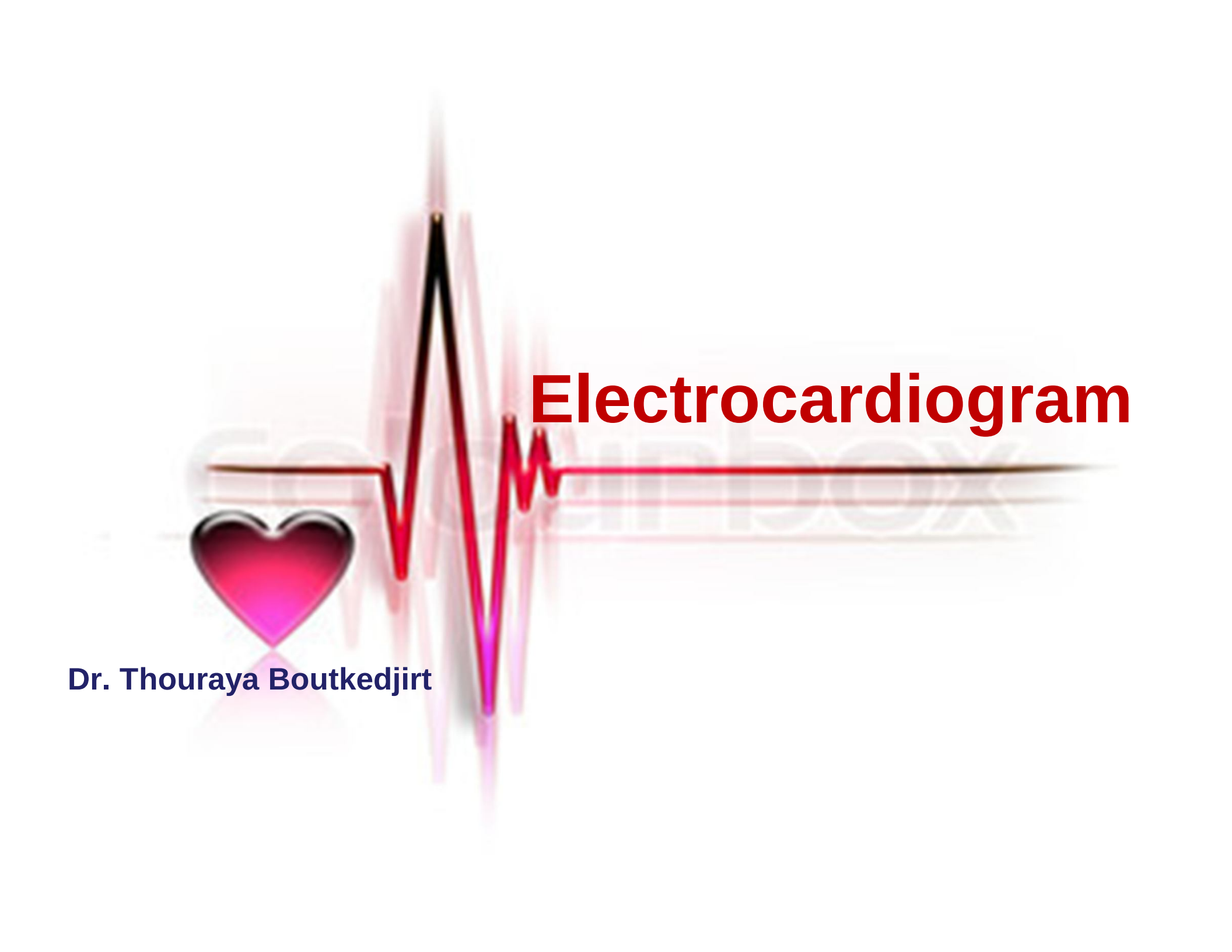


Electrocardiogram

Dr. Thouraya Boutkedjirt

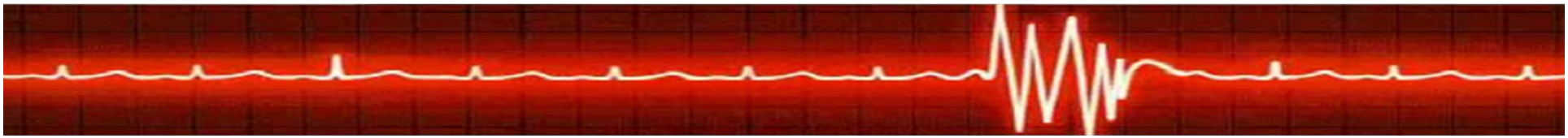
Contents

1. **ECG paper.**
2. **ECG leads:**
   - **Limb leads.**
   - **Chest leads.**
3. **Interpretation of the ECG.**
4. **Cardiac axis**
5. **Heart rhythm.**
6. **Heart rate.**

- **ECG records the electrical changes (depolarization and repolarization) that take place in the heart/per cycle.**

- **These changes can be detected by electrodes attached to the surface of the body.**

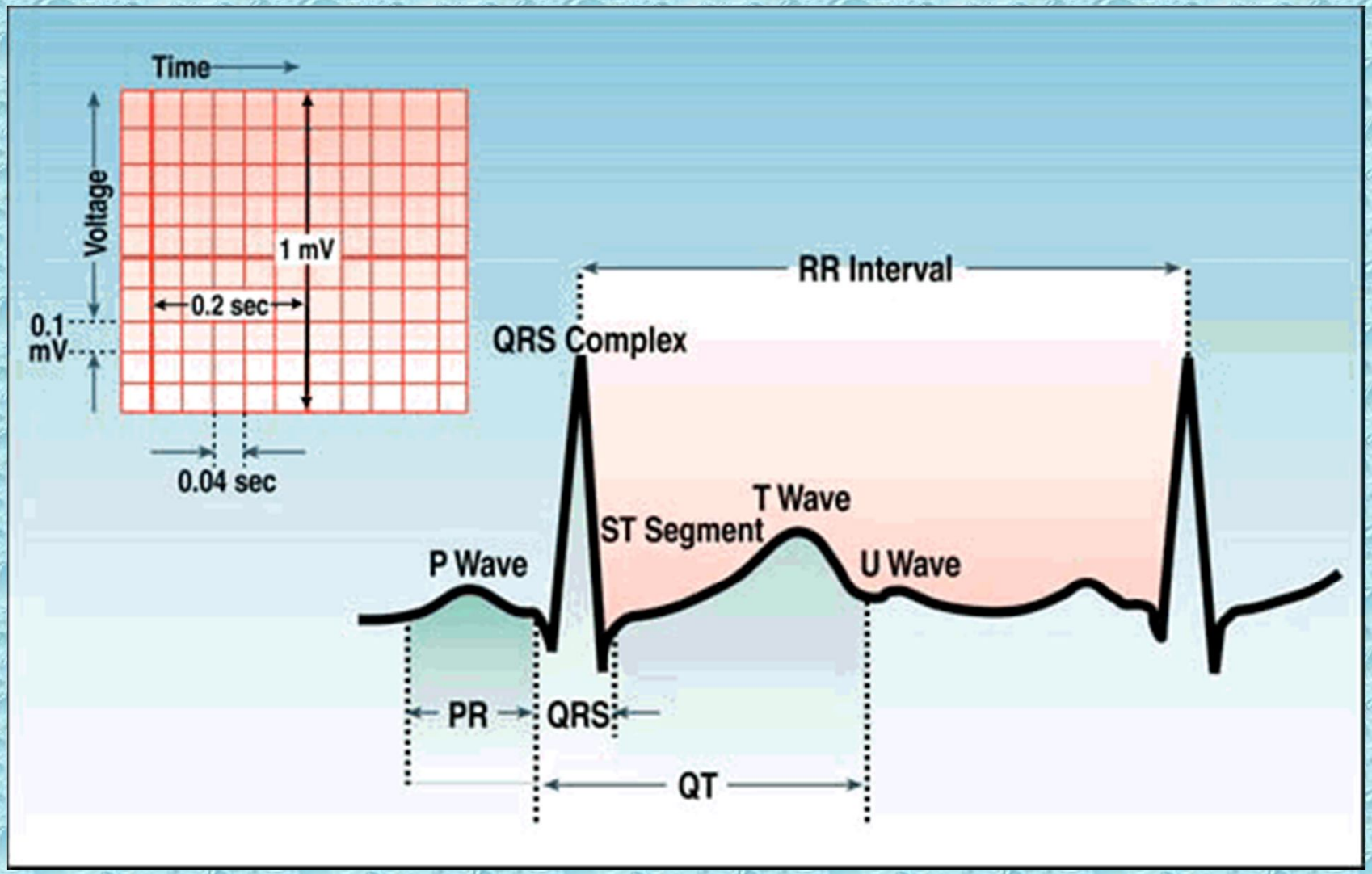
- **Subject supine, relaxed.**
- **Temperature of the room : neutral.**



ECG Paper

- **The ECG is recorded on a graphic paper with standard-sized squares.**
- **The horizontal axis: time measured in seconds.**
  - **1mm: 0.04 seconds**
  - **1 large square: 0.20 seconds.**
  - **5 large squares: 1 second.**
- **The vertical axis: changes of voltage.**
  - **10mm = 1cm = 1millivolt.**
  - **A signal of 1(mV) should move the stylus vertically 1 cm (2 large squares).**
- **The standard paper speed is 25mm/sec.**

