

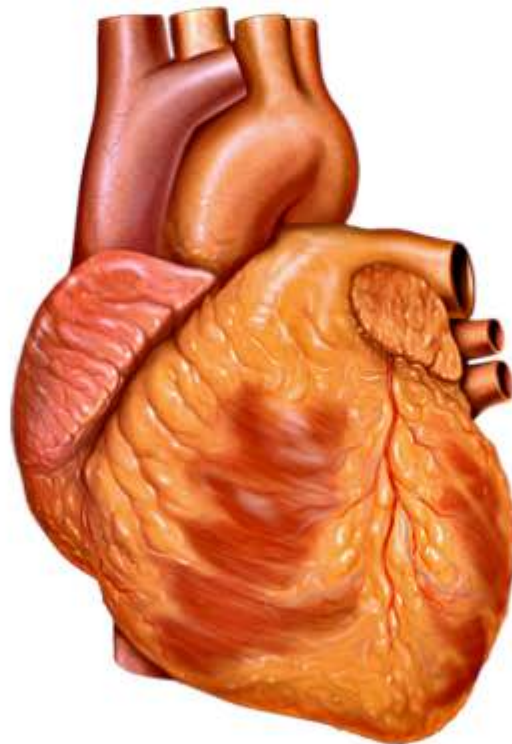


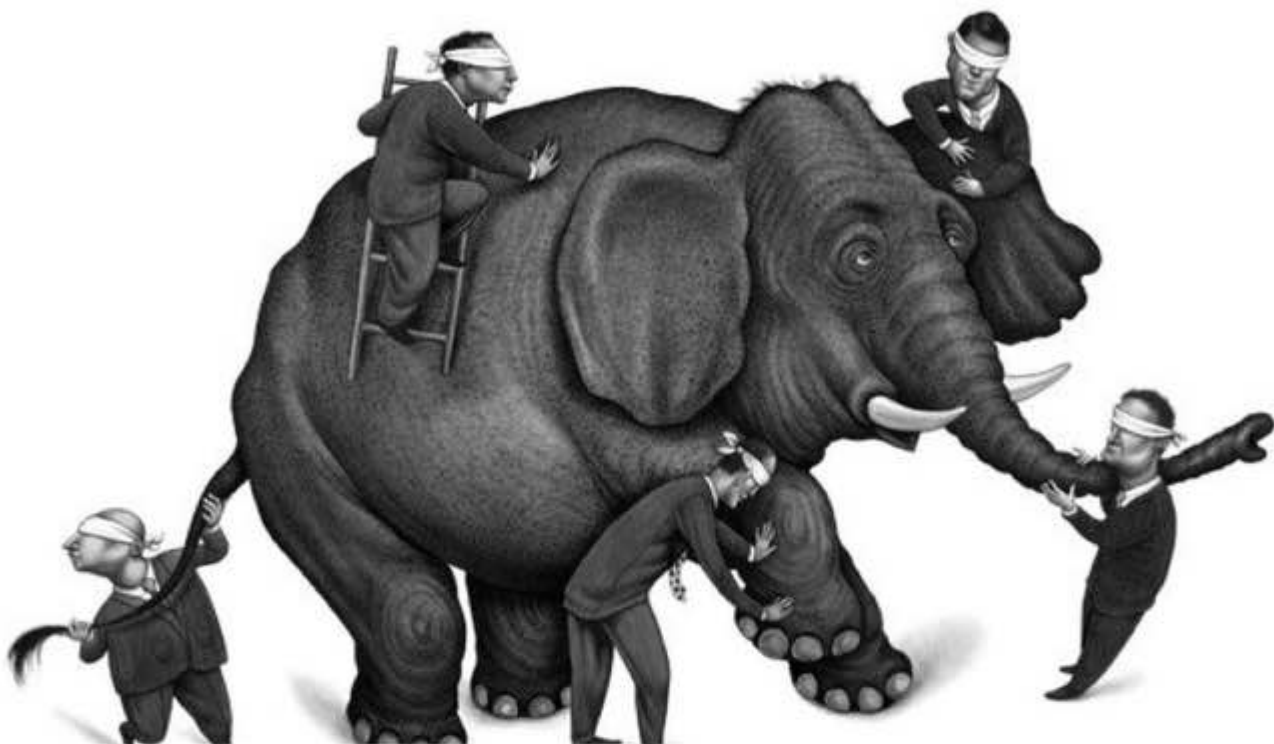
ECG Course

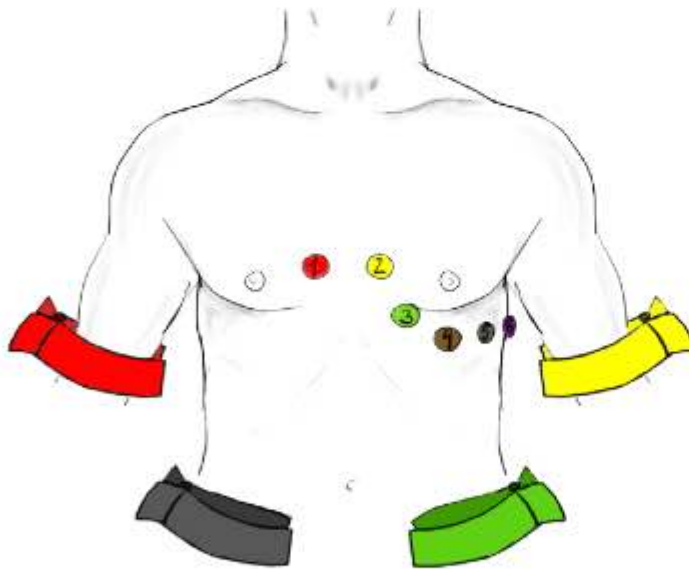
Sarah Taaghi MD

Interventional Electrophysiologist

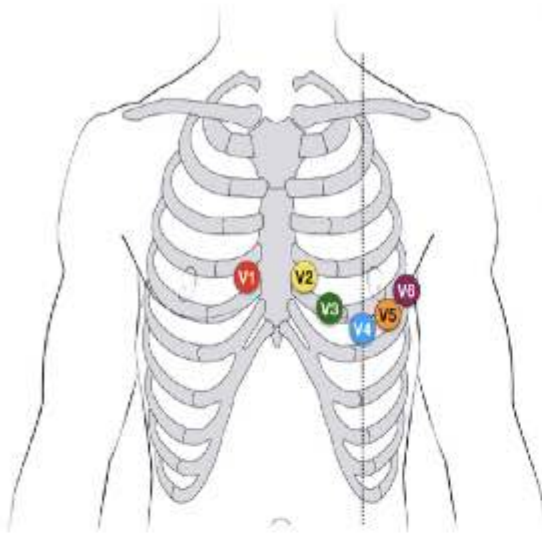
Assistant professor of Cardiology / IUMS





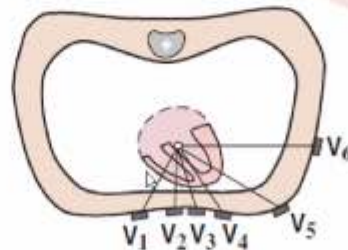
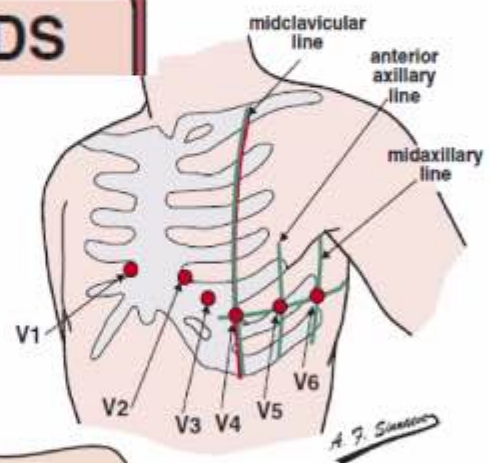


قسم سز

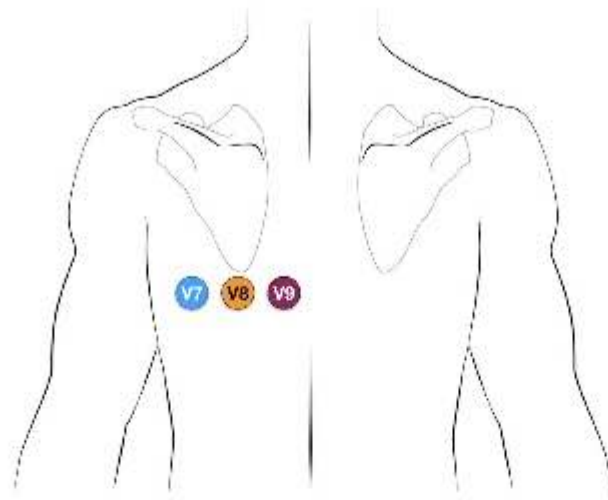


- V₁** 4th intercostal space to the right of the sternum
- V₂** 4th intercostal space to the left of the sternum
- V₃** Directly between the leads V₂ and V₄
- V₄** 5th intercostal space at midclavicular line
- V₅** Level with V₄ at left anterior axillary line
- V₆** Level with V₅ at midaxillary line
(directly under the midpoint of the armpit)

THE PRECORDIAL LEADS

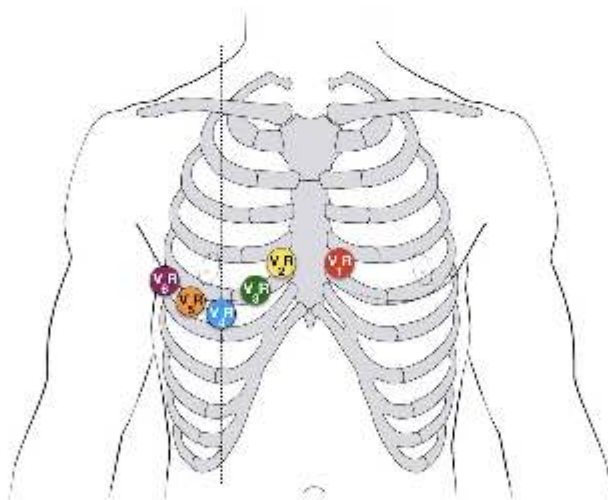


Posterior ECG

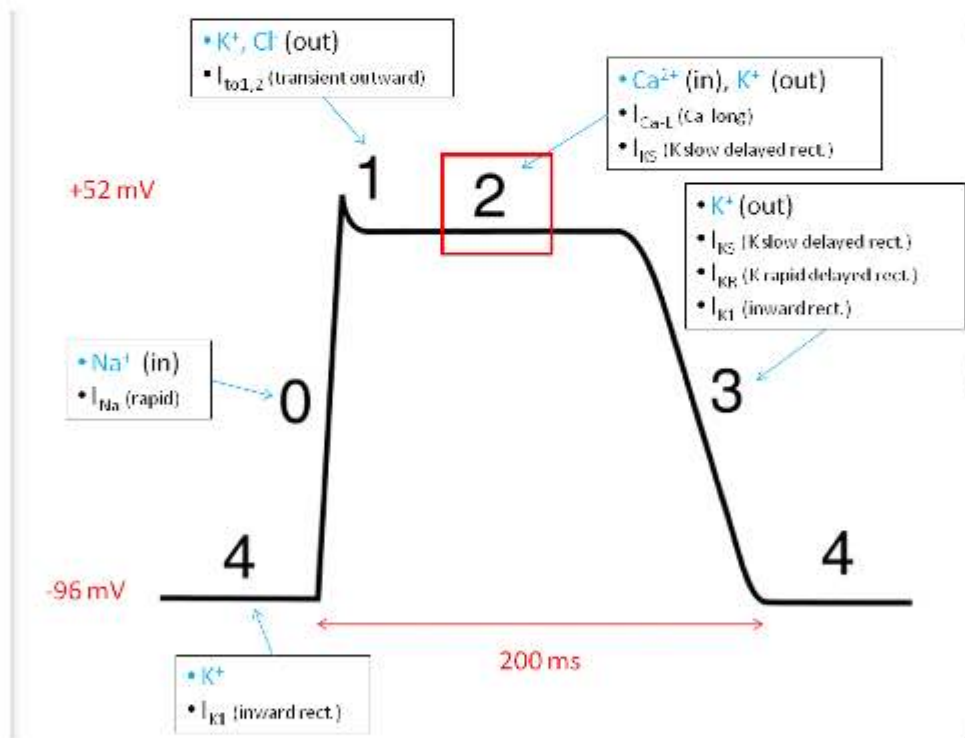
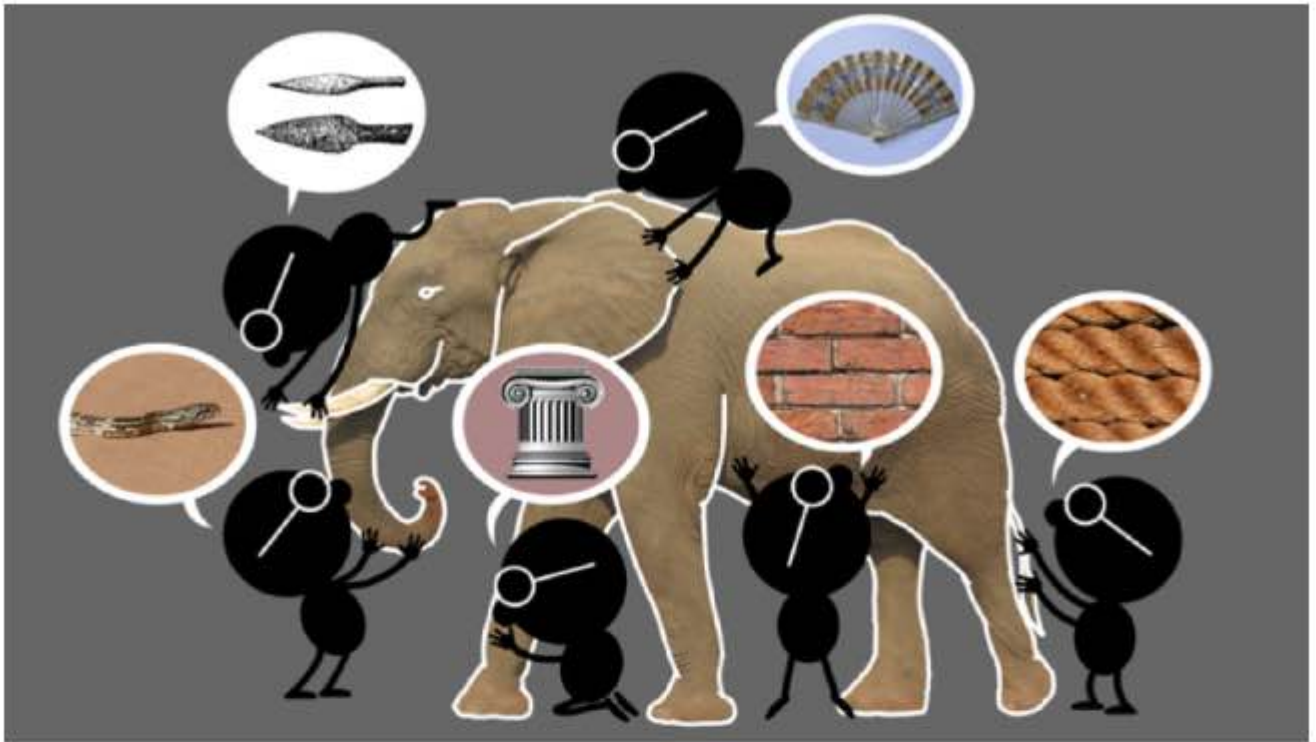


