



# *Lecture - 03*



## **Electrocardiogram**



## The Heart: Structures

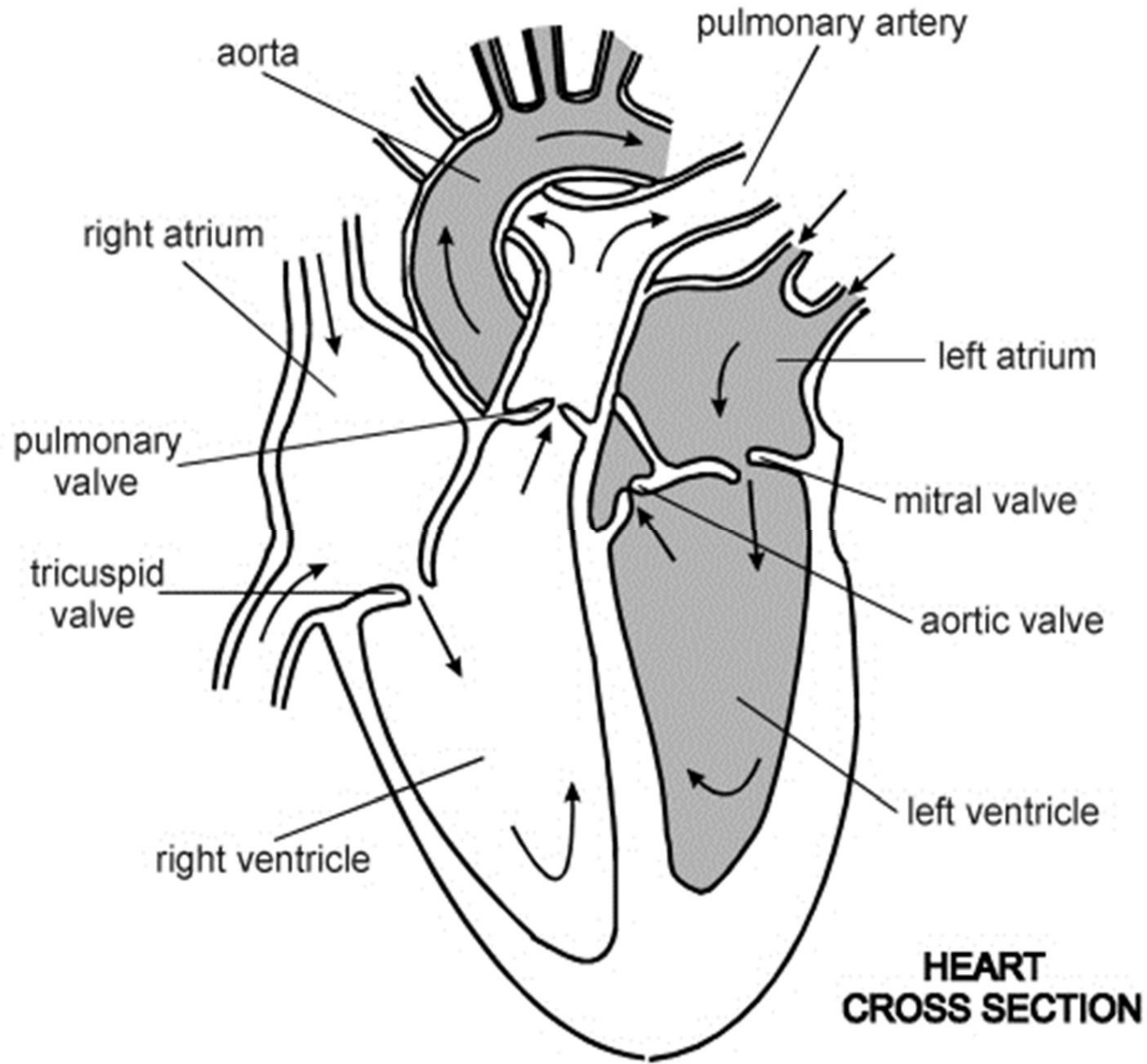
- Four chambers
  - Two **atria**
    - Upper chambers
    - Left and right
    - Separated by **interatrial septum**
  - Two ventricles
    - Lower chambers
    - Left and right
    - Separated by **interventricular septum**
- Atrio-ventricular septum separates the atria from the ventricles.

## The Heart: Structures (cont.)

- **Tricuspid valve** – prevents blood from flowing back into the right atrium when the right ventricle contracts
- **Bicuspid valve** – prevents blood from flowing back into the left atrium when the left ventricle contracts
- **Pulmonary valve** – prevents blood from flowing back into the right ventricle
- **Aortic valve** – prevents blood from flowing back into the left ventricle