ECG Paper

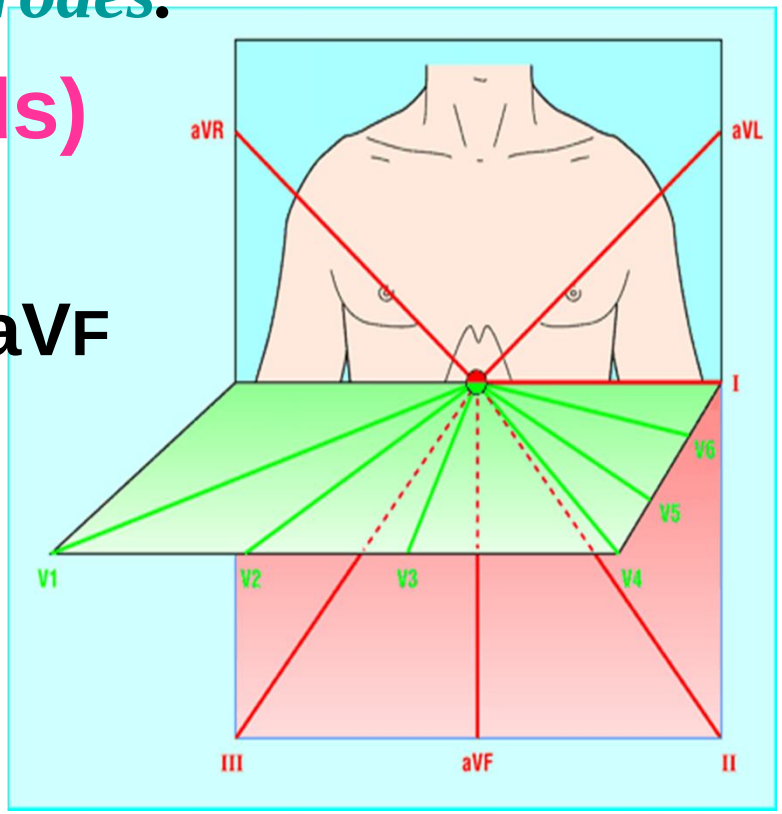

Time
Voltage
1 mV
0.2 sec
0.1 mV
0.04 sec
RR Interval
QRS Complex
T Wave
ST Segment
P Wave
U Wave
PR
QRS
QT

The 12 standard ECG leads

- ***A lead is formed by a pair of electrodes.***
- **Frontal Plane (6 limb leads)**

  Bipolar Leads: I , II , and III

  Unipolar leads: **aVR, aVL, aVF**



- **Transverse Plane:**

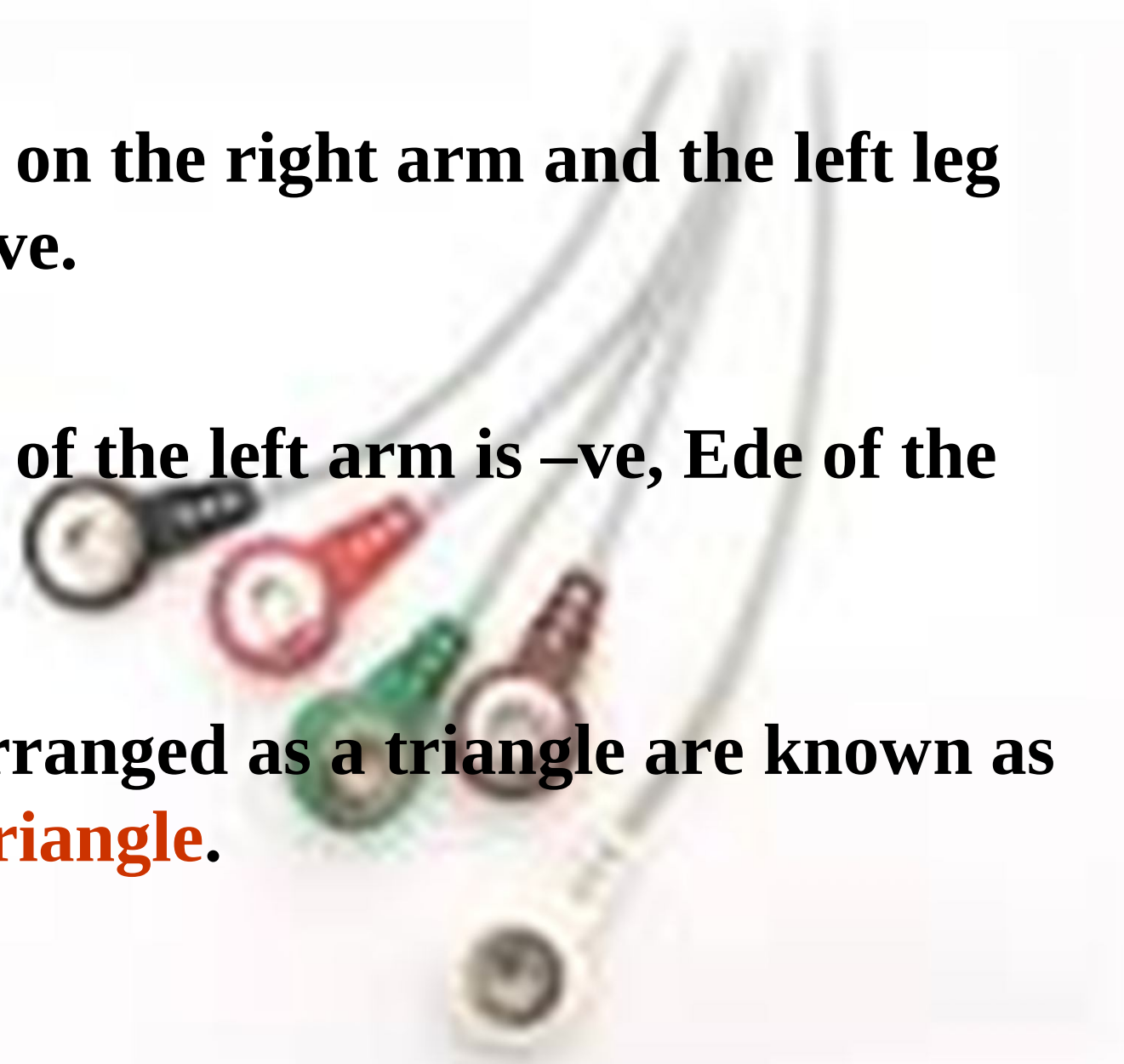
  Unipolar chest leads: **V1** to **V6**

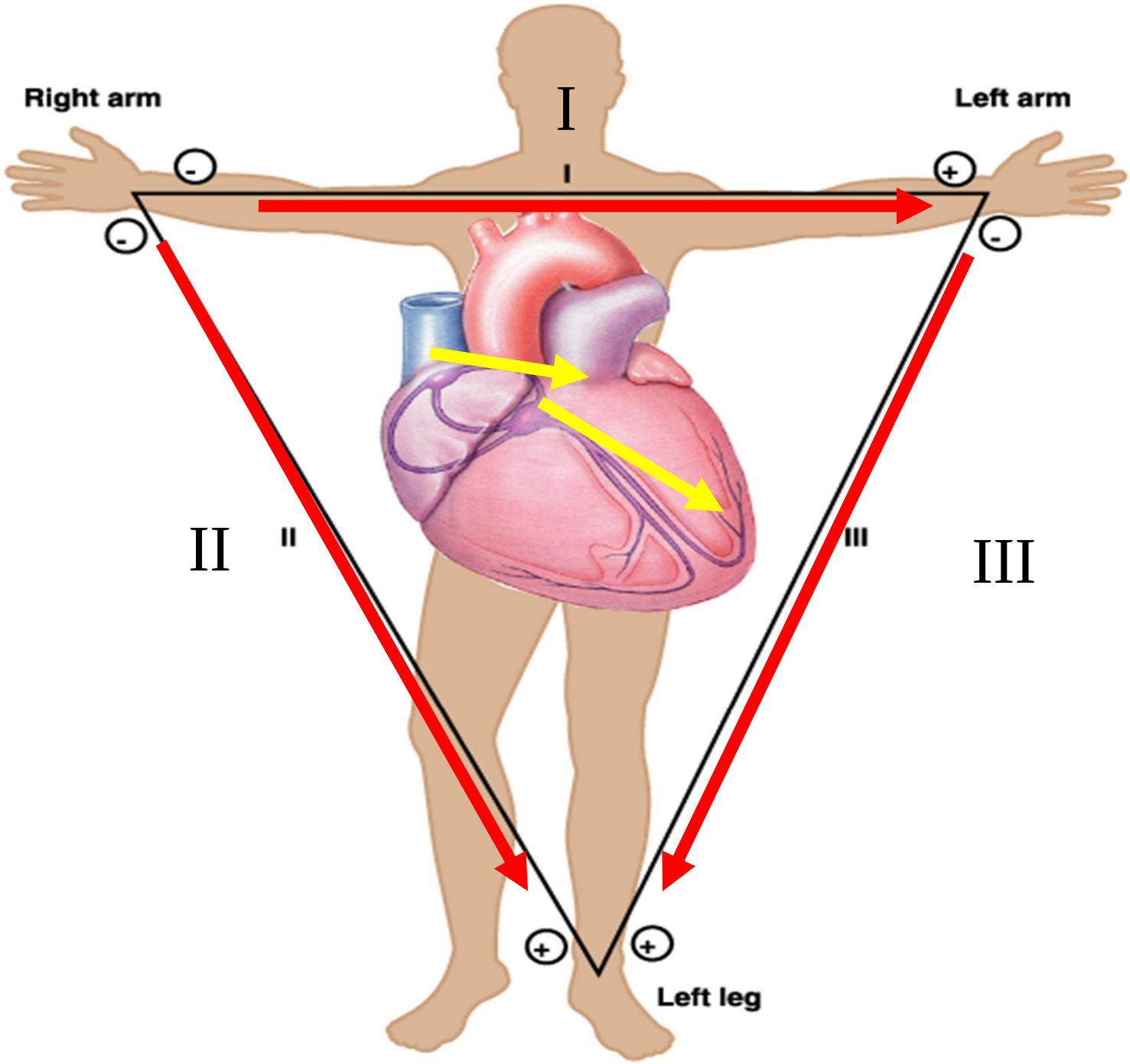
3 bipolar limb leads: I, II, III

- ***Record the difference in potential between 2 limbs*.**
- ***ECG was first recorded by placing electrodes on 3 places: Right and Left arms and Left leg***
- ***(Recording +ve Ede) (-ve reference Ede)***

- ***Depolarization moving towards a +ve Ede produces a +ve deflection.***
- ***Depolarization moving in the opposite direction produces a –ve deflection*.**