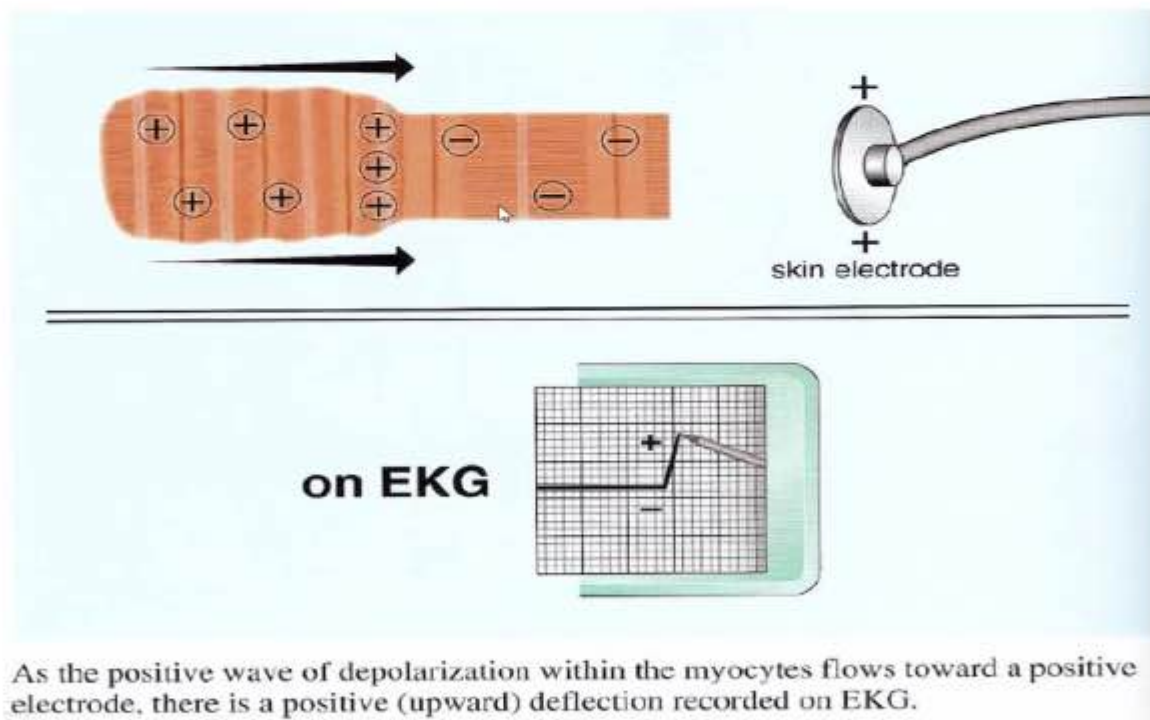
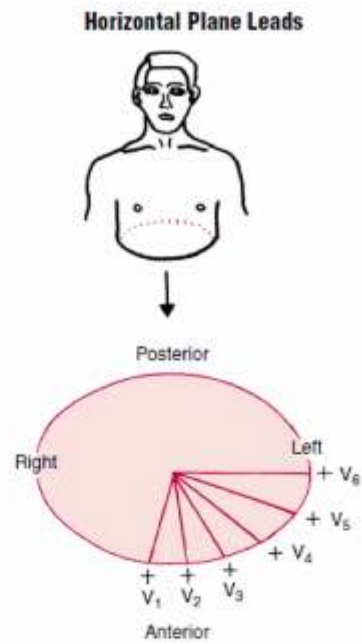
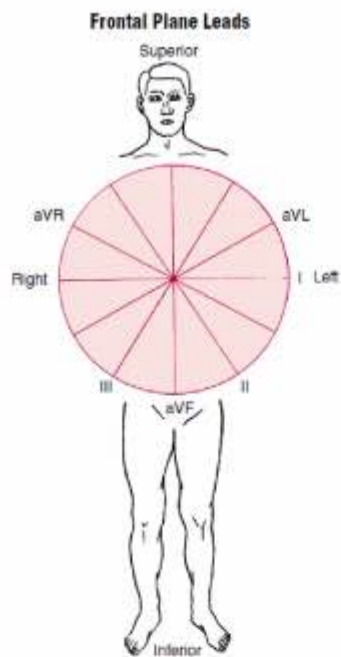
مجمع آموزش و پژوهش در طب اسلامی
مجمع آموزشی درمانی
حضرت رسول اکرم (ص)

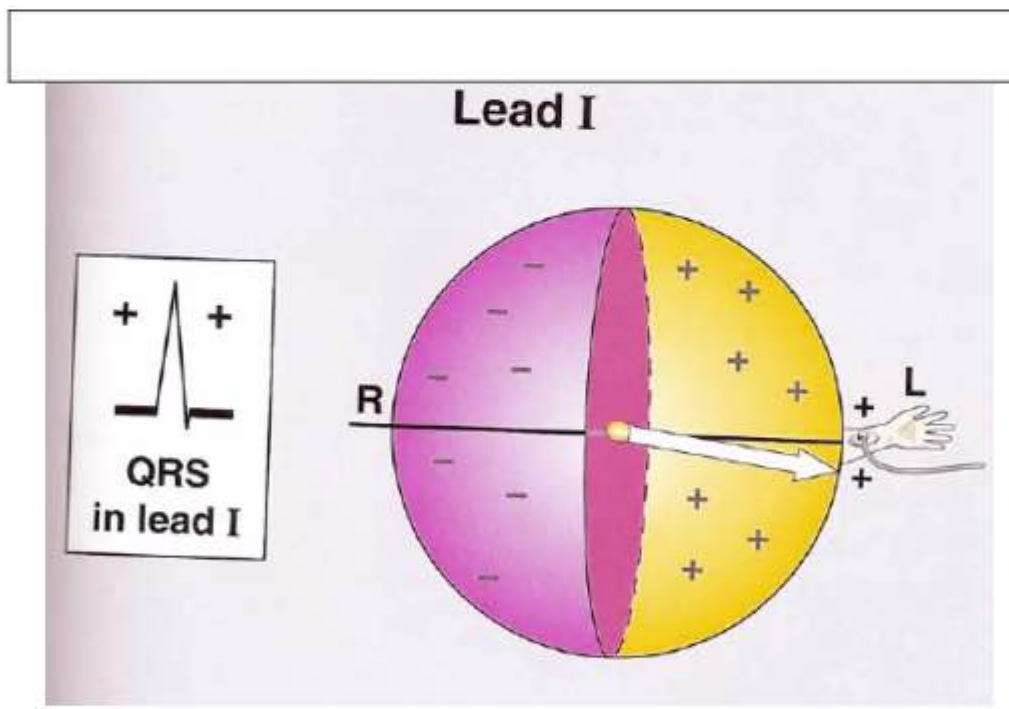
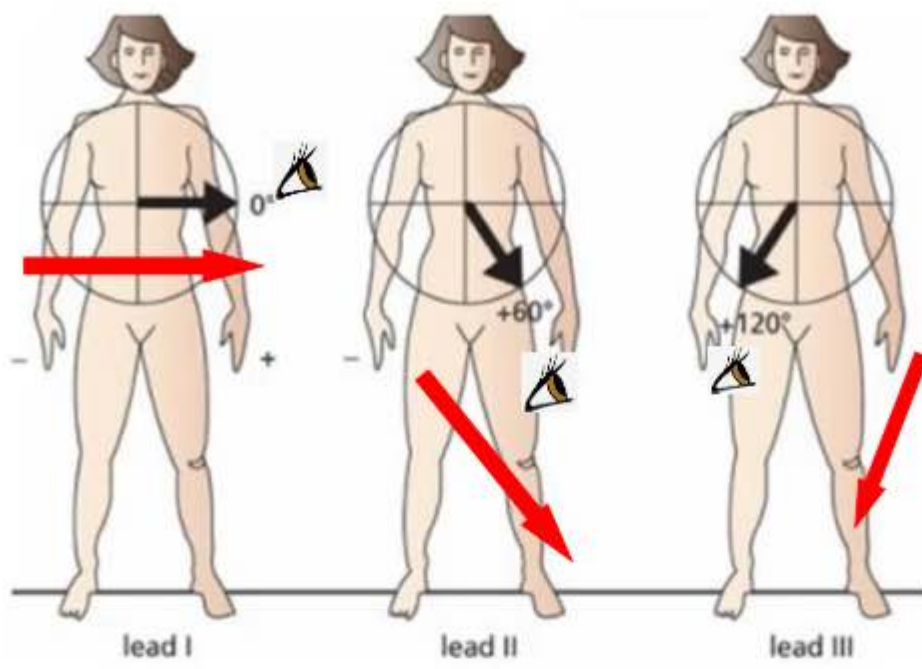
Right side ECG

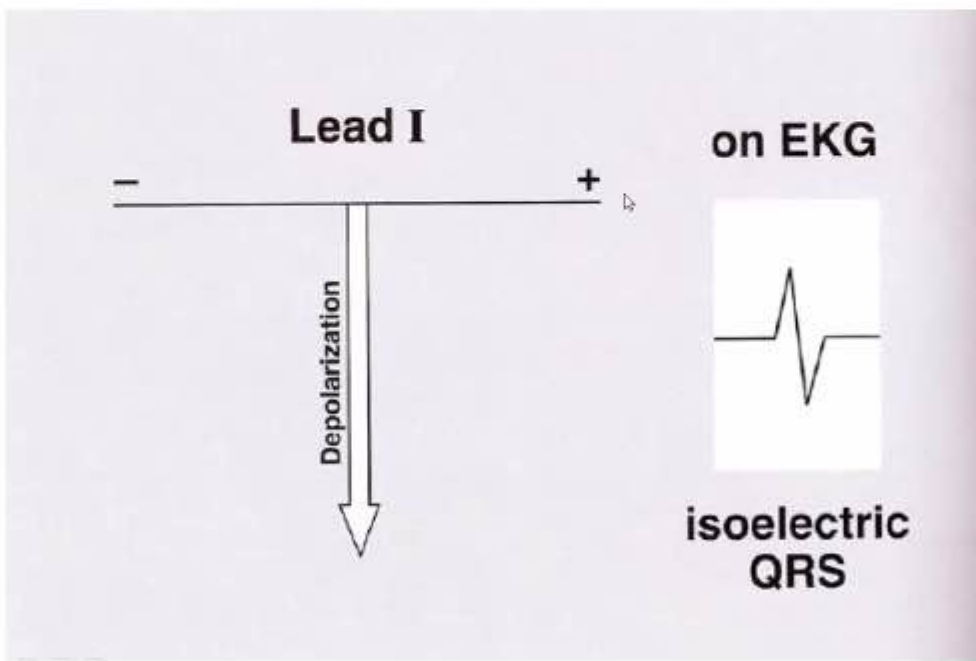
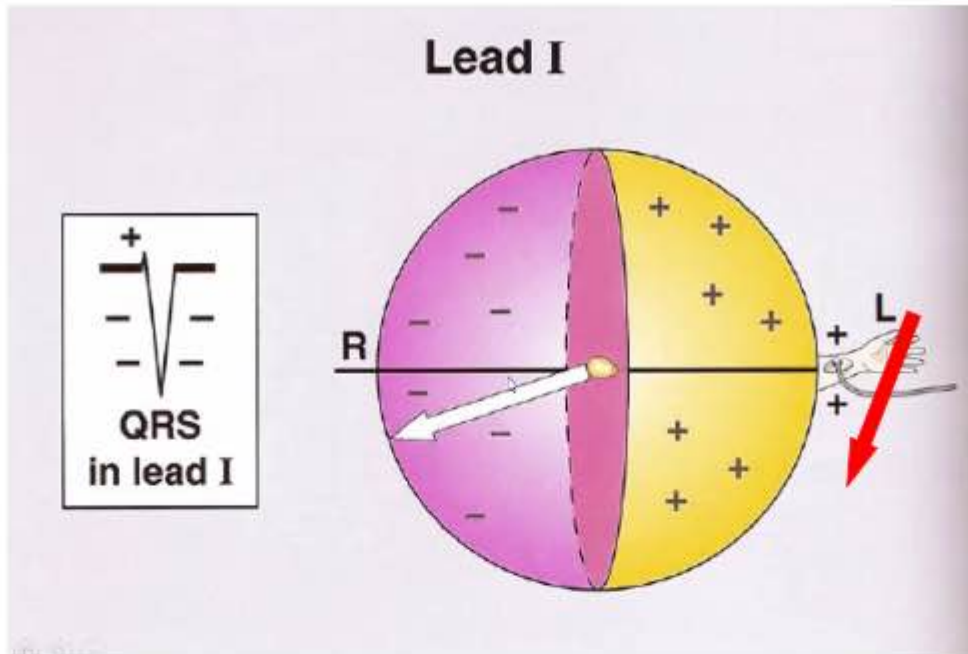


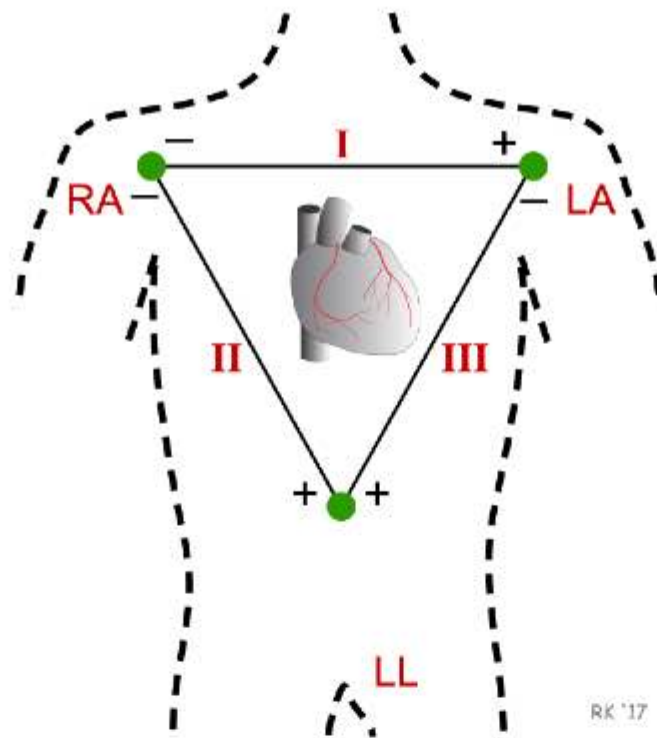
مجمع آموزش و پژوهش در طب اسلامی
مجمع آموزشی درمانی
حضرت رسول اکرم (ص)