# The Heart: Cardiac Cycle

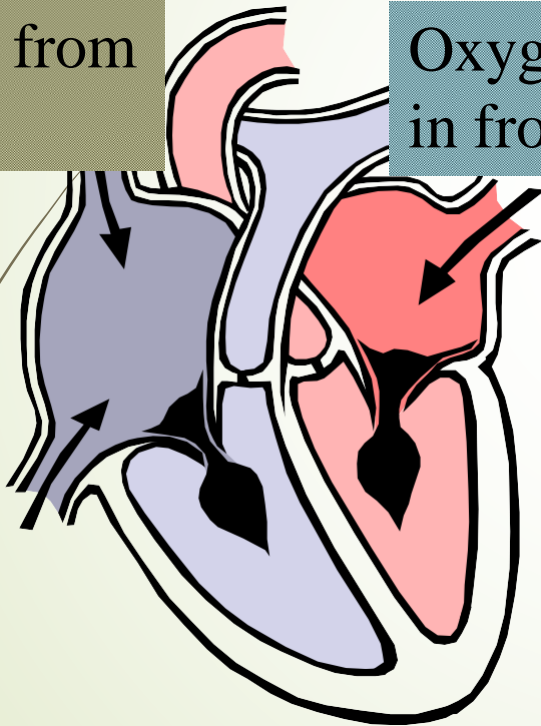
- One heartbeat = one cardiac cycle
  - Atria contract and relax
  - Ventricles contract and relax
- Right atrium contracts
  - Tricuspid valve opens
  - Blood fills right ventricle
- Right ventricle contracts
  - Tricuspid valve closes
  - Pulmonary semilunar valve opens
  - Blood flows into pulmonary artery
- Left atrium contracts
  - Bicuspid valve opens
  - Blood fills left ventricle
- Left ventricle contracts
  - Bicuspid valve closes
  - Aortic semilunar valve opens
  - Blood pushed into aorta