- **Lead I: Left arm Ede is +ve, the other is –ve.**
- **Lead II: Edes on the right arm and the left leg with the leg +ve.**
- **Lead III: Ede of the left arm is –ve, Ede of the left leg is +ve.**
- **The 3 leads arranged as a triangle are known as Einthoven's triangle.**

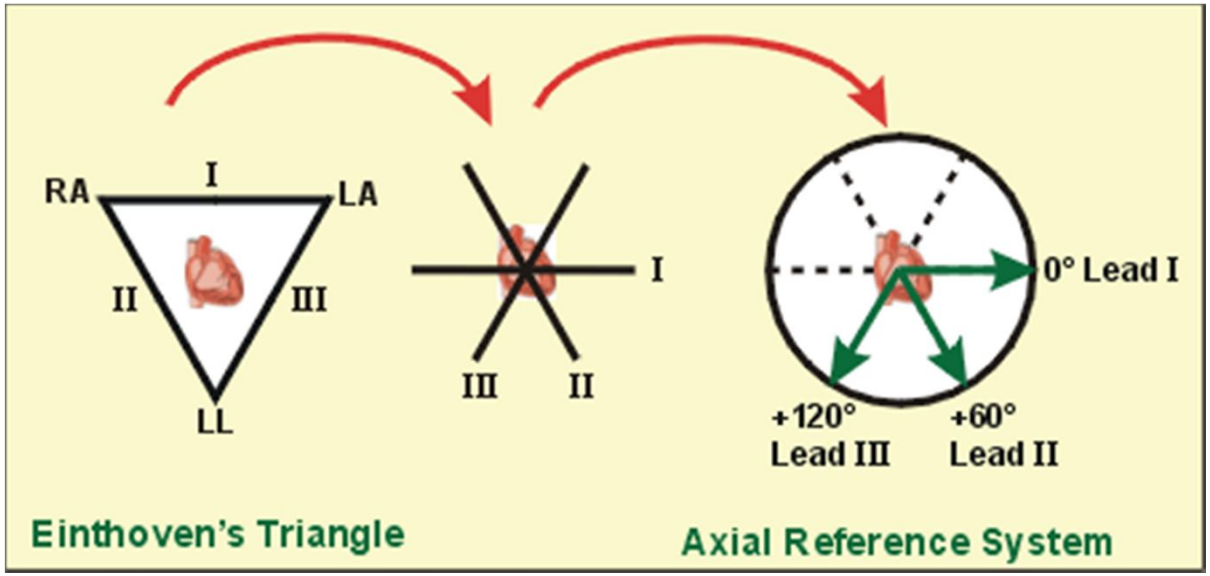



Right arm
Left arm
I
I
II
II
III
III
Left leg

Formation of the triaxial system & assignment of degrees to leads I, II, III

- By bringing the sides of the triangle to the common center.
- The axes are 60° apart.
- ***Axis of a lead: direction from the negative to the positive electrode***

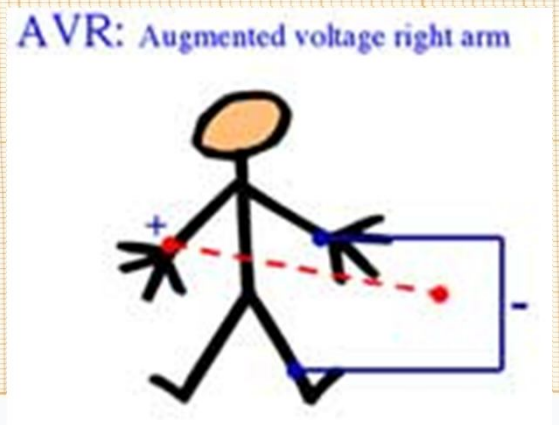
- Lead I (+) is at 0°
- Lead II (+) is at +60°
- Lead III (+) is at +120°

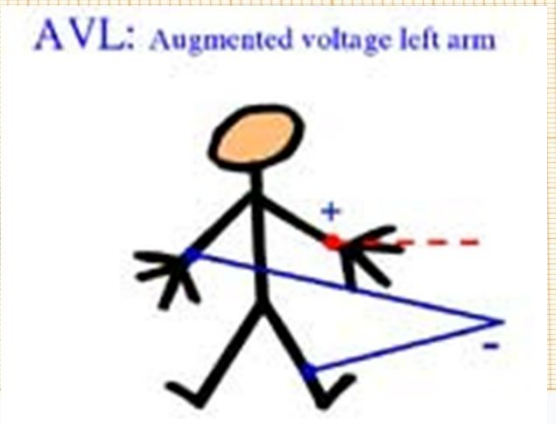


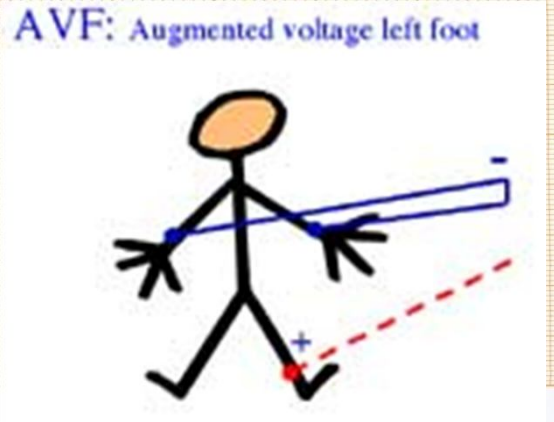
Augmented unipolar limb leads aVR, aVL, and aVF

Are recordings between 1 limb and the other 2 limbs.

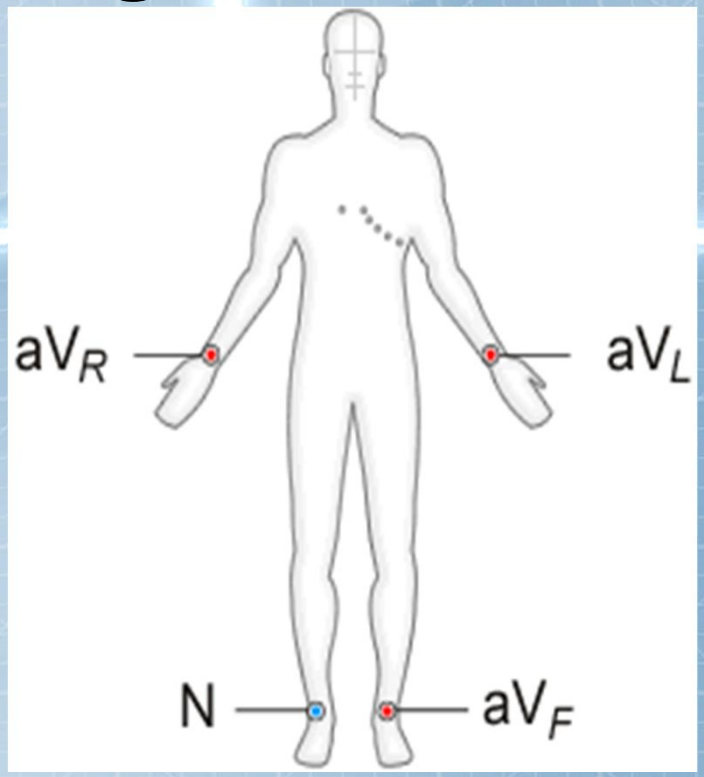
- **Lead aVR (augmented,Voltage,Right arm)**
- **aVL: uses left arm as +ve.**
- **aVF: uses left leg as +ve.**

