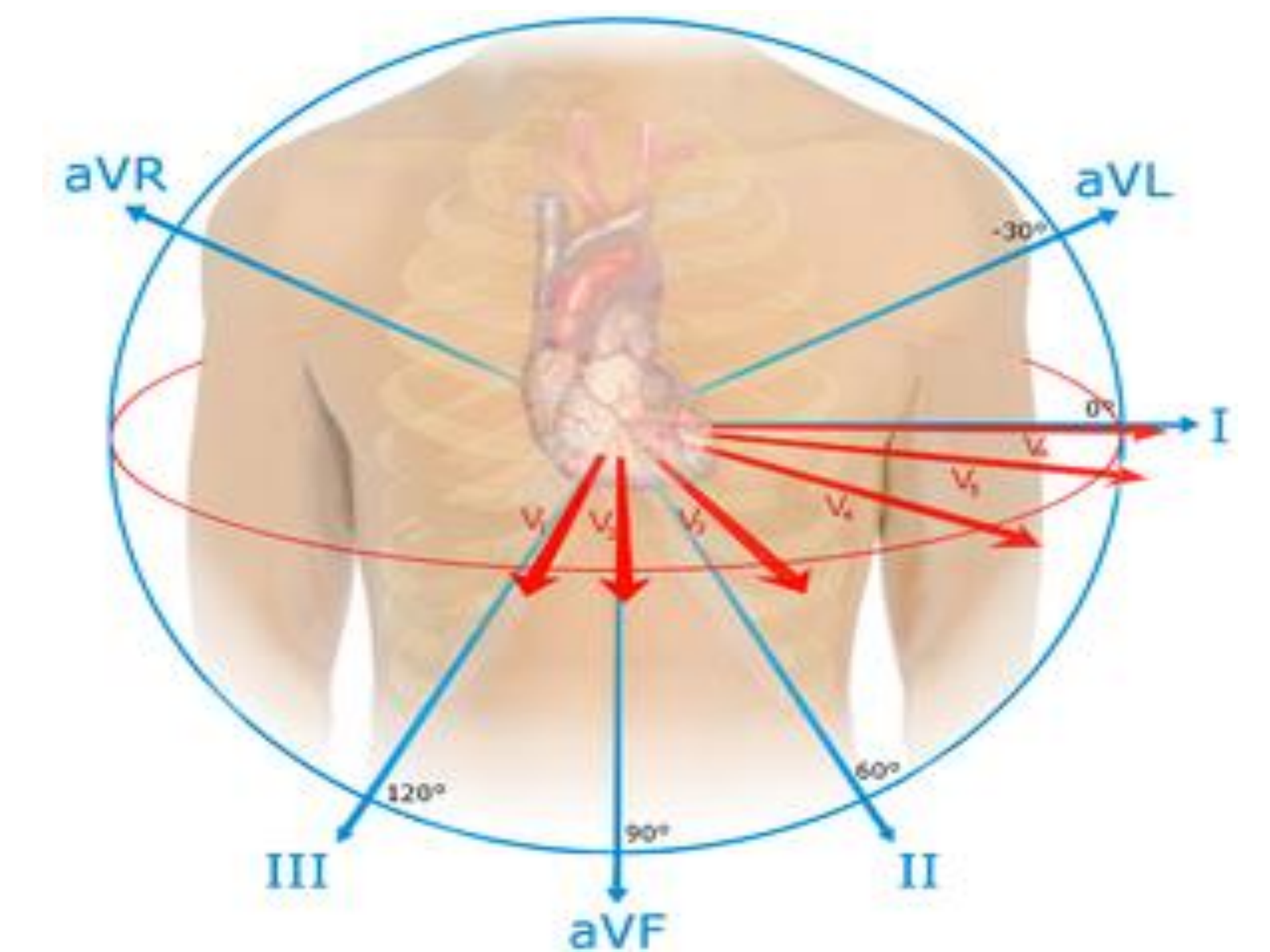
- Each lead can be thought of as ‘looking at’ an area of myocardium



Chest leads (unipolar leads)