# The Heart: *Blood Flow*

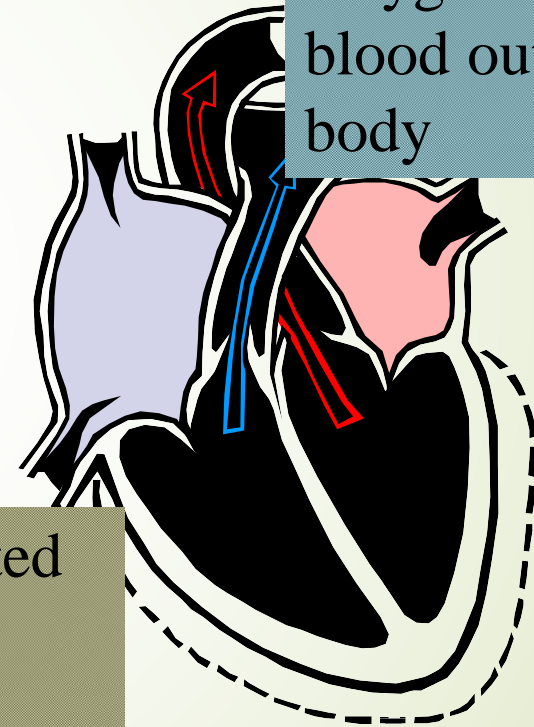
Deoxygenated  
blood in from  
body



**Atria Contract**

Oxygenated blood  
in from lungs

Deoxygenated  
blood out  
to lungs

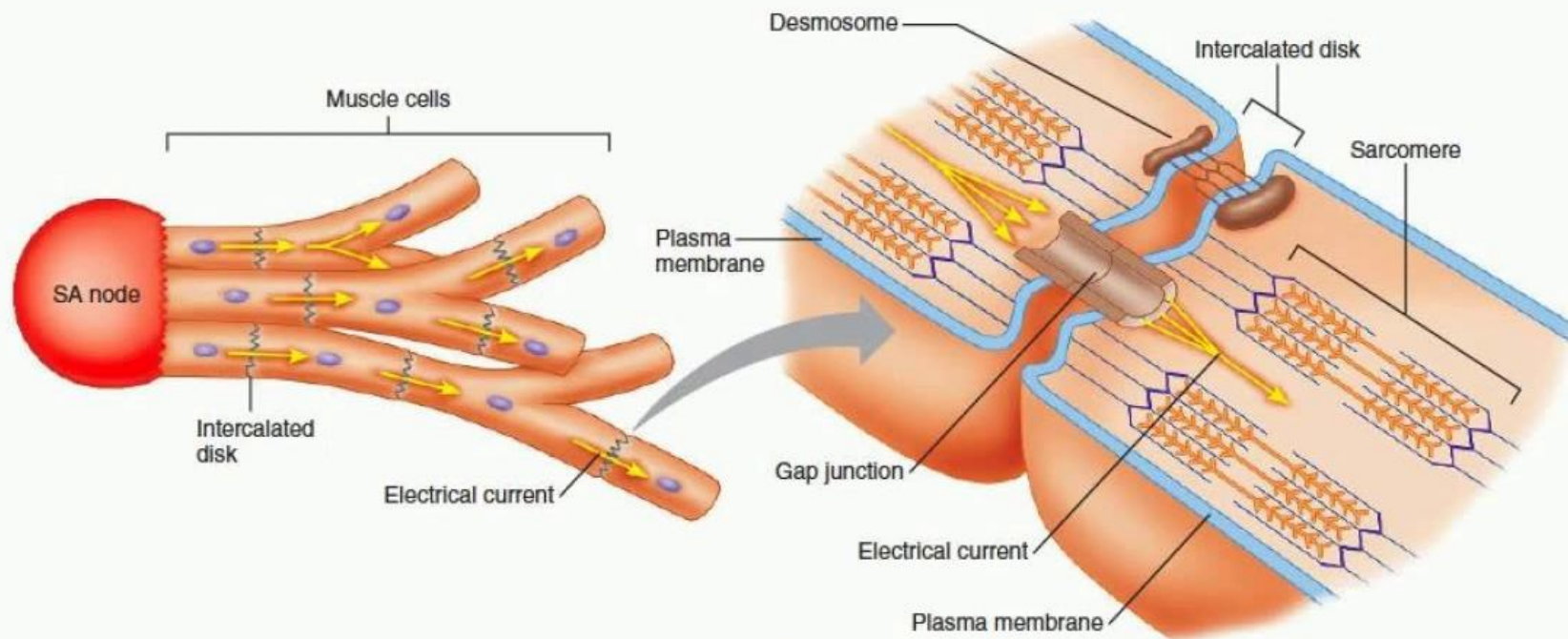


Oxygenated  
blood out to  
body

**Ventricles Contract**

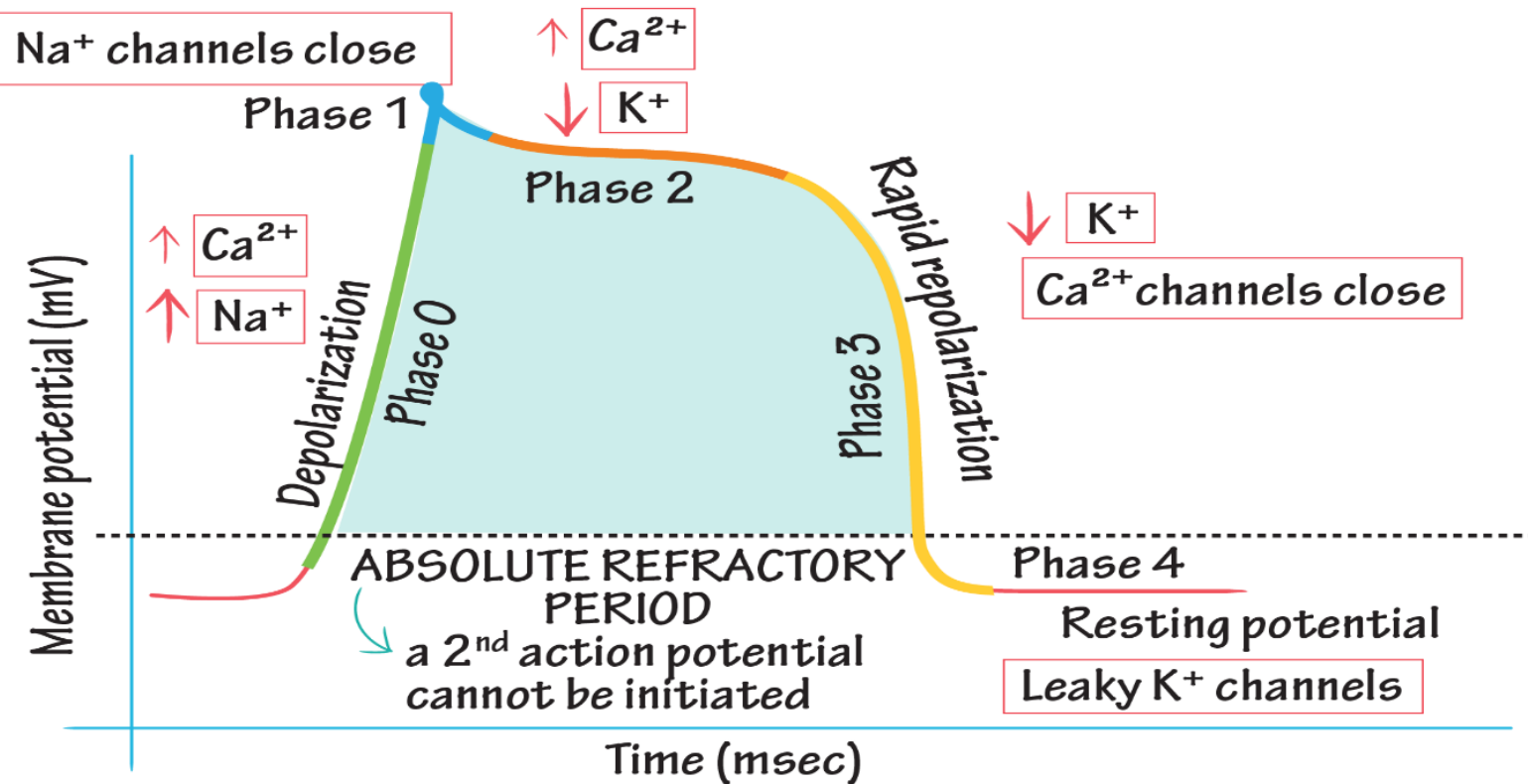
## The Heart: *Heart Sounds*

- One cardiac cycle – two heart sounds (lubb and dubb) when valves in the heart snap shut
  - Lubb – First sound
    - When the ventricles contract, the tricuspid and bicuspid valves snap shut.
  - Dubb – Second sound
    - When the atria contract and the pulmonary and aortic valves snap shut.