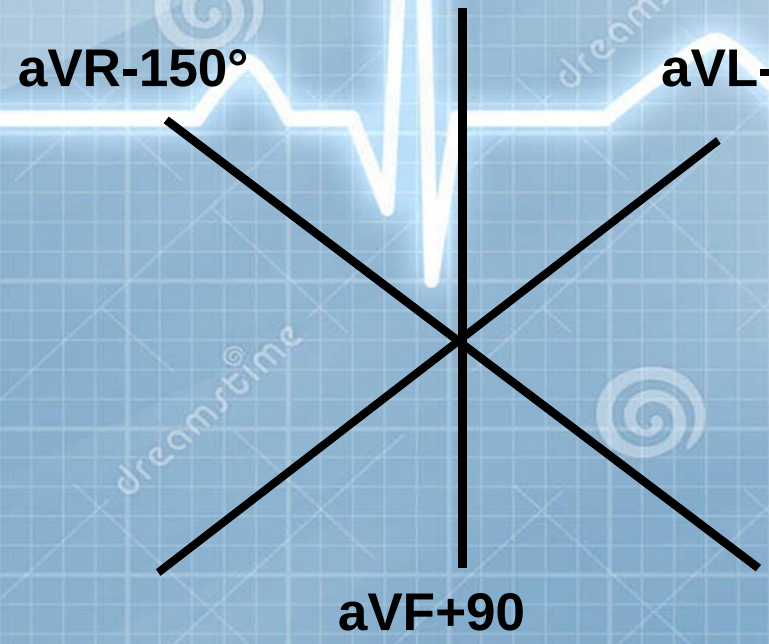






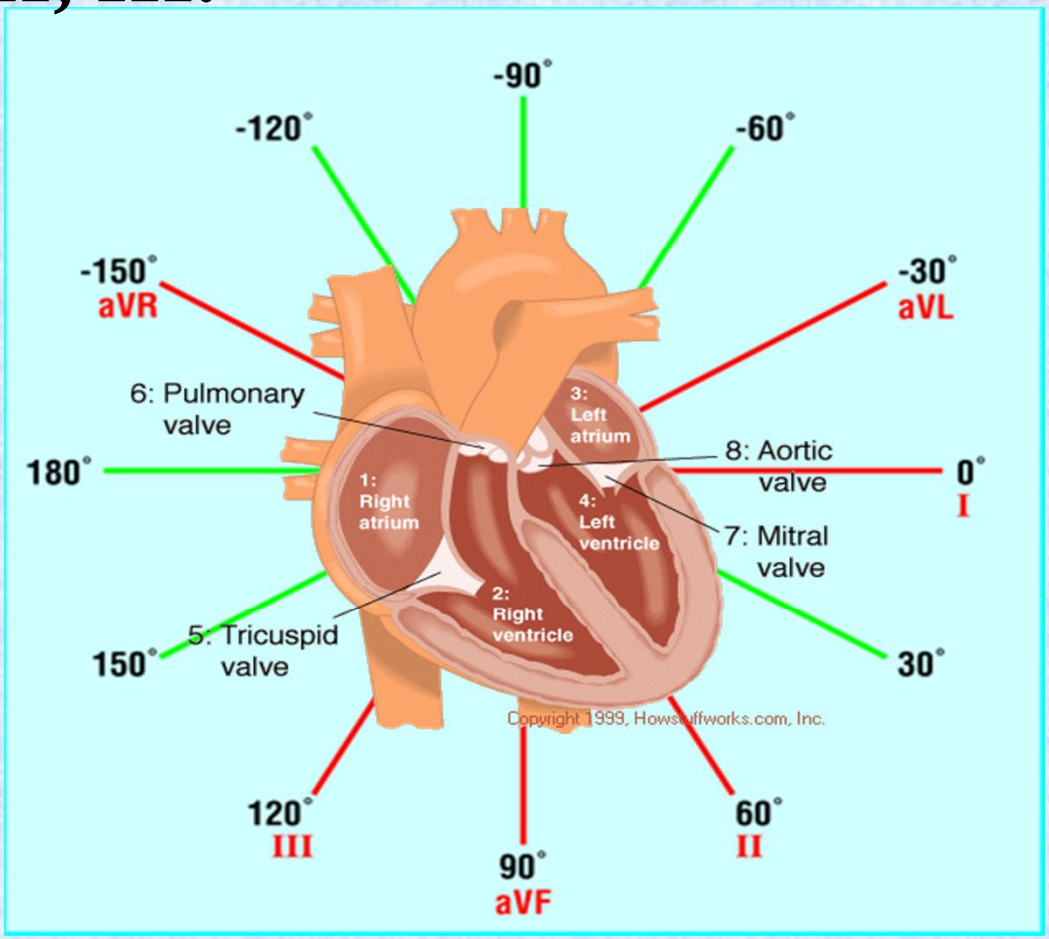
- **Leads aVR, aVL, aVF cross at # angles and produce an intersection of 3 other lines.**
- **Angles of 60° like for lead I, II, III.**





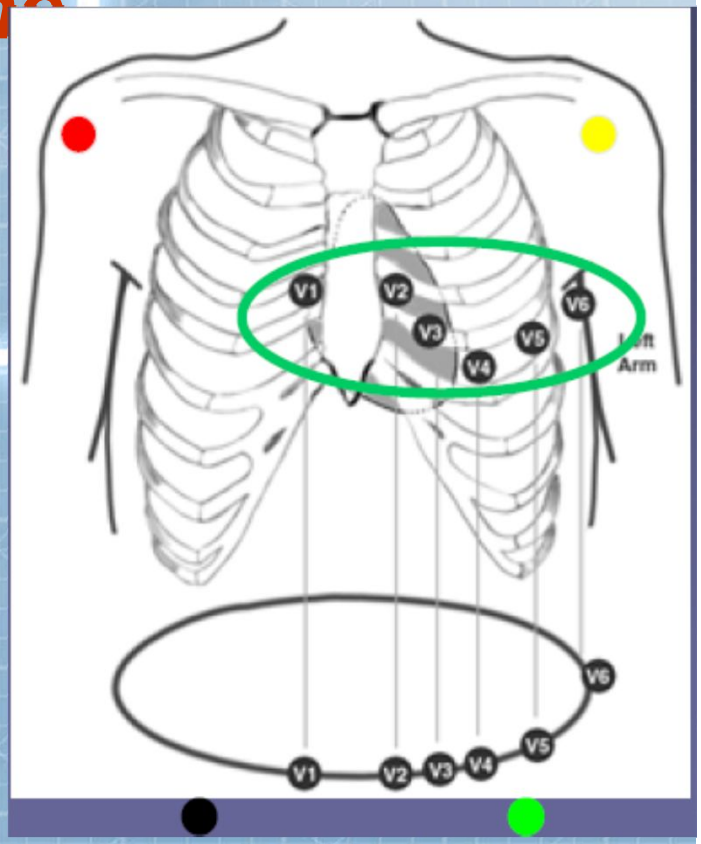
Formation of hexaxial system

- ***Leads aVR, aVF, aVL divide the angles formed by lead I, II, III.***
- ***The leads cross precisely at 30°.***



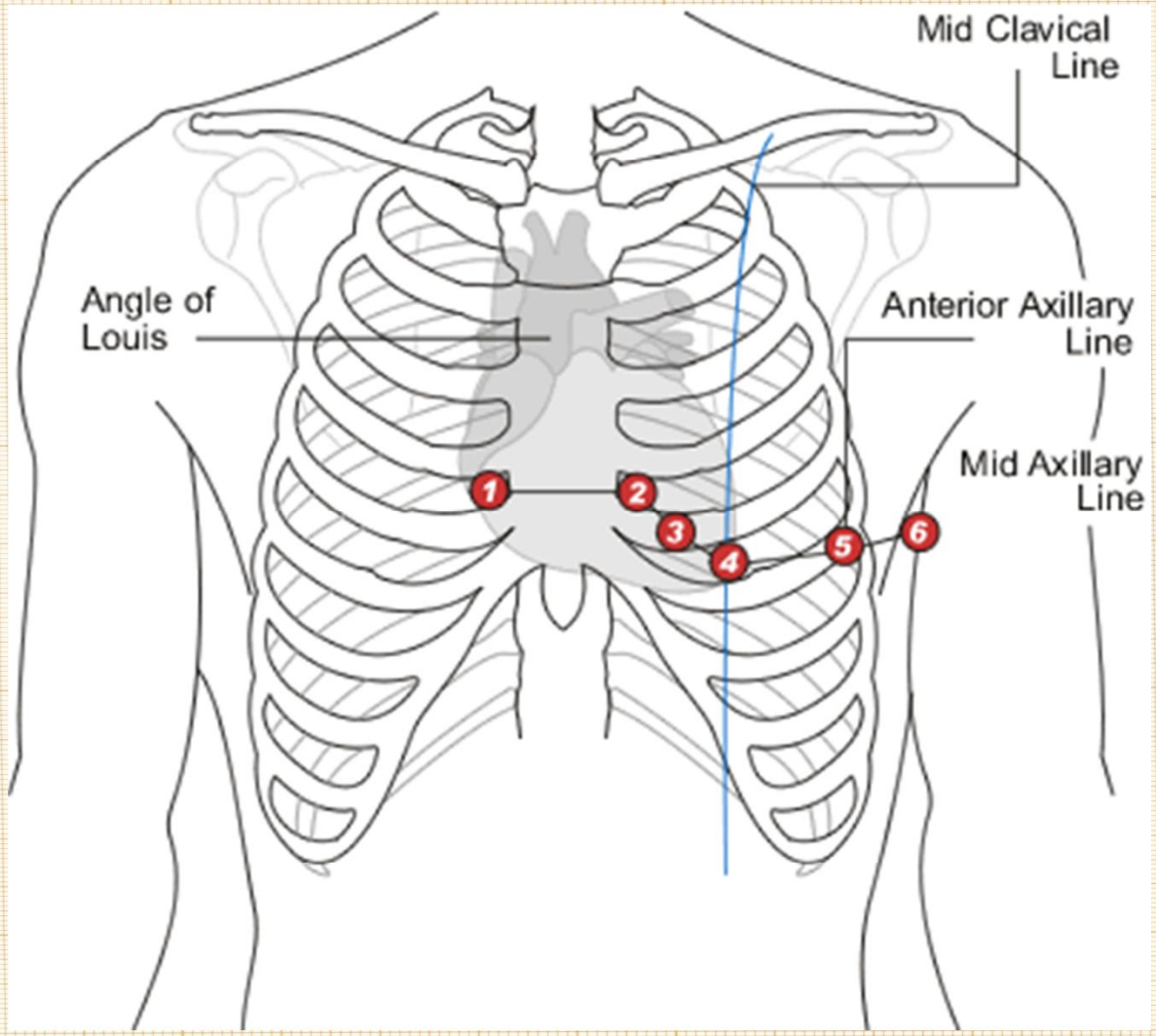
B: ***6 standard "chest leads" depict electrical events in the horizontal plane***

- ***One +ve Ede is placed on 6 different positions around the chest.***
- ***The reference –ve Ede is a combined limb lead.***



Chest leads:

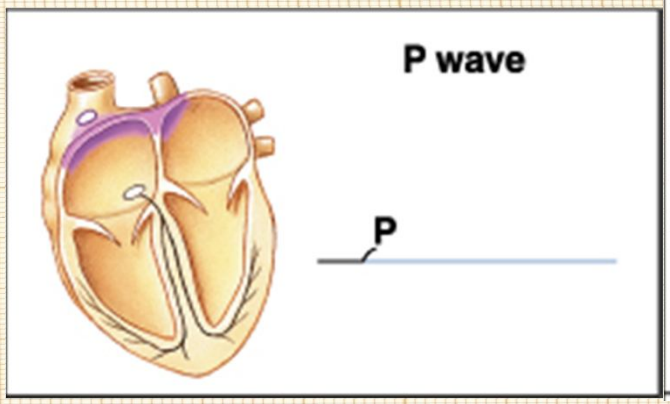
- **V1** – Right sternal border, 4th ICS.
- **V2** – Left sternal border, 4th ICS.
- **V3** – Halfway between leads V2 & V4.
- **V4** – Left mid- clavicular line, 5th ICS.
- **V5** – Anterior axillary line, 5th ICS.
- **V6** – Mid axillary line, 5th ICS.