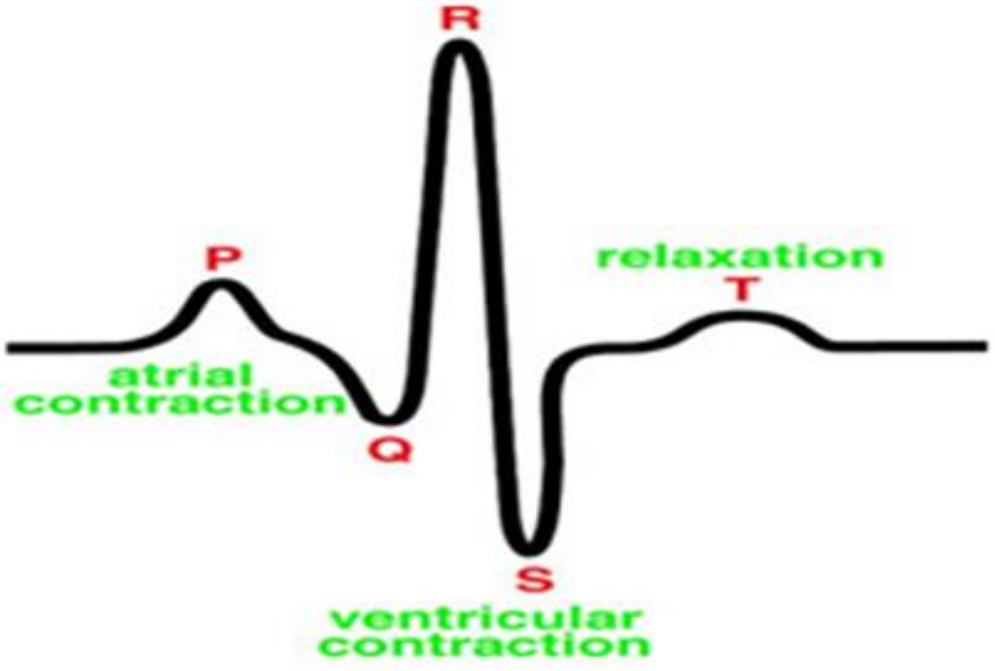
- The precordial leads, V1 to V6, also called C1-C6 are also unipolar leads but instead of recording between limbs they are placed directly on the chest, so the sensing electrode is sensing the heart from a very close and particular angle.




aVR
aVL
-30°
0°
I
V6
V5
V4
V1
V2
V3
120°
90°
60°
III
aVF
II

Elements of the trace

- An ECG will give a trace of a healthy heart that looks like the graph below. Each trace is a single heartbeat and therefore lasts about 0.8 seconds.
- The main features of the trace are labelled as P, Q, R, S and T according to convention.

