



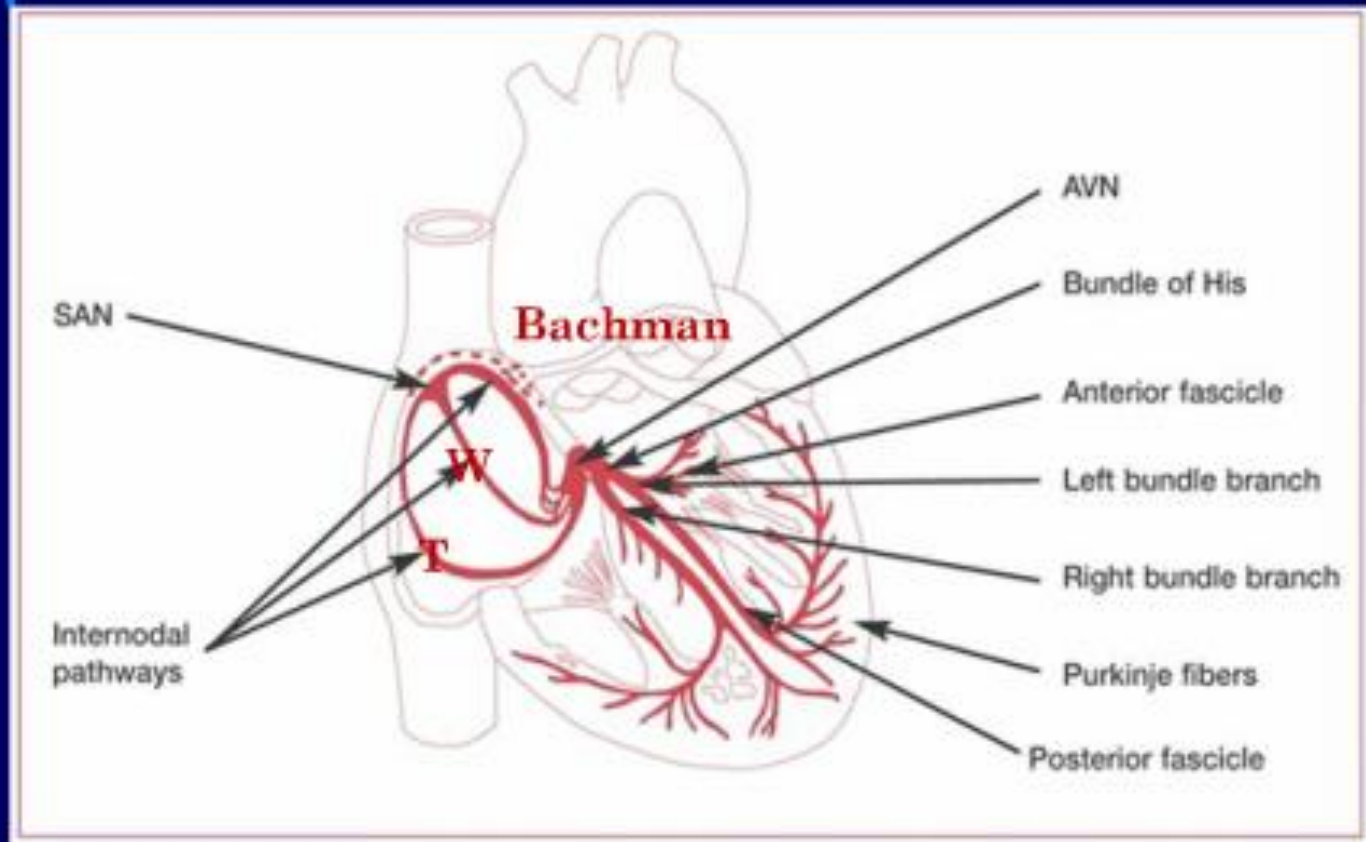
PEDIATRIC ECG

NIMA MEHDIZADEGAN

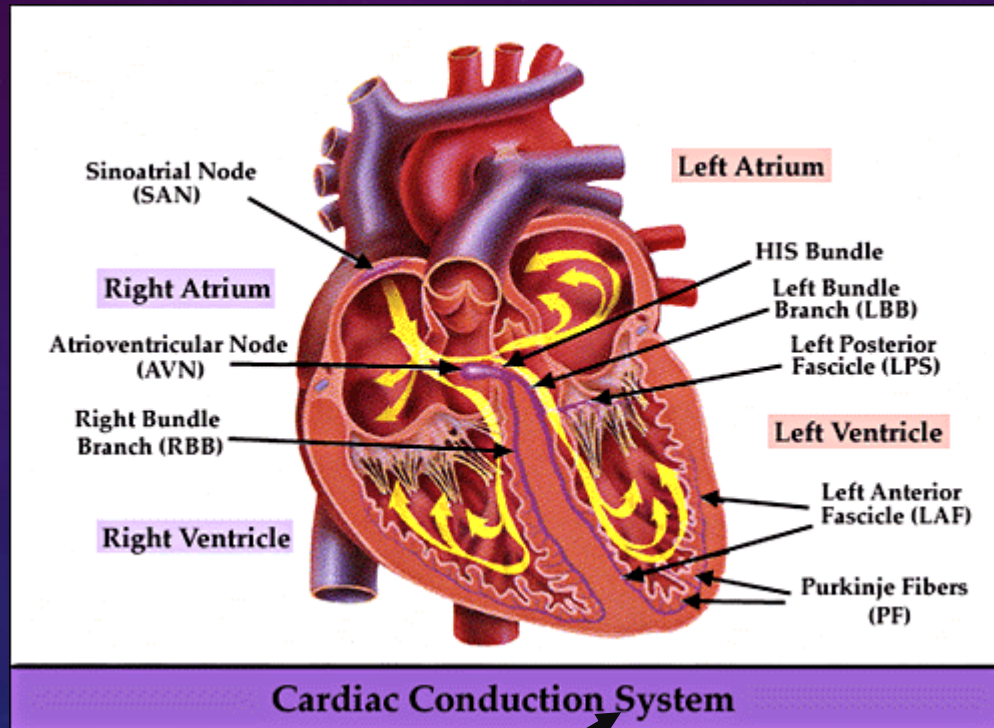
ASSISTANT PROFESSOR OF

PEDIATRIC CARDIOLOGY

The cardiac conduction system



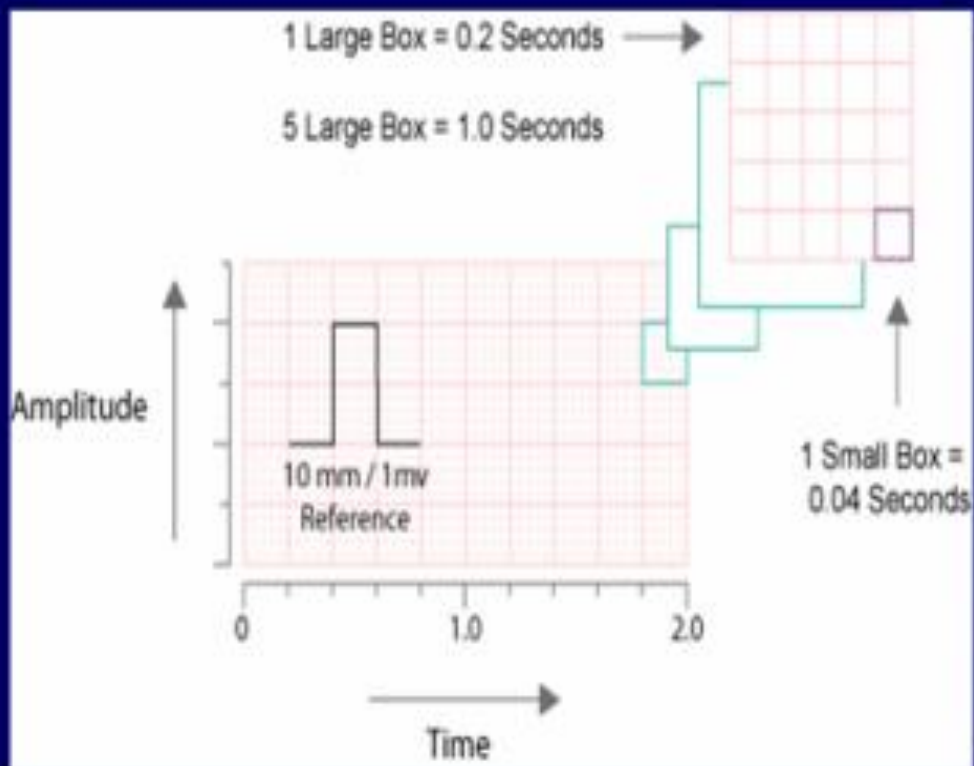
Internodal fibres: Bachman, Wenkebach and Thorel