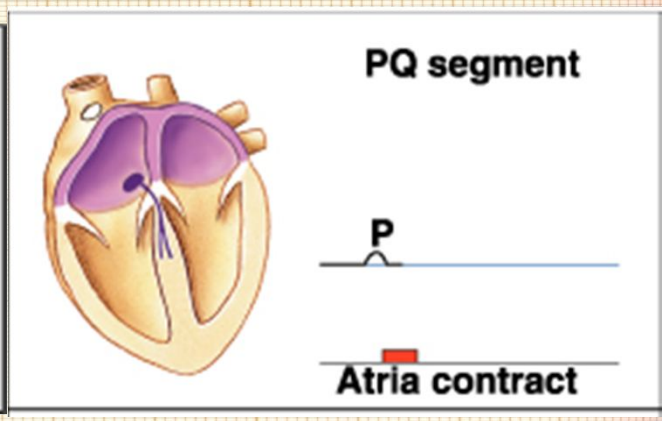

Mid Clavical Line
Angle of Louis
Anterior Axillary Line
Mid Axillary Line
1
2
3
4
5
6

Interpretation of the normal ECG

Atrial activation:

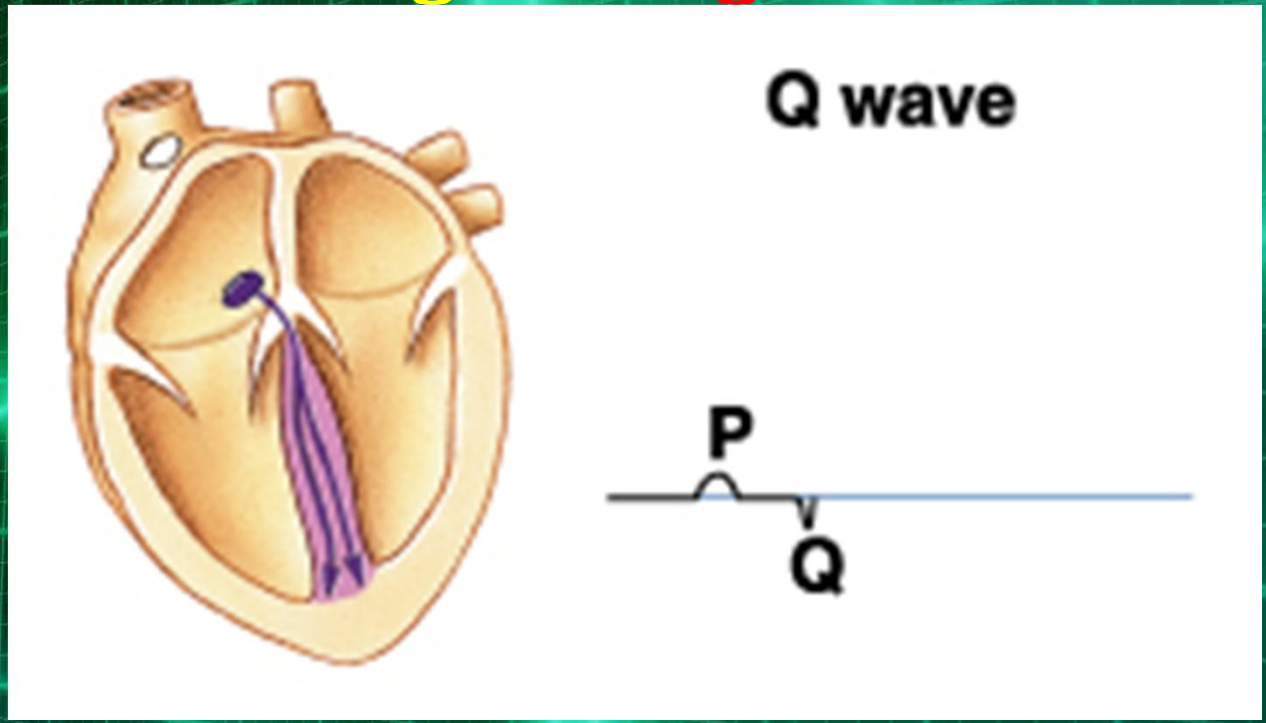
- The impulse originates at SA node, spreads through the atria.
- This causes positive upward deflection.
- The P wave represents the depolarization of both atria.
- Pw: <0.12 sec
  < 2.5 mm





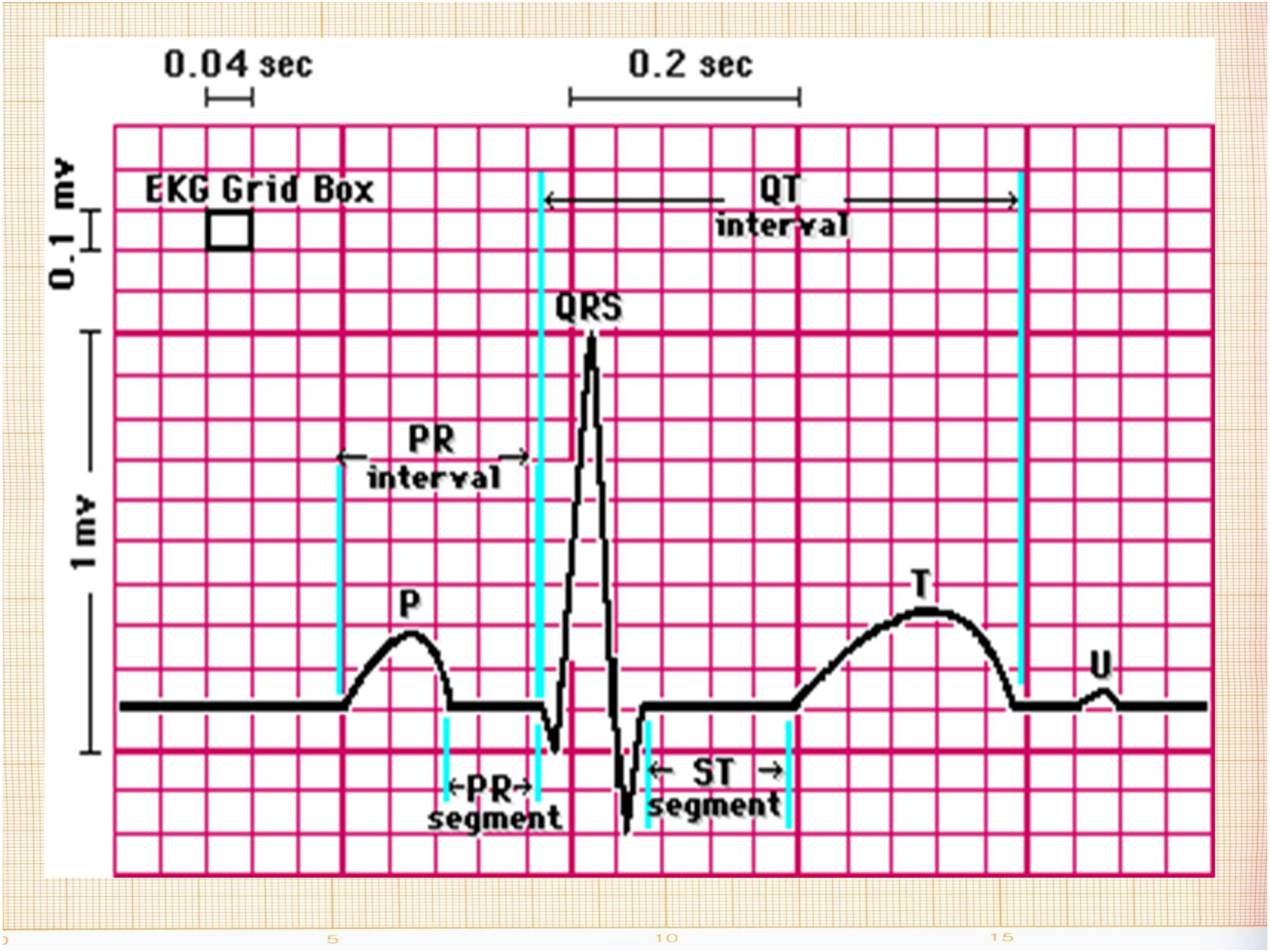
Septal Activation:

- The impulse spreads to the AV node, common bundle of His and R and L bundle branches then enters the IV septum.
- This occurs during PR segment.



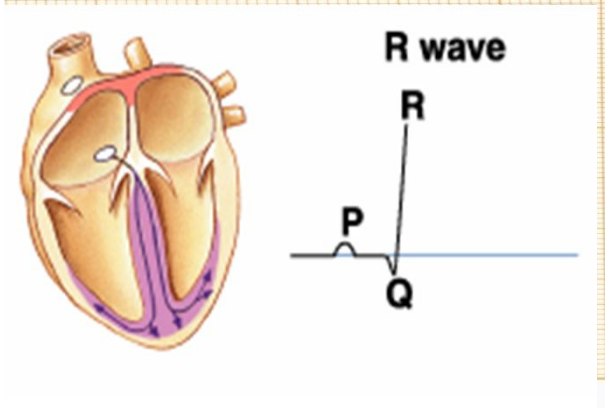
- ***PR interval:*** ***P wave + PR segment.***
- ***Time of transmission of electrical impulse from the beginning of atrial depolarization to the beginning of ventricular depolarization.***
- ***PR: 0.12 - 0.20 seconds*** ***(less than 1 large square).***

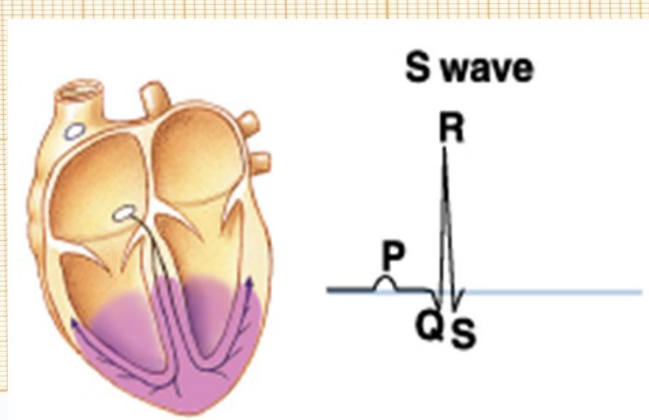
- ***Block AV: PR prolonged > 0.20 seconds.***
- ***PR shortens as heart rate increases.***

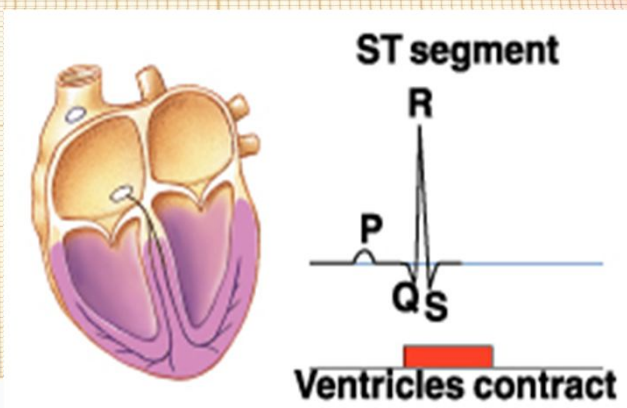

0.04 sec
0.2 sec
0.1 mV
EKG Grid Box
QT
interval
QRS
PR
interval
1mV
P
T
U
PR
segment
ST
segment

Ventricular depolarization

- The wave of depolarization spreads in the Purkinje fibers to all parts of the ventricles.
- The initial negative deflection is Q wave.
- The first positive deflection is R wave.
- The negative deflection after R wave is : S wave.
- QRS duration: < 0.10 sec.