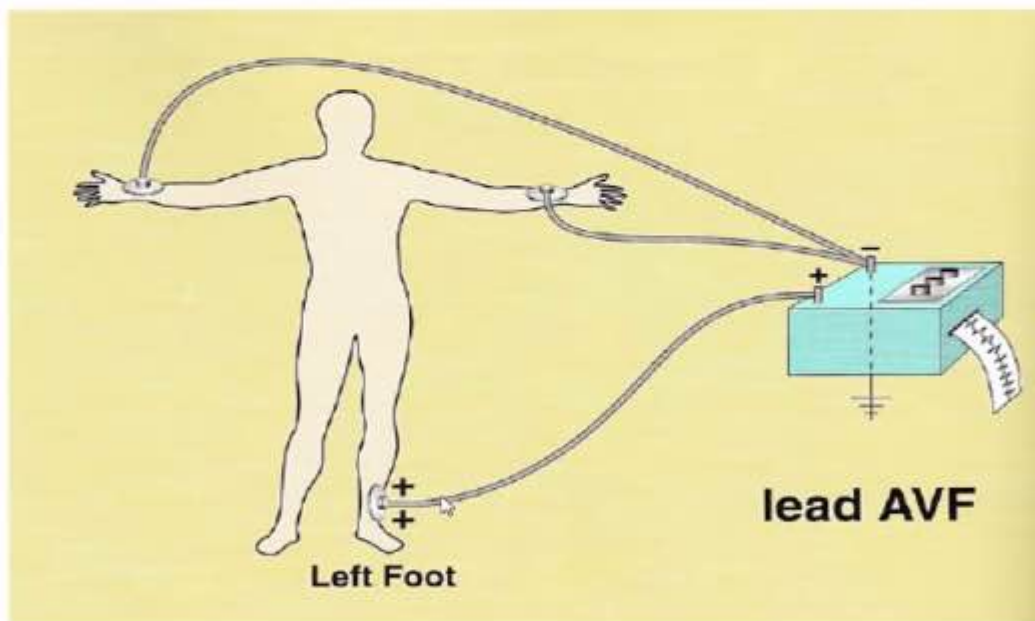


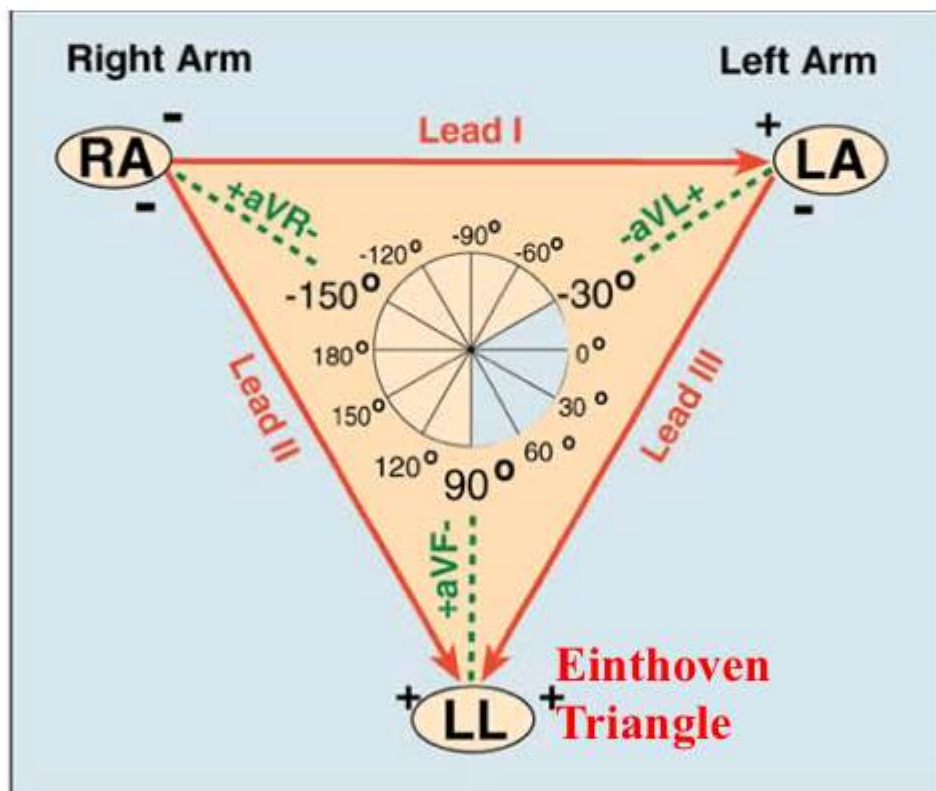
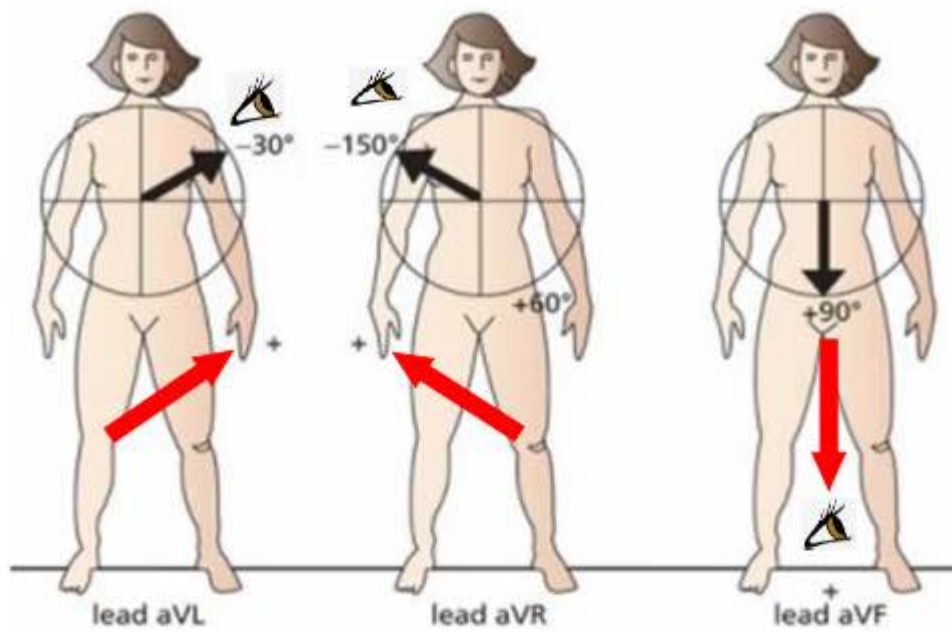




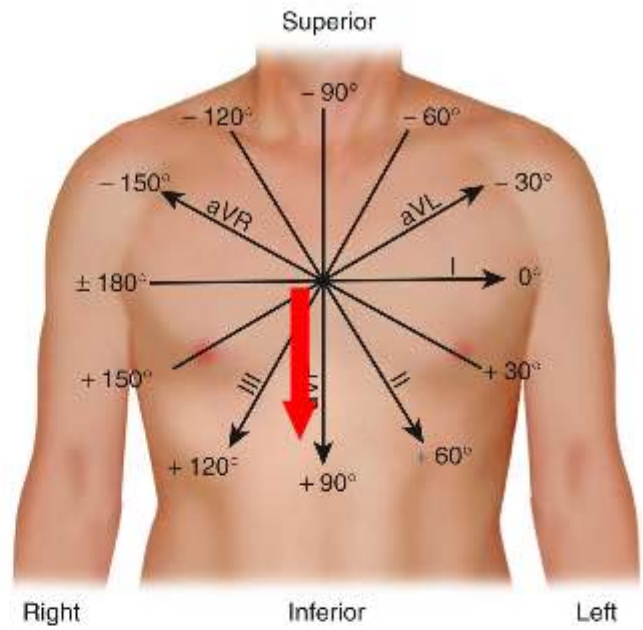
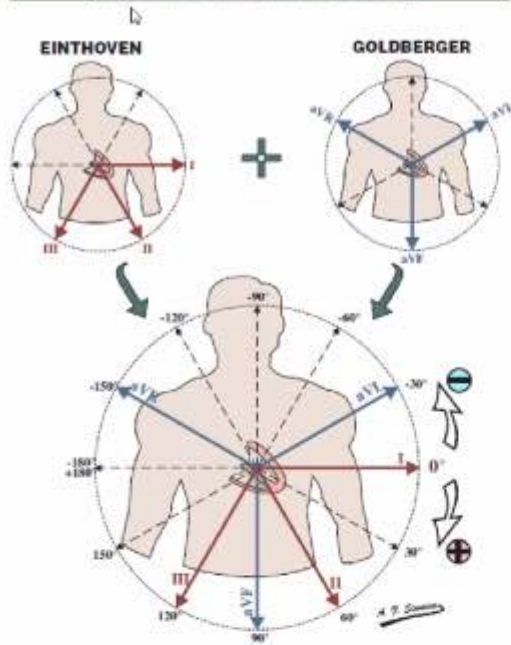
RK '17

AUGMENTED LIMB LEADS ACCORDING TO GOLDBERGER

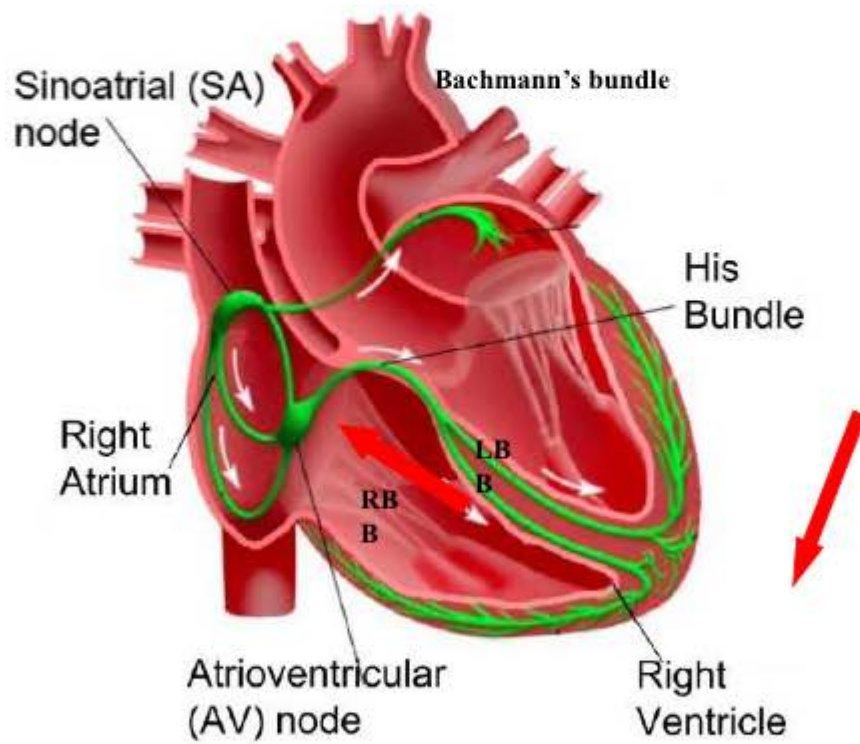
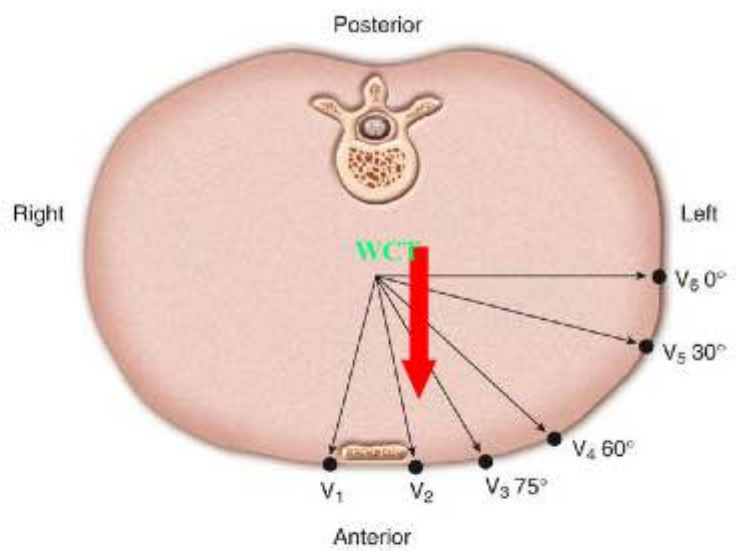
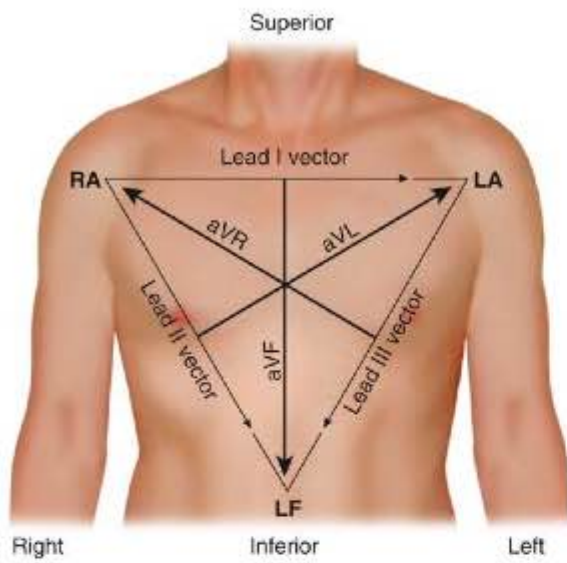


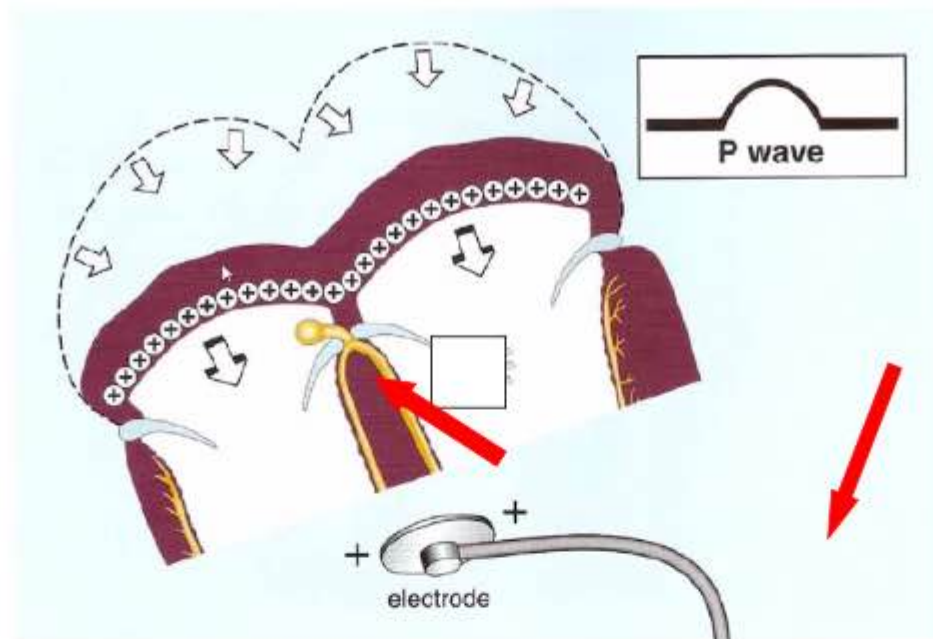


THE LIMB LEADS IN THE FRONTAL PLANE (HEXAXIAL REFERENCE FIGURE)