Septum

ECG PAPER

PINK/
BLUE



Electrodes

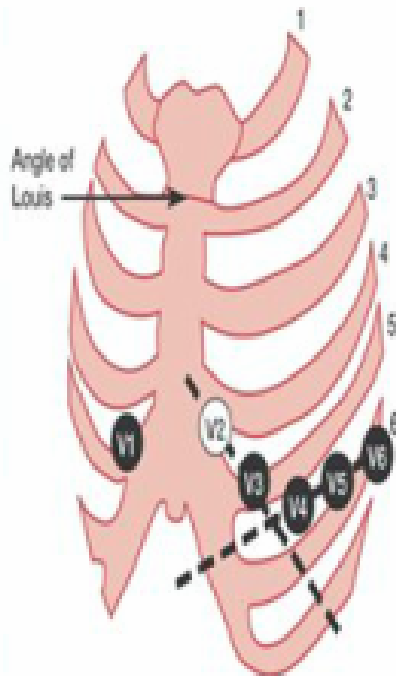




Electrode Placement

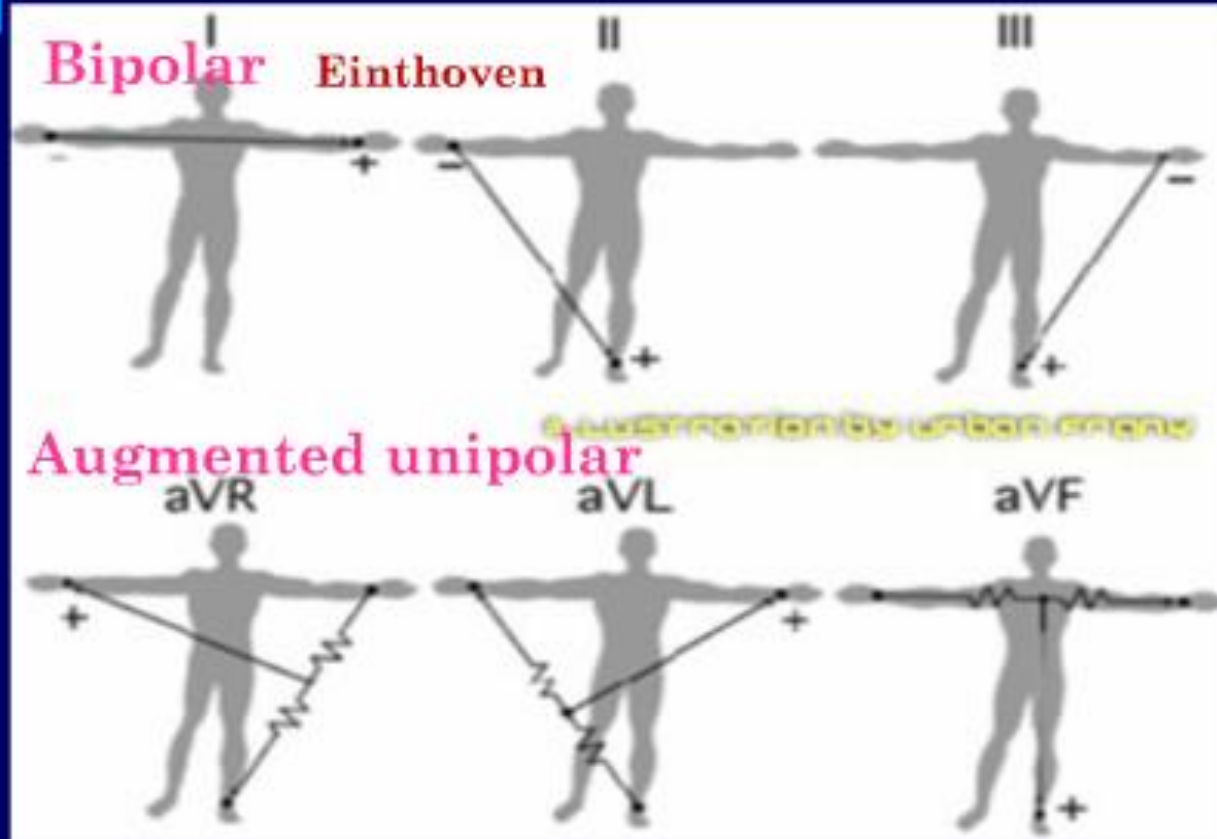
- Assure good conduction gel
- Prep area with alcohol prep
- Poor placement or preparation
 - Often results in artifact
- Stray energy from other sources can also lead to poor ECG tracings (noise)
- Avoid
 - Bone
 - Large muscles or hairy areas
 - Limb vs. Chest placement

Methods

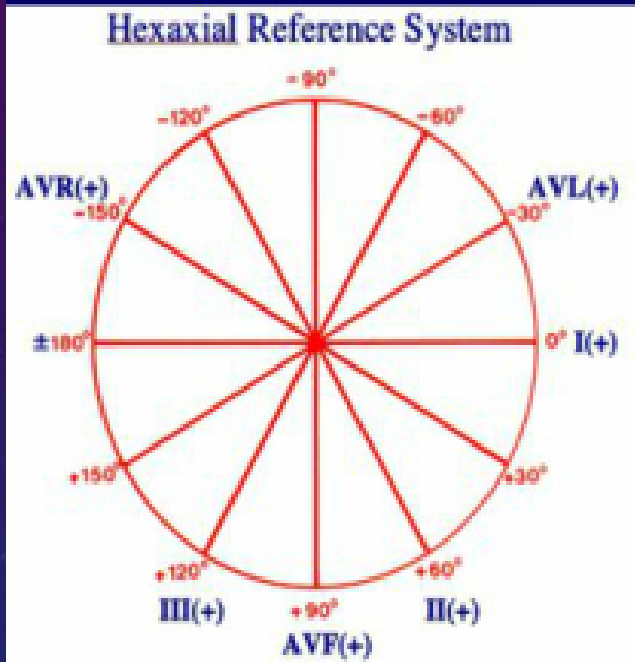


1. Ask the patient to undress down to the waist and lie down
2. Remove excess hair where necessary
3. Attach limb leads on forearm
4. **Attach the chest leads**
 - V1 and V2: either side of the sternum on the fourth rib
 - V4: on the apex of the heart
 - V3: halfway between V2 and V4
 - V5 and V6: horizontally laterally from V4
5. Ask the patient to relax
6. Press record

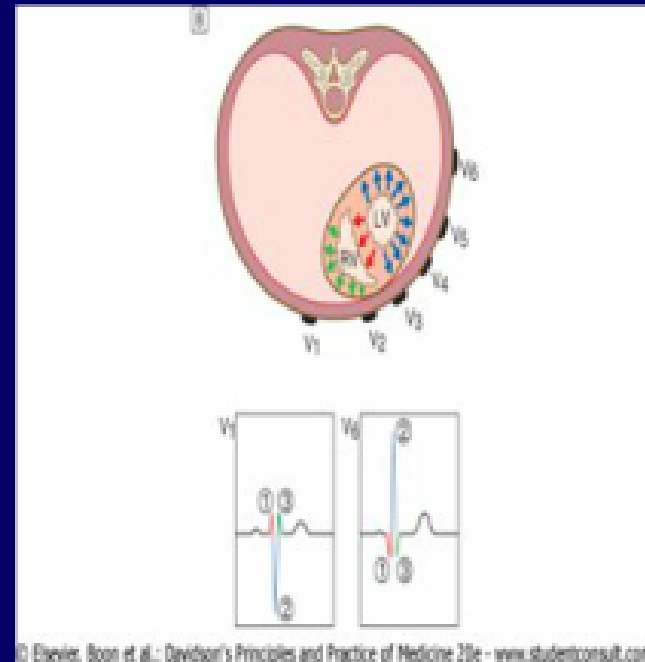
Limb leads



Reference Systems



Hexaxial / Frontal



Horizontal

LEADS POSITION

LEFT LATERAL	LI,AVL , V5-6
ANTERIOR	V1 TO V4
INFERIOR	II, III & aVF
CAVITARY	aVR

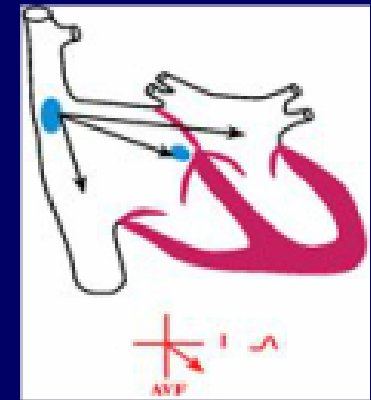
Sequence of electrical activity in the heart forming the P-Q-R-S-T waves

□ I.