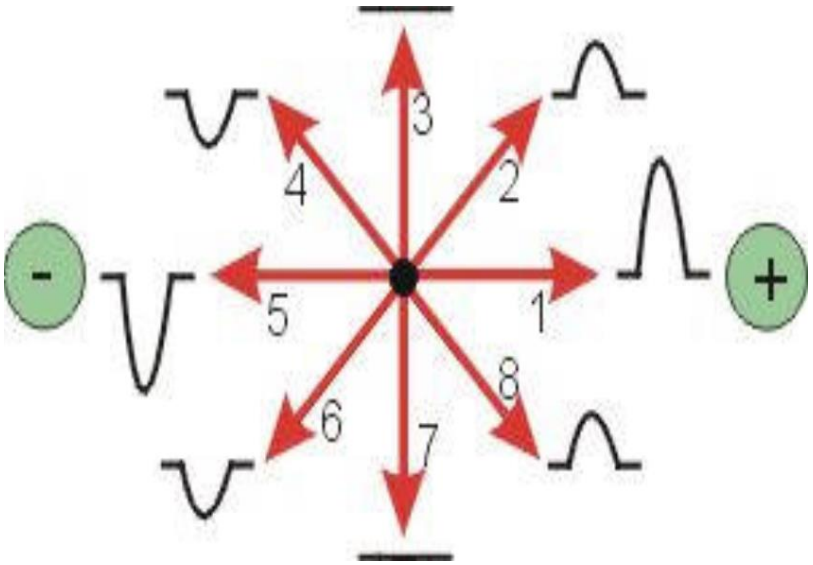


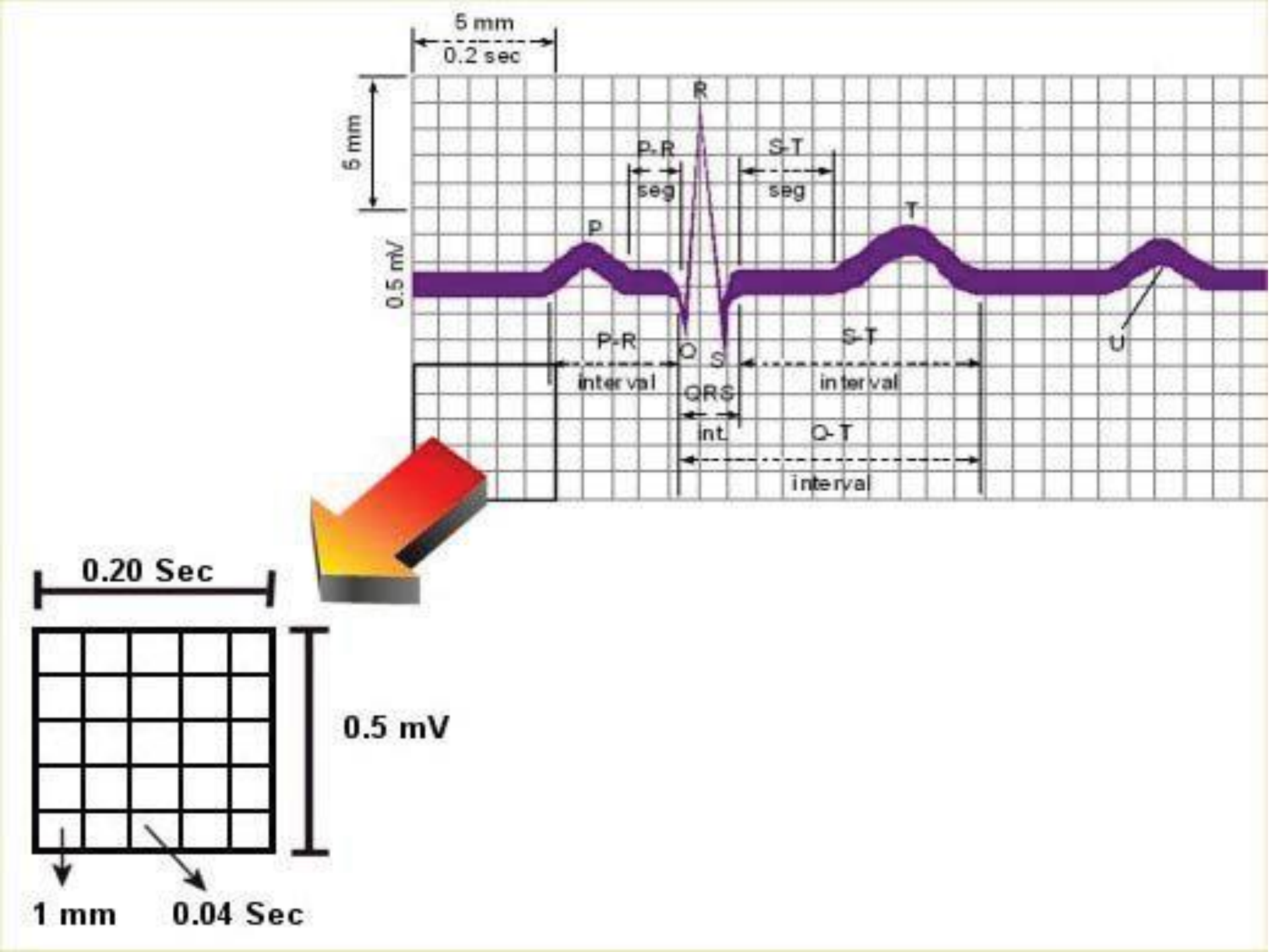
- The "P" wave corresponds to atrial depolarisation and contraction.