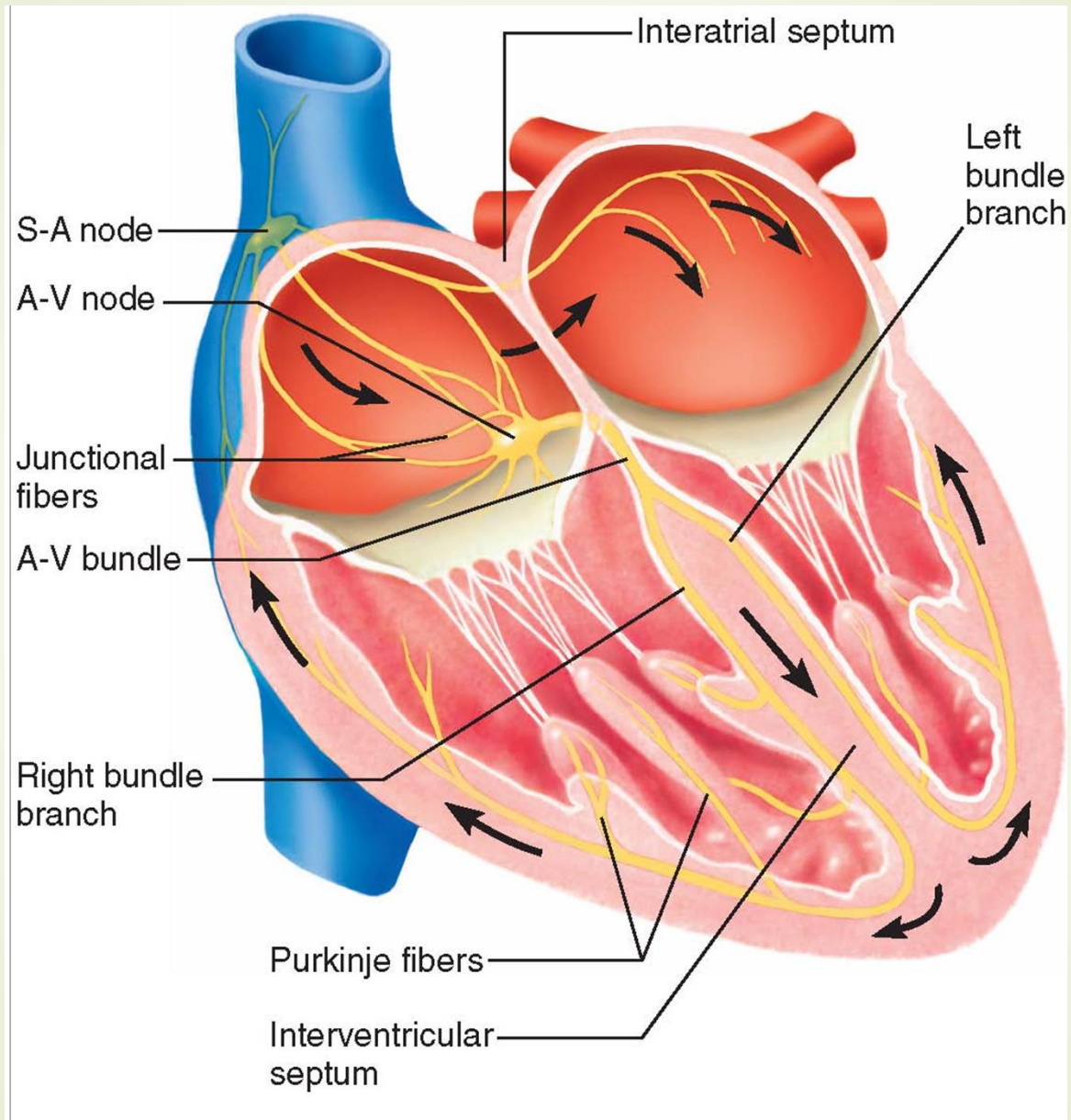


## CARDIAC ACTION POTENTIAL



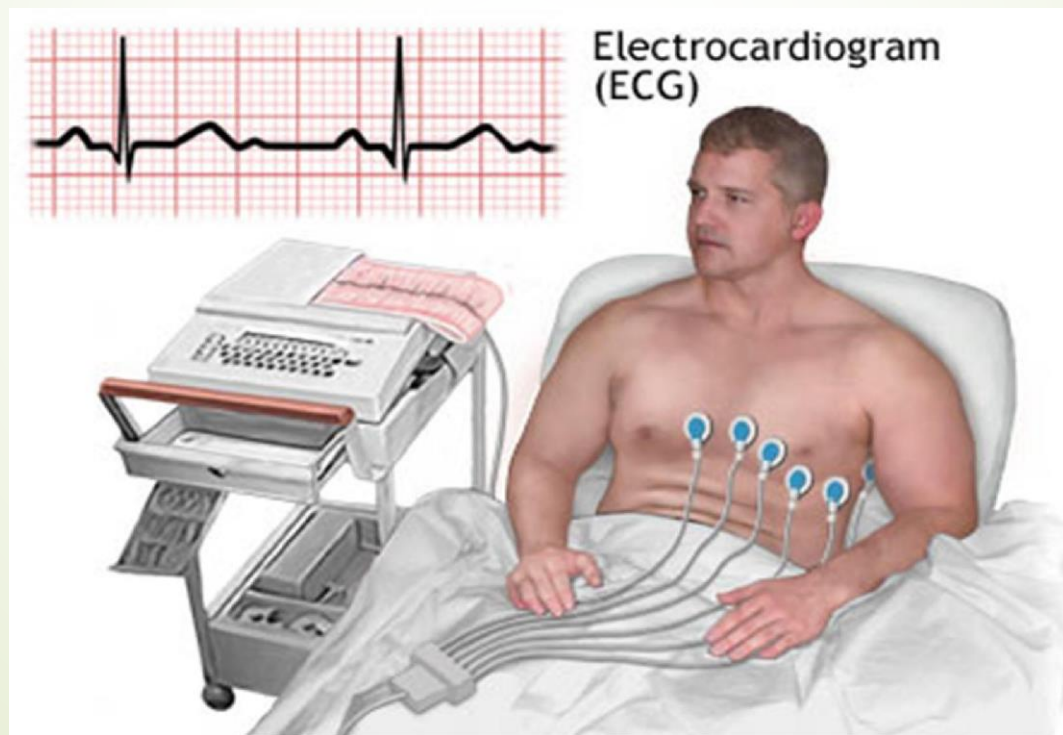
# The Heart: Cardiac Conduction System

- **Group of structures that send electrical impulses through the heart**
- ***Sino atrial node*** (SA node)
  - Wall of right atrium
  - Generates impulse
  - Natural pacemaker
  - Sends impulse to AV node
- ***Atrioventricular node*** (AV node)
  - Between atria just above ventricles