Atrial depolarization

Axis: 0-90

P wave is upright in I & AVF

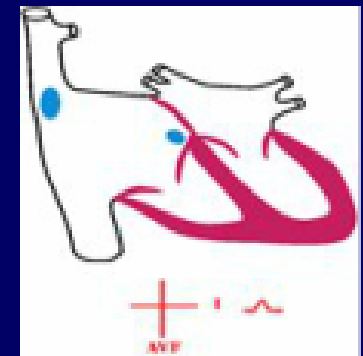


□ II.

Slow AV node conduction

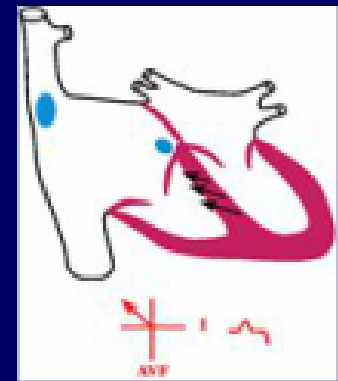
No electrical activity recorded by ECG

PR interval is flat



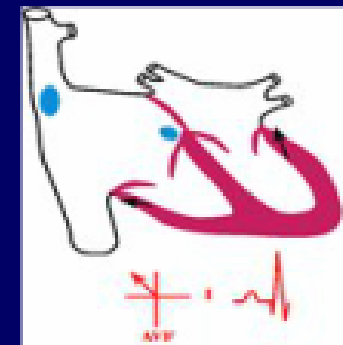
Sequence of electrical activity in the heart forming the P-Q-R-S-T waves

- III.
Depolarization of the ventricular septum
Axis: 180-270
Negative deflection in I & AVF
- IV.
Depolarization of the ventricles
Axis: 0-90
Upright in I & AVF

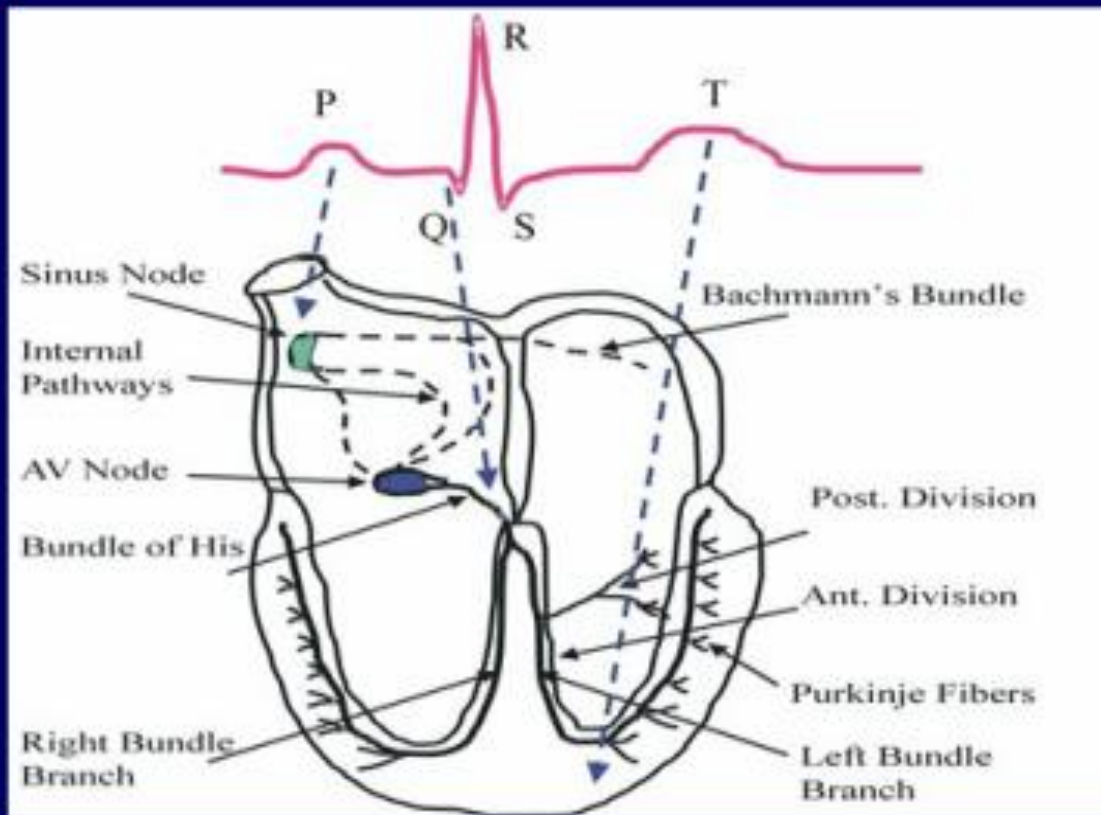


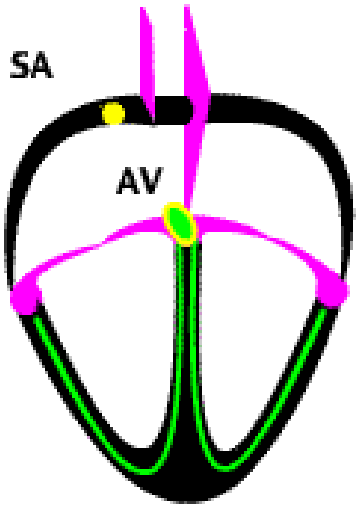
Sequence of electrical activity in the heart forming the P-Q-R-S-T waves

- V.
Depolarization of the heart base
Axis: 180-270
Negative deflection in I & AVF
- VI.
Repolarization of the Ventricles
Upright deflection in I & AVF