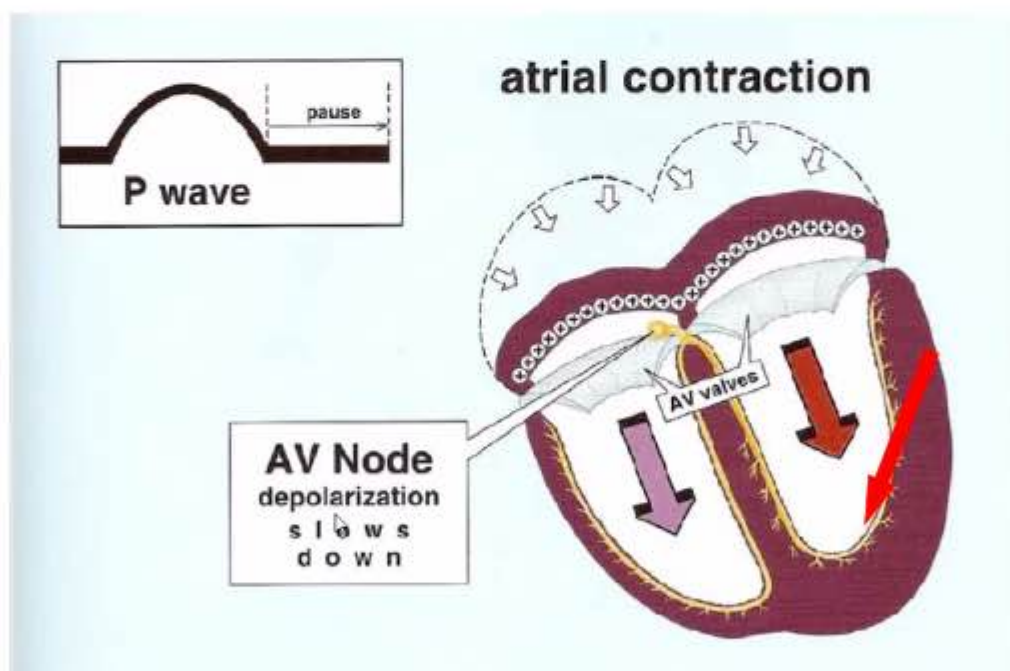


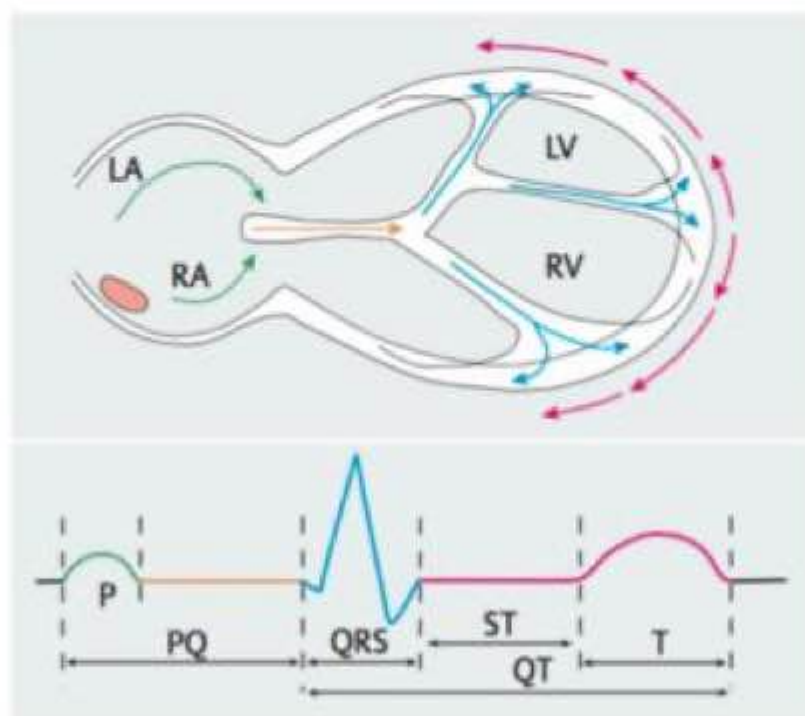
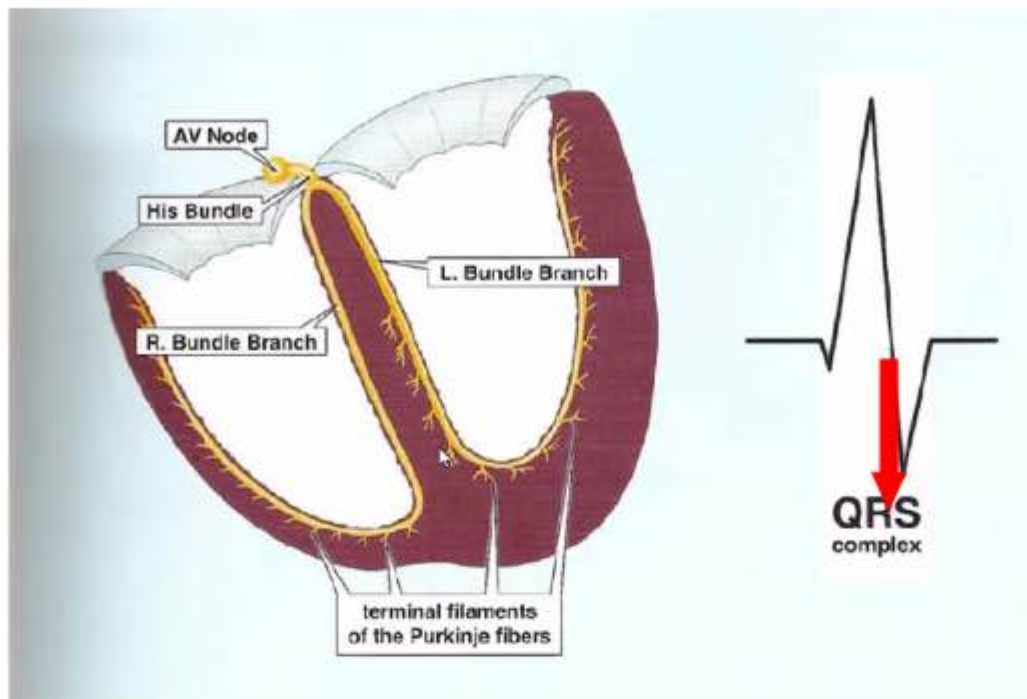
Lead	Angle	
Inferior Leads		
Lead II	+60°	
Lead III	+120°	
Lead aVF	+90°	
Left Lateral Leads		
Lead I	+0°	
Lead aVL	-30°	
Right-sided Lead		
Lead aVR	-150°	

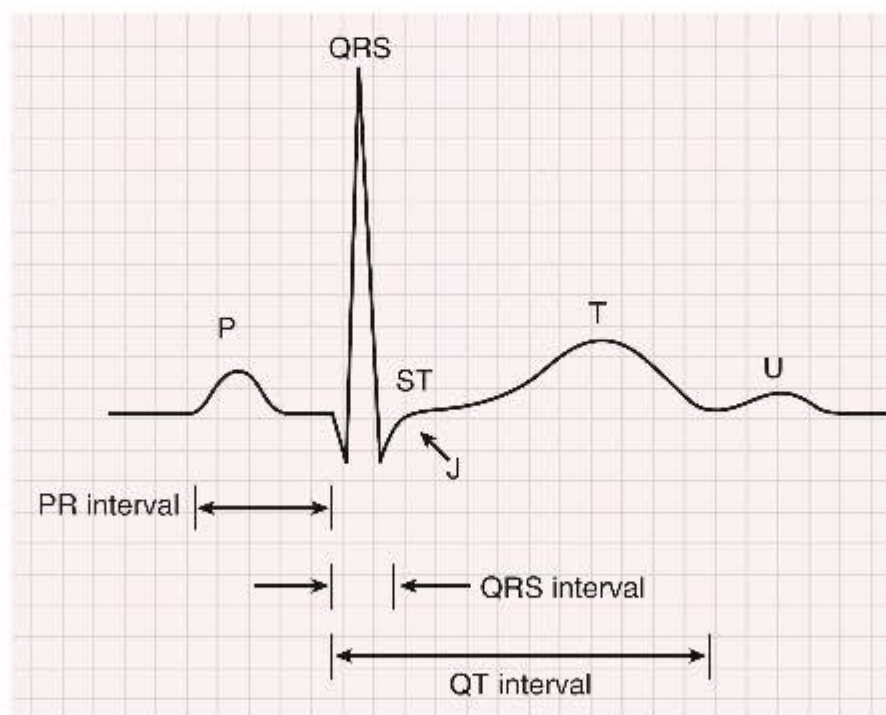
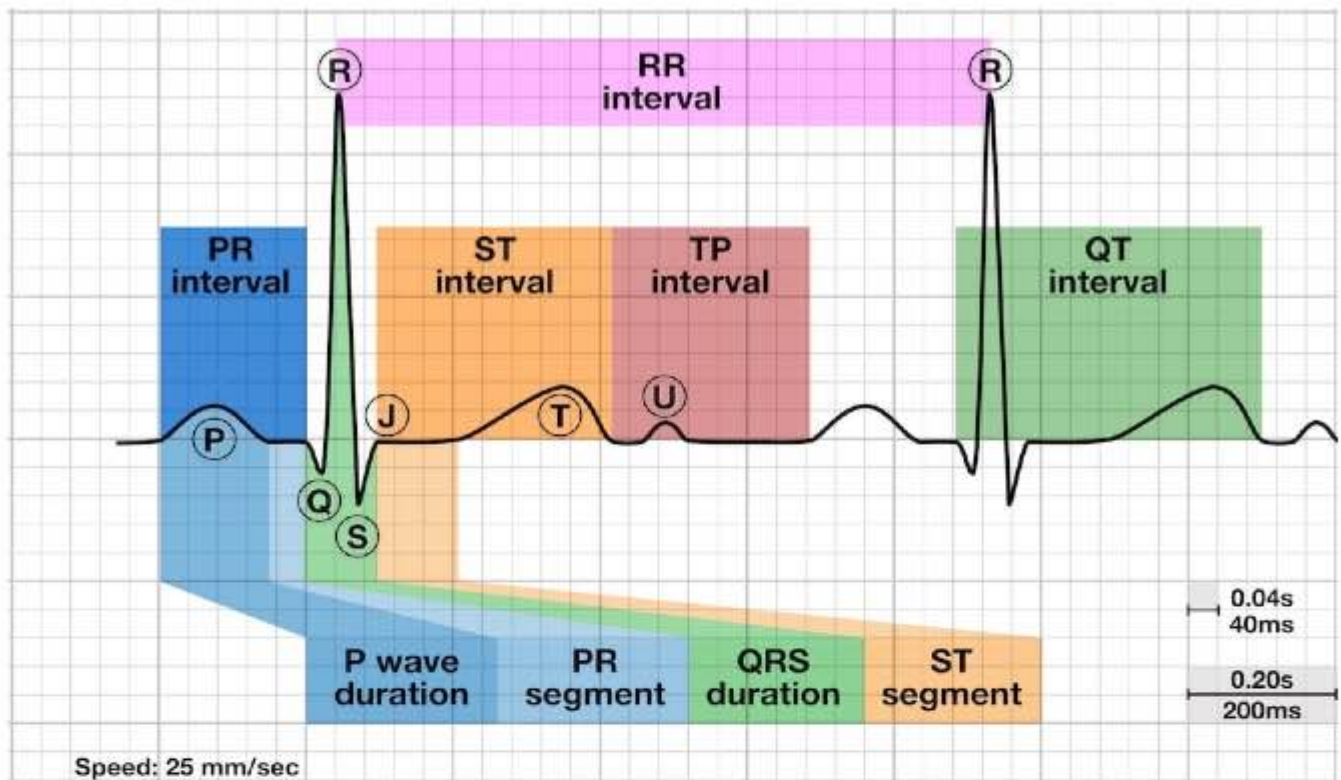


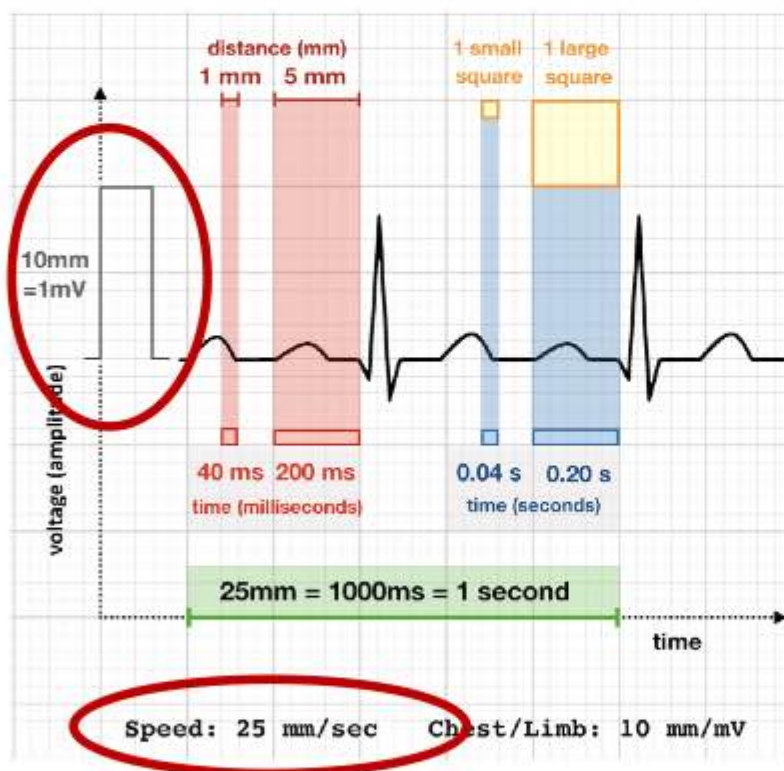
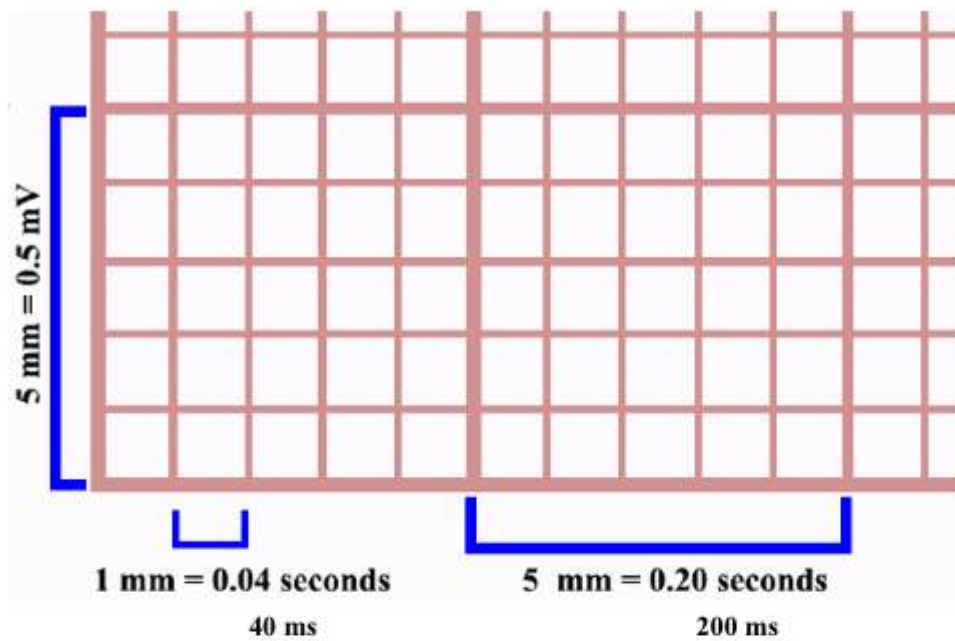


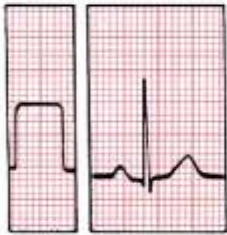
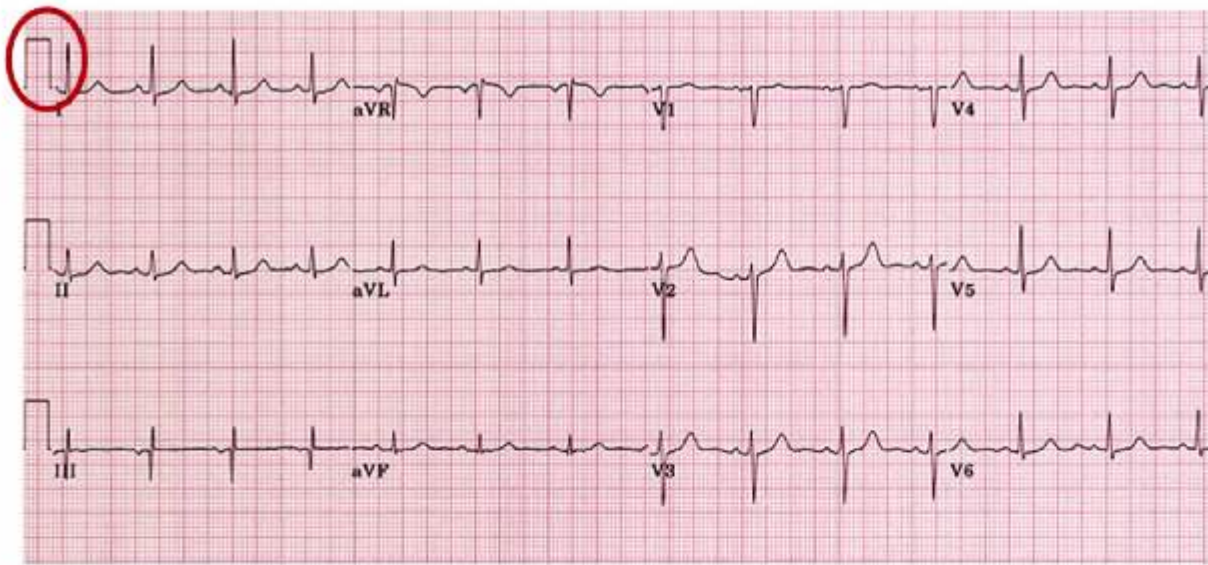
Each depolarization wave emitted by the SA Node spreads through both atria, producing a **P wave** on the EKG.



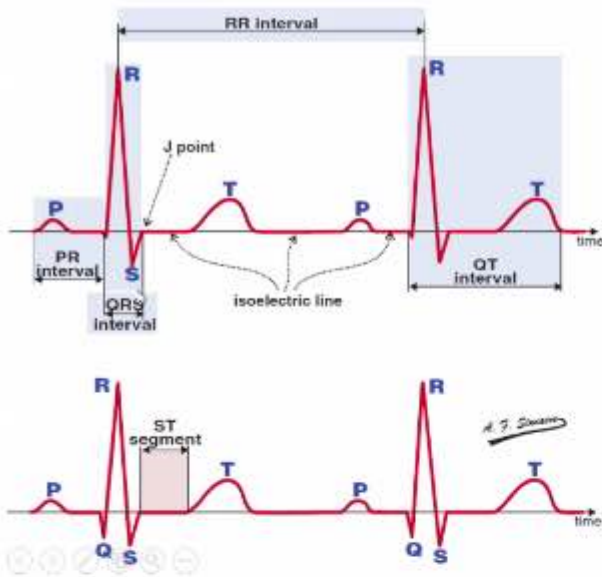








ABOUT INTERVALS AND SEGMENTS



- **Intervals** are periods of time including waves and complexes.
- **Segments** are always measured between waves but never include them.
- The **baseline** or **isoelectric** line is a straight flat line seen when no electric activity of the heart is detected.

