

# ECG & Cardiac Arrhythmias

# Introduction:

The body acts as a conductor of electricity.

**As the wave of depolarization is transmitted throughout the heart , electrical currents spread into tissues surrounding the heart and to the surface of the body.**

The placement of electrodes on the skin on opposing sides of the heart enables the electrical current generated by the heart to be recorded.

# **What is an ECG ?**

**The electrocardiogram (ECG/EKG) is a representation of the electrical events of the cardiac cycle.**

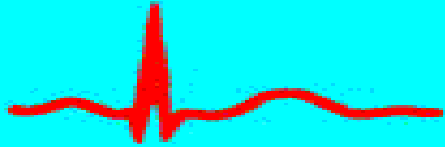
**Each event has a distinctive waveform, the study of which can lead to greater insight into a patient's cardiac pathophysiology.**

# **Cardio-diagnostic Investigations**

- 1. ECG Recording**
- 2. Cardiac Monitoring**
- 3. TMT/Exercise ECG/Dobutamine Stress Test**
- 4. Holter monitoring**
- 5. Echocardiography**
- 6. Pericardiocentesis**
- 7. Pulse Oxymetry**
- 8. Chest X-ray**
- 9. Cardiac Angiography**
- 10. Others: Pulse, BP, Heart Sound, CT, MRT etc**

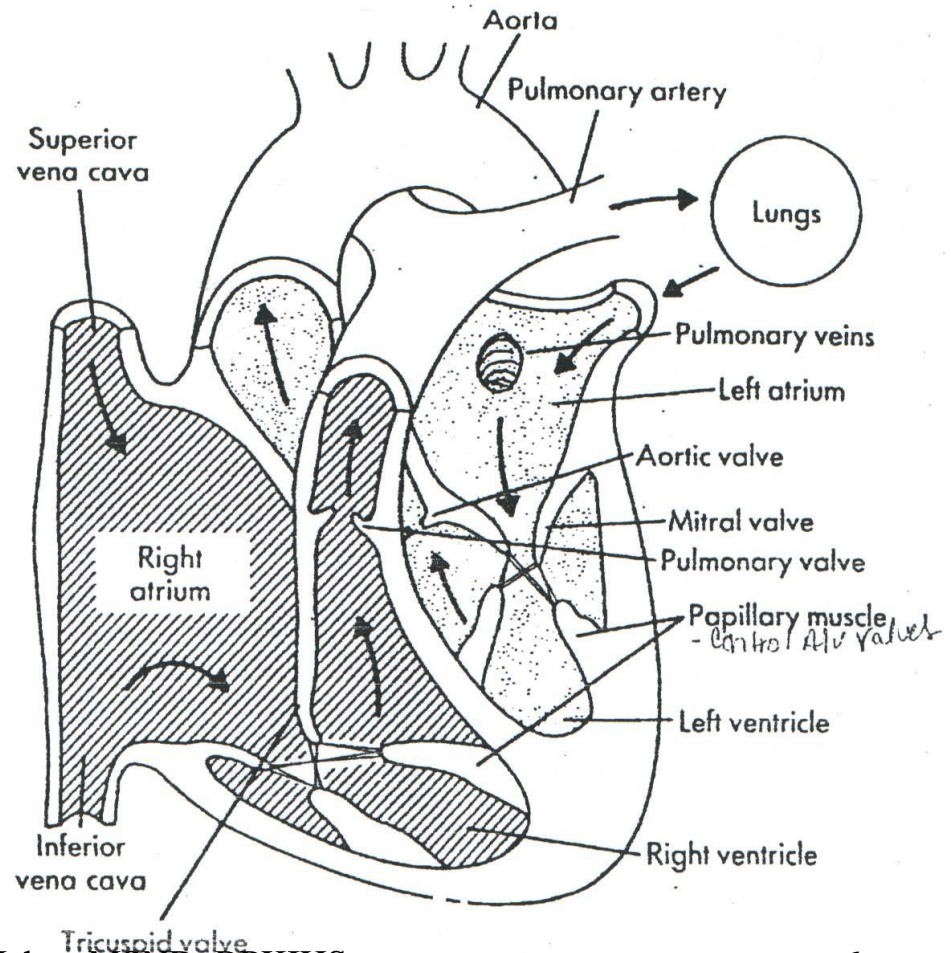
# Purpose:

- Arrhythmias
- Myocardial ischemia and infarction
- Pericarditis
- Chamber hypertrophy / Cardiomegaly.
- Electrolyte disturbances (i.e. hyperkalemia, hypokalemia)
- Drug toxicity (i.e. digoxin)
- To provide vital information regarding the patient's condition and progress( **Death: flat ECG**)



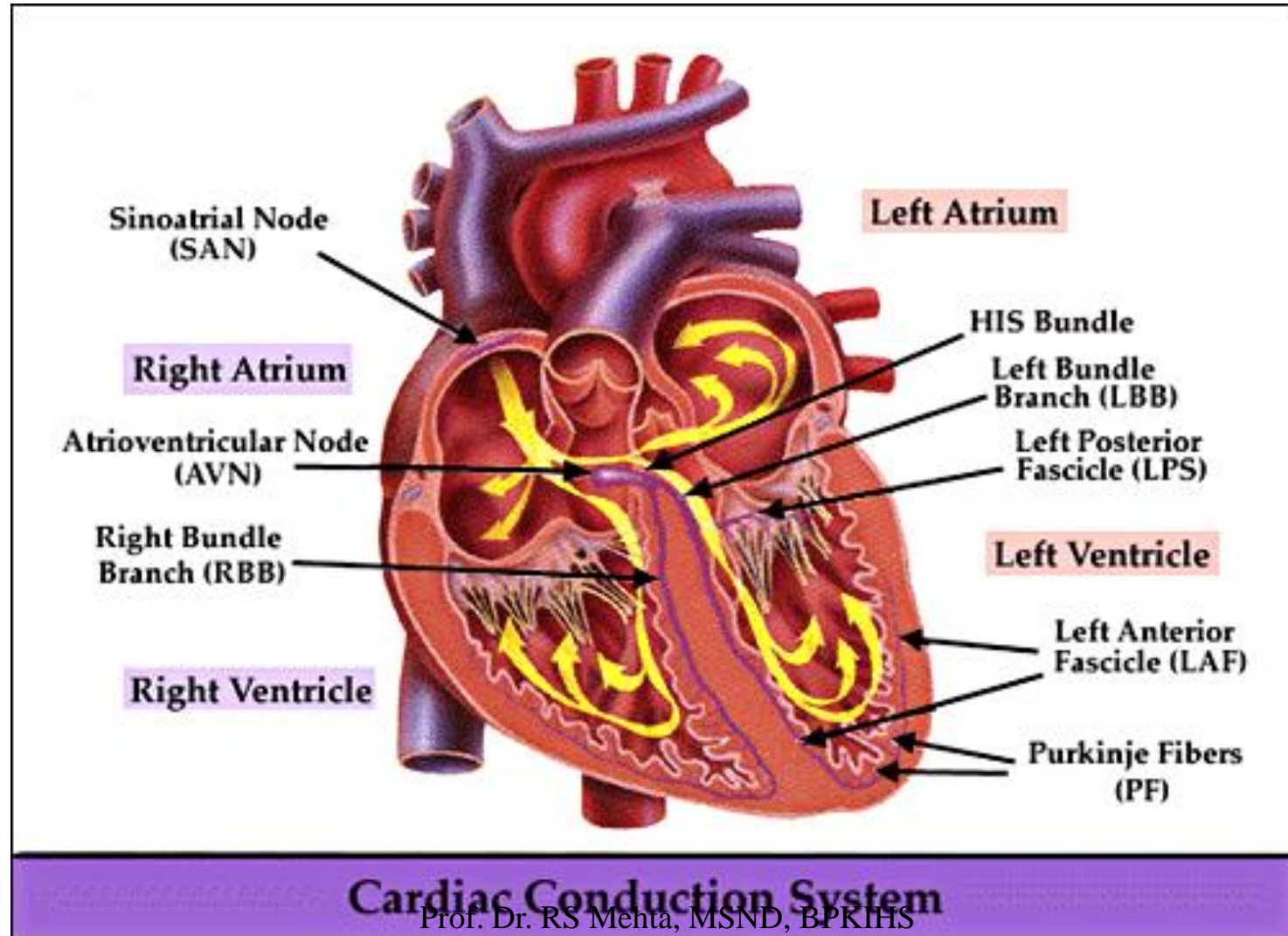
# Anatomy & Physiology

- Blood Flow through heart
  - Superior and Inferior Vena Cava
  - Right Atrium
  - Right Ventricle
  - Pulmonary Artery
  - Lungs
  - Pulmonary Vein
  - Left Atrium
  - Left Ventricle
  - Aorta
  - Body