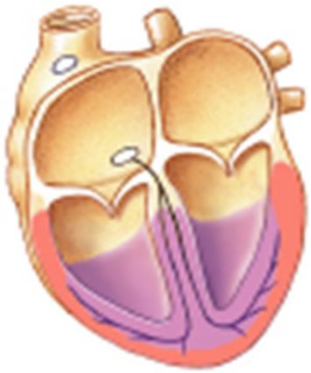


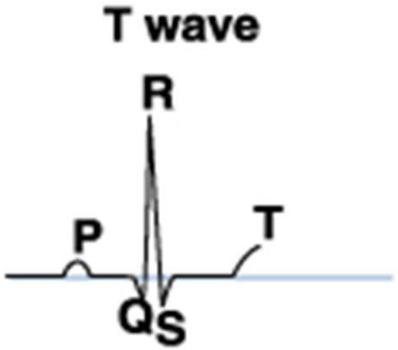


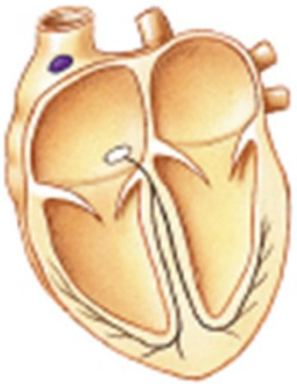


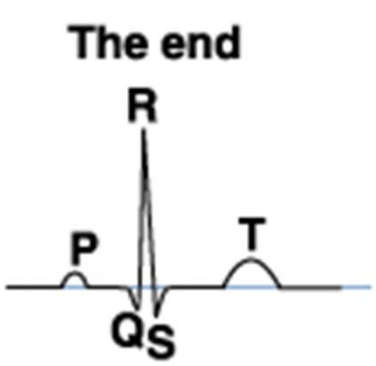
Ventricular repolarization: T wave

- Ventricular repolarization represented by ST segment and T wave.
- **ST segment**: period between the end of QRS and the start of T wave.
- **QT interval**: from beginning of Q wave to end of T wave (ventricular dep and rep) < 0.43 sec.
- **ST interval**: QT-QRS = 0.32 sec.







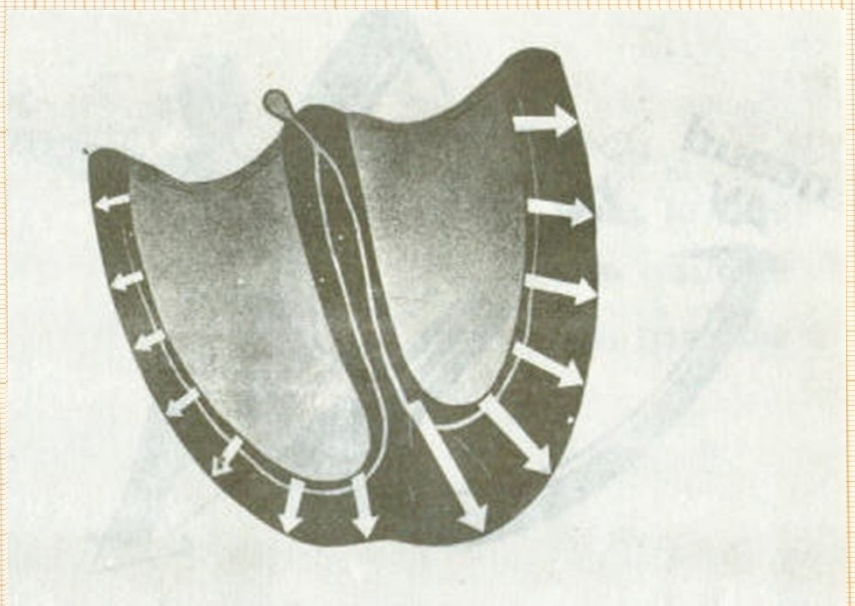


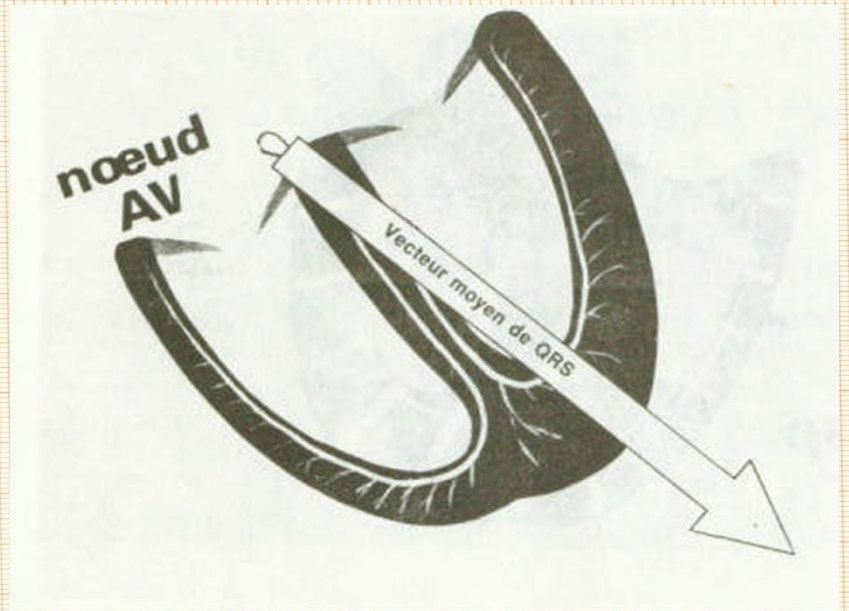
ECG intervals

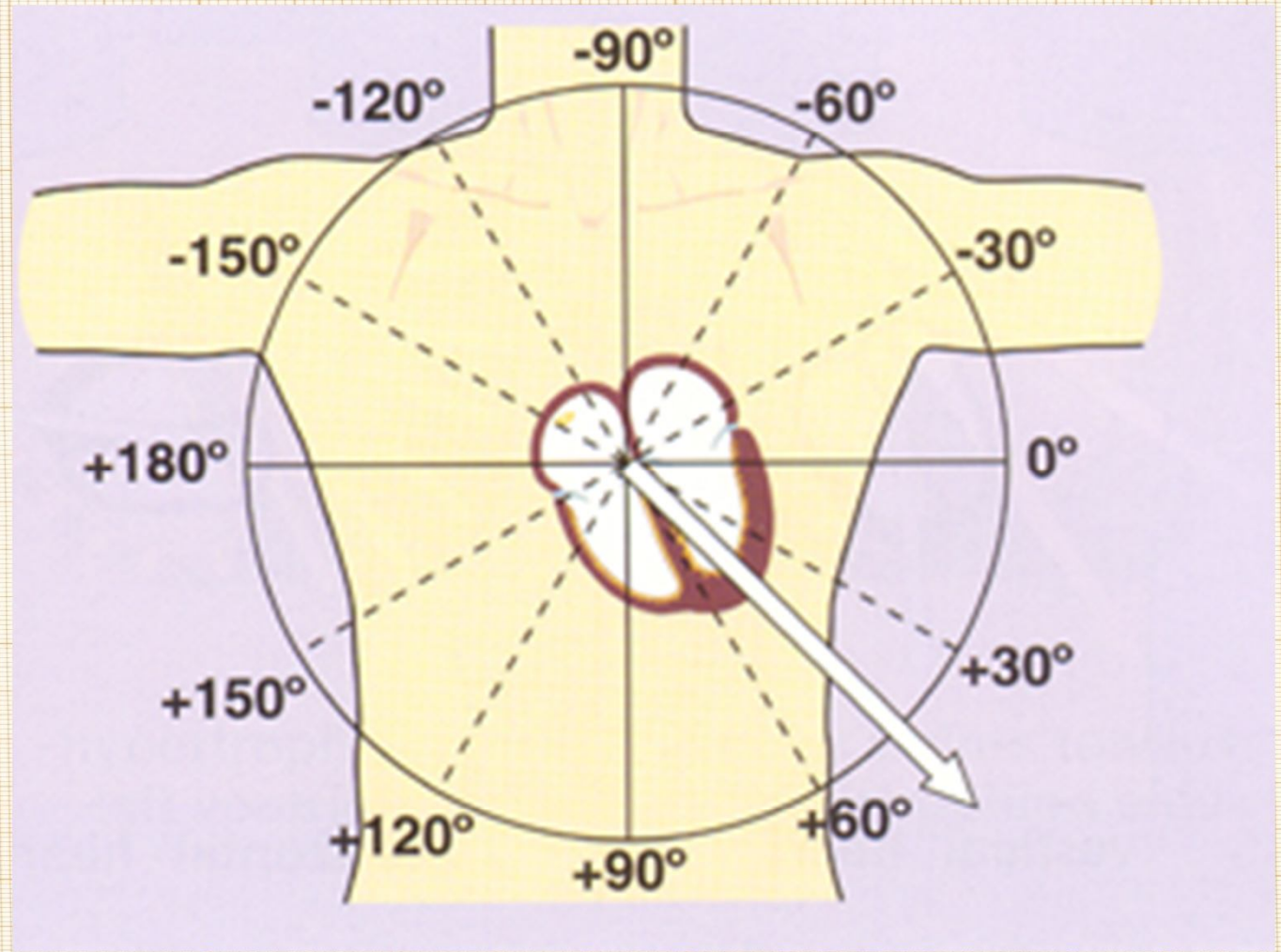
Intervals	Normal Duration(s)		Events in the Heart During Interval
	Average	Range	
PR interval Pw + PR segment.	0.18	0.12-0.20 < 1 large square	Atrial depolarization and conduction through AV node
QRS duration	0.08	To 0.10	Ventricular depolarization and atrial repolarization
QT interval	0.40	To 0.43	Ventricular depolarization plus ventricular repolarization
ST interval (QT minus QRS)	0.32	…	Ventricular repolarization