ECG rule of 4

4 initial features

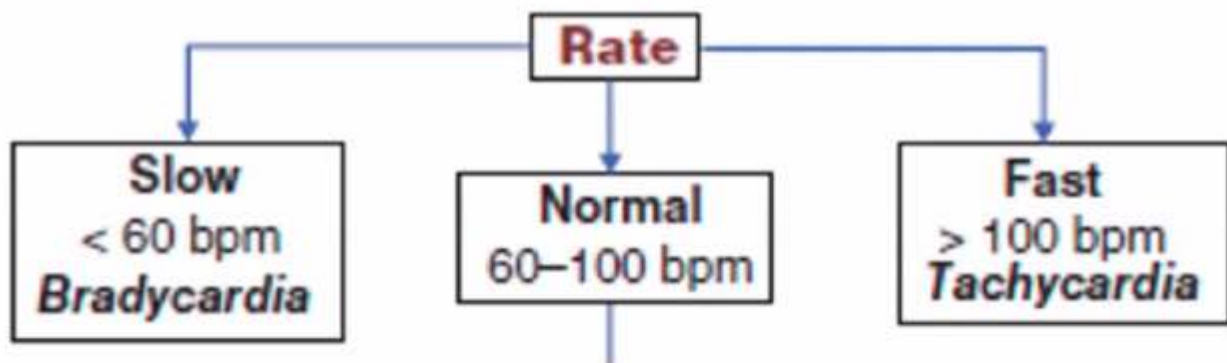
Hx
Rate
Rhythm
Axis

4 intervals

PR
QRS
ST
QT

4 waves

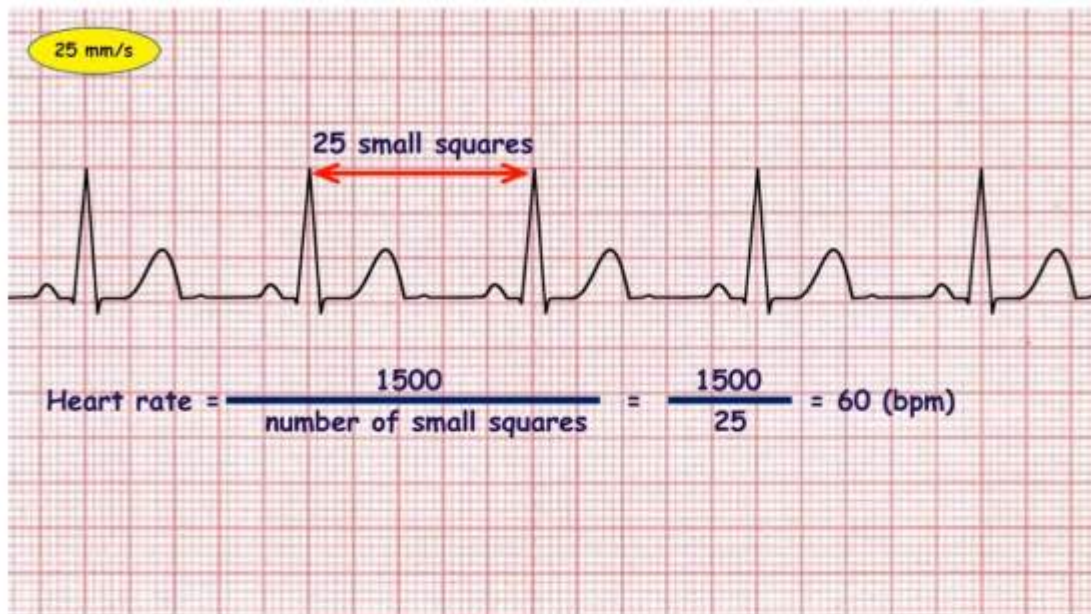
P
QRS
T
U



Rhythm

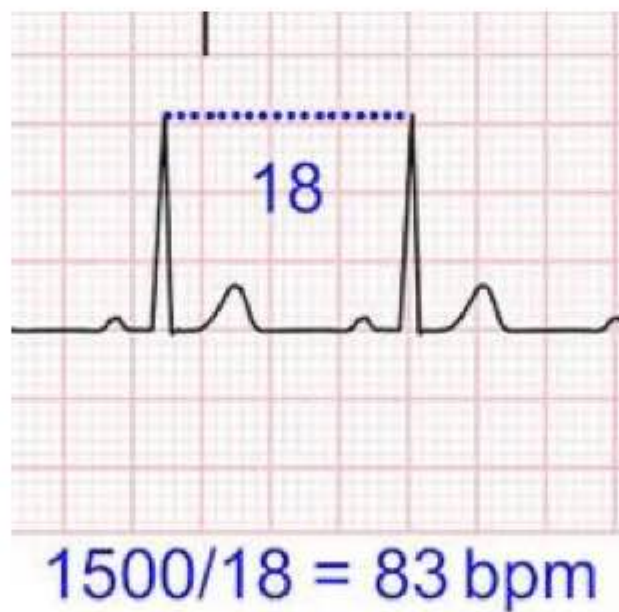
1. Regular or irregular?
2. Are P waves visible?
3. P and QRS relation?

Rate



Speed: 25mm per sec

So in 60 sec = 1500mm



25 mm/s

5 large squares

$$\text{Heart rate} = \frac{300}{\text{number of large squares}} = \frac{300}{5} = 60 \text{ (bpm)}$$

Heart rate



300-150-100-75-60-50-43-33

300

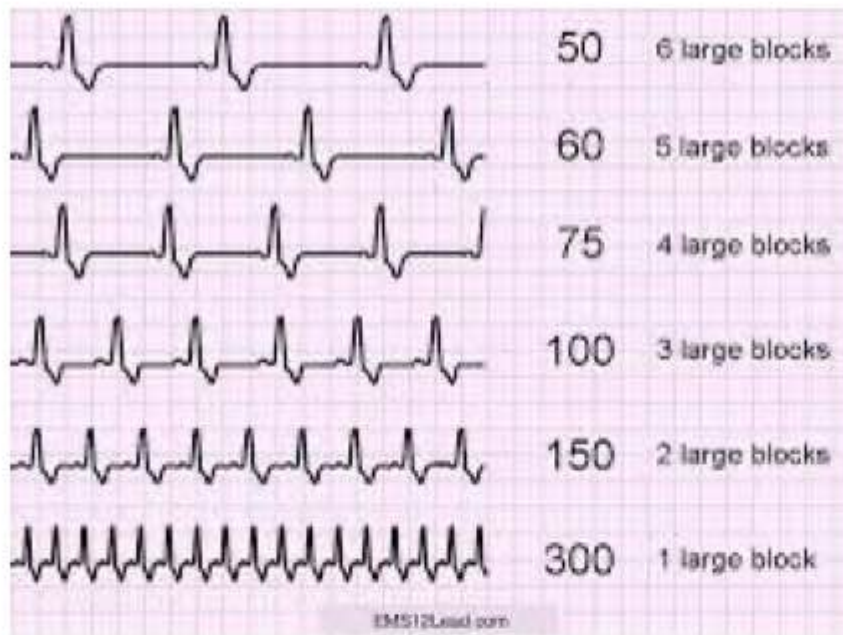
150

100

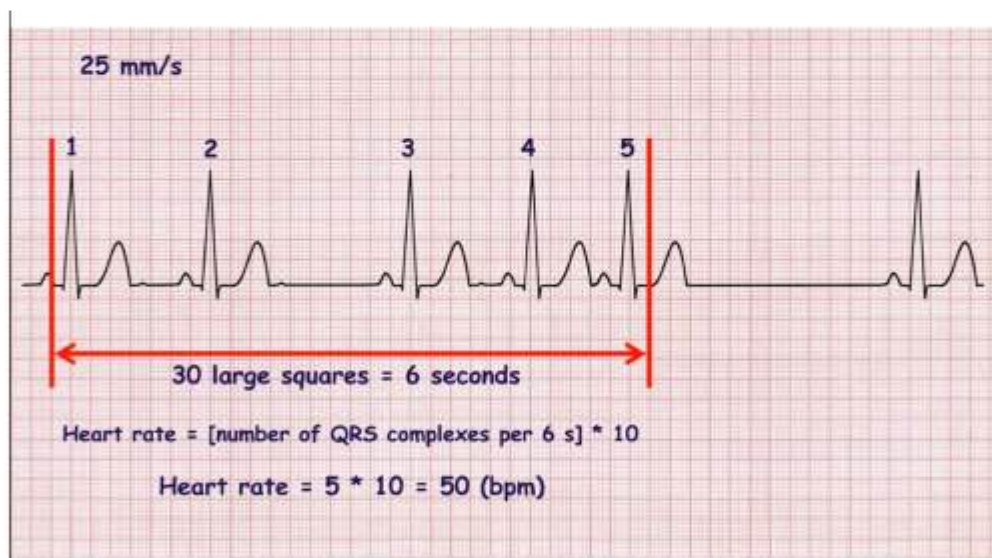
75

60

50



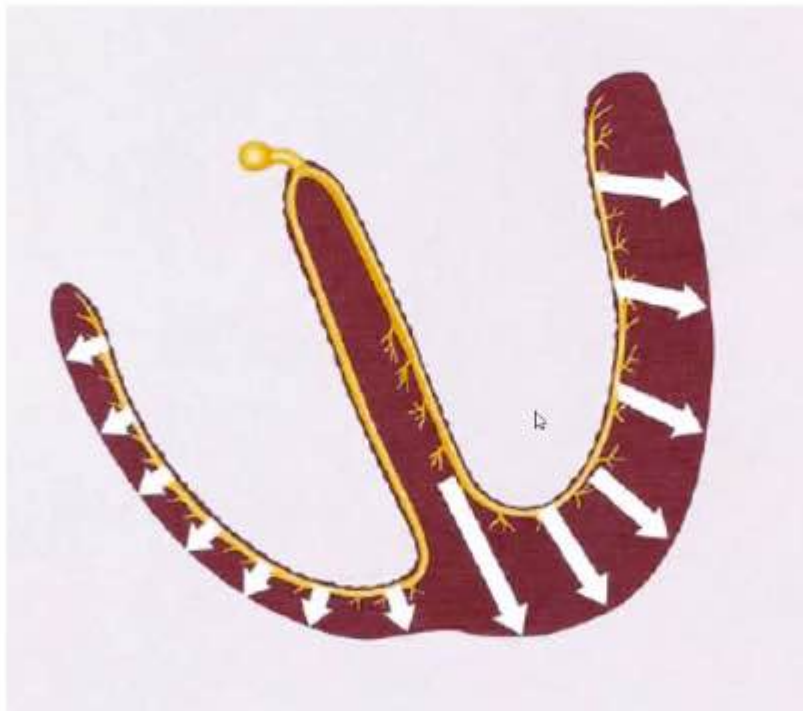
What if rhythm is not regular?!!

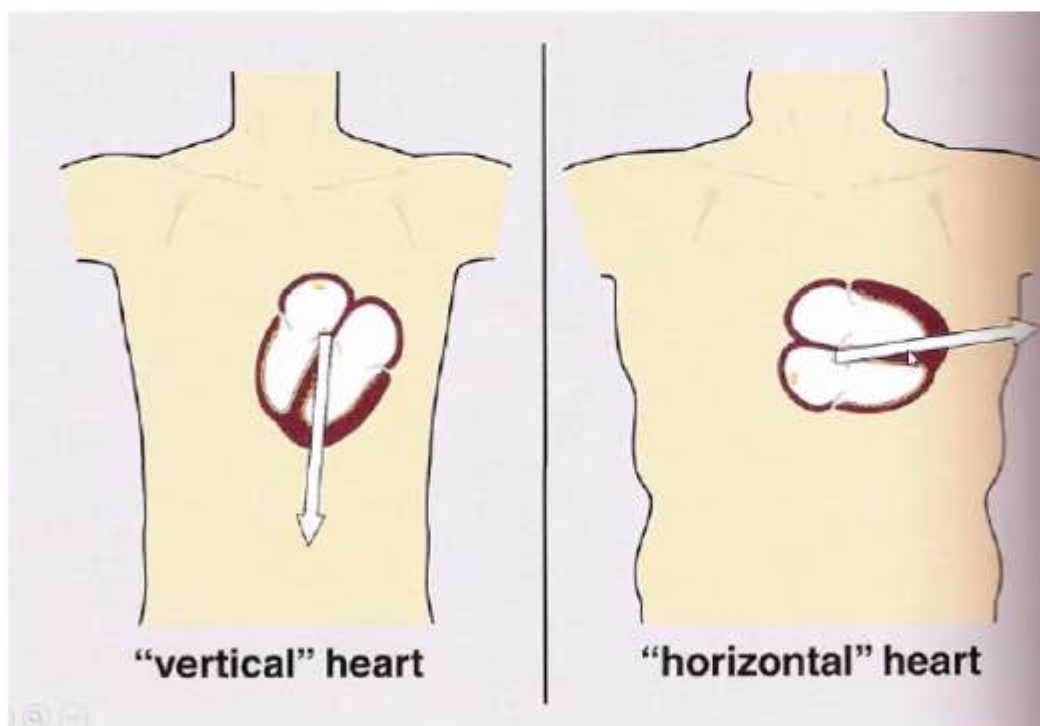
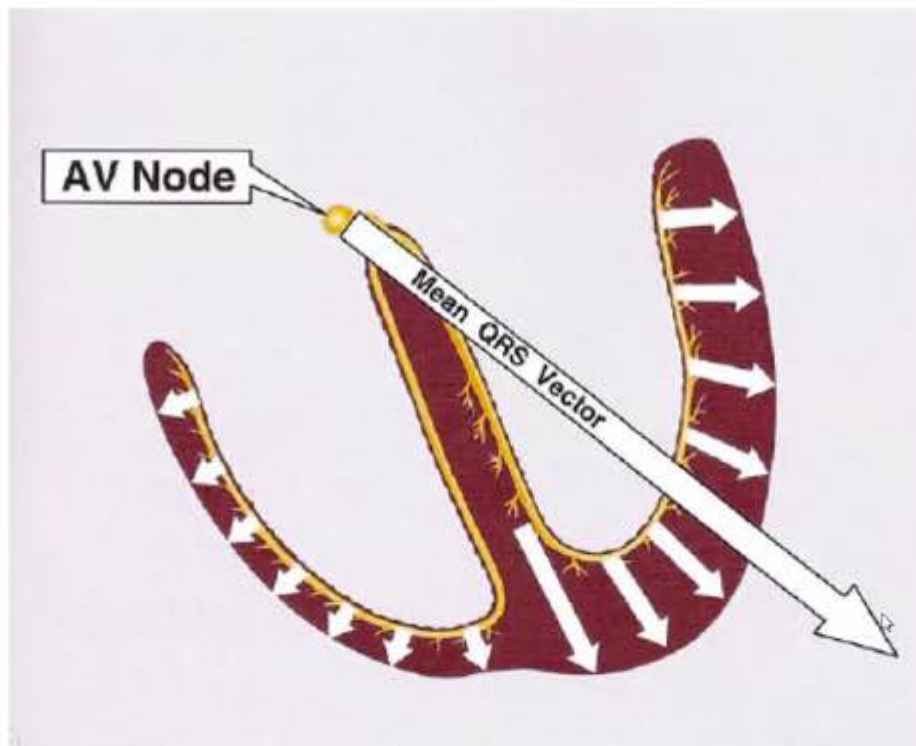