  - Atria contract
  - Sends impulse to the bundle of His
- ***Bundle of His***
  - Between ventricles
  - Two branches
  - Sends impulse to Purkinje fibers
- ***Purkinje fibers***
  - Lateral walls of ventricles
  - Ventricles contract



# Electrocardiogram

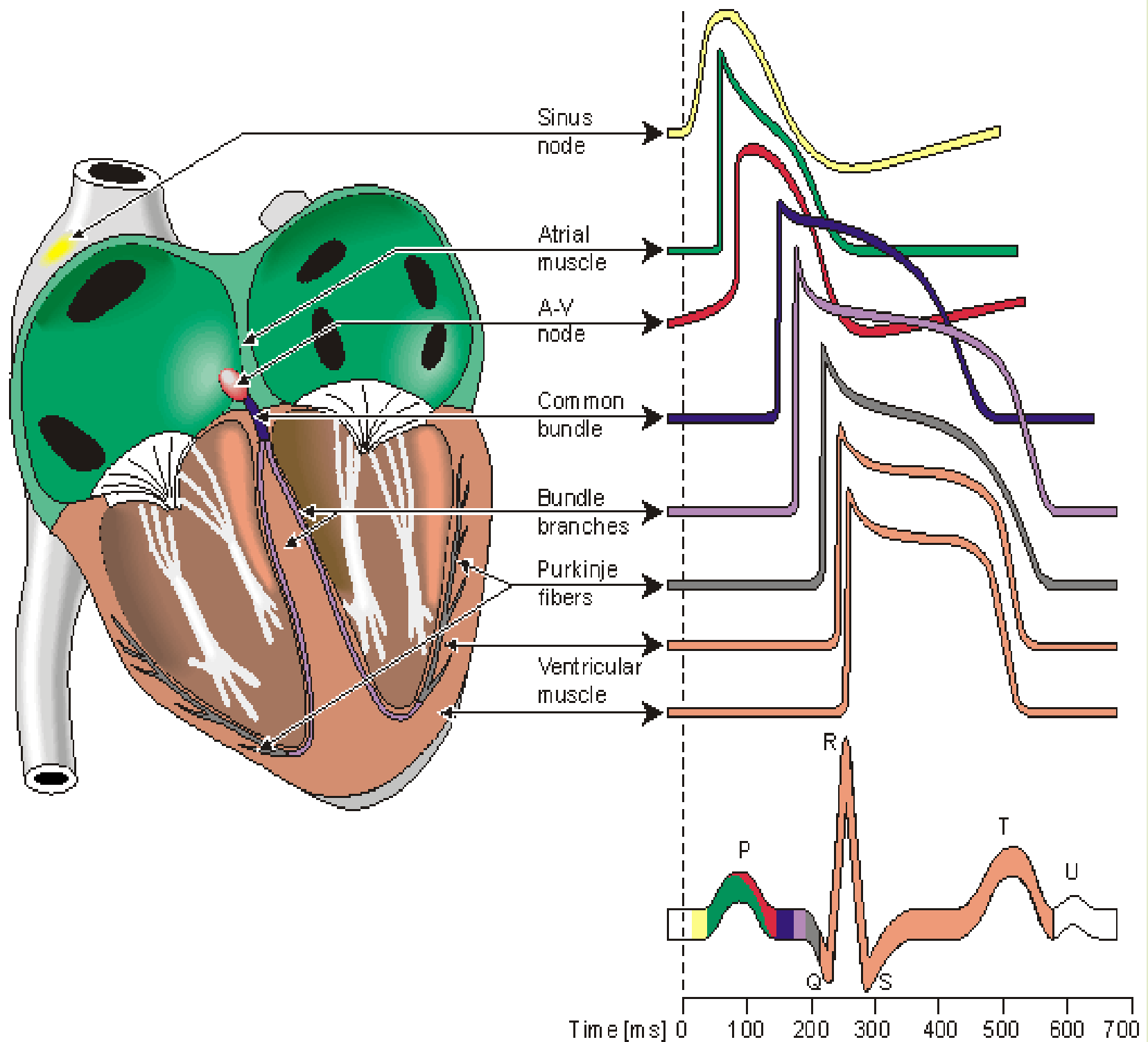
- Variations in electrical potential radiate from the heart
- ECG records electrical events in the heart.