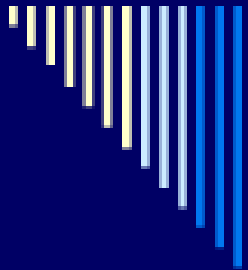
Activation and recording





- Pacing
- Conductive
- Nonconductive
- Contractile

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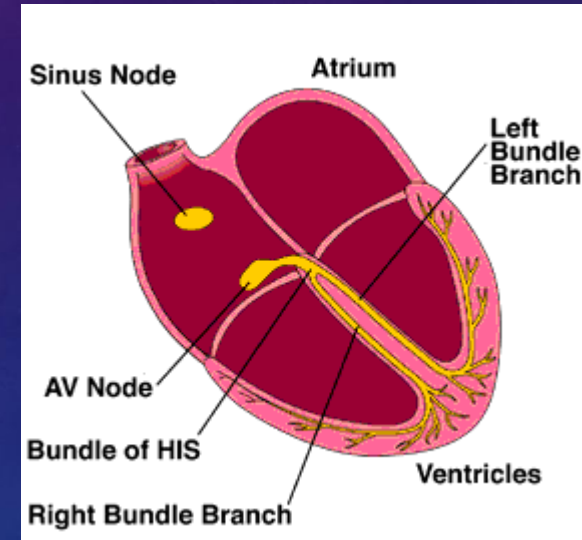
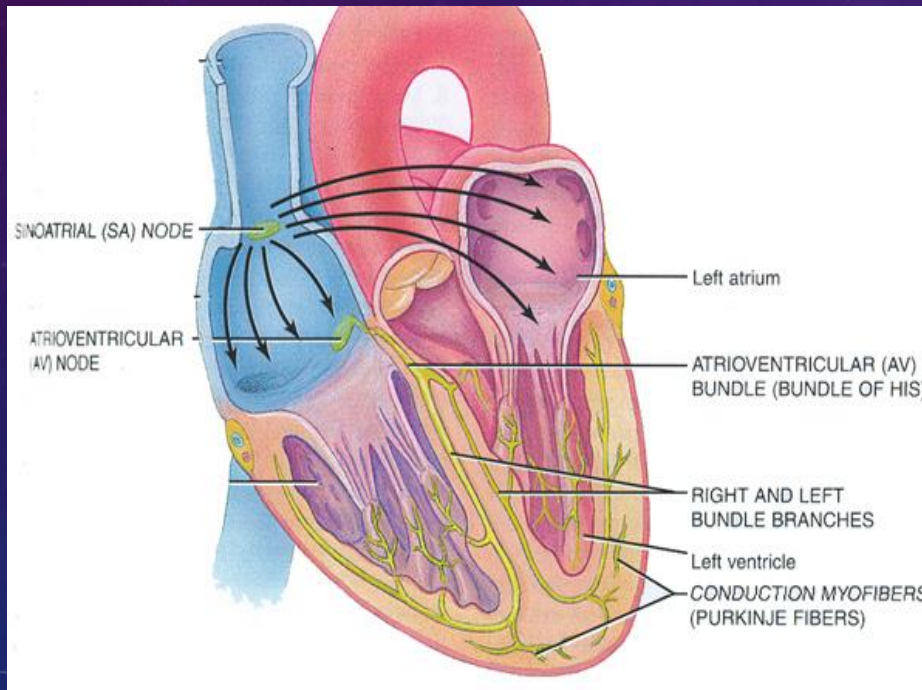
ANATOMY of ECG

- WAVES: PQRSTU
- COMPLEX: Combination of multiple waves
- SEGMENT: A straight line connecting two waves
- INTERVAL: comprises at least one wave plus the connecting straight line