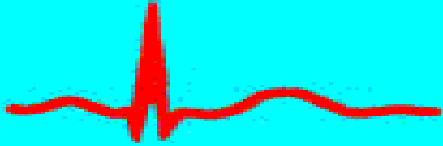


# Review Basic of ECG

# Conduction System

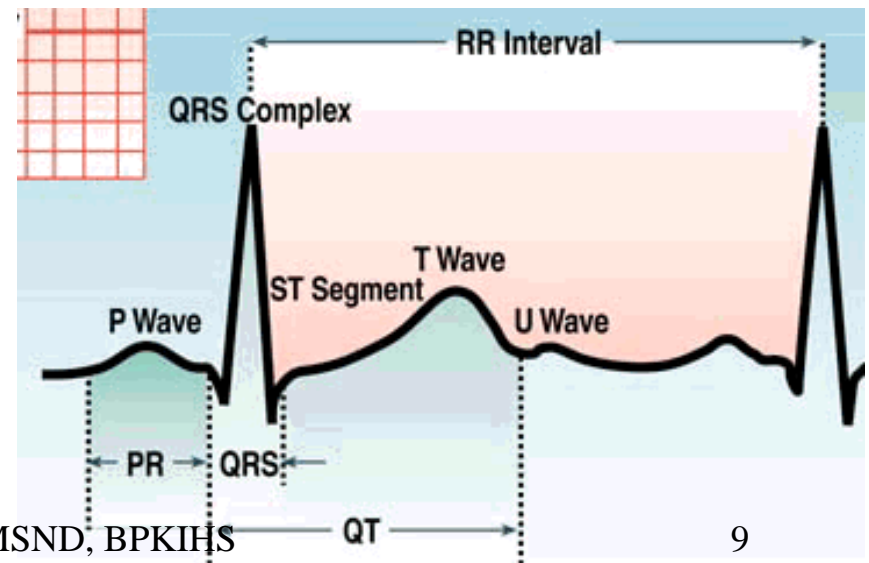


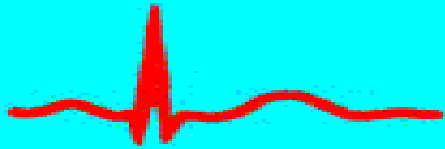




# Conduction System

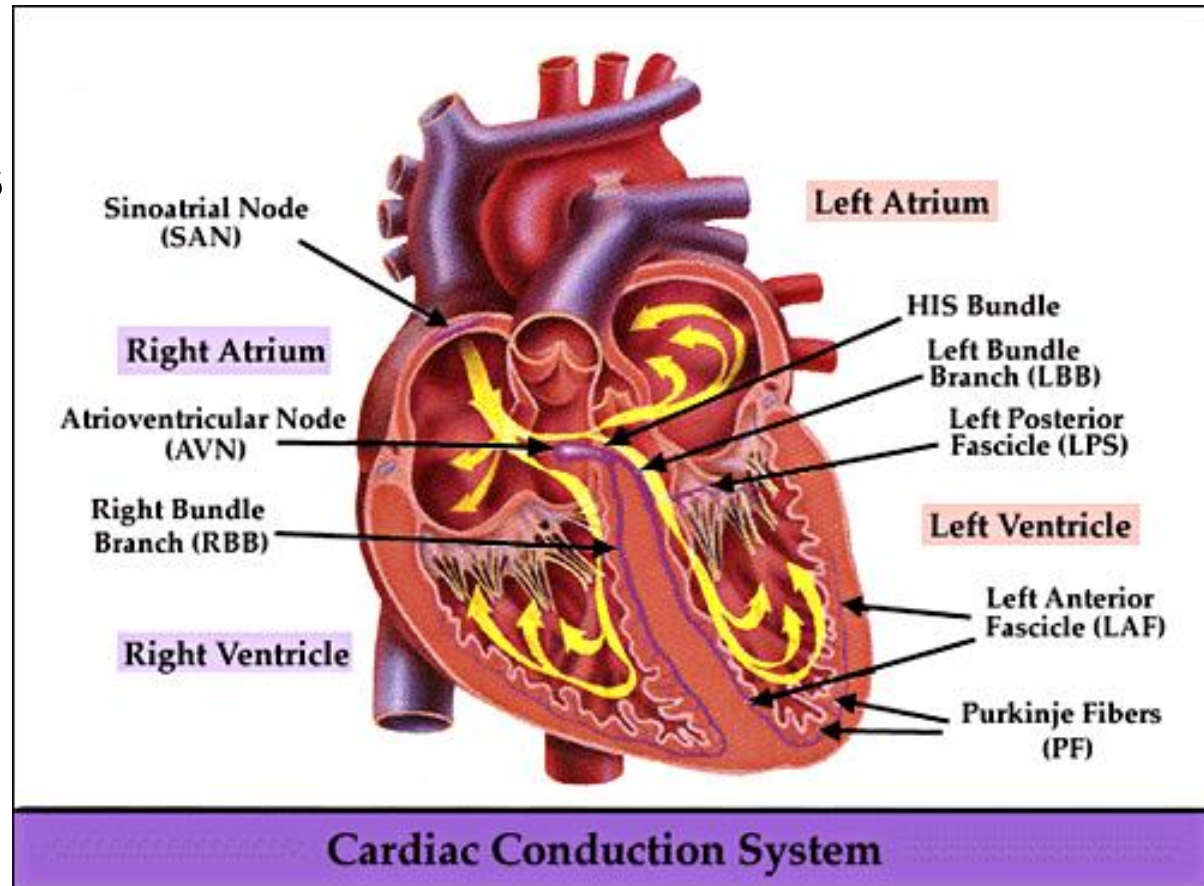
- The heart has a conduction system separate from any other system
- The conduction system makes up the PQRST complex we see on paper
- An arrhythmia is a disruption of the conduction system
- Understanding how the heart conducts normally is essential in understanding and identifying arrhythmias

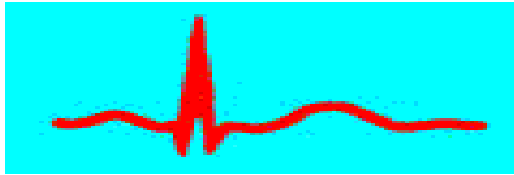




# Conduction System

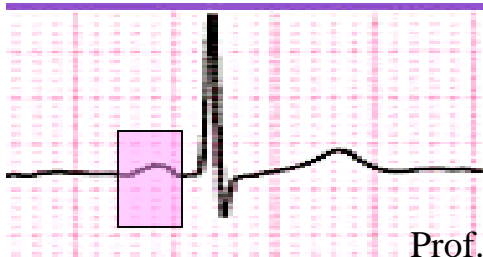
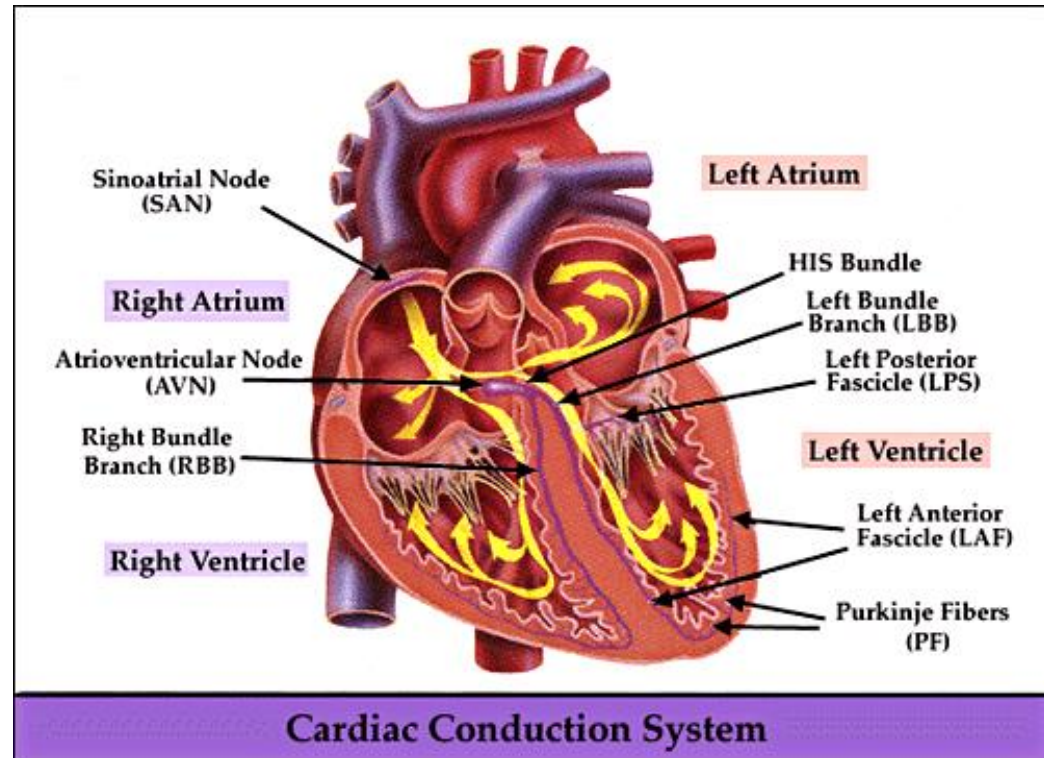
- SA Node
- Inter-nodal and inter-atrial pathways
- A-V Node
- Bundle of His
- Perkinje Fibers

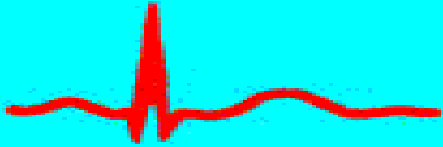




# SA Node

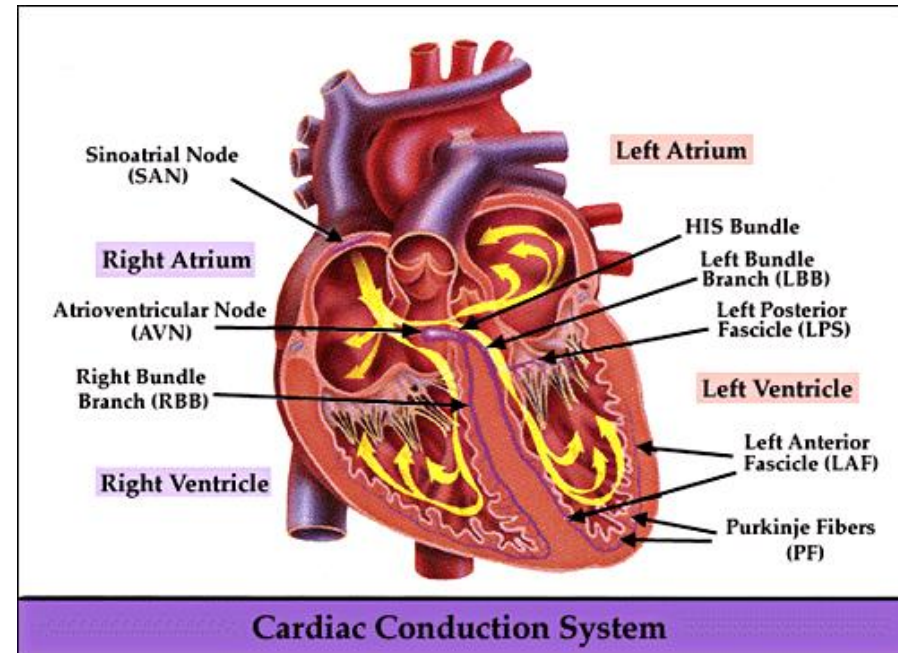
- The primary pacemaker of the heart
- Each normal beat is initiated by the SA node
- Inherent rate of 60-100 beats per minute
- Represents the P-wave in the QRS complex or atrial depolarization (firing)





# AV Node

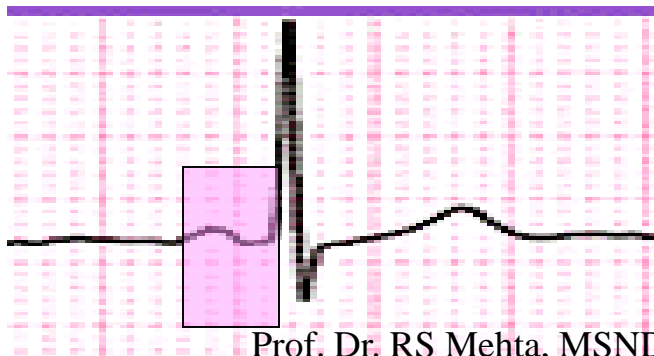
- Located in the septum of the heart
- Receives impulse from inter-nodal pathways and holds the signal before sending on to the Bundle of His
- Represents the PR segment of the QRS complex





# AV Node

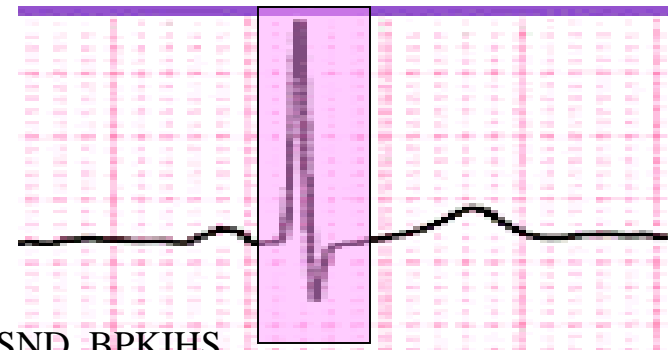
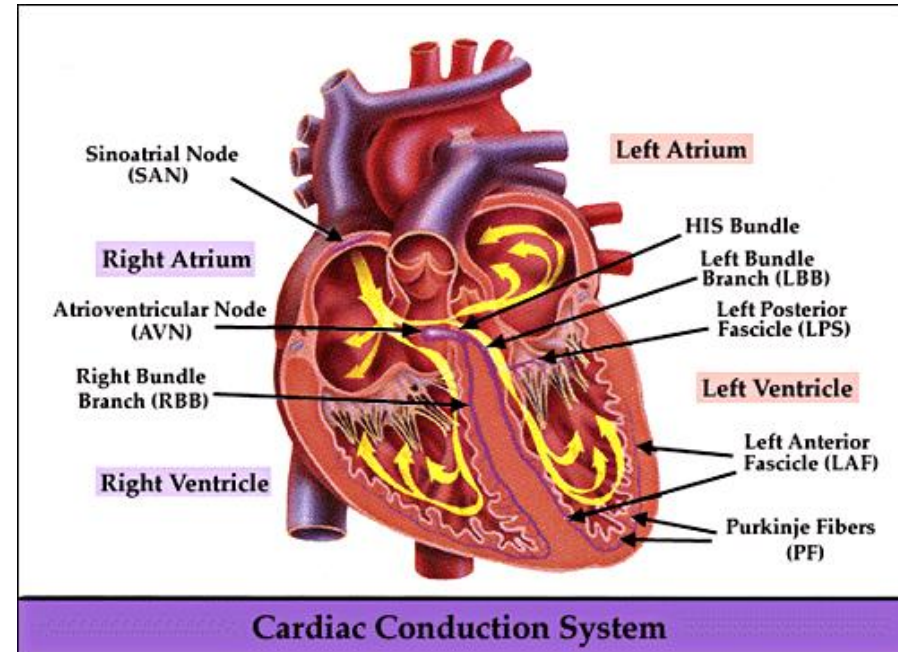
- Represents the PR segment of the cardiac cycle
- Has an inherent rate of 40-60 beats per minute
- Acts as a back up when the SA node fails
- Where all junctional rhythms originate