# Purpose of ECG

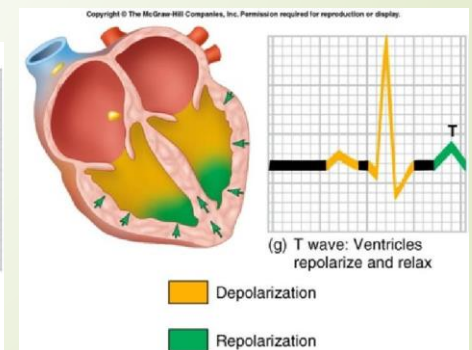
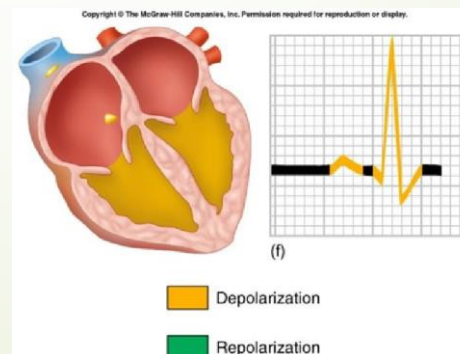
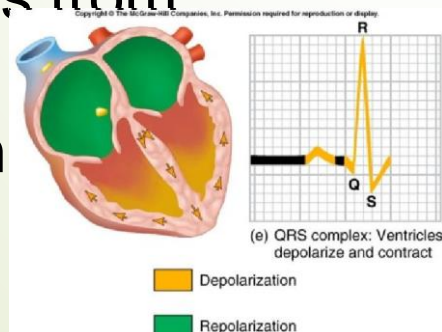
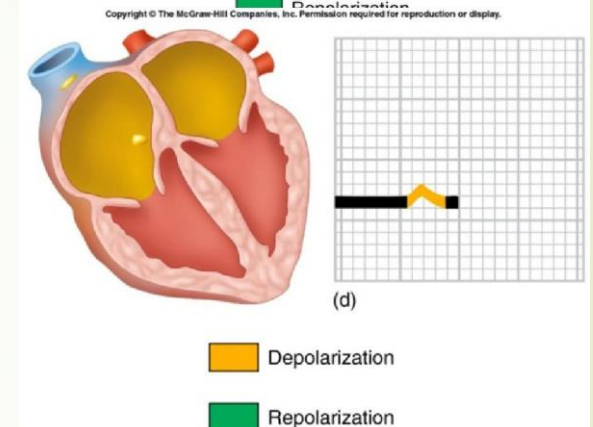
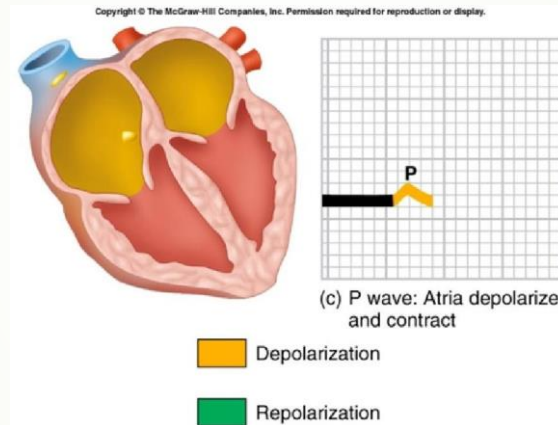
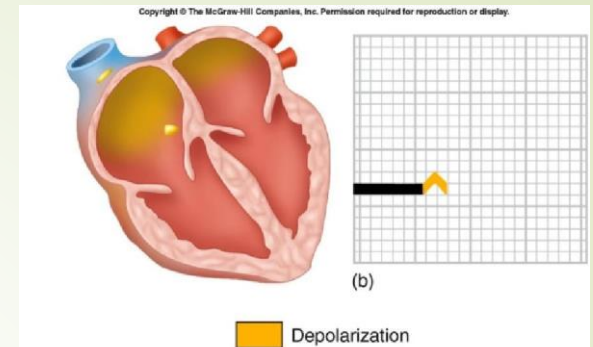
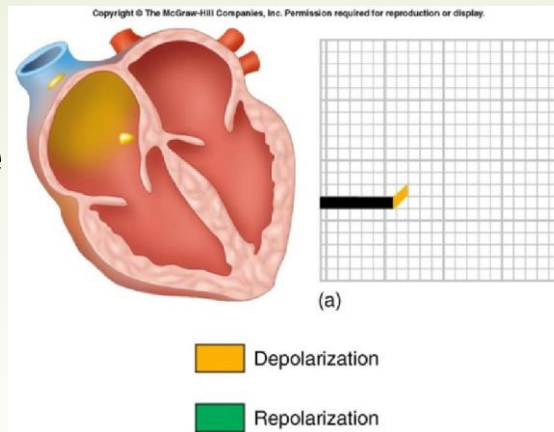
- Picture of electrical events
- Established electrode pattern results in specific tracing pattern
- Health of heart can be examined using EKG
- Electrical pattern reveals blood supply problems