- The "QRS" complex relates to the depolarisation and contraction of the ventricles, it is much larger than the "P" wave due to the relative muscle masses of the atria and ventricles - and masks the repolarisation and relaxation of the atria.

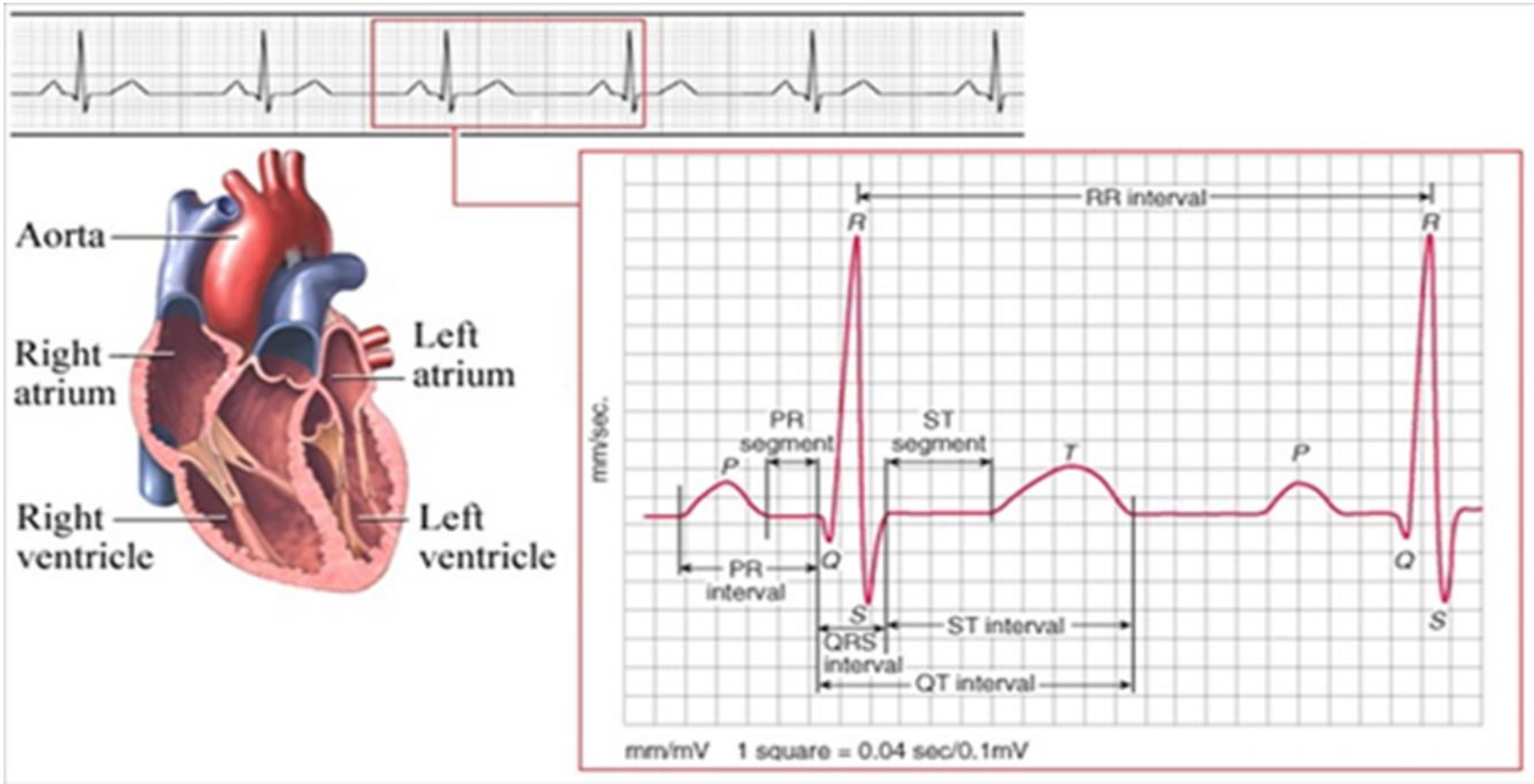
- The repolarization and relaxation of the ventricles can be seen in the form of the "T" wave, the repolarisation of the atria being masked by the "QRS" complex.