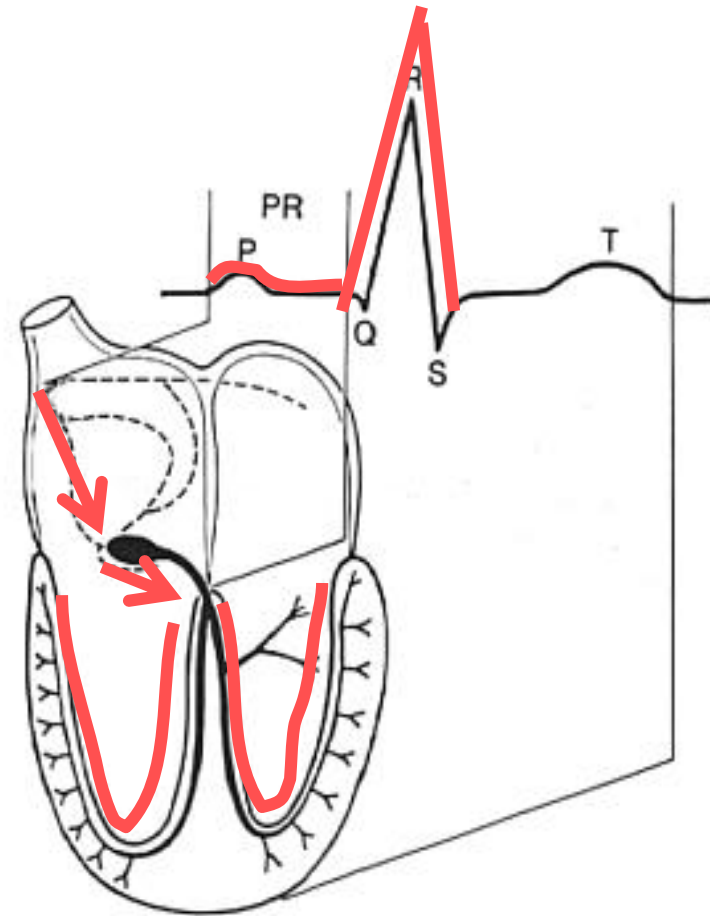
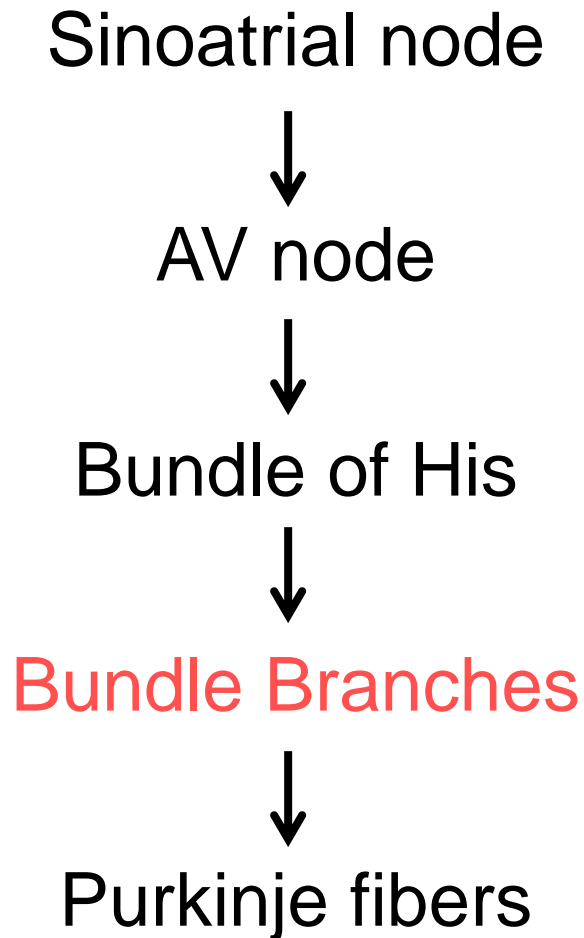
# QRS Complex

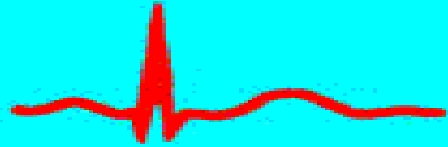
- Represents the ventricles depolarizing (firing) collectively. (Bundle of His and Purkinje fibers)
- Origin of all ventricular rhythms
- Has an inherent rate of 20-40 beats per minute





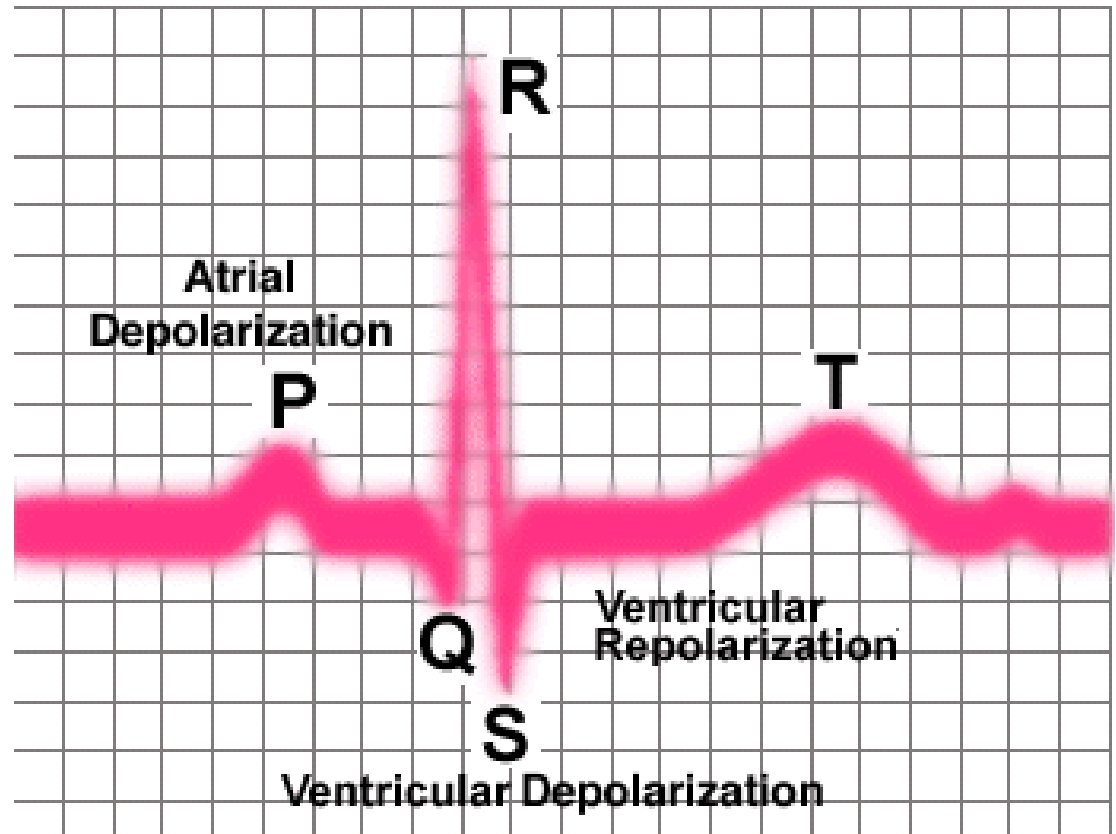
# Normal Impulse Conduction



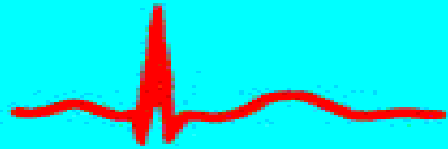


# EKG Trace

- Isoelectric line  
(baseline)
- P-wave
  - Atria firing
- PR interval
  - Delay at AV

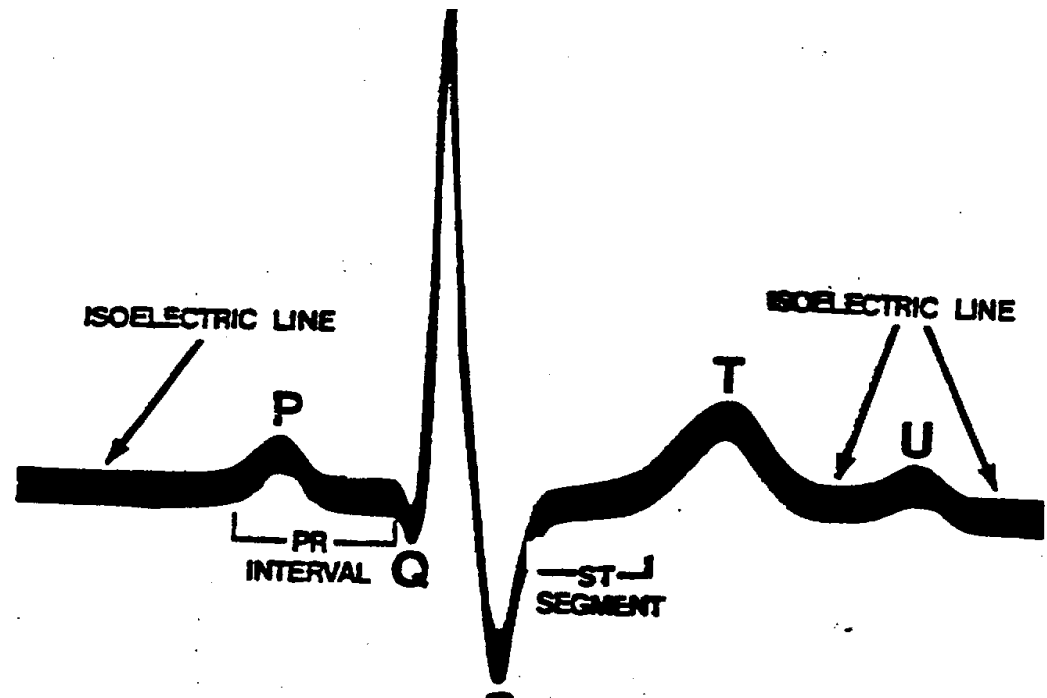






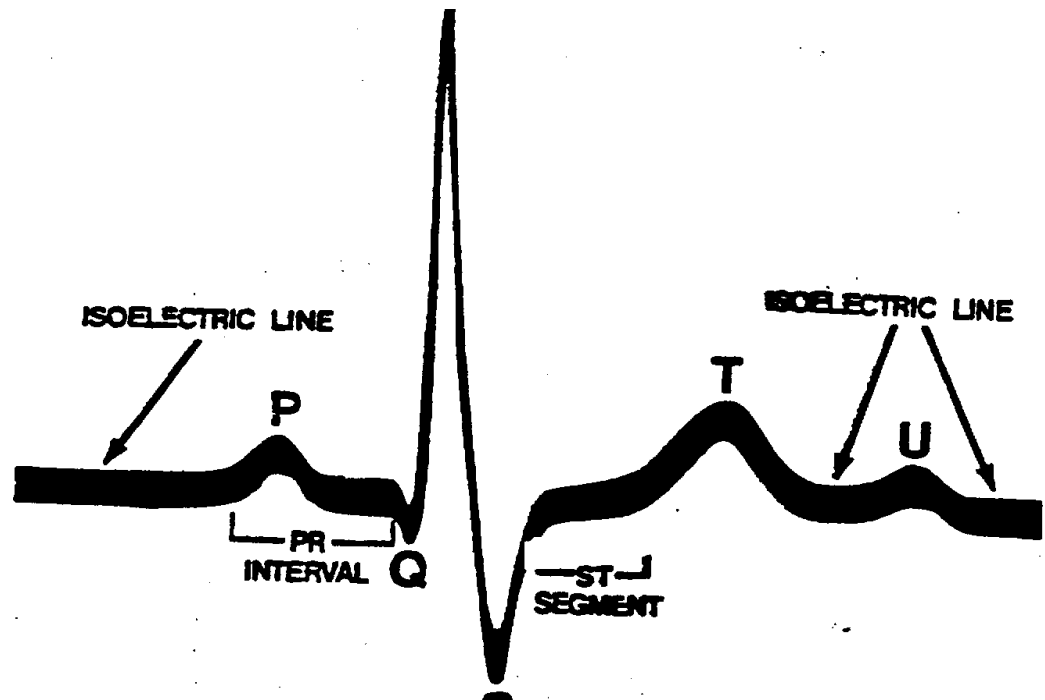
# EKG Trace

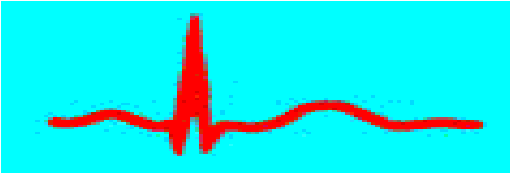
- QRS
  - Ventricles firing
- T-wave
  - Ventricles repolarizing