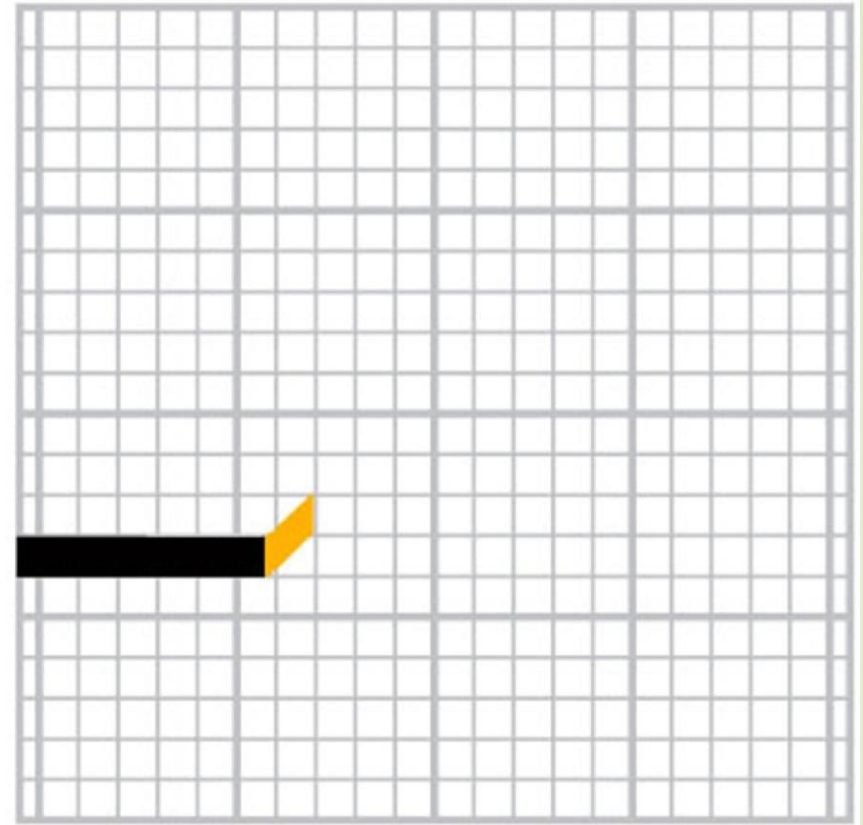
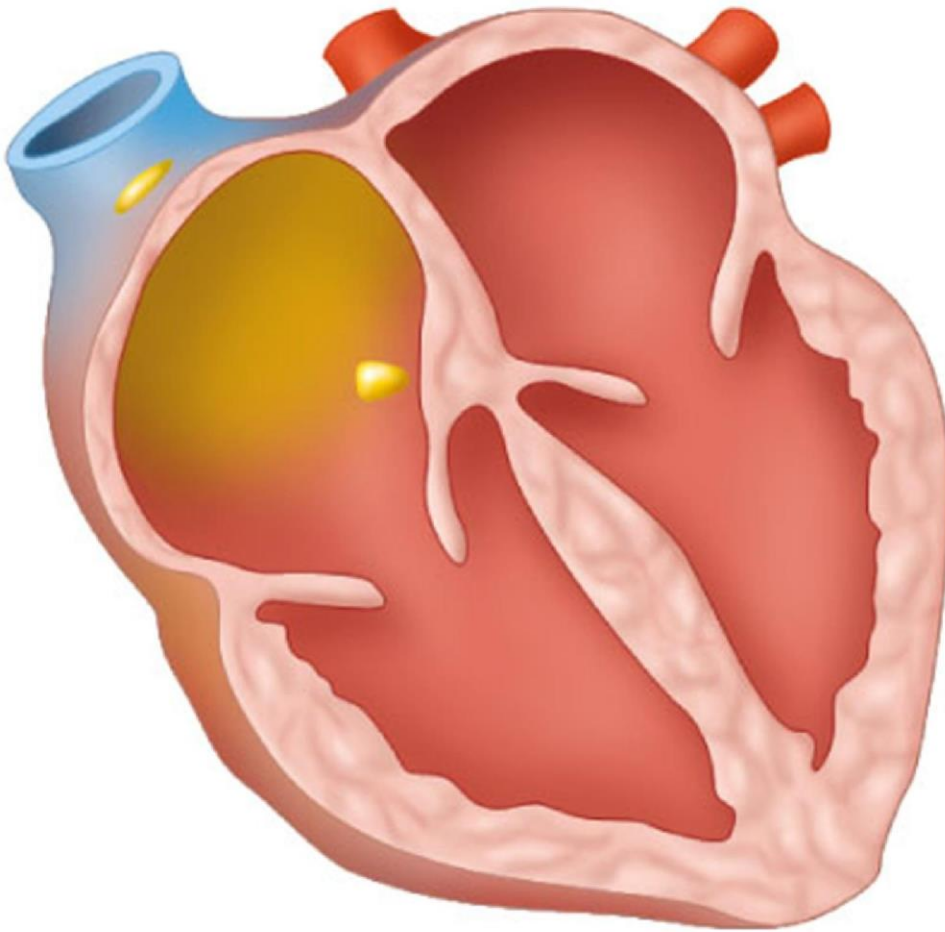




# ECG

- 3 distinct waves are produced during cardiac cycle
- P wave caused by atrial depolarization
- QRS complex caused by ventricular depolarization
- T wave results from ventricular repolarization