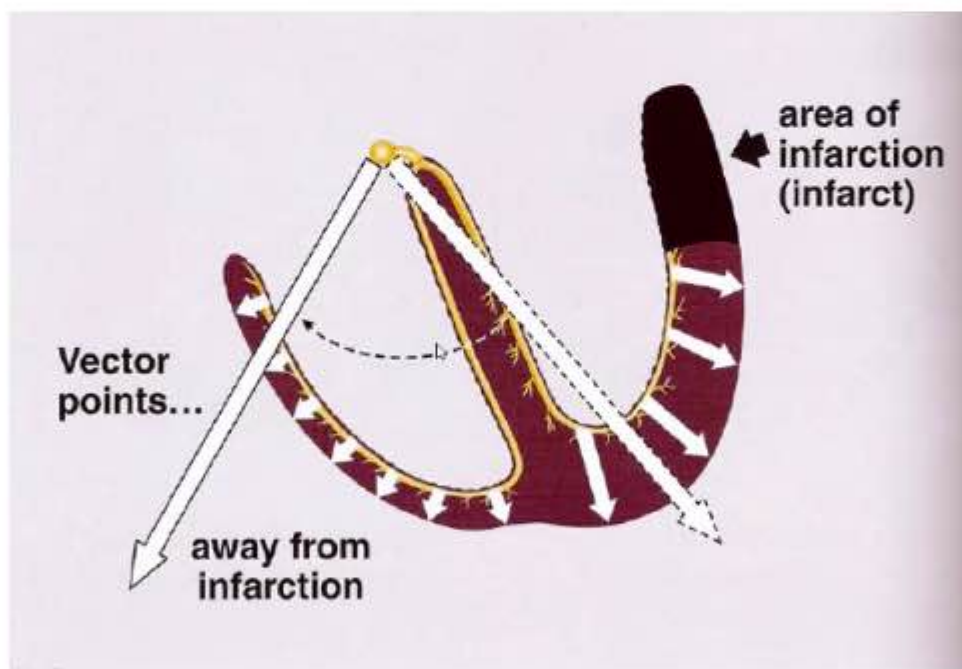
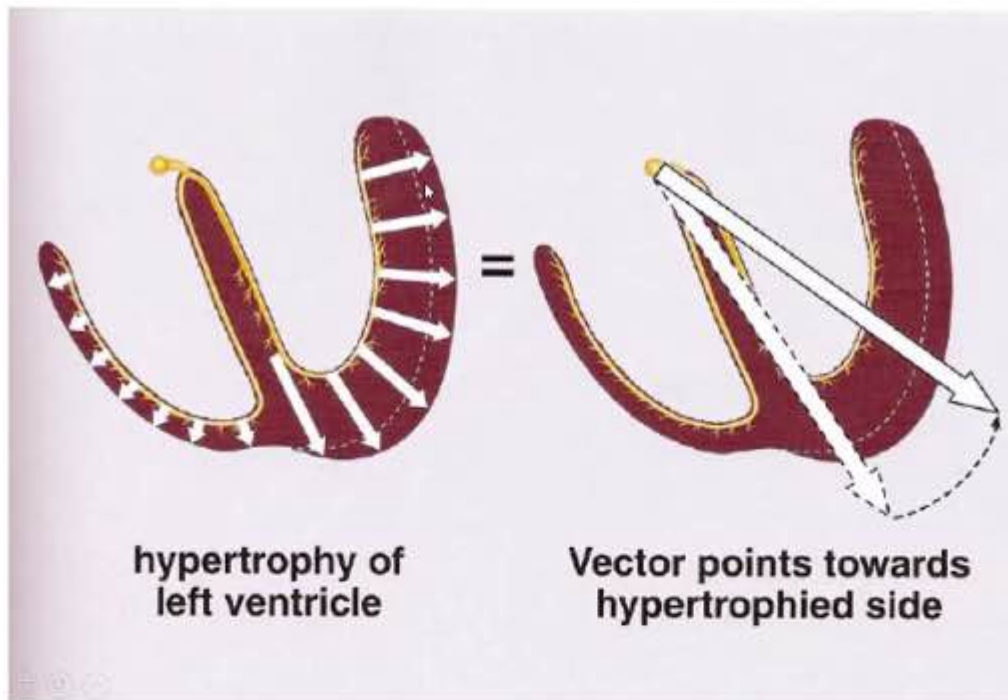
Axis



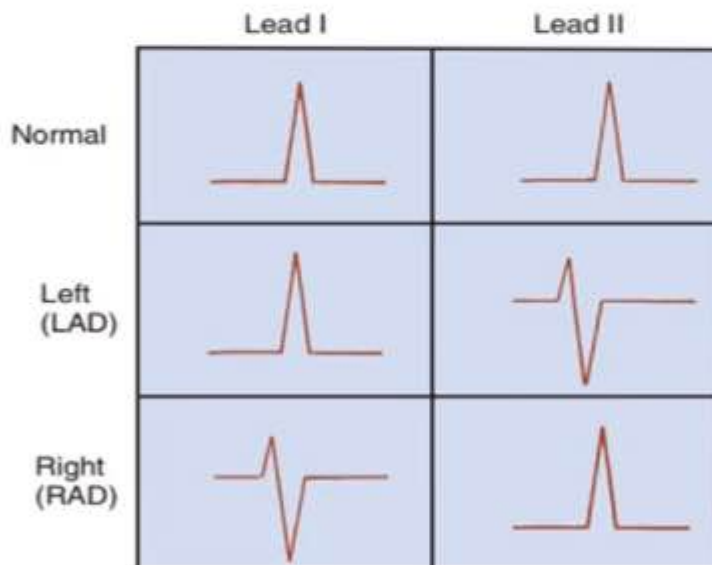
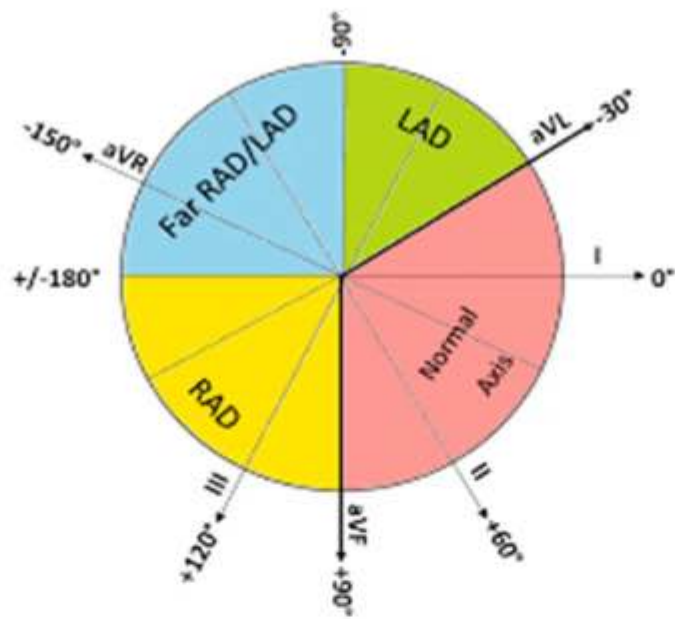
(A) The directions of each of the goalie's kicks during the course of the game. (B) A single vector represents the average direction and distance of all of these kicks.

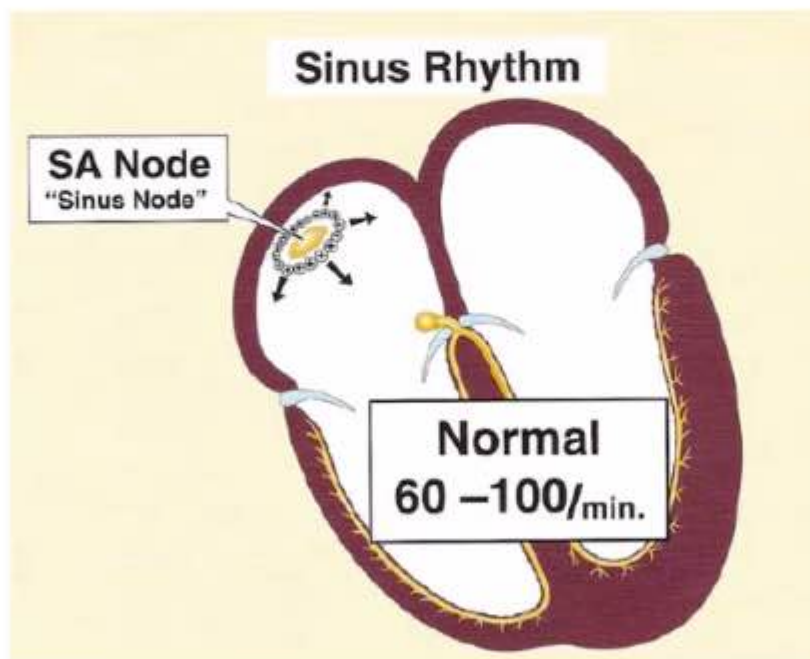
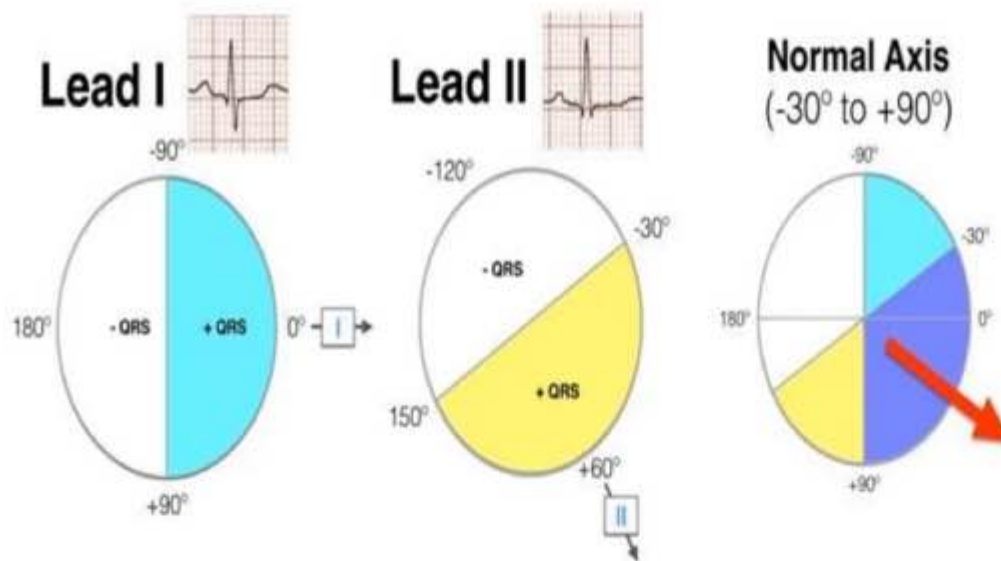






Axis

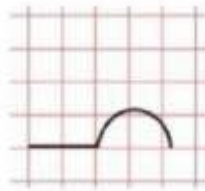




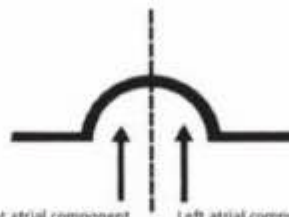
2.5 × 3 □



P wave



The EKG records a small deflection, the P wave.

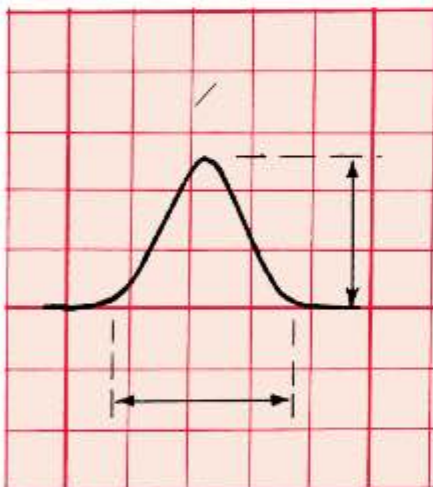


Right atrial component Left atrial component
The components of the P wave.

Normal duration < 120 msec

Normal amplitude :
Limb leads < 0.25 mv (2.5 mm)

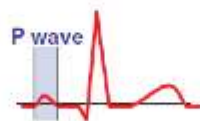
Axis : 60 degree



P wave

STEP 10: P wave

P waves are best seen in lead II and V1



Normal P wave * lead II ≤ 0.12 s and < 2.5 mm
* lead V1 biphasic

Sinus p wave

Positive in : II

Usually + in : I , aVL , aVF

- In aVR

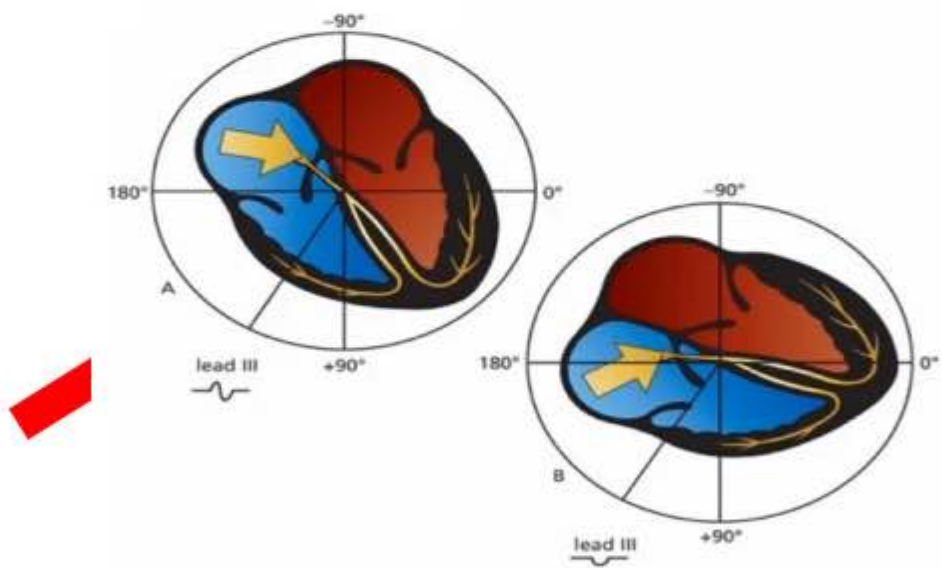
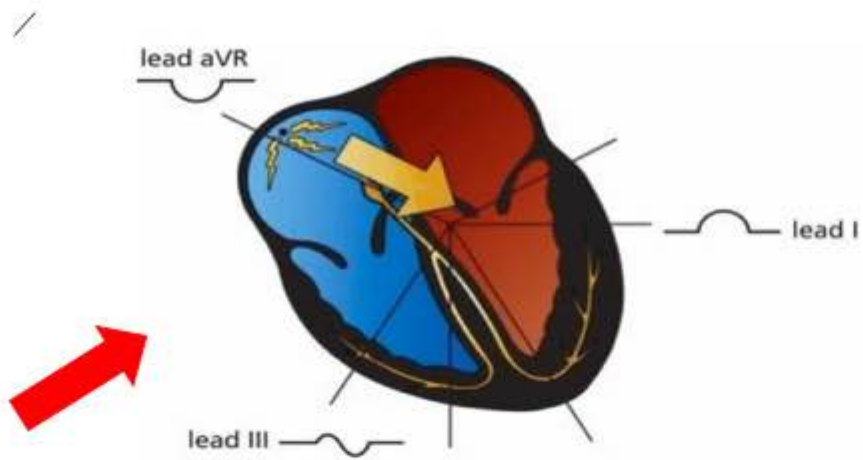
P wave is + in precordial leads

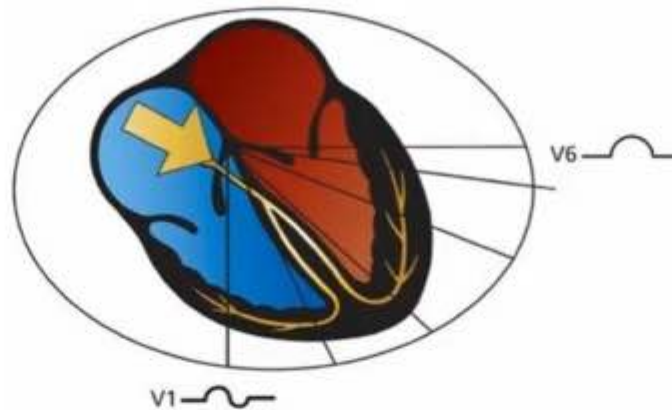
Can be biphasic in V1



The normal P wave

- Upper limit for a normal P wave duration : 120 msec (lead with the widest P wave)
 - The amplitude in the limb leads normally is less than 0.25 mV
 - Terminal negative deflection in the right precordial leads is normally less than 0.1 mV in depth.
- 





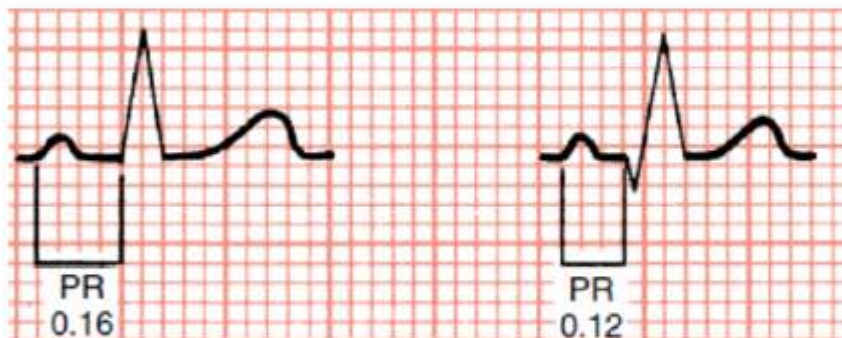
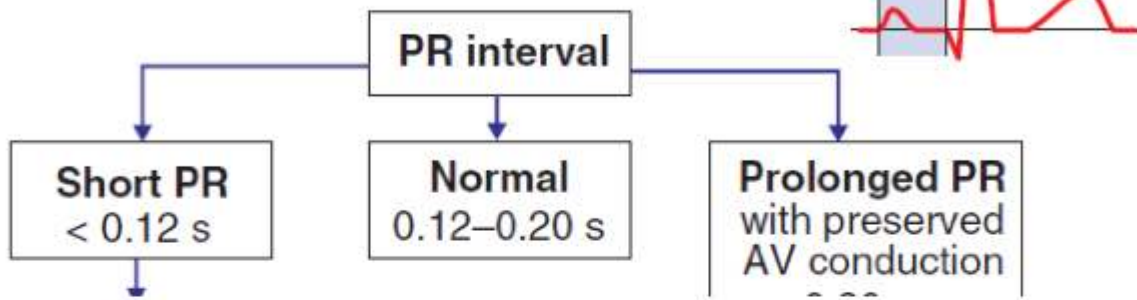
Atrial depolarization in the horizontal plane. V1 records a biphasic wave, and V6 records a positive wave.