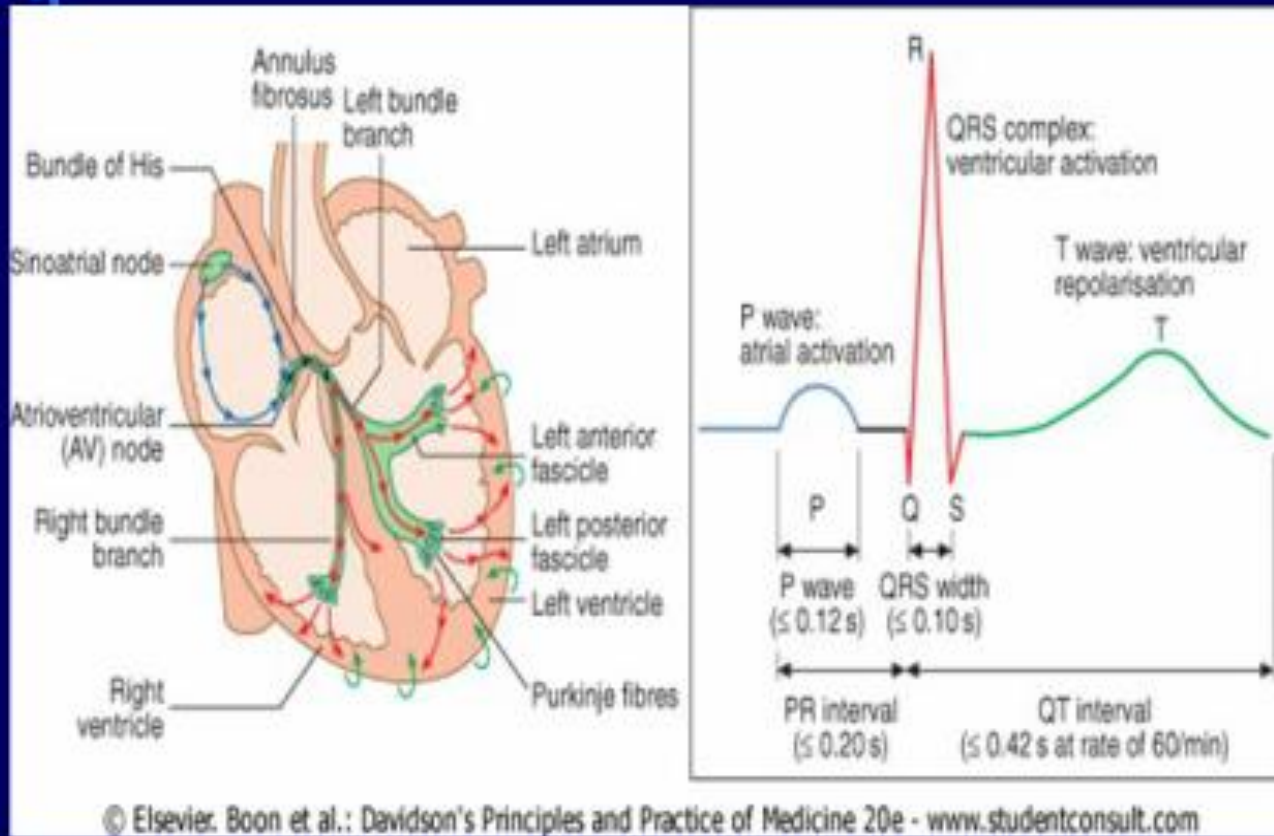
HEART PHYSIOLOGY

Closed system
Supply nutrients/O₂

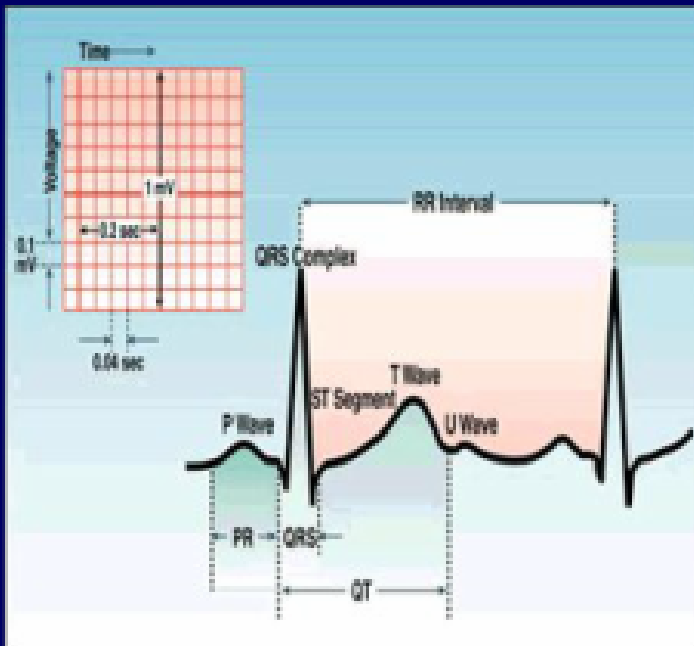
Pressure driven
Remove metabolites



The ECG



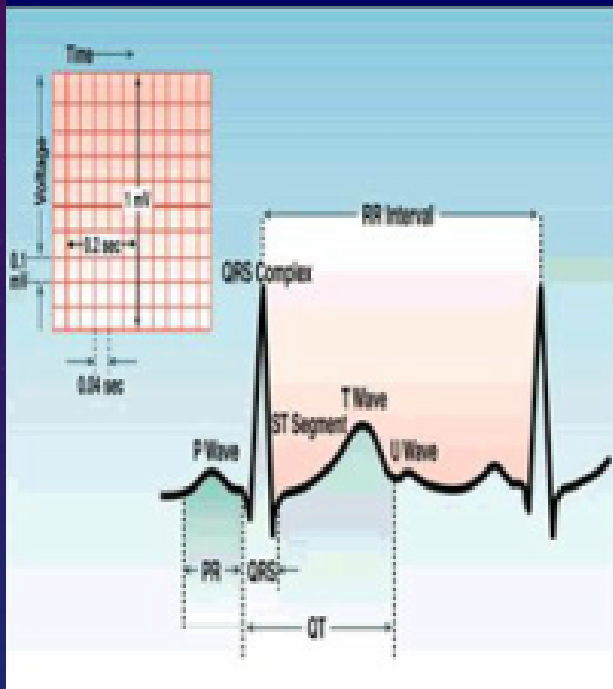
Components of ECG Complex



- P, Q, R, S, T Waves
- PR Interval
- QRS Interval
- QT Interval
- ST Segment

Components of the ECG Complex

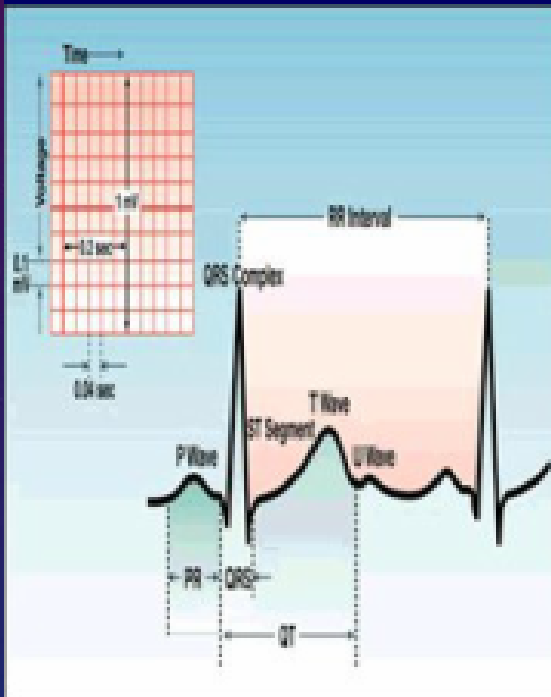
PR Interval



- Time impulse takes to move through atria and AV node
- From beginning of P wave to beginning of QRS complex.
- Duration normally 0.12 - 0.2 sec
- May be shorter with faster rates

Components of the ECG Complex

QRS Interval

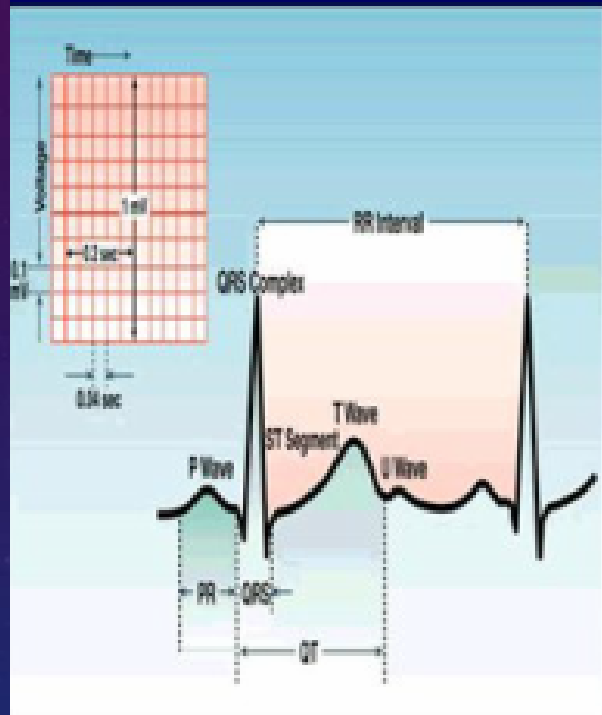


- Time impulse takes to depolarize ventricle
- From beginning of Q wave to beginning of ST segment
- Usually < 0.12 sec

Components of the ECG Complex

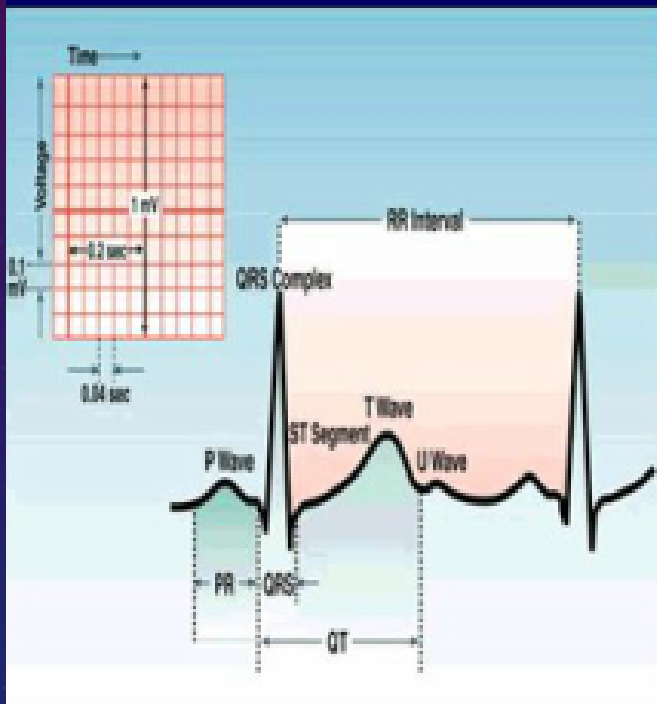
J Point

- Point where QRS complex returns to isoelectric line
- Beginning of ST segment
- Critical in measuring ST segment elevation



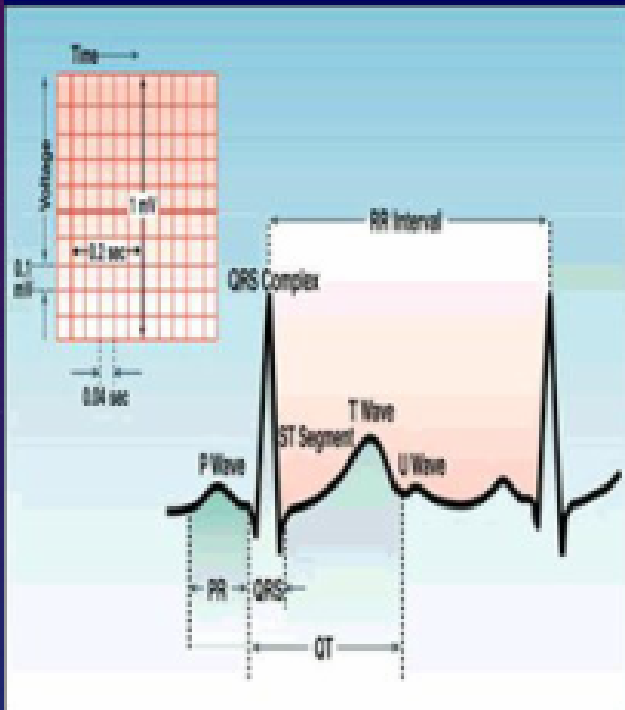
Components of the ECG Complex

ST Segment



- Reflects the period of zero potential between ventricular depolarization and repolarization.
- Measured from J point to onset of T wave
- Elevation or depression may indicate abnormality

Components of the ECG Complex

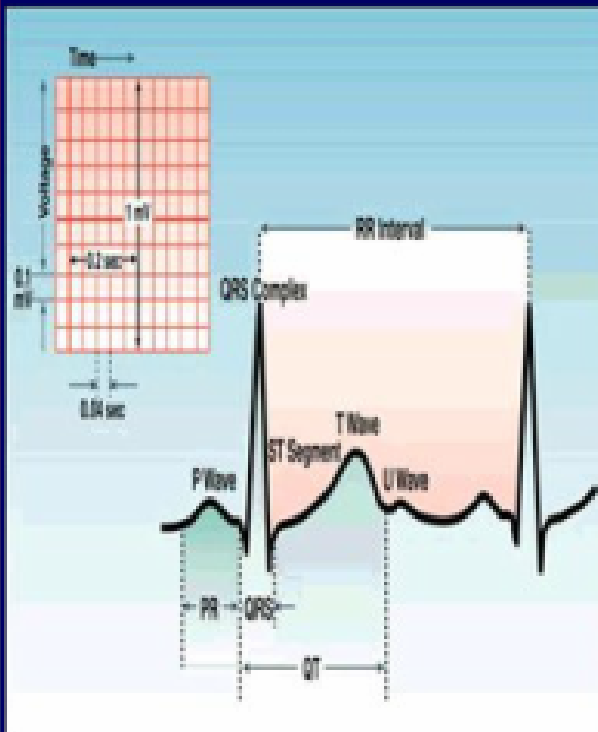


T Wave

- Represents ventricular repolarization
- Concurrent with end of ventricular systole

QT and QTc:

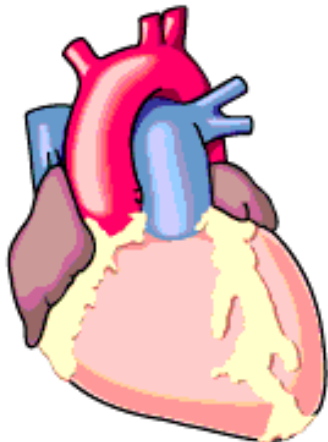
QT interval:



- Represents the time taken for ventricular depolarization and repolarization
- Extends from beginning of the QRS complex to the end of the T wave.
- Duration varies according to age, sex and HR.
- $QTc = QT / \text{square root of RR interval}$
- Normal QTc <0.45 infant, <0.44 children & <0.43 | adults

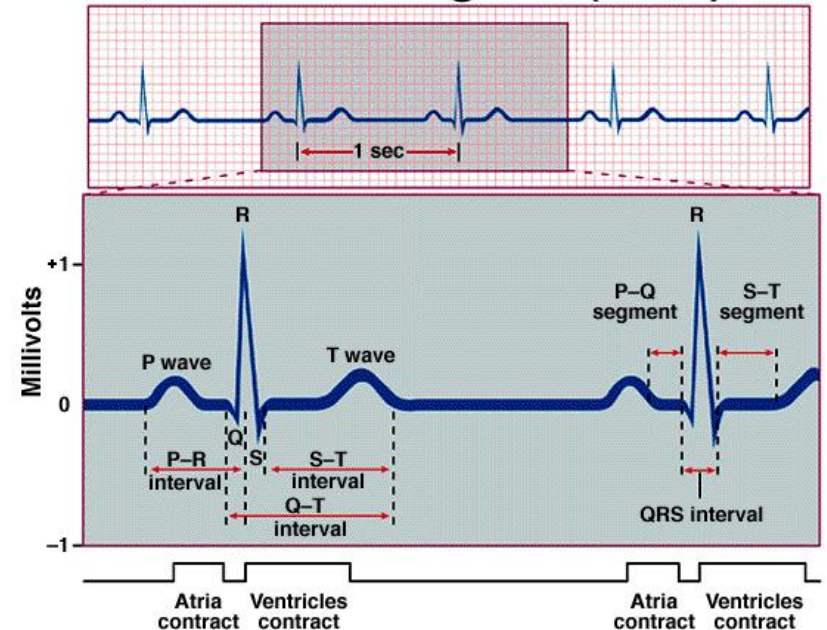
HEART PHYSIOLOGY

- P - atria depolarization
- QRS - ventricle depolarization
- PR - conduction A-V
- T - ventricle repolarization
- QT - duration ventricle of repolarization

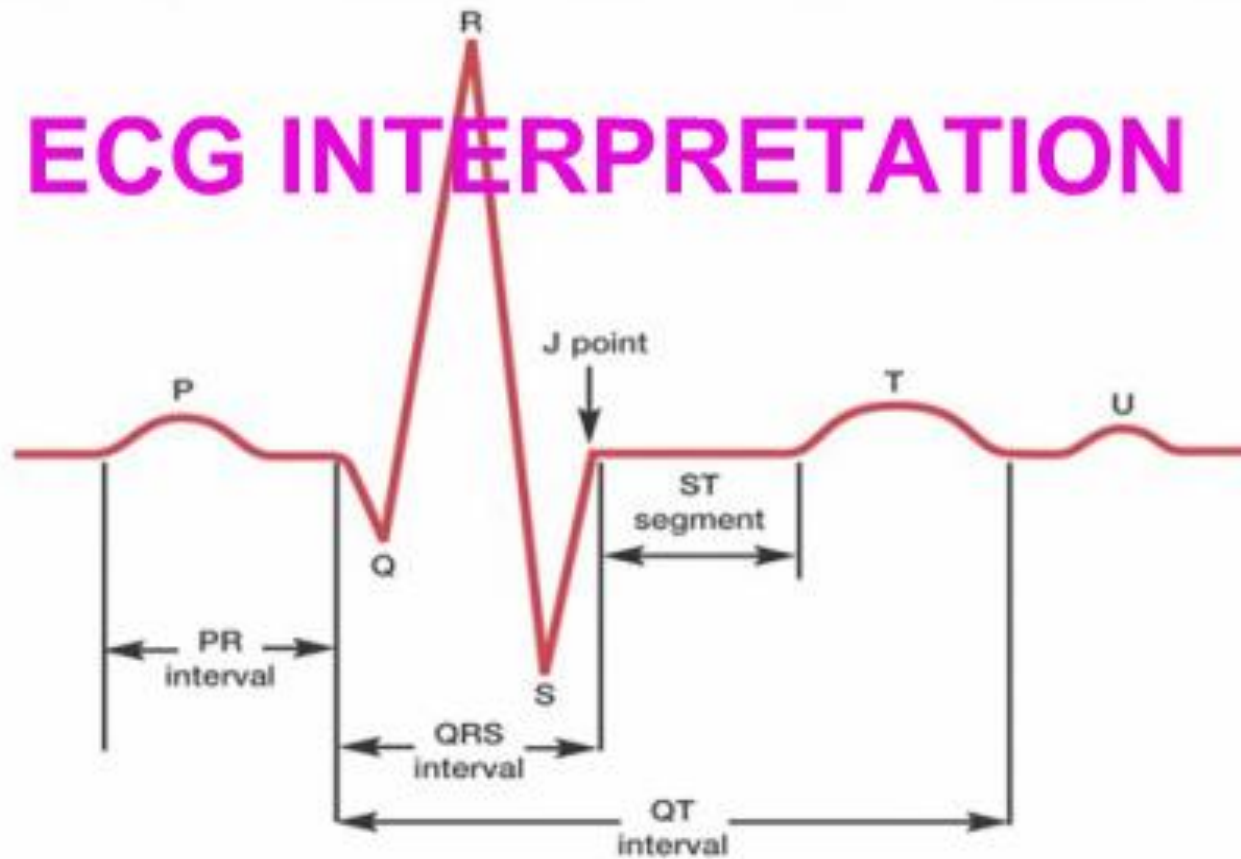


Kenneth S. Saladin, ANATOMY AND PHYSIOLOGY: THE UNITY OF FORM AND FUNCTION, Copyright © 1998, The McGraw-Hill Companies, Inc. All rights reserved.

Electrocardiogram (ECG)



ECG INTERPRETATION

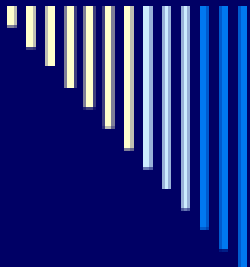




Interpreting ECG

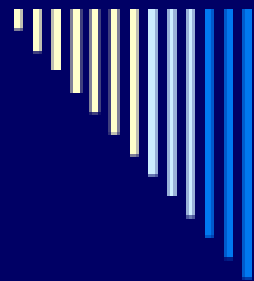
Things you **MUST** note prior to starting the interpretation process:

- **What is the patients age?** many of the values will be affected by this.
- **Is the ECG "full standard"?**
- **Is the ECG "standard speed"?**
- **What is the clinical features and examination findings?**



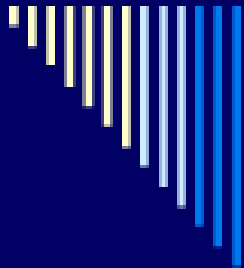
Pediatric Vs adult ECG

1. 13 or 15 instead 12 leads ECG
2. V3R or V4R are important for RVH evaluation
3. RAD and upright T waves in right precordial leads are normal up to 48hrs
4. Right sided chest leads R/S is larger
5. T waves are inverted in V4R & V1-2 during infancy till early adolescence.



ECG ANALYSIS

- Heart rate (atrial and ventricular rates, if different)
- Rhythm (sinus or non sinus) by considering P axis
- The QRS axis, T axis & QRS-T angle
- Intervals: PR, QRS, and QT
- The P wave amplitude & duration
- The QRS amplitude & R/S ratio also abn Q waves
- ST segment and T-wave abnormalities



Heart rate

- Triplicate method (approximate)
 - 300-150-100-75-60-50
- R-R method
 - Divide 1500 by # of small squares between consecutive R waves
- 6 Second method
 - Multiply # of R waves in a 6 second strip by 10
- Measure the R-R interval (in seconds) and divide 60 by the R-R interval
- Count the R-R cycle in 6 large divisions (1/50 minute) and multiply it by 50.
- Rate meter unreliable!!!