# EKG Trace

- ST segment
  - Ventricle contracting
  - Should be at isoelectric line
  - Elevation or depression may be important
- U wave
  - Perkinje fiber repolarization?

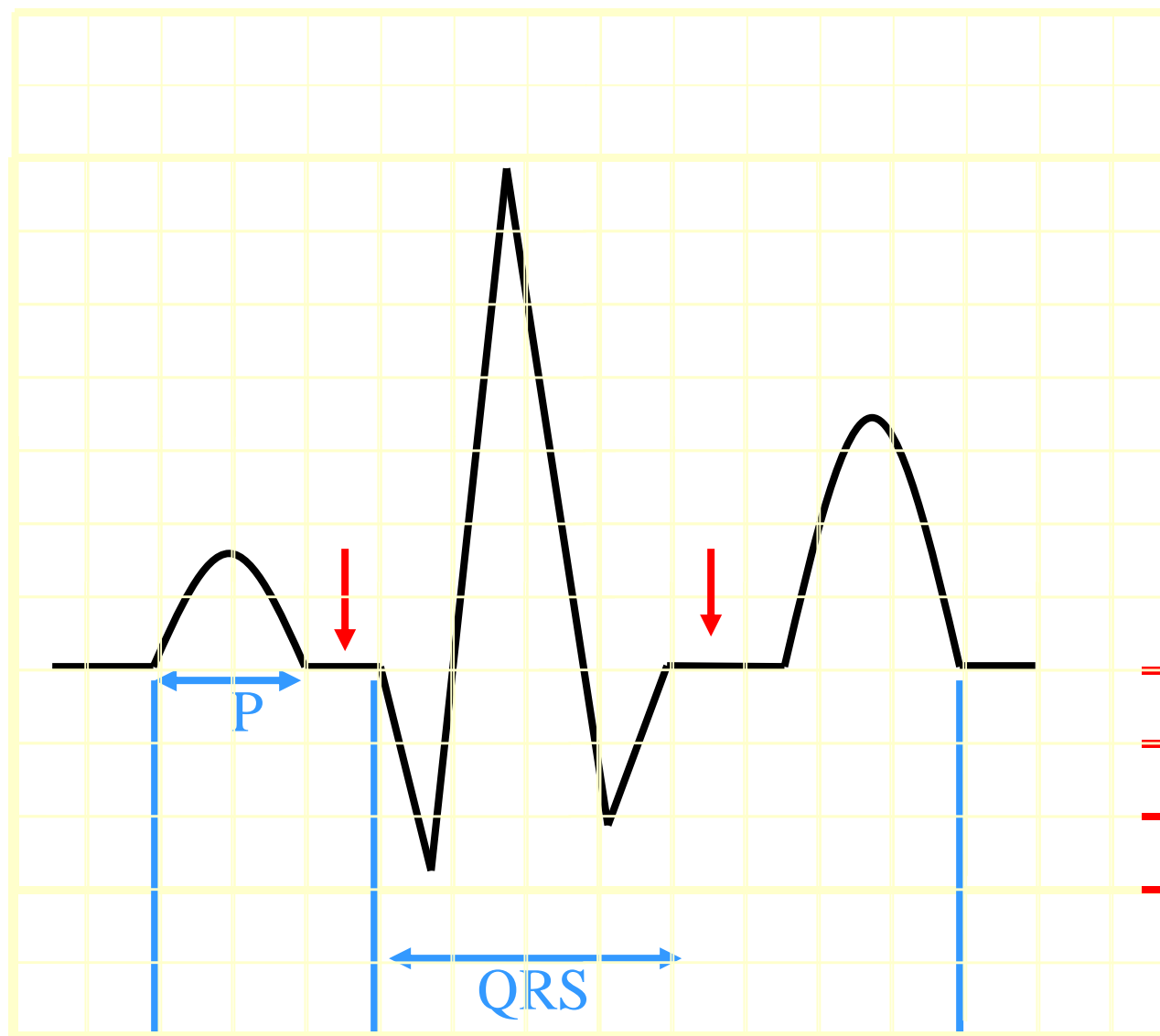




# Waveform Analysis

- For each strip it is necessary to go through steps to correctly identify the rhythm
  1. Is there a P-wave for every QRS?
    - P-waves are upright and uniform
    - One P-wave preceding each QRS
  2. Is the rhythm regular?
    - Verify by assessing R-R interval
    - Confirm by assessing P-P interval
  3. What is the rate?
    - Count the number of beats occurring in one minute
    - Counting the p-waves will give the atrial rate
    - Counting QRS will give ventricular rate

1mm =  
0.1mv



1mm =  
0.04s

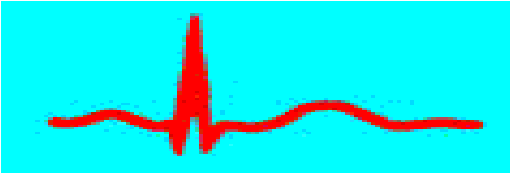
Paper  
speed

segments  
20

PR Int

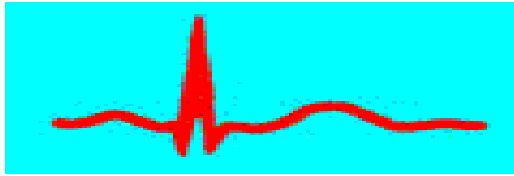
QT interval

Prof. Dr. RS Mehta, MSND, BPKIHS



# Summary

- Normal
  - Heart rate = 60 – 100 bpm
  - PR interval = 0.12 – 0.20 sec
  - QRS interval  $< 0.12$
  - SA Node discharge = 60 – 100 / min
  - AV Node discharge = 40 – 60 min
  - Ventricular Tissue discharge = 20 – 40 min



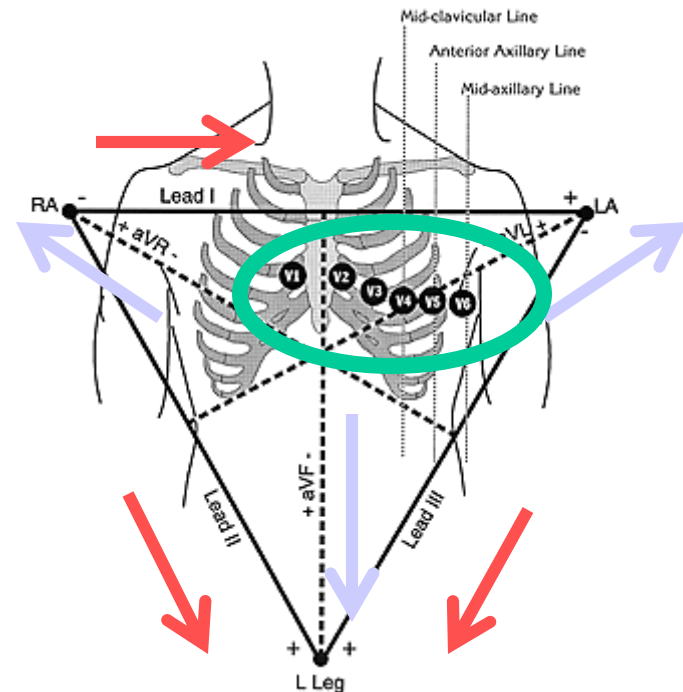
# Summary

- Cardiac cycle
  - P wave = atrial depolarization
  - PR interval = pause between atrial and ventricular depolarization
  - QRS = ventricular depolarization
  - T wave = ventricular repolarization

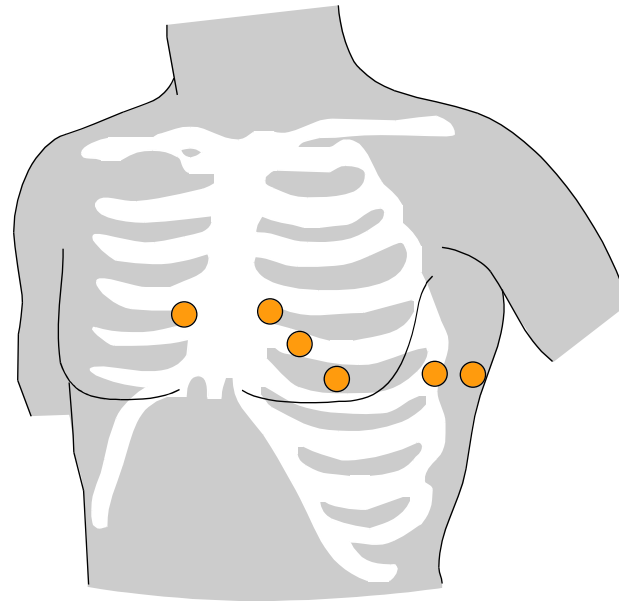
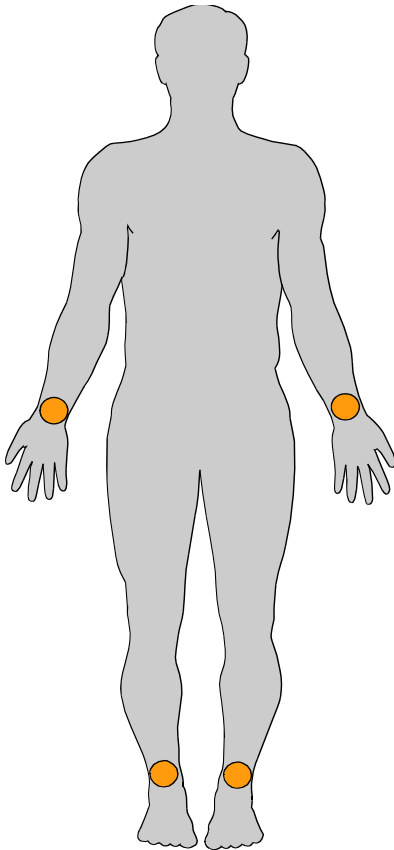
# The 12-Leads

The 12-leads include:

- 3 Limb leads (I, II, III)
- 3 Augmented leads (aVR, aVL, aVF)
- 6 Precordial leads ( $V_1$ -  $V_6$ )



# Lead Views



Leads placed in limbs (arm/leg) RT Minimum Muscle as to decrease muscle twitching.