PR interval

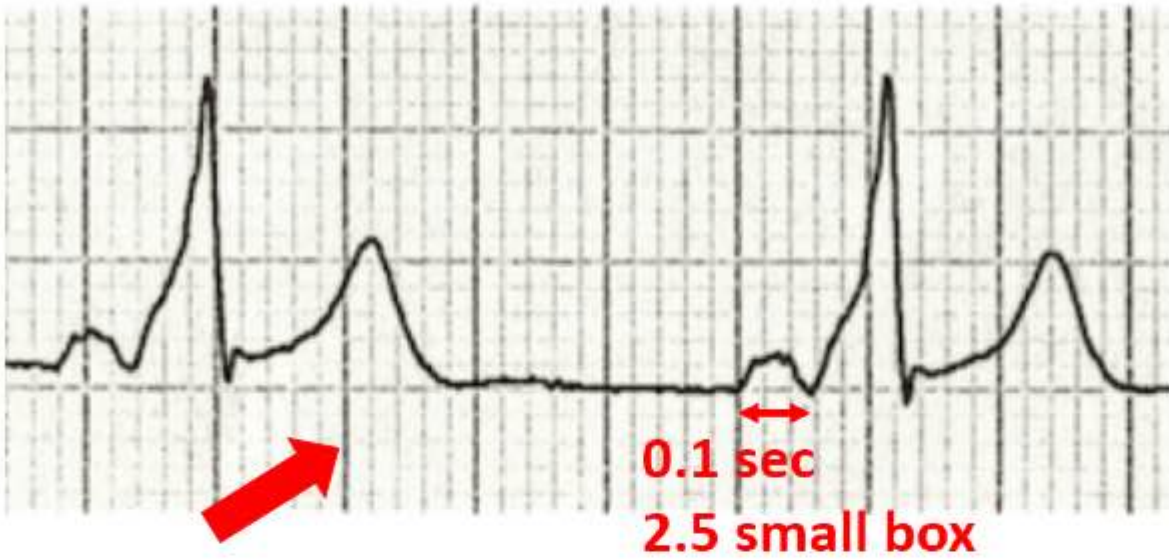
- Due to physiologic pause in AV Node.
- Buying time for atrium to deliver all of the blood into ventricle before contraction!!
- **Duration 120-200 msec**
- Must be determined from shortest interval!

HOW TO READ AN ECG 2

STEP 6A: Measurement of PR interval



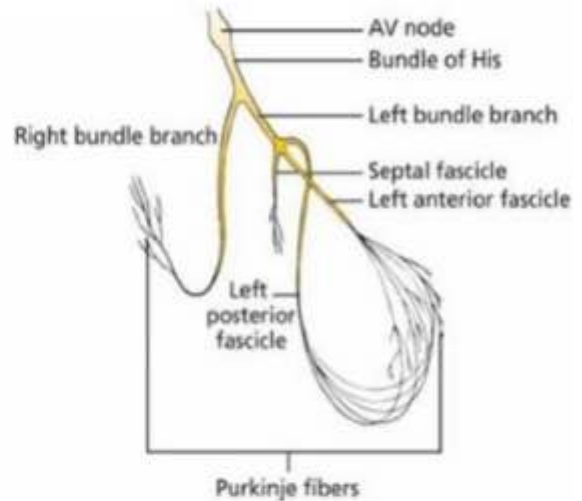
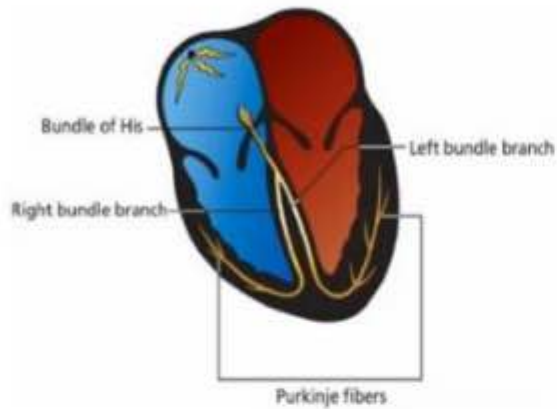
Normal: 3-5 small box
120-200 msec



QRS complex

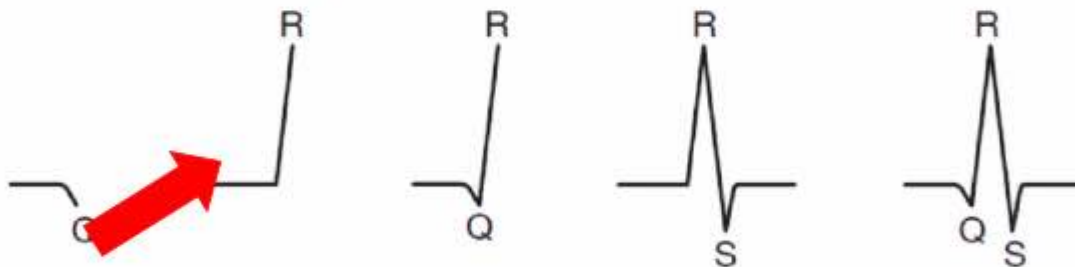
Product of two events:

1. Endocardial activation
2. Transmural activation of the two ventricles.

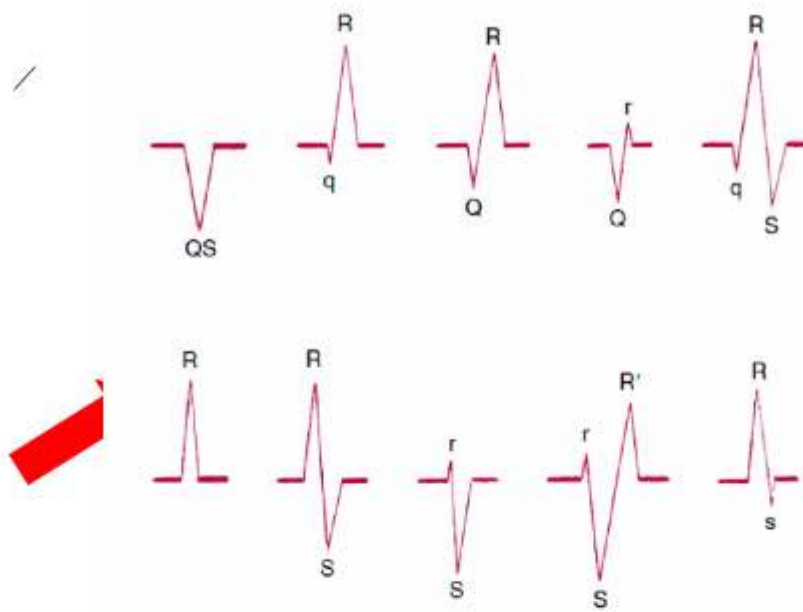


How to name it?

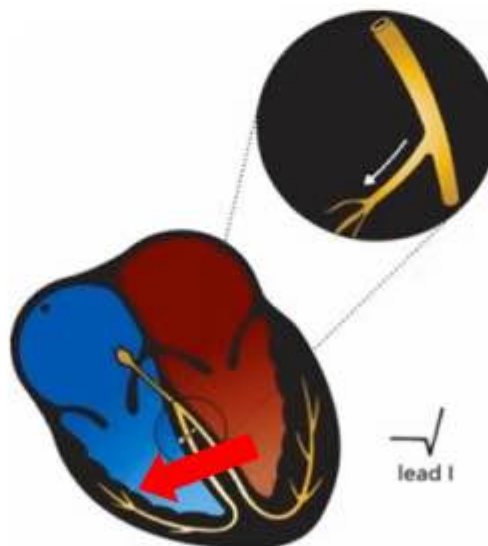
Parts of the QRS complex

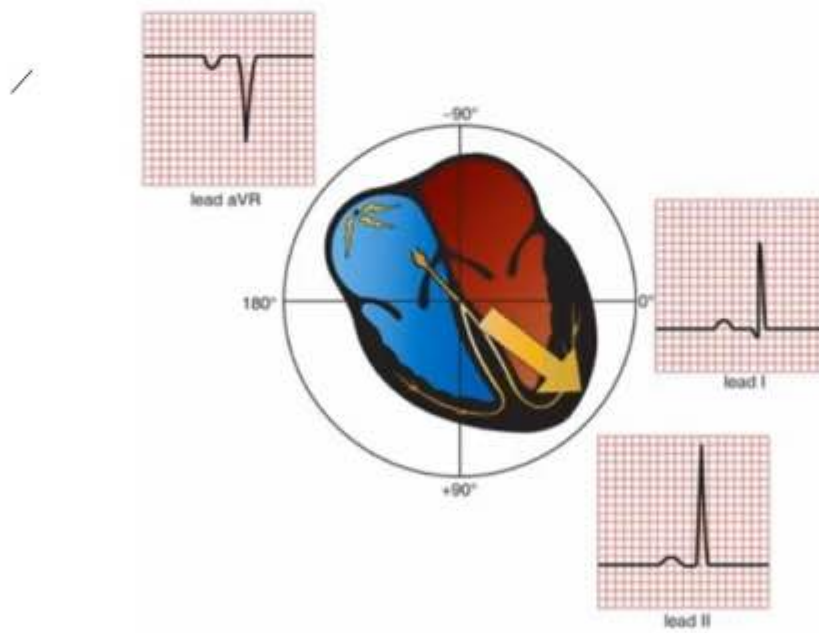
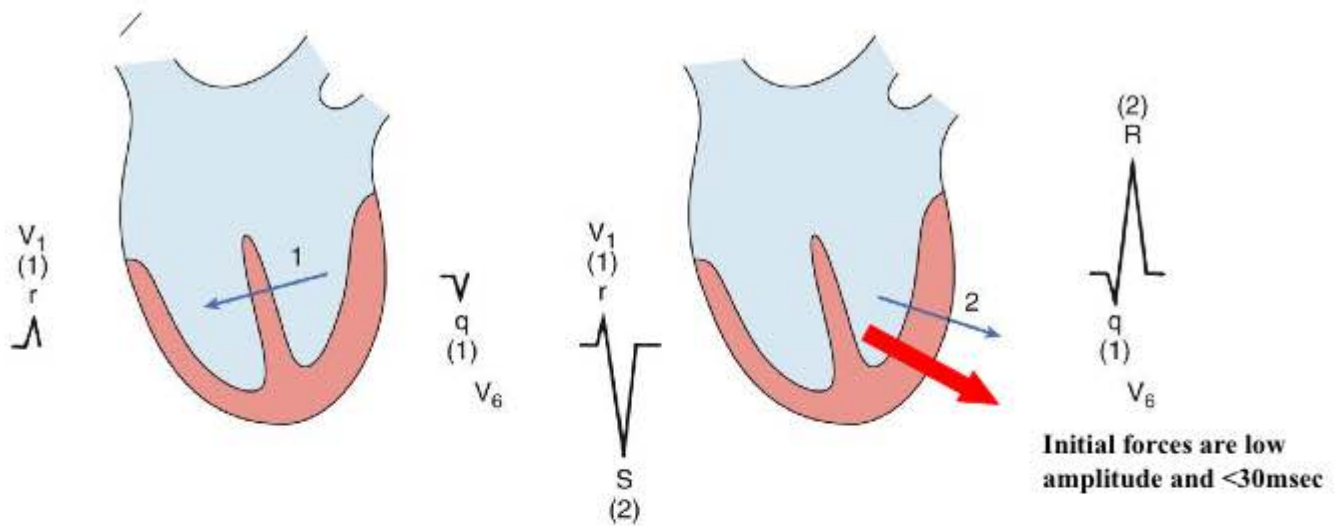


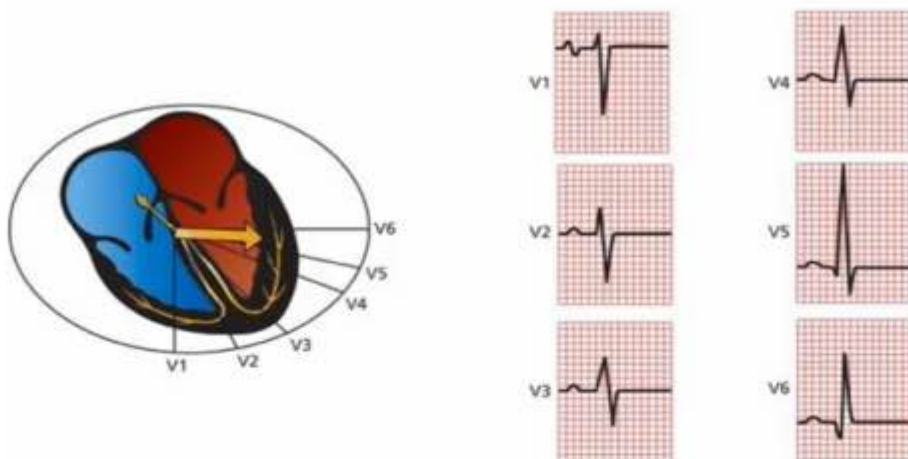
How to Name the QRS Complex



Septal Q Waves







Ventricular depolarization in the precordial leads. Note the normal pattern of R wave progression. The wave in lead V3 is biphasic.