Heart rate

- When ventricular and atrial rates are different , P-P interval is used for calculation.
- Normal HR (and range) per minute are

Age	HR
Newborn	145 (90-180)
6months	145 (105-185)
1year	132 (105-170)
4year	108 (72-135)
14year	85 (60-120)

Rhythm

- ❑ P waves preceding each QRS complex indicates sinus rhythm.
- ❑ Normal P axis is 0 to +90 degrees.
- ❑ Normal P wave upright in leads I and aVF and inverted in aVR.






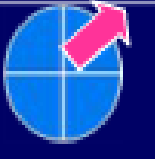


QRS AXIS

- Net direction of electrical activity during depolarization.
- Successive approximation method:

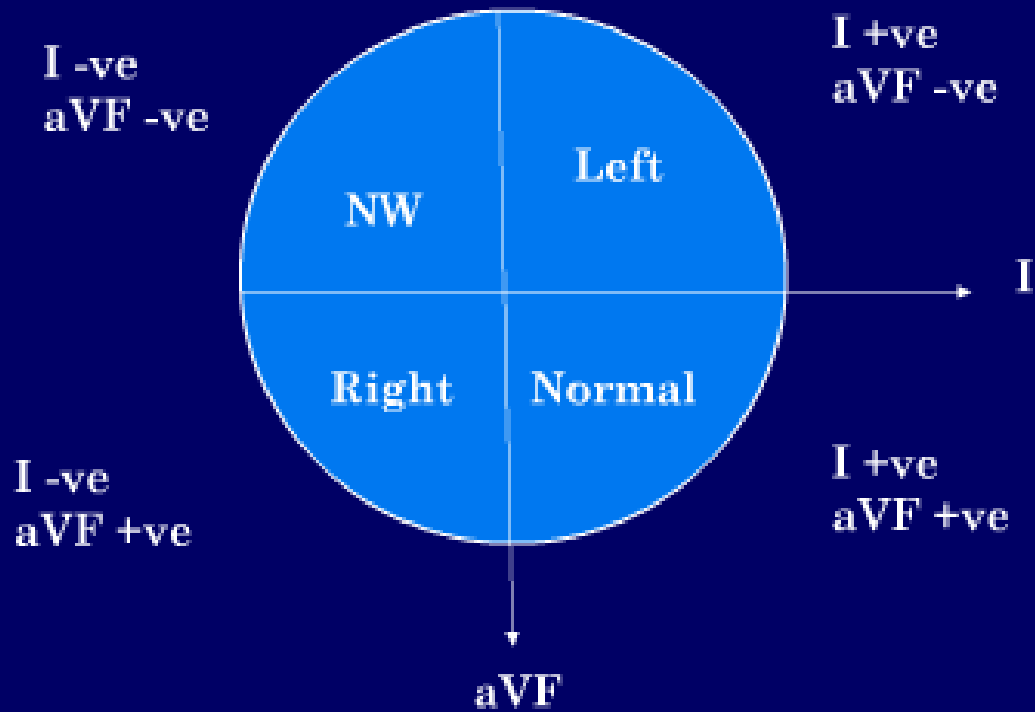
Step 1: locate a quadrant using leads I & aVF

Step 2: axis is perpendicular to a lead with equiphase QRS complex (among remaining 4 limb leads)

Locating quadrants of mean QRS axis from net deflections leads I and aVF

	I	aVF	
0 - +90 Normal	+ve	+ve	
0 - -90 Left	+ve	-ve	
+90 - +- 180 Right	-ve	+ve	
-90 - +- 180 north west	-ve	-ve	

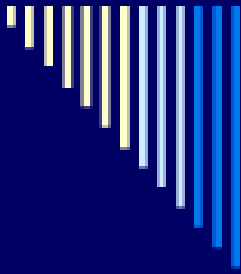
AXIS





Normal QRS Axis

Age	Mean (degrees)	Range
1wk- 1mo	+ 110	+30 to +180
1-3mo	+ 70	+10 to +125
3mo-3yr	+ 60	+10 to +110
Older than 3yr	+ 60	+20 to +120
Adult	+ 50	-30 to +105



Abnormal QRS Axis

Axis	LAD	RAD	SUPERIOR
CAUSE	<input type="checkbox"/> LVH <input type="checkbox"/> LBBB <input type="checkbox"/> Lt ant hemiblock	<input type="checkbox"/> RVH <input type="checkbox"/> RBBB	<input type="checkbox"/> Lt ant hemiblock <input type="checkbox"/> ECD <input type="checkbox"/> Tricuspid atresia



INTERVALS IN ECG

- PR interval
 - QRS duration
 - QT interval
 - P wave duration
-

PR Interval

- Varies with age and HR
- Ranges from 0.12 to 0.20 sec
- Abnormalities are :

Increased (>0.2 sec)	Shortened (<0.12 sec)
<ul style="list-style-type: none">-Myocarditis-Digitalis toxicity-Quinidine toxicity-ASD, ECD & Ebstein Anomaly	<ul style="list-style-type: none">- Wolf Parkinson White syndrome- Lown- Ganong- Levine syndrome- Glycogenosis- DMD- Friedreich ataxia- AV nodal rhythm- Low atrial rhythm

Variable PR interval are seen in wandering atrial pacemaker and Wenkebach's phenomenon (Mobitz type I second degree)

What is the PR interval ?





QRS DURATION

Prolonged in ventricular conduction disturbances :

- ❑ RBBB
 - ❑ LBBB
 - ❑ Preexcitation and
 - ❑ Interventricular blocks (as seen in hyperkalemia ,quinidine/ procainamide toxicity , myocardial dysfunction and myocardial fibrosis).
-

Broad QRS complexes and strange-looking ECGs



- A wide(>0.2 sec) QRS complex: bundle branch block.
- New LBBB can be diagnostic of myocardial infarction (MI).



QT interval

- Varies with HR
- HR corrected QT (QTc) is calculated by Bazett's formula:

QT measured

- $QTc = \frac{\text{QT measured}}{\text{Square root of R-R interval}}$

Square root of R-R interval

- Normal is 0.40 ± 0.014



QT interval: abnormalities

Long	Short
<ul style="list-style-type: none">• Hypocalcemia , Hypokalemia• Rheumatic carditis• AMI• Myocarditis ,• Quinine , procainamide, phenothiazines, TCAs, ampicillin, erythromycin & terfenadine therapy• CVA• Hypothermia• CCF• Long QT syndrome	<ul style="list-style-type: none">➤ Hypercalcemia➤ Digitalis and➤ Hyperthermia➤ Short QT syndrome <300millisec



P waves

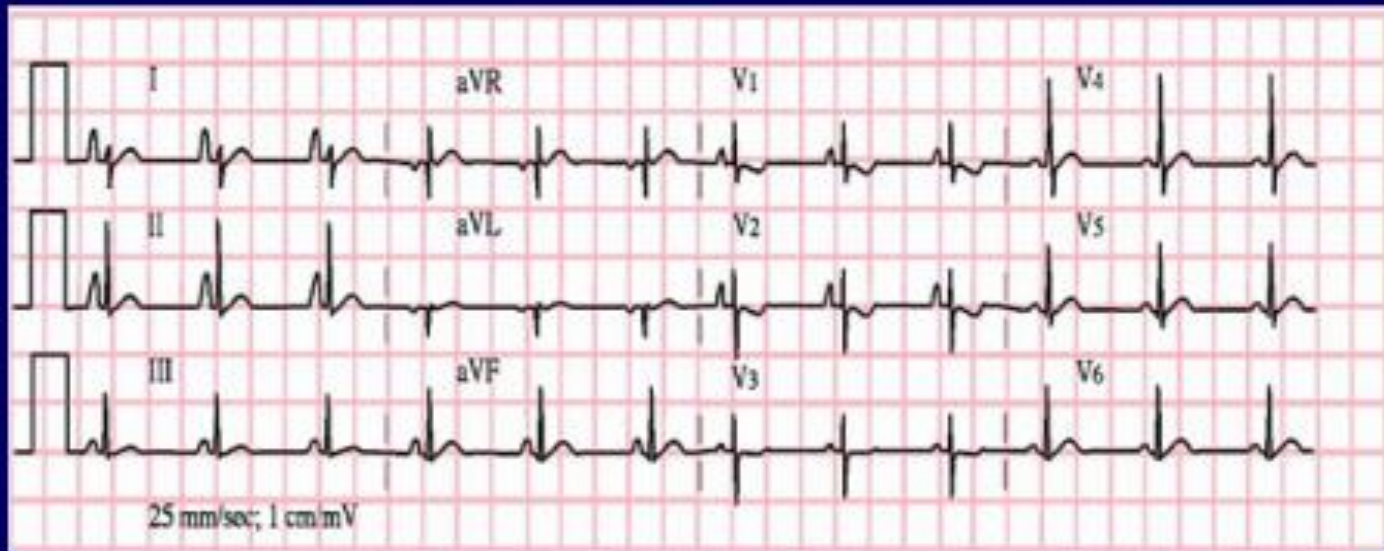
- Best visualized in lead II and V1
- Amplitude $< 3\text{mm}$ & duration $< 0.09\text{sec}$
- What to see:
 - Present or absent ?
 - Do they all look alike?
 - Regular interval
 - Upright or inverted in Lead II?
 - Upright = atria depolarized from top to bottom
 - Inverted = atria depolarized from bottom to top