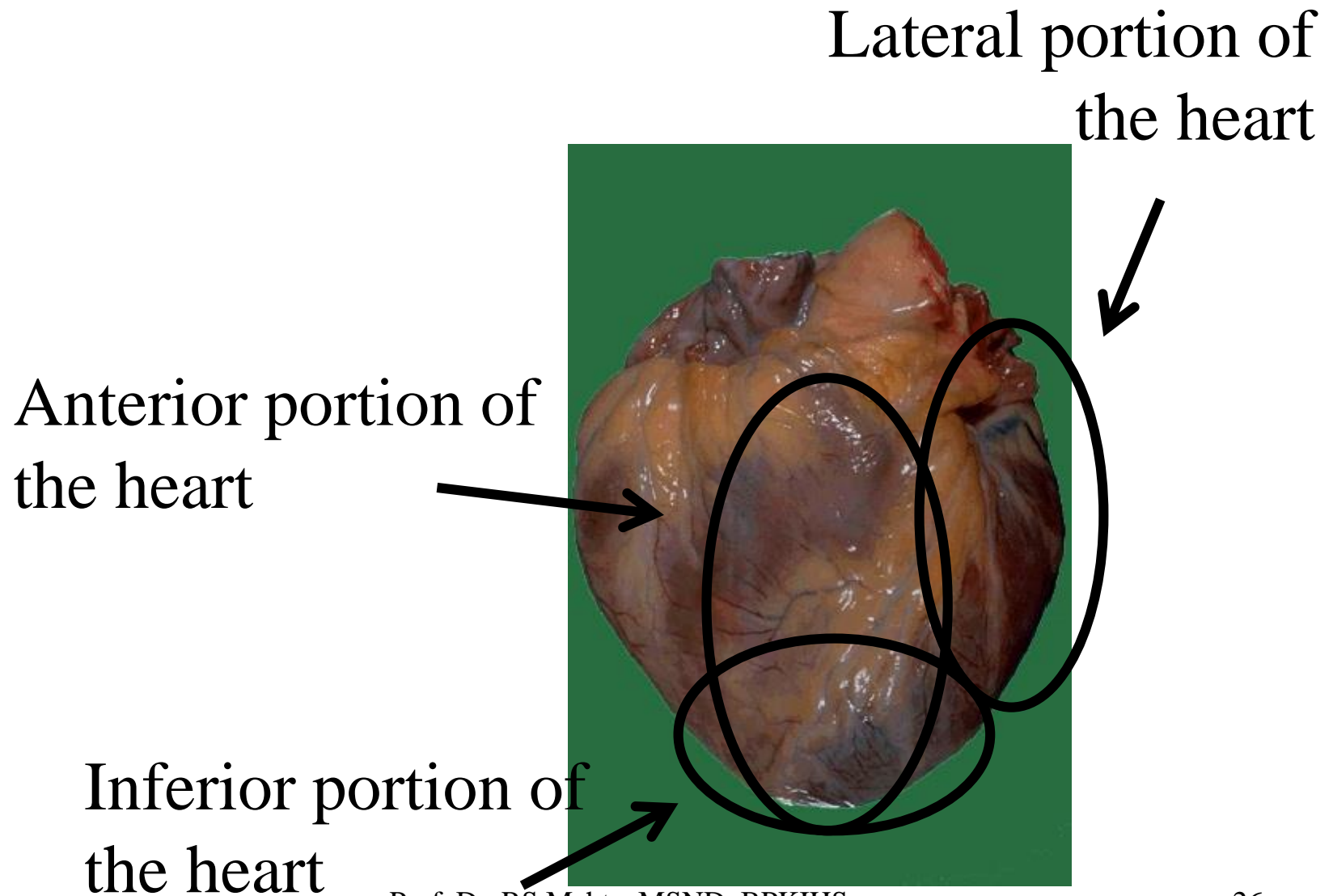
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# Anatomic Groups (Summary)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

# Other MI Locations



# Features to Analyze on every ECG

1. Standardization / Calibration / Technical Quality
2. Heart Rate
3. Rhythm
4. PR interval
5. P-wave Size
6. QRS-width/interval
7. QT interval
8. R-wave progression in chest leads
9. Abnormal q-wave
10. ST Segment
11. T-wave
12. U- wave
13. Others-Axis, voltage etc

# Determining the Heart Rate

**1 Small Squire = 1mm/0.04sec.**

**1 Large Squire = 5mm/0.2sec.**

**5 Large Squire = 25mm/1 sec.**

**Calibration:** 25mm/sec,  $25 \times 60 = 1500$

: 10mm/sec,  $10 \times 60 = 600$

: 100mm/sec,  $100 \times 60 = 6000$

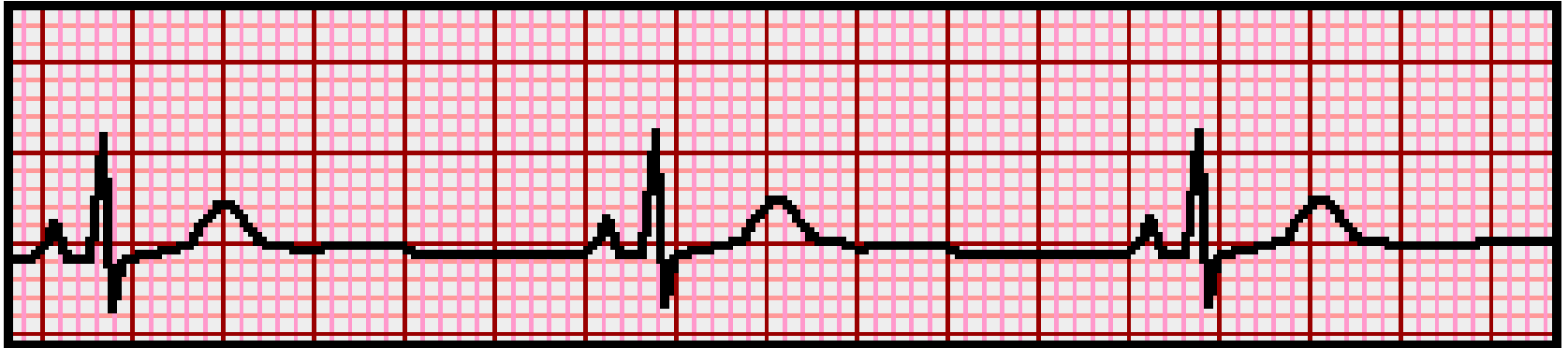
# Rule of 300 (Clinical use)

Take the number of “big boxes” between neighboring QRS complexes, and divide this into 300. The result will be approximately equal to the rate

# When Heart Rate Regular:

- 300/ No of large squares between 2 'R' wave  
= HR/min (  $300/4=75$  min)
- 1500 No. of small square between 2 'R' wave  
=HR/min.( $1500/20=75$ min)

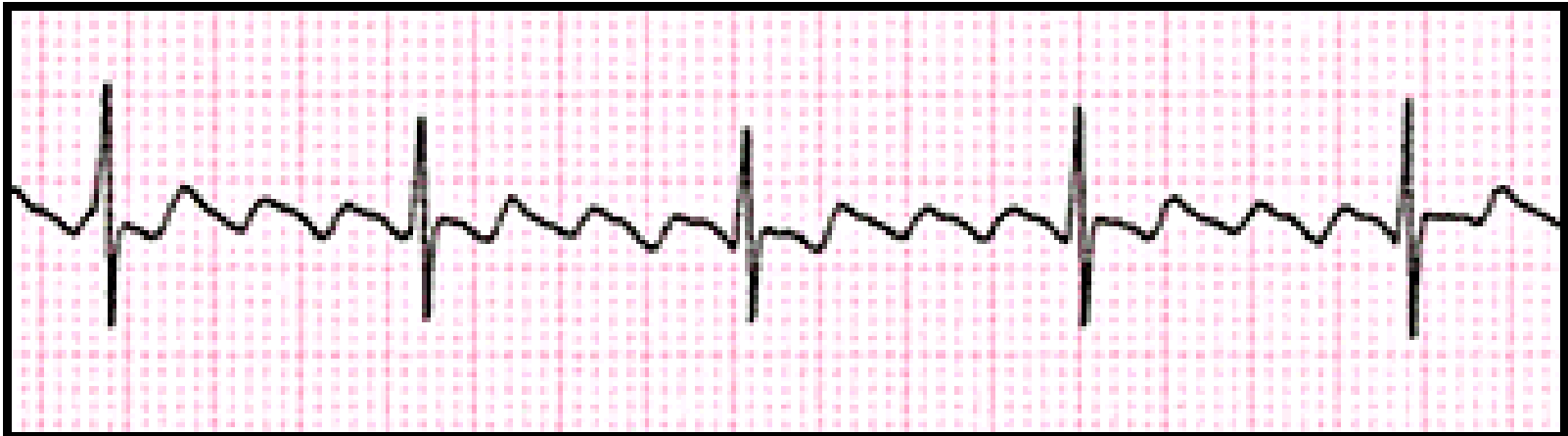
# What is the heart rate?



[www.uptodate.com](http://www.uptodate.com)

$$(300 / 6) = 50 \text{ bpm}$$

# What is the heart rate?



[www.uptodate.com](http://www.uptodate.com)

$$(300 / \sim 4) = \sim 75 \text{ bpm}$$

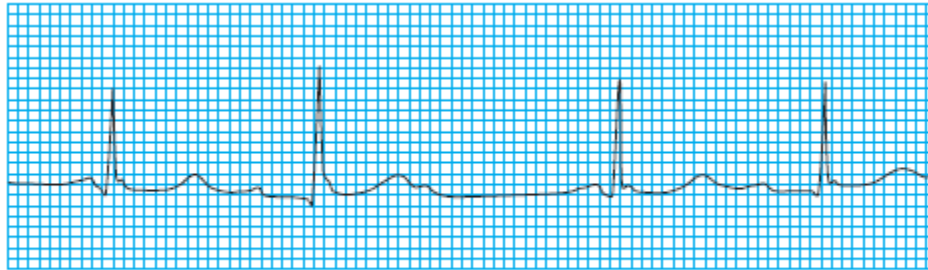
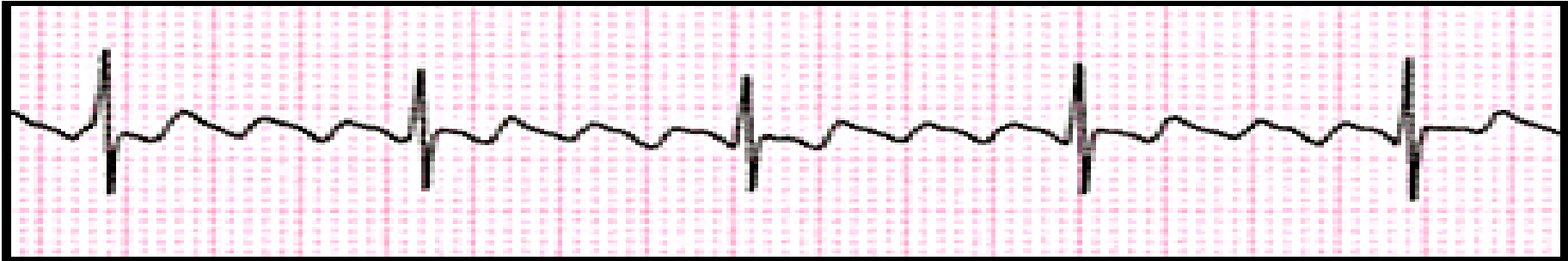


# The Rule of 300

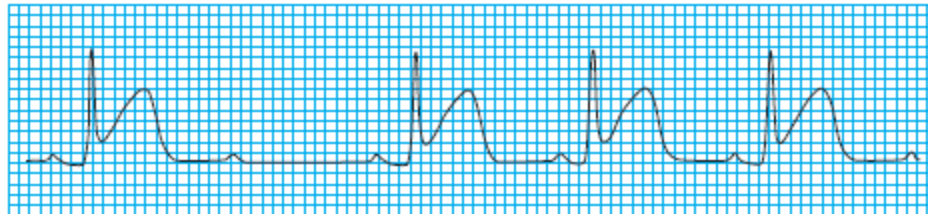
It may be easiest to memorize the following table:

# of big boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50

# Rhythm

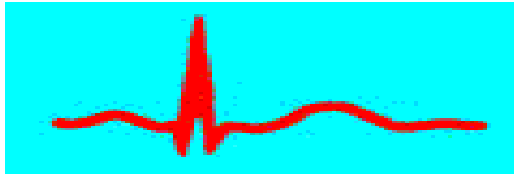


Mobitz type I block (Wenckebach phenomenon)



Mobitz type II block—a complication of an inferior myocardial infarction. The PR interval is identical before and after the P wave that is not conducted

# Common ECG View

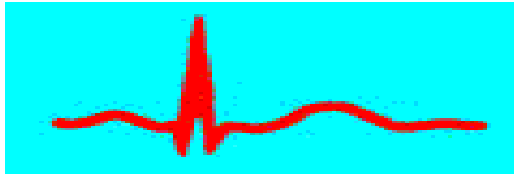


# Sinus Rhythms

## Normal Sinus Rhythm



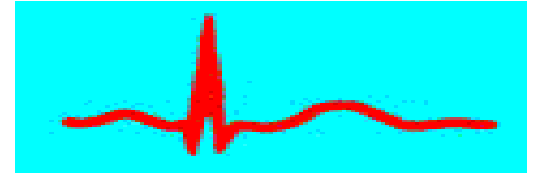
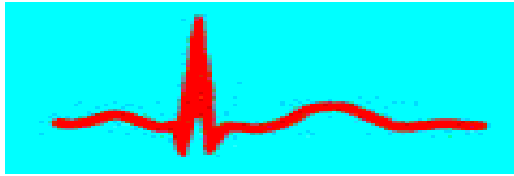
Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
60 - 100	Regular	Before each QRS, Identical	.12 - .20	<.12



# Sinus Rhythms

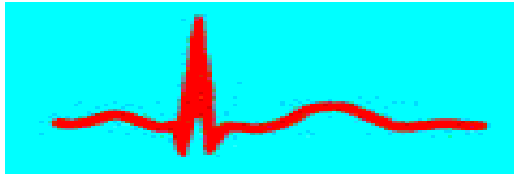
- Normal Sinus Rhythm
  - Sinus Node is the primary pacemaker
  - One upright uniform p-wave for every QRS
  - Rhythm is regular
  - Rate is between 60-100 beats per minute

# ECG Video Show



# Cardiac Arrhythmias

## Abnormal Rhythm?



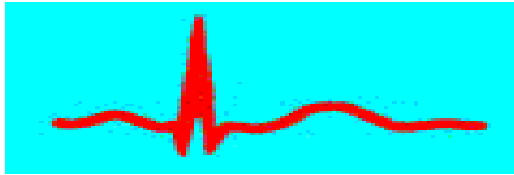
# Sinus Rhythms

## Sinus Bradycardia



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
<60	Regular	Before each QRS, Identical	.12 - .20	<.12



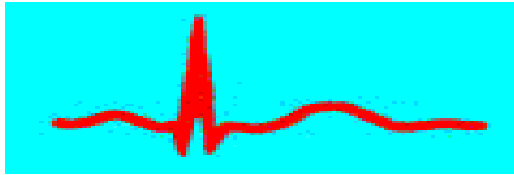


# Sinus Rhythms

## Sinus Tachycardia



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
>100	Regular	Before each QRS, Identical	.12 - .20	<.12

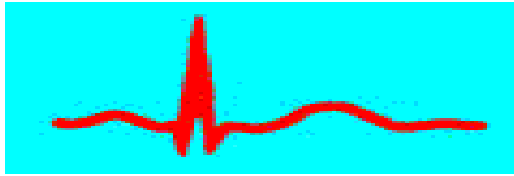


# Sinus Rhythms

## Sinus Arrhythmia

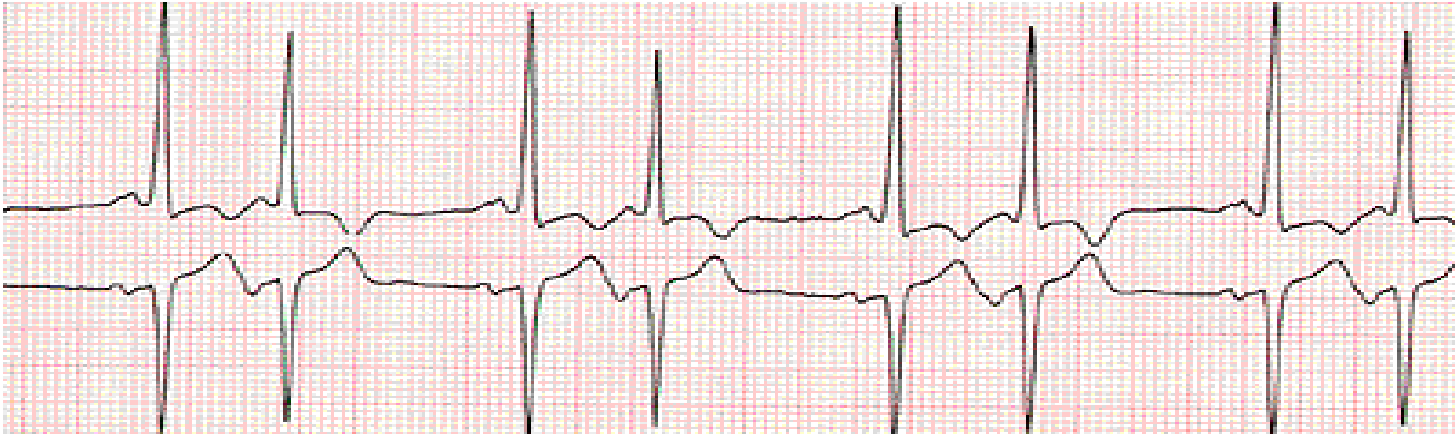


Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Var.	<b>Irregular</b>	Before each QRS, Identical	.12 - .20	<.12

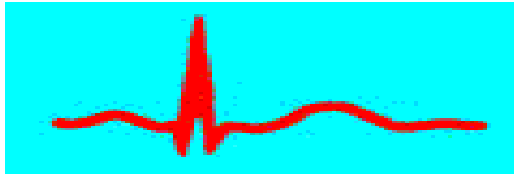


# Atrial Rhythms

## Premature Atrial Contraction (PAC)



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
NA	Irregular	Premature & abnormal or hidden	.12 - .20	<.12



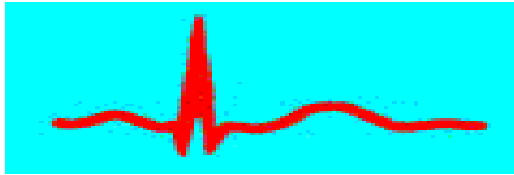
# Atrial Rhythms

## Atrial Fibrillation



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Var.	Irregular	Wavy irregular	NA	<.12



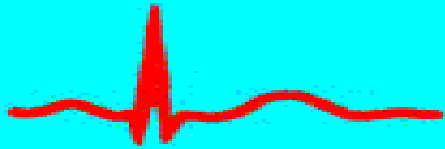


# Atrial Rhythms

## Atrial Flutter



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Atrial=250 – 400 Ventricular Var.	Irregular	Sawtooth	Not Measur- able	<.12

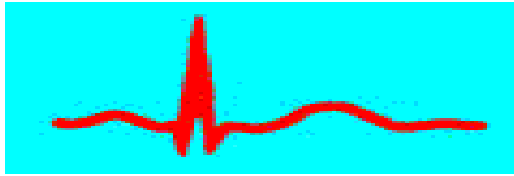


# Ventricular Rhythms

## Premature Ventricular Contraction (PVC)



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Var.	Irregular	No P waves associated with premature beat	NA	Wide >.12

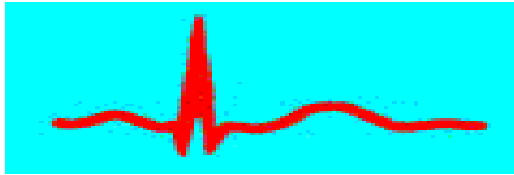


# Ventricular Rhythm



## PVC





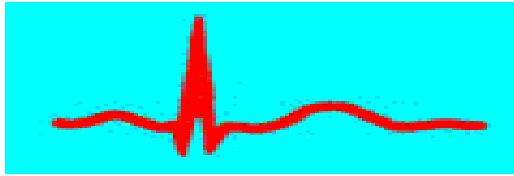
# Ventricular Rhythms

## Ventricular Tachycardia



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
100 – 250	Regular	No P waves corresponding to QRS, a few may be seen	NA	>.12



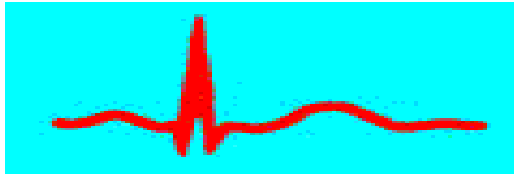


# Ventricular Rhythms

## Ventricular Fibrillation



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
0	Chaotic	None	NA	None



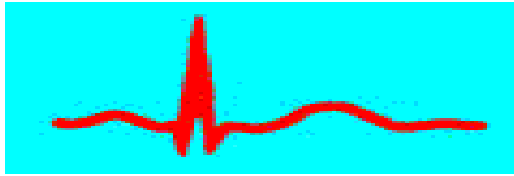
# Asystole

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Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
None	None	None	None	None

**Begin CPR**

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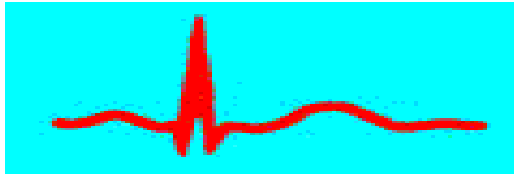


# Heart Block

## First Degree Heart Block

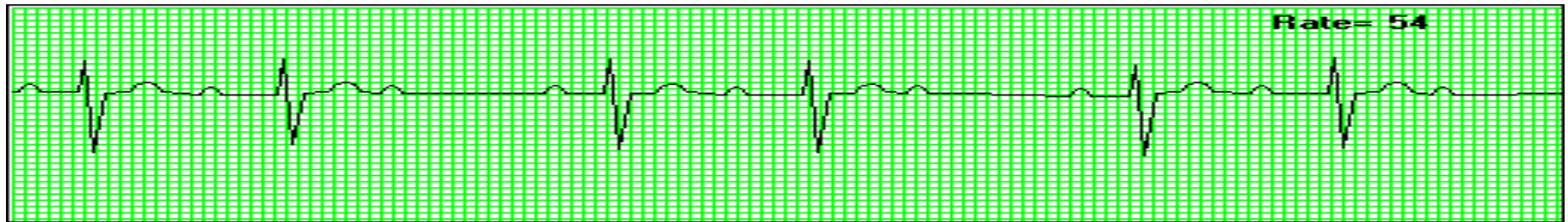


Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Norm.	Regular	Before each QRS, Identical	> .20	<.12



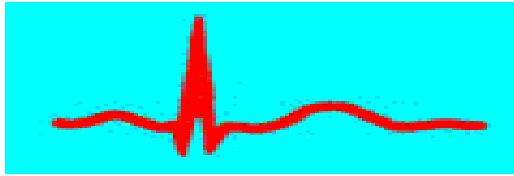
# Heart Block

## Second Degree Heart Block Mobitz Type I (Wenckebach)



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Norm. can be slow	Irregular	Present but some not followed by QRS	Progressively longer	<.12



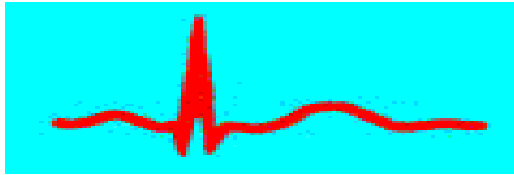


# *Heart Block*

## **Second Degree Heart Block Mobitz Type II (Classical)**



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
Usually slow	Regular or irregular	2 3 or 4 before each QRS, Identical	.12 - .20	<.12 <b>depends</b>



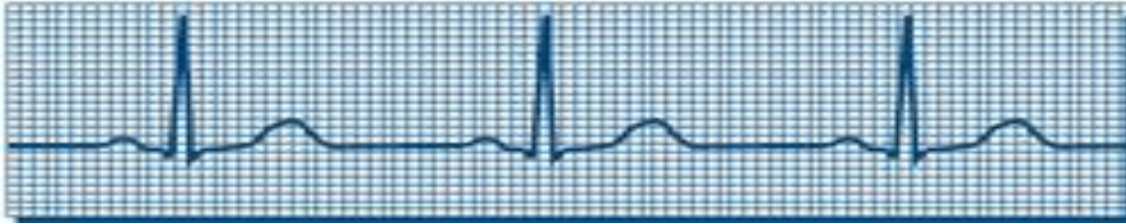
# Heart Block

## Third Degree Heart Block (Complete)



Heart Rate	Rhythm	P Wave	PR Interval (sec.)	QRS (Sec.)
30 – 60	Regular	Present but no correlation to QRS may be hidden	Varies	<.12 depends

# Look Some ECGs

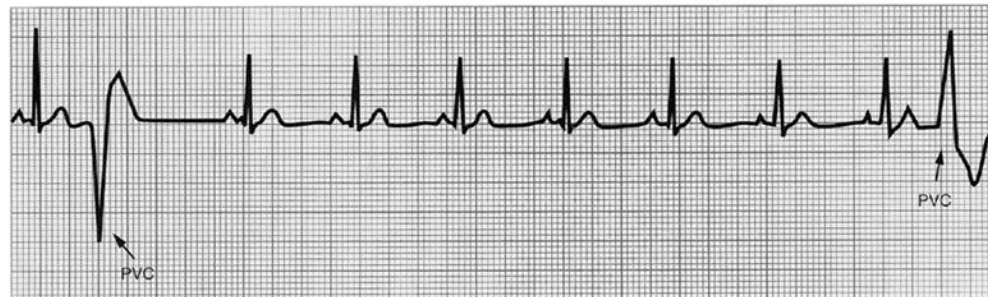
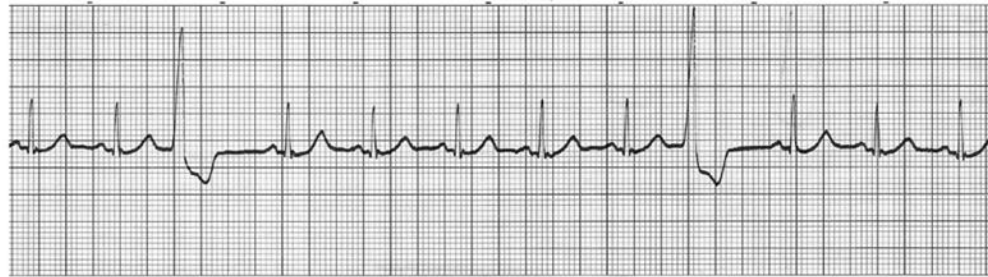




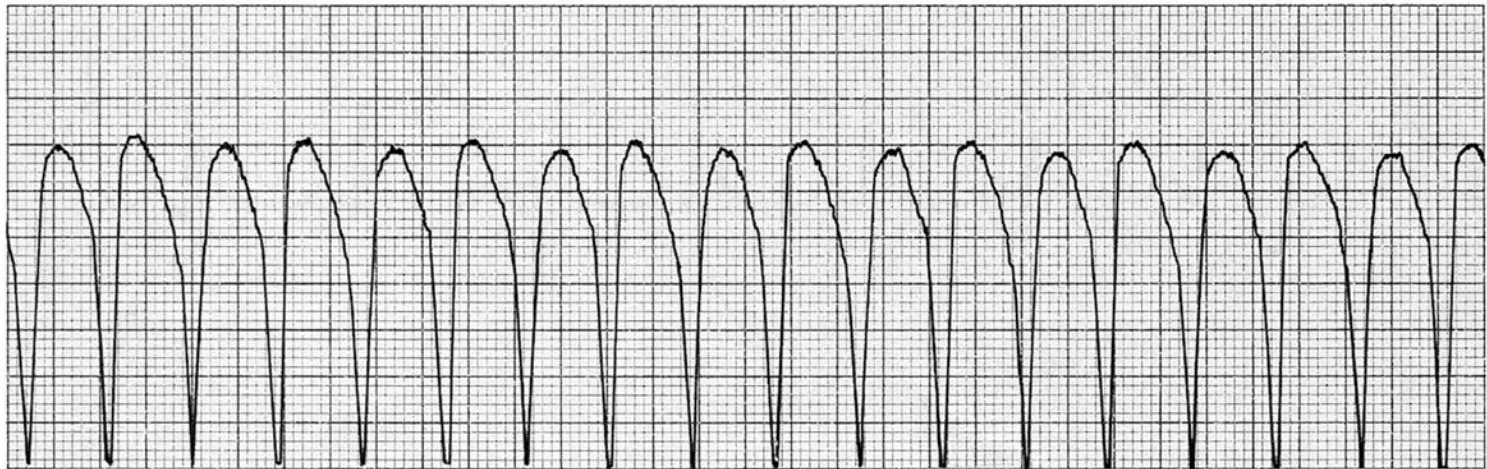
# Normal Sinus Rhythm



# Premature Ventricular Complex

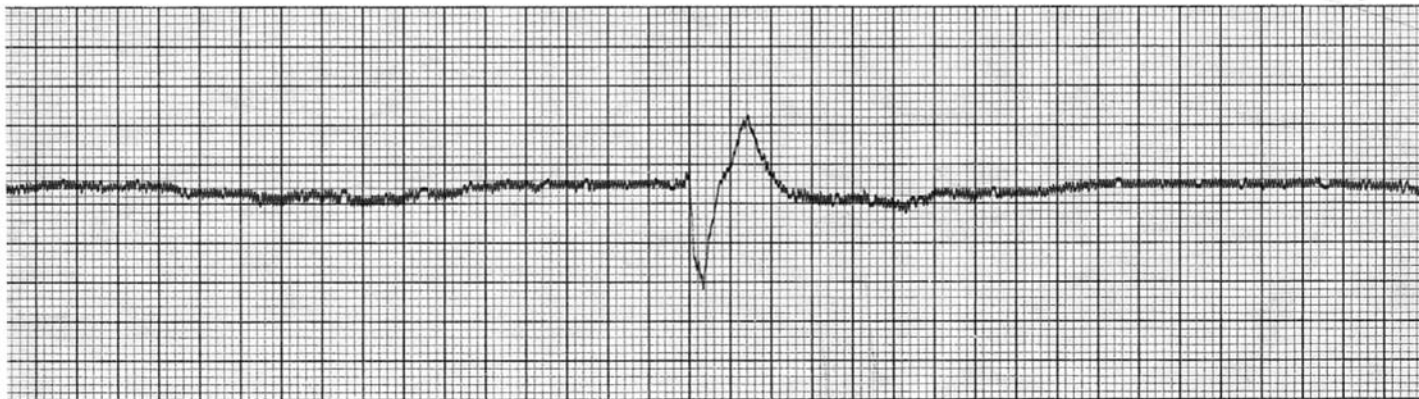


# Ventricular Tachycardia



# Ventricular Fibrillation

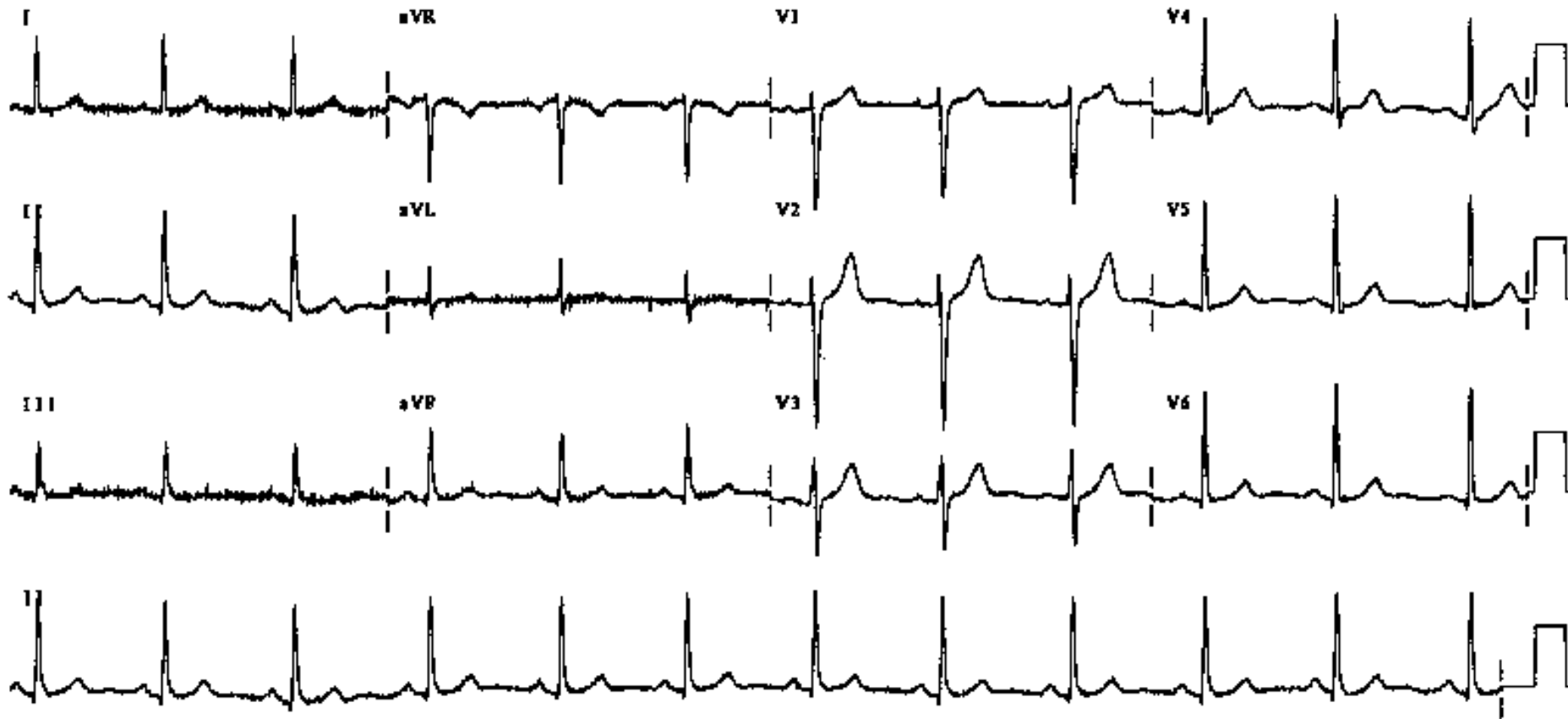
## Agonal Rhythm



# Third-Degree Heart Block



# Normal EKG

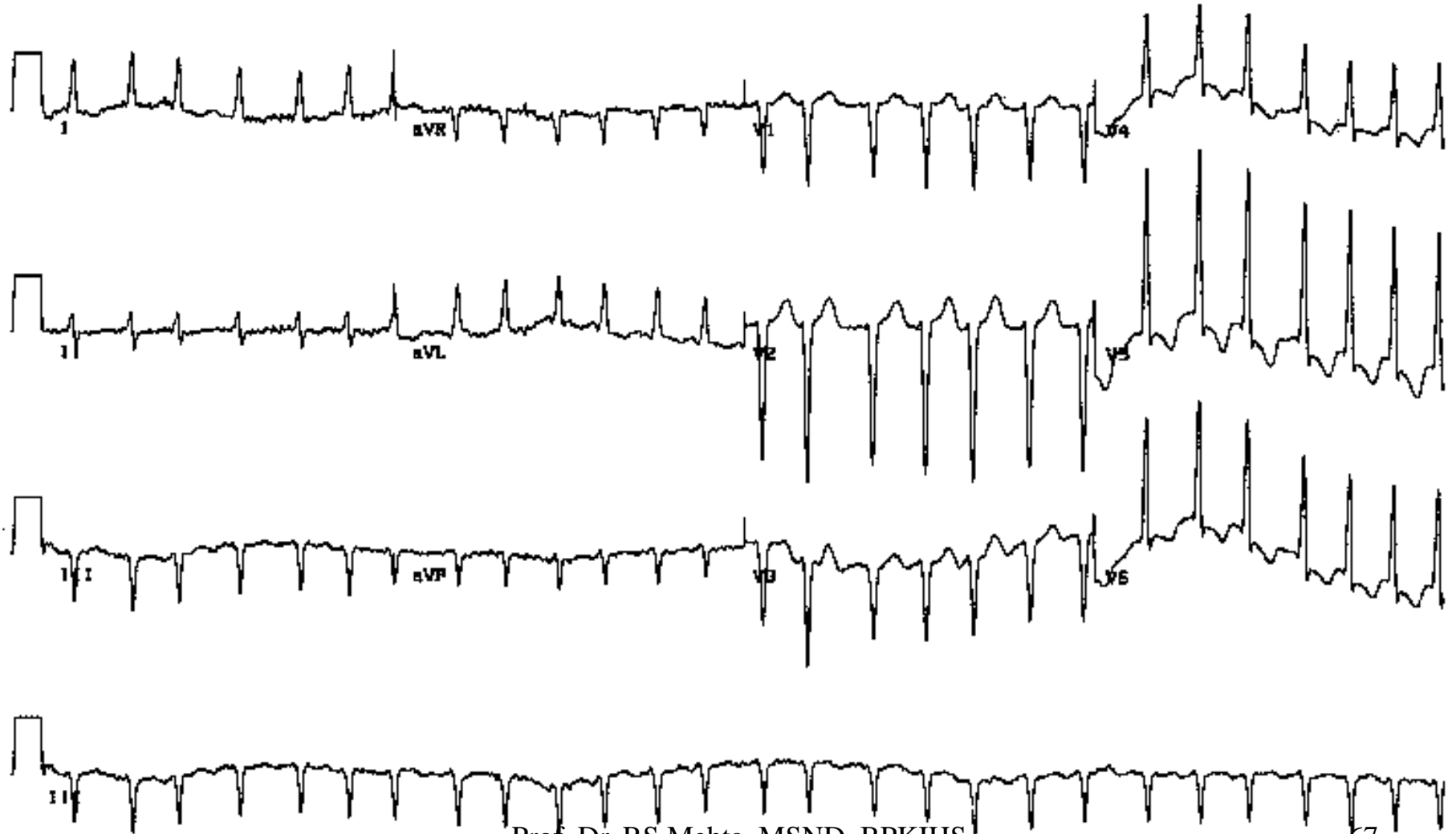


LOC 00000-0000 Speed: 25 mm/sec Limb: 10 mV Chest: 10 mm/mV

50% 0.15-150 Hz

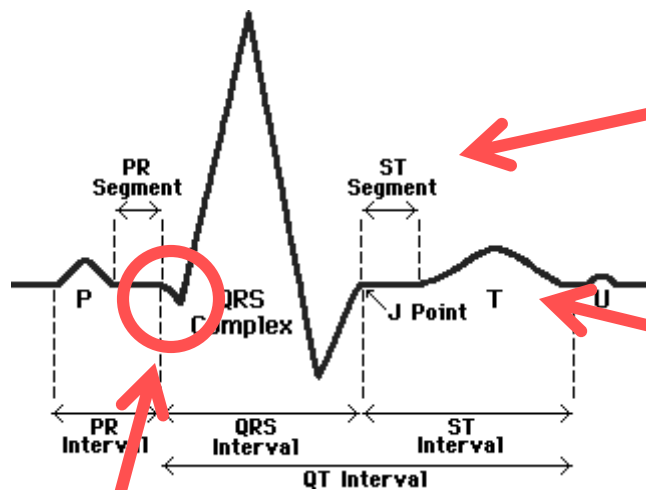
16405

# Atrial Fibrillation with Rapid Ventricular Response



# ECG Changes

Ways the ECG can change include:

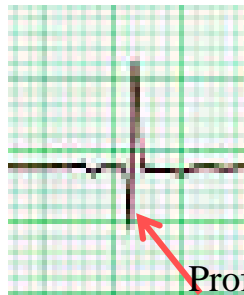


ST elevation & depression

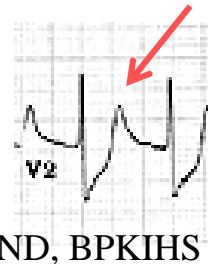


T-waves

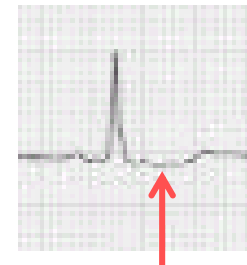
Appearance of pathologic Q-waves



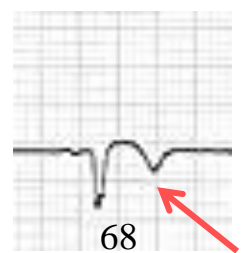
peaked



flattened



inverted





# Diagnosis of Arrhythmia

- **Medical history**
- **Physical examination**
- **ECG**
- **Laboratory test**

# Therapy Principal

- **Pathogenesis therapy**
- **Stop the arrhythmia immediately if the hemodynamic was unstable**
- **Individual therapy**

# **Rx. : Commonly used drugs**

- |                                |                        |
|--------------------------------|------------------------|
| 1. <b>Lidocaine (xylocard)</b> | 7. Metoprolol          |
| 2. Procanamide                 | 8. Verapamil           |
| 3. Mexiletine                  | 9. Diltiazem           |
| 4. Moricizine                  | 10. Isoprenaline       |
| 5. Propafenone                 | <b>11. Epinephrine</b> |
| <b>6. Propranolol</b>          | <b>12. Atropine</b>    |

# Drugs

<b>VASOPRESER</b>	<b>ANTIARRYTHMIAS</b>
Epinephrine	Amiodarone, Lidocaine
Norepinephrine	Atropine
Vasoprossine	Adenosine
Dopamine	$\beta$ - blockers
Dobutamine	Calcium channel blockers

Miscellaneous : Na Bicarbonate, Ca-Glucomate, Heparin

# RX

- **Drugs**
- **Cardioversion: Low Voltage**
- **DC SHOCK: 200, 200-250, 270/360**
- **Carotid Massage**
- **Pri-cordail Thumb**
- **Artificial Pacing**

# DC Cardio version



**150-200, 200-250, 270-260 / 200, 250, 270**

Monophasic = 360 J once or Biphasic = 270 J Once ok 2010 guidelines

# Synchronized Cardioversion

- Shock delivery is timed with **QRS complex**
- Indications :
  - SVT reentry
  - Atrial Flutter
  - Atrial Fibrillation
- Energy used is lower than Defibrillation.

# Precordial Thump

- Only to be executed by health care workers
- Risk of conversion of coordinated cardiac rhythm to VF/ Pulseless VT/ asystole
- Not part of the training in BCLS & ACLS



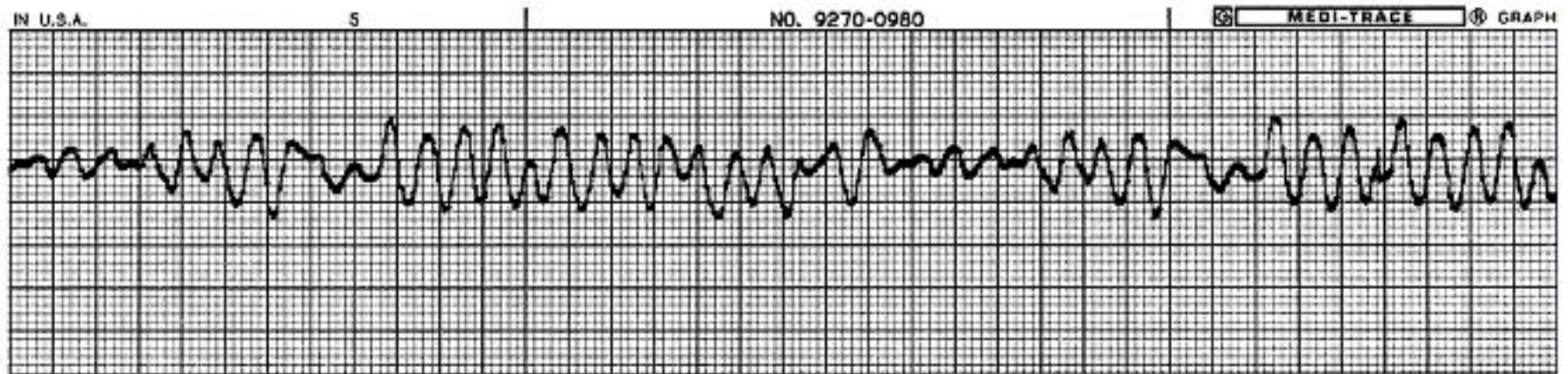
# SHOCKABLE



**Figure 27-16** Ventricular tachycardia in lead V1.

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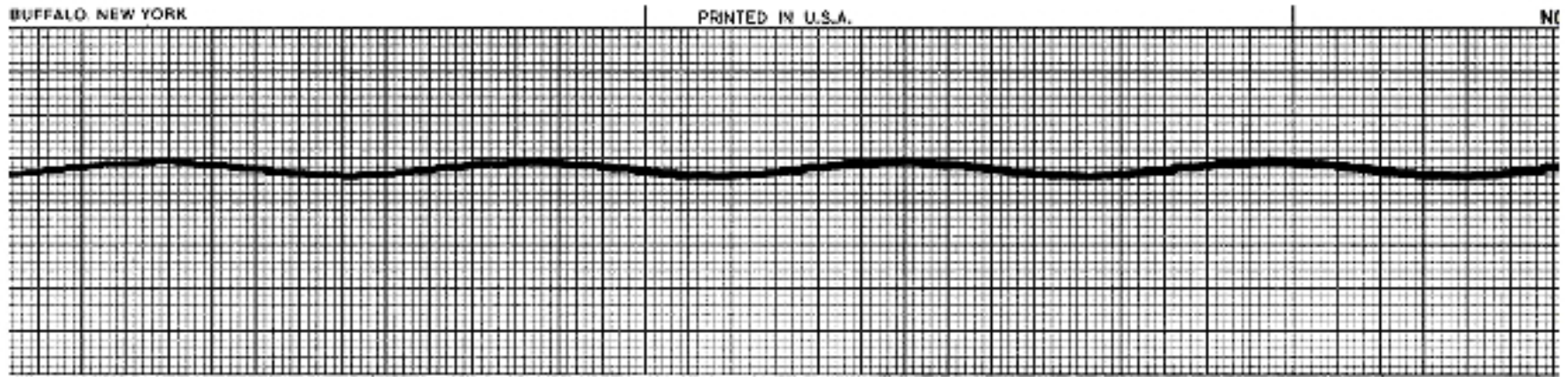
# SHOCKABLE



**Figure 27-17** Ventricular fibrillation in lead II.

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# NON SHOCKABLE



**Figure 27-19** Asystole. (Always check two different leads to confirm rhythm.)

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# Thank you