R Wave Progression

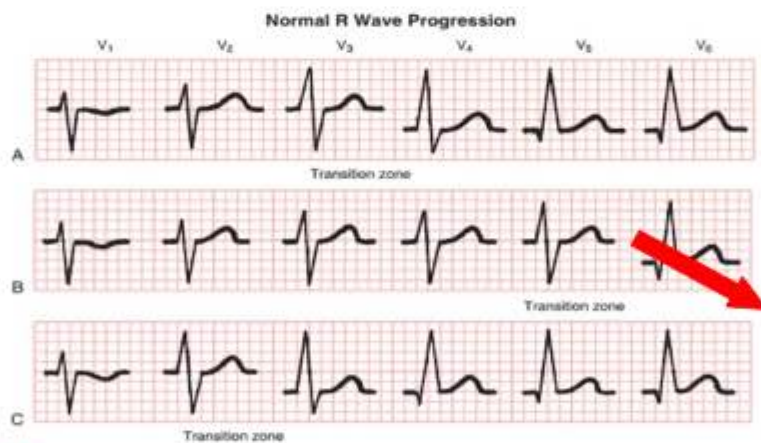
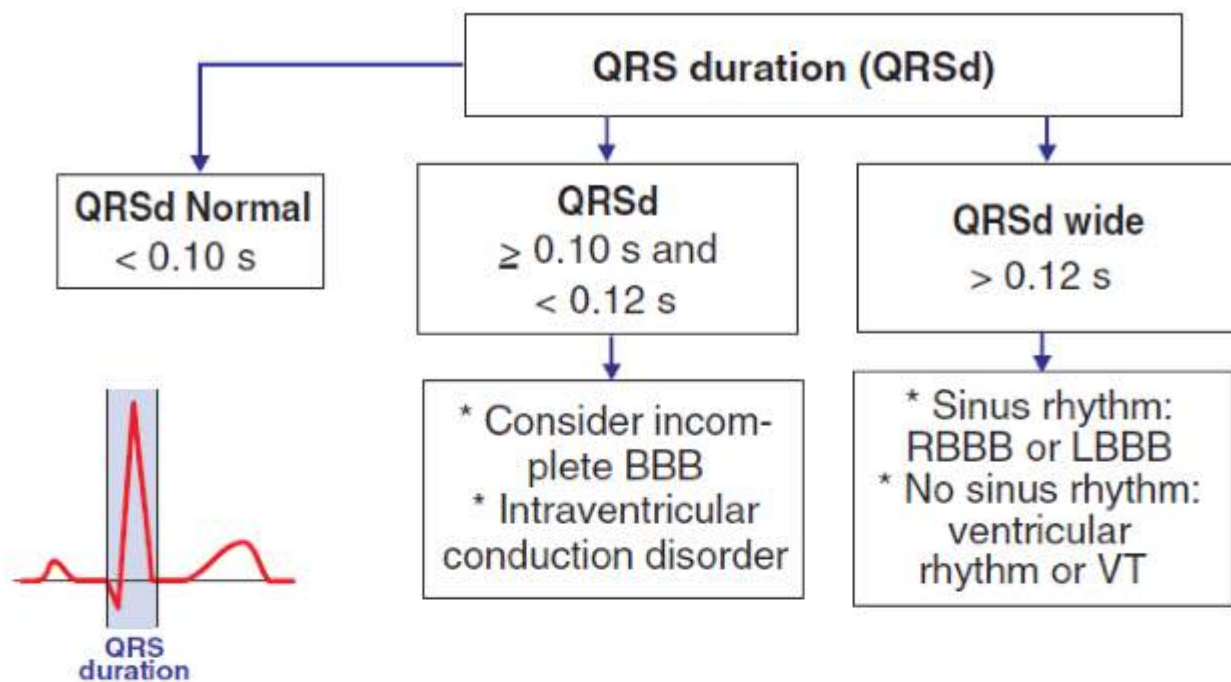


Fig. 5.8 R waves in the chest leads normally become relatively taller from lead V₁ to the left chest leads. (A) Notice the transition in lead V₄. (B) Somewhat delayed R wave progression, with the transition in lead V₄. (C) Early transition in lead V₂.

STEP 6B: Measurement of QRS complex: duration



QRS Interval



QRS

QRS amplitude :

- Men > women
- African-American > other races
- Low amplitude :
 - < 0.5 mv in all frontal leads and < 1 mv in precordial

- Normal QRSD < 110 - 120 ms

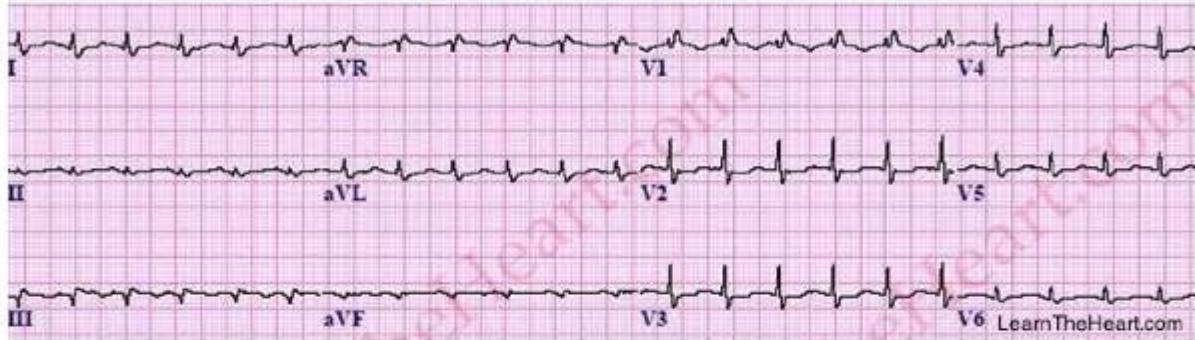
Low voltage :

- Limbs < 5 mm
- Precordial < 10 mm

Low Voltage ECG

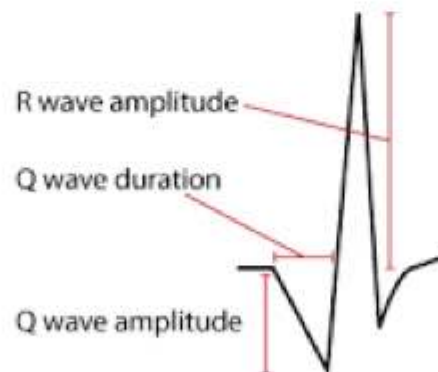
Low voltage is defined as peak-to-peak QRS amplitude of < 5 mm in the limb leads and/or < 10 mm in the precordial leads. Low voltage may be present in the following situations:

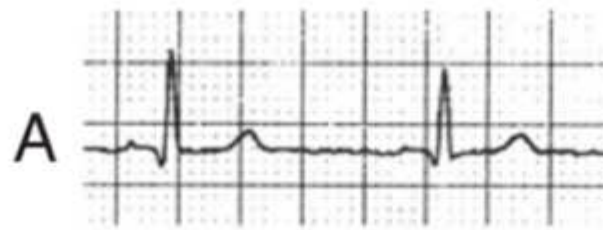
1. Obesity
2. COPD
3. Pericardial effusion
4. Severe hypothyroidism
5. Subcutaneous emphysema
6. Massive myocardial damage/infarction
7. Infiltrative/restrictive diseases such as amyloid cardiomyopathy.



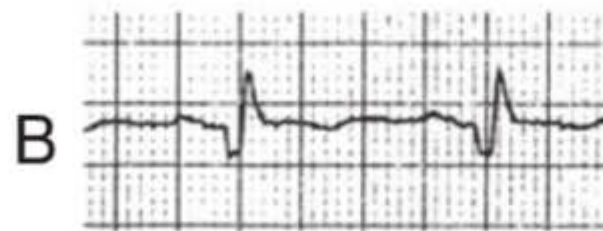
Pathologic Q wave

**Q wave duration of > 40 ms or
size $> 25\%$ of the QRS complex amplitude**





Normal Q Waves



Pathologic Q Waves

ST segment

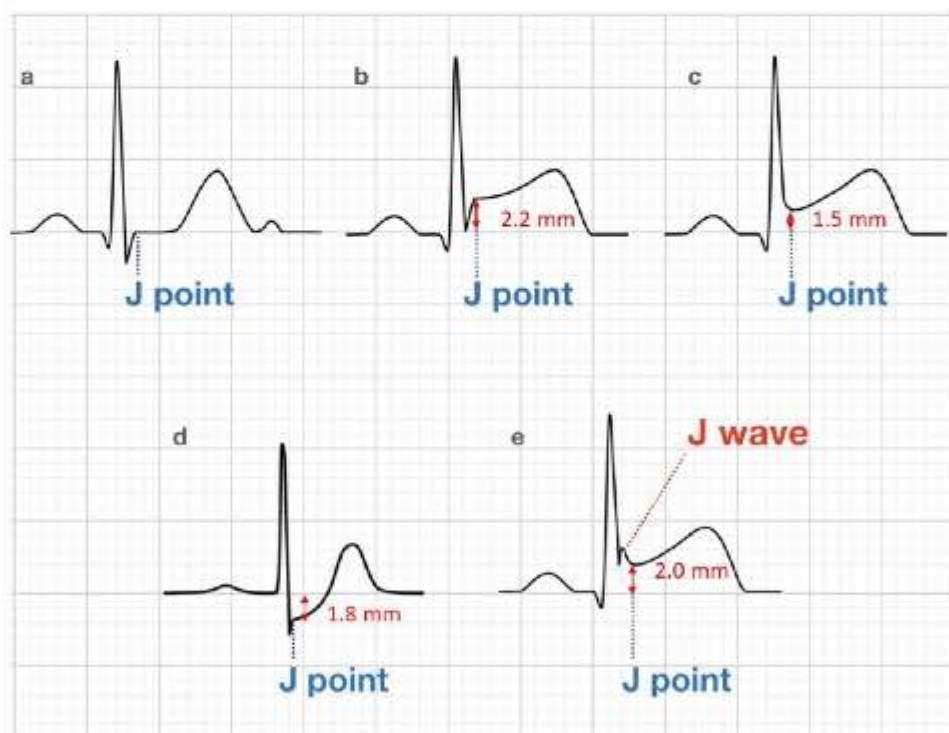
- Reflect plateau phase
- Onset : J point



Normal ST

Onset of the ST-T wave, the **junction or J point** , is normally at or near the isoelectric baseline (**typically the PR segment**) .

The level of the ST segment generally is measured at the **J point** or, in some applications such as exercise testing, **40 or 80 msec after the J point** .

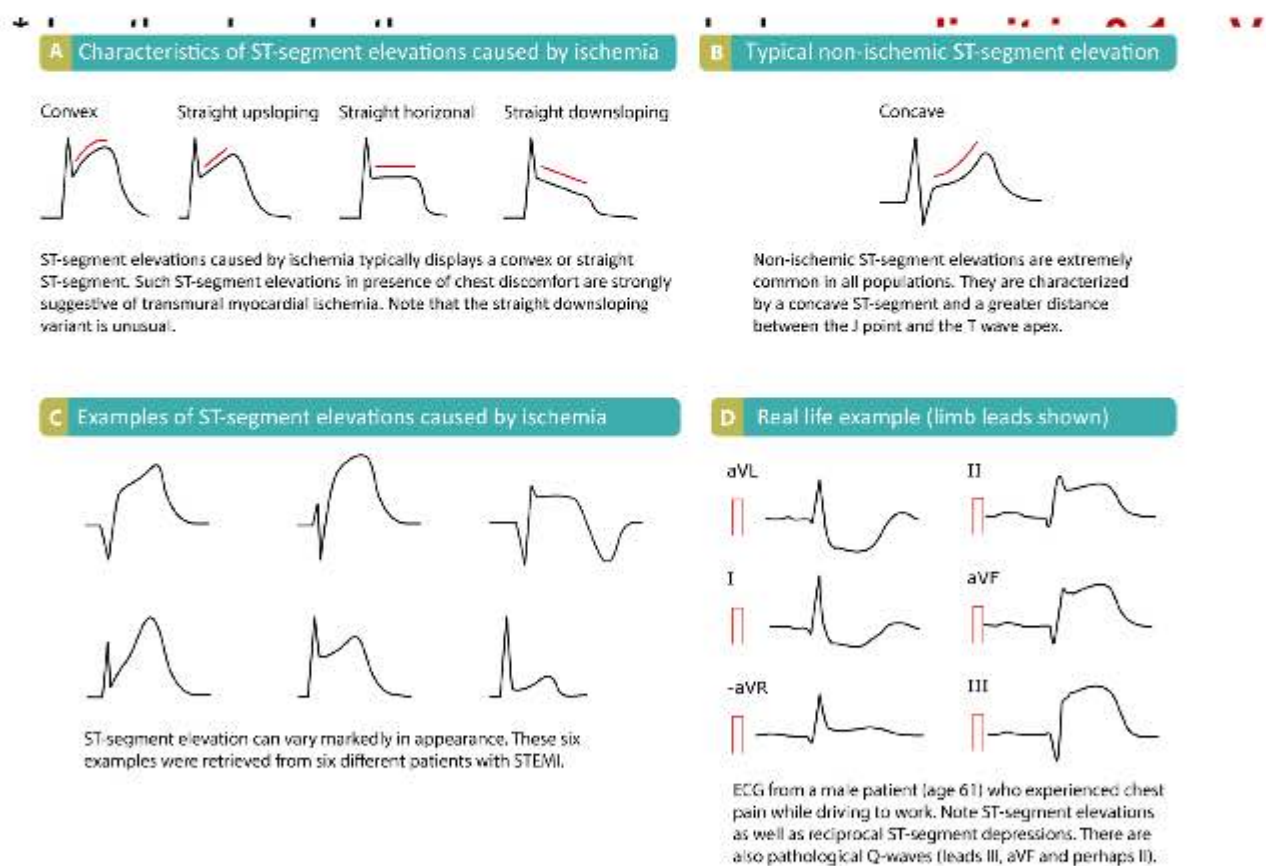


Normal ST

* Amplitude of the normal J point and ST segment varies with **race, sex, and age**.

* **Typically are greatest in lead V₂**, and they are higher in **young men** than in young women and in **African Americans** than in whites

* For the upper limits of normal J point elevation **in leads V₂ and V₃ are 0.2 mV for men age 40 or older, 0.25 mV for men younger than 40, and 0.15 mV for women**



T wave

Tall T wave :
Limb > 5 mm
Precordial > 10 mm



Ventricular repolarization generates a T wave on the EKG. The T wave is usually positive in leads with tall R wave

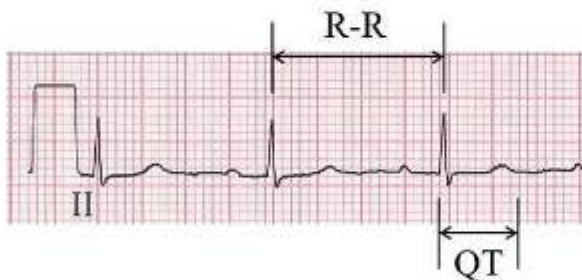
QT interval

1. **From onset of QRS to end of T**
2. **Shows : Total duration of ventricular activation and relaxation**
3. **Measure in the lead with longest QT: V2 or V3**
4. **No prominent U**
5. **Rate dependent: so correct it!!**



Bazzett formula

/



$$QT_c = \frac{QT}{\sqrt{R-R}}$$

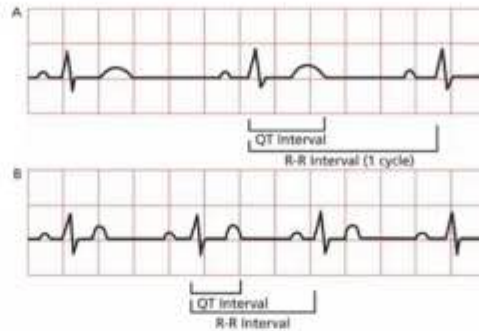
Note: RR are in seconds

QTc normal: 390 – 450 (men) / 460 (women)

The QT Interval

Hodges formula

$$QTc = QT + 1.75 * (HR - 60)$$



U wave

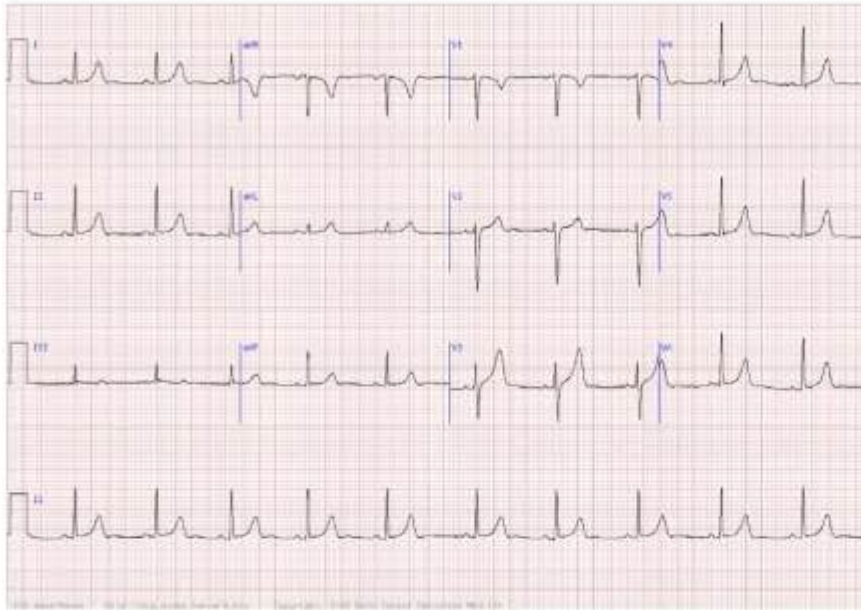
- Less than 0.1 – 0.15 mv
- Less than 160-200 ms
- Same polarity with T
- Largest in V2 – V3
- Most seen in slow heart rates , HTN , hypokalemia

Wave or Interval	Duration (msec)
P wave duration	<120
PR interval	<200
QRS duration	<110–120 *
QT interval _c (corrected)	≤440–450 *

Note

- **Isolated negative T wave in V1 can be normal if T is positive in V2**
- **Negative QRS , T and P can be normal in III if not company by II and aVF**

Normal ECG



10/2/2020

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