Normal sinus rhythm



Each P wave followed by single QRS complex

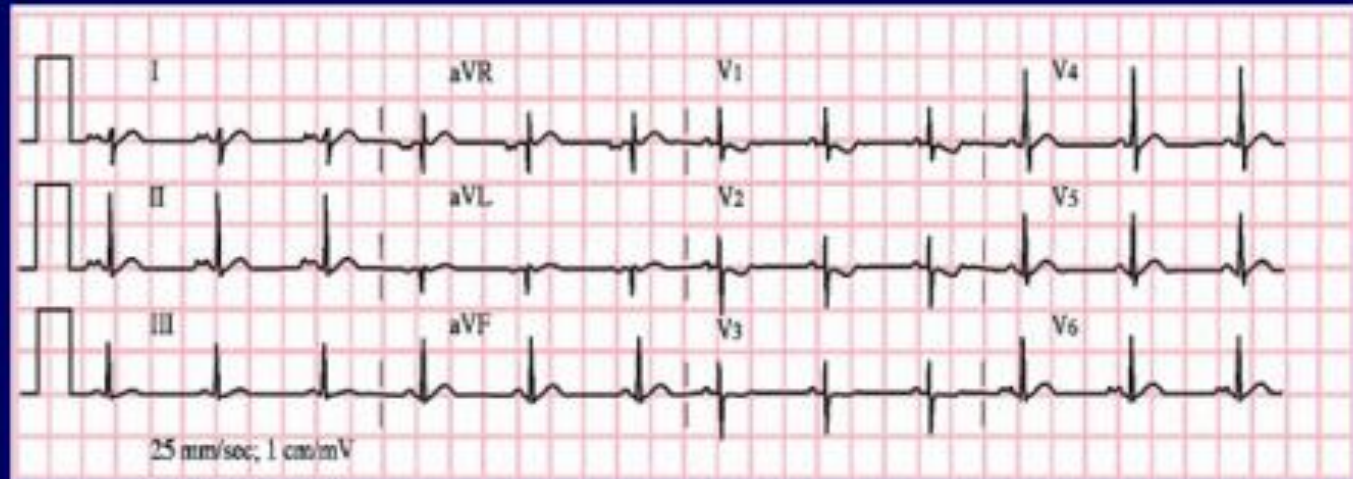
RAH- P PULMONALE



Tall P wave >3mm

Conditions: PS, Ebstein anomaly, Tricuspid atresia, Cor pulmonale

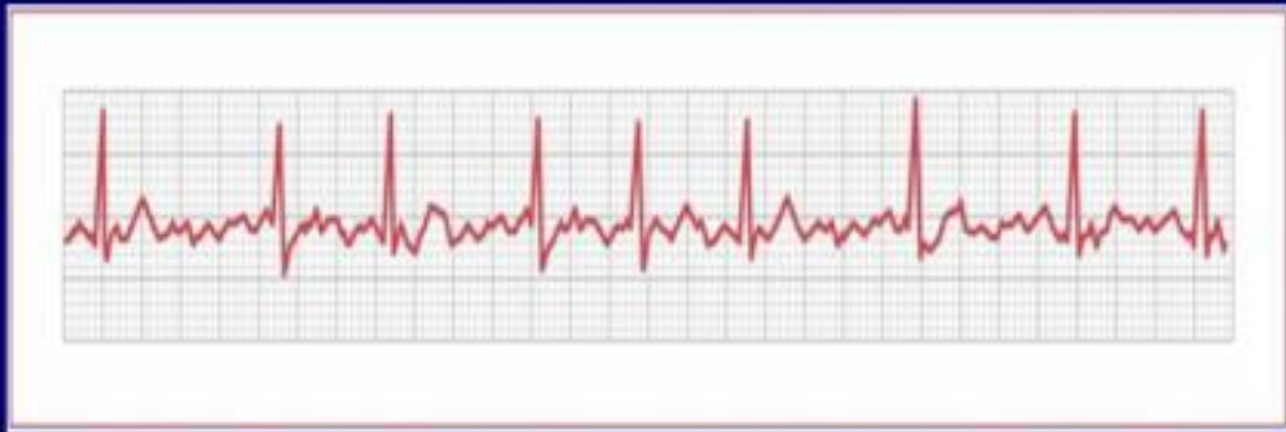
LAE- P MITRALE



- Wide & notched P waves :> 0.08 sec in infants and small children and > 0.12 sec in older children and adults.
- V1: P wave diphasic with prolong negative segment

Conditions: large lt to rt shunt and severe MS or MR

P waves



- No P waves and irregular narrow QRS complexes

ECG demonstrating atrial fibrillation

P waves



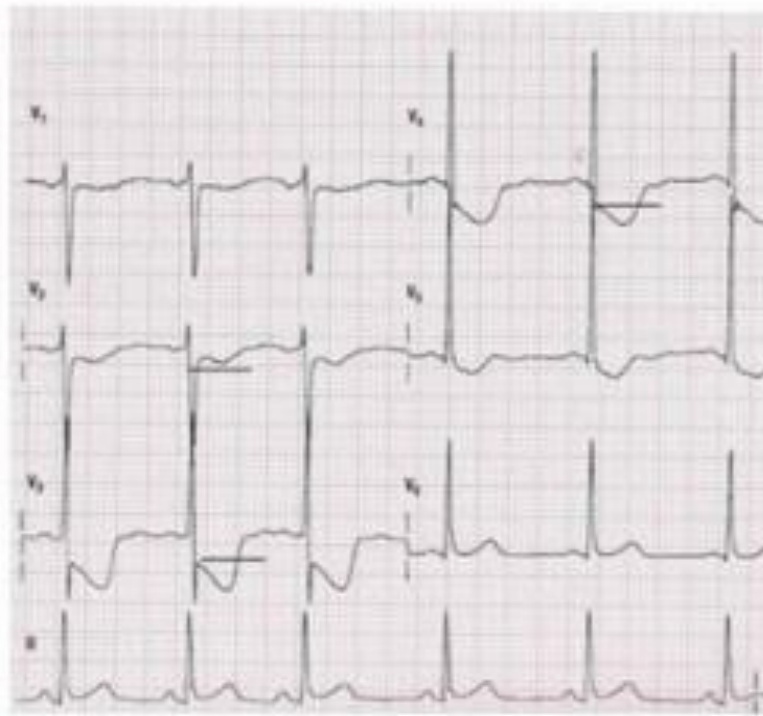
- A saw tooth waveform signifies **ATRIAL FLUTTER**.
- The number of atrial contractions to one ventricular contraction should be specified.



ST SEGMENT

- Represents time interval between ventricular depolarization and repolarization.
- Taken from end of QRS complex to beginning of the T wave.
- Usually isoelectric ,however ,elevation or depression of ST segment up to 1mm in limb leads and up to 2mm in the precordial leads is within normal limits in infants and children.

ST-Segment Depression



ST-Segment Elevation