Cardiac axis

- ***The mean QRS vector is the preponderant direction of the potential during depolarization.***
- ***The mean electrical axis of the ventricles is 59°.***






-90°
-120°
-60°
-150°
-30°
+180°
0°
+150°
+30°
+120°
+60°
+90°

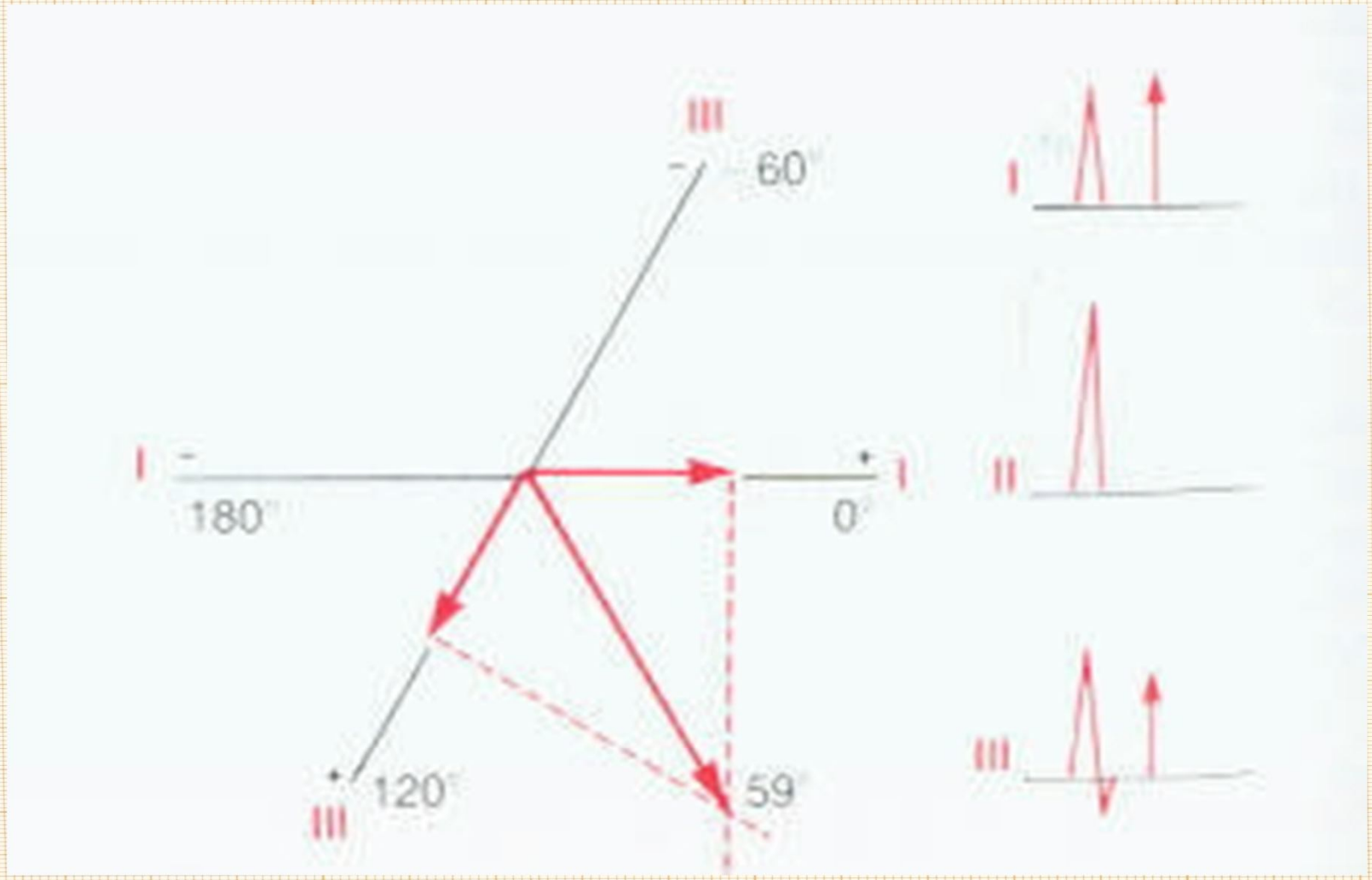
Determining the cardiac axis

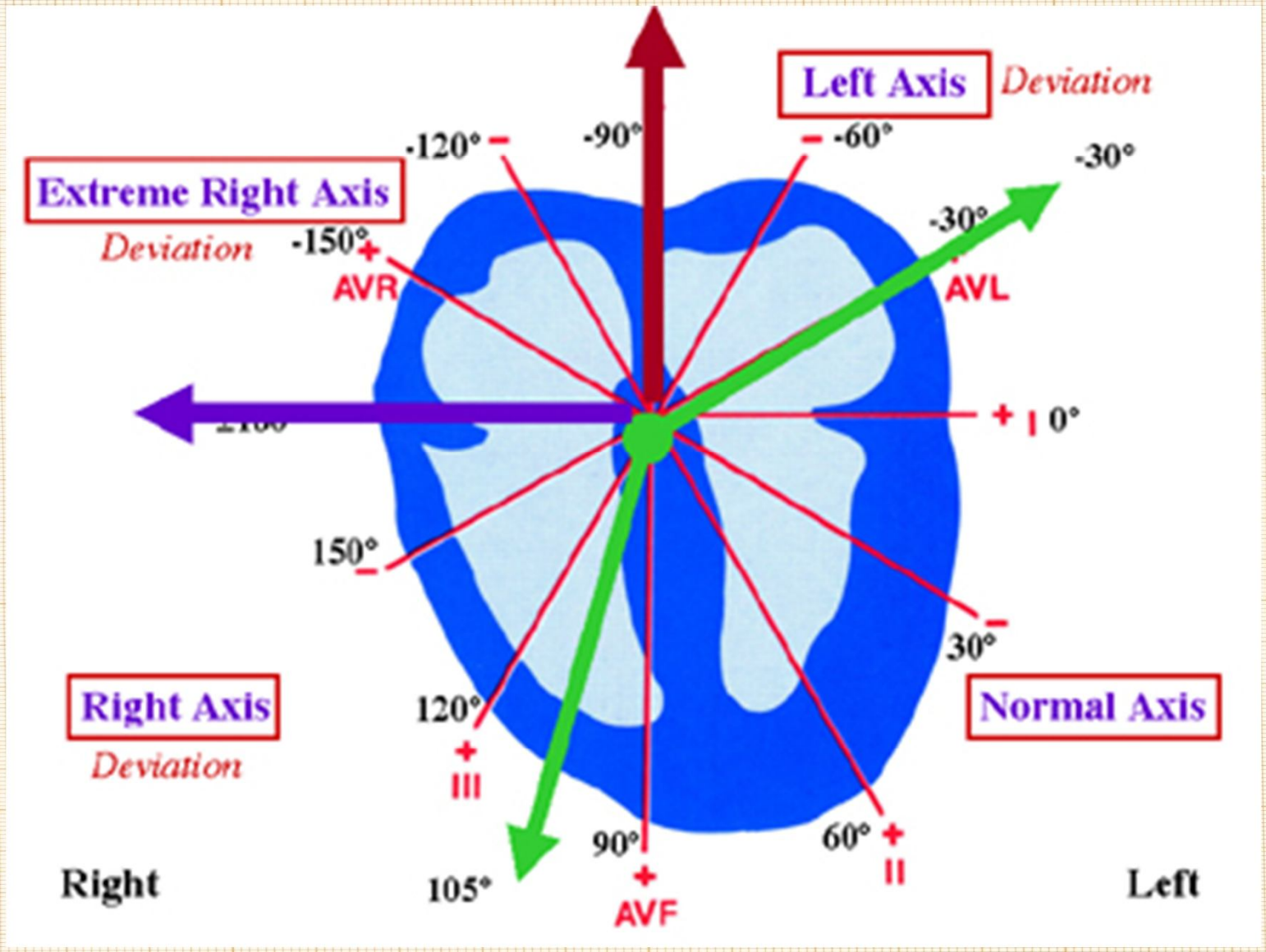
1. *Determine the net potential : (height of R wave- depth of S wave) in lead I and III.*

2. *Plot on the axes of the respective leads.*

3. *Draw perpendicular lines from the apices of the 2 net potentials of lead I and III.*

4. *The intersection point is the apex of the mean QRS vector.*


III
60°
I
I
180°
0°
120°
III
59°
I
II
III


Left Axis
Deviation
-120°
-90°
-60°
-30°
Extreme Right Axis
Deviation
-150°
AVR
-30°
AVL
±180°
0°
150°
30°
Right Axis
Deviation
120°
III
Normal Axis
90°
60°
II
105°
AVF
Right
Left

Normal Axis:	**from 0 ° to +90 °**
Left Axis Deviation: **Obese (normal)** **L V hypertrophy**	**from 0 ° to -90 °**
Right Axis Deviation: **Thin tall (normal)** **R V hypertrophy** **R B B B**	**from + 90° to ± 180 °**
Extreme Right Axis Deviation:	**from -90 ° to ± 180°**