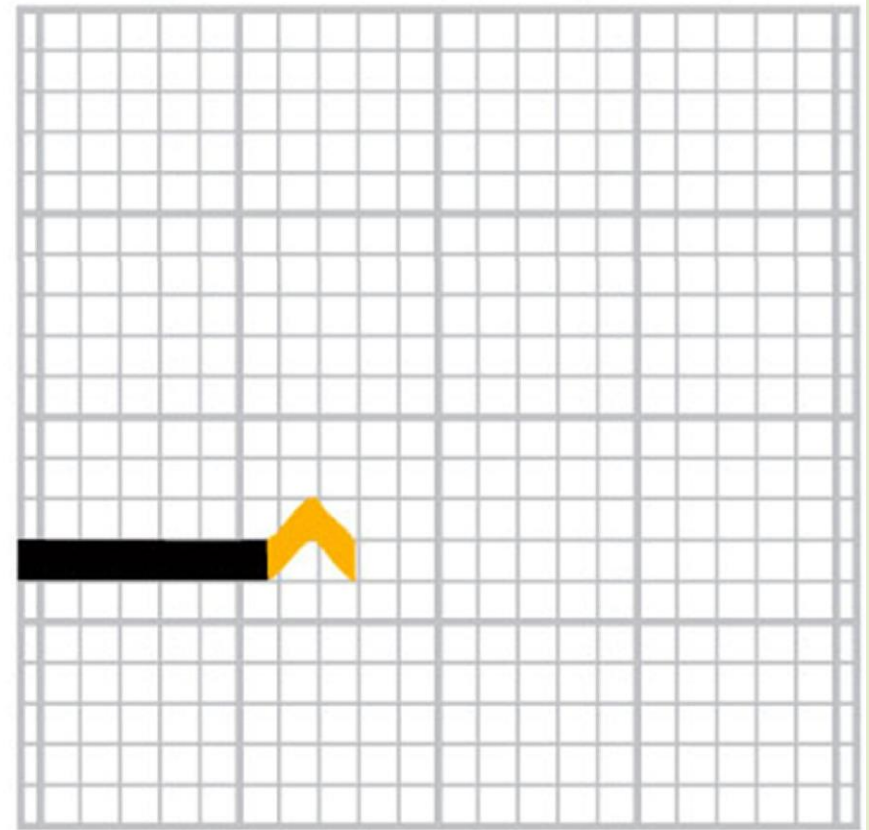
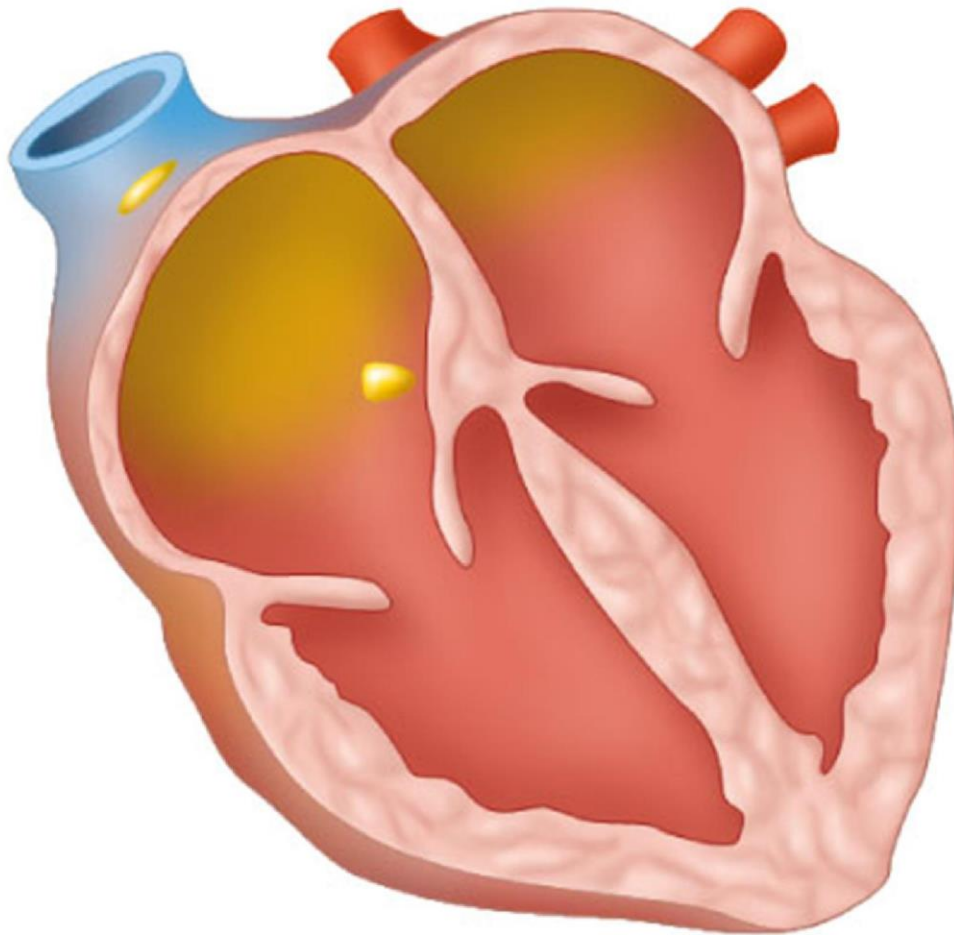




(a)

 Depolarization

 Repolarization