- The voltage change is sensed by measuring the current change across 2 electrodes – a positive electrode and a negative electrode.
- If the electrical impulse travels towards the positive electrode this results in a positive deflection.
  If the impulse travels away from the positive electrode this results in a negative deflection.




5 mm
0.2 sec
5 mm
0.5 mV
R
P-R
seg
S-T
seg
P
T
U
P-R
interval
Q
S
S-T
interval
QRS
int.
Q-T
interval
0.20 Sec
0.5 mV
1 mm
0.04 Sec

- Heart Rate = 1500 / No. of small squares between two consecutive R waves
- Heart rate= 300/no. of large squares between two consecutive R waves.



Rhythm and Rate

- **Rhythm**
- If the interval between all R waves is equal then it is regular rhythm
- If the interval between all R waves is unequal then it is irregular rhythm (arrhythmia).

- **Rate**
- If the rate is < 60 beat / min (sinus bradycardia) (or < 50 beats/min during sleep).
- If the rate is >100 beat / min (sinus tachycardia)

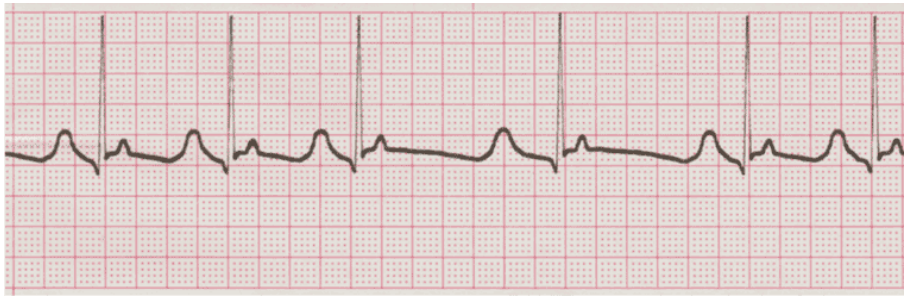
What is measured or can be detected on the ECG?

1. The underlying rate and rhythm mechanism of the heart.
2. The orientation of the heart (how it is placed) in the chest cavity.
3. Evidence of increased thickness (hypertrophy) of the heart muscle.
4. Evidence of damage to the various parts of the heart muscle.
5. Evidence of acutely impaired blood flow to the heart muscle.
6. Patterns of abnormal electric activity that may predispose the patient to abnormal cardiac rhythm disturbances.

Normal Rhythm

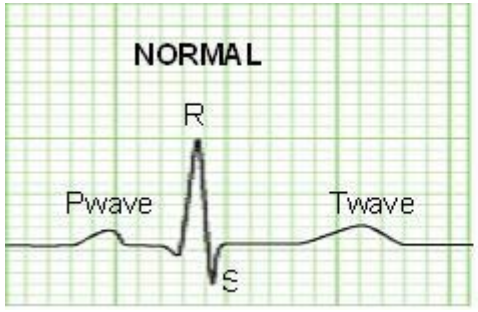
Tachycardia

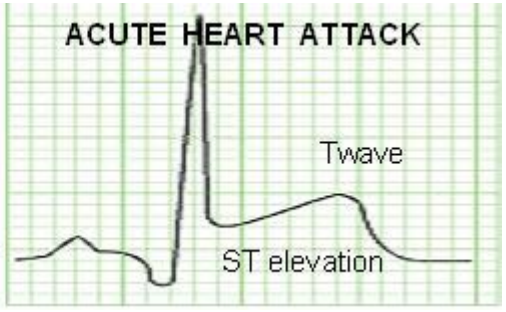
Arrhythmia



Bradycardia

Acute heart attack





Myocardial ischemia

Thank you