Inspection method

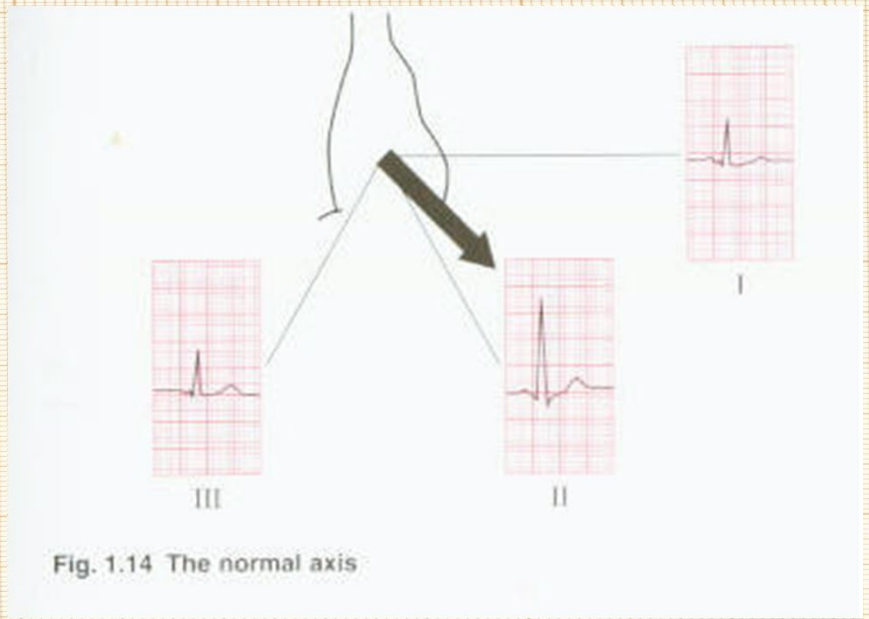
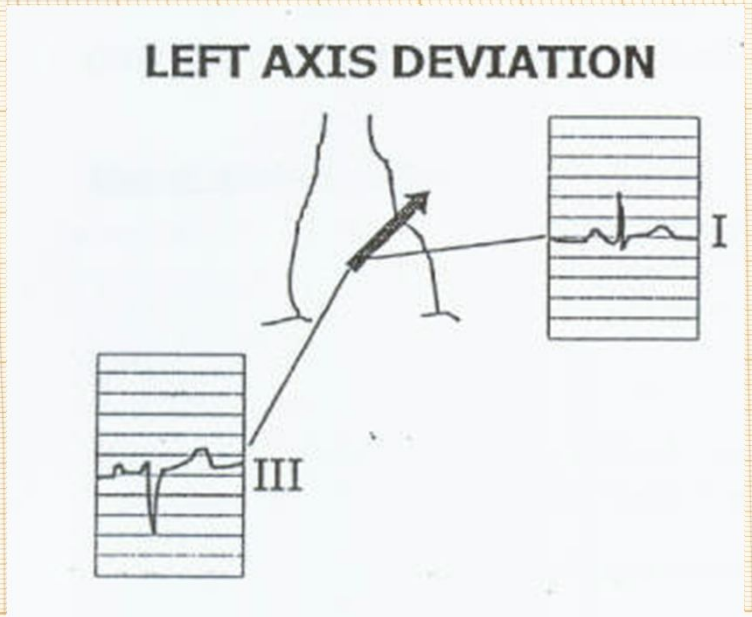
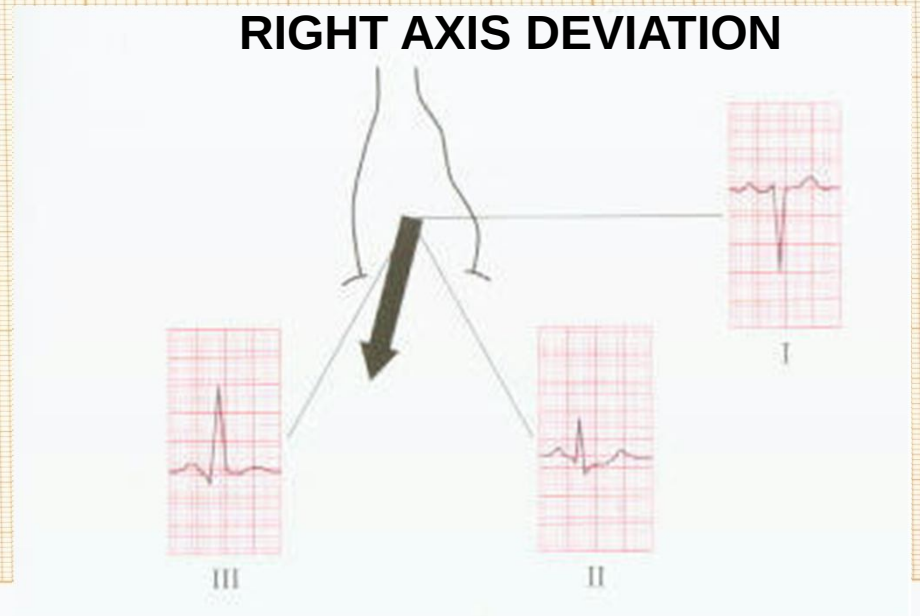
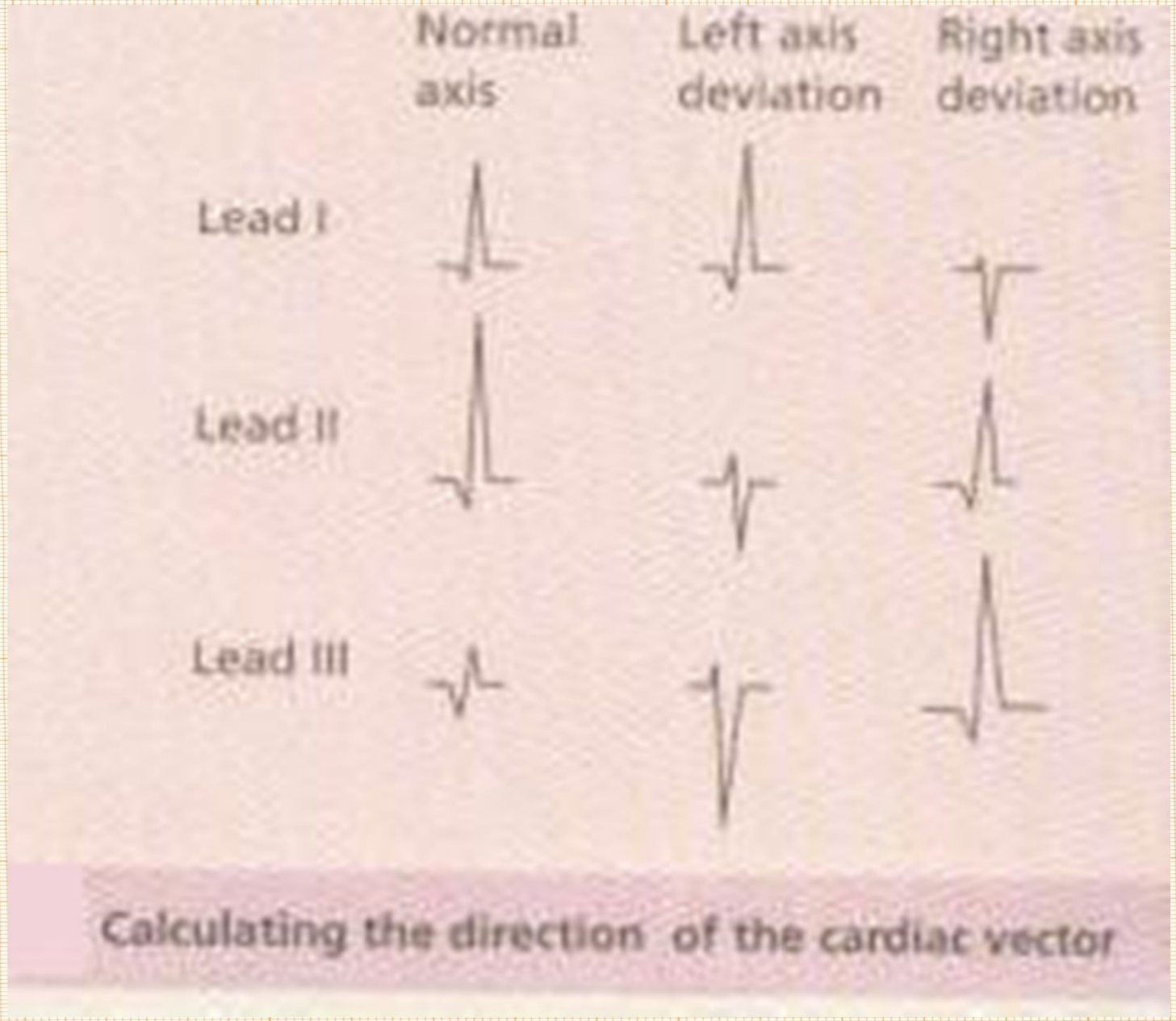


Fig. 1.14 The normal axis







Calculating the direction of the cardiac vector

Rythm

Sinus rhythm: P wave before every QRS:
Impulse from SA node

- Sinus Regular distance between R-R: constant
- Sinus Irregular

Sinus arrythmia (norma pysiological phenomenonl)

- Deep inspiration :Rwaves closer :fast rate
- Deep expiration: bradycardia

Heart rate

Examine the distance between QRS complexes.

If the distances are regular, use one of these two formulas:

$$\frac{300}{\text{Big squares between R-R}}$$

Or:

$$\frac{1500}{\text{Small squares between R-R}}$$

To obtain the heart rate in beats per minute.

1 complex every 1 major division = 300/min

1 complex every 2 major divisions = 150/min

1 complex every 3 major divisions = 100/min

1 complex every 4 major divisions = 75/min

1 complex every 5 major divisions = 60/min

1 complex every 6 major divisions = 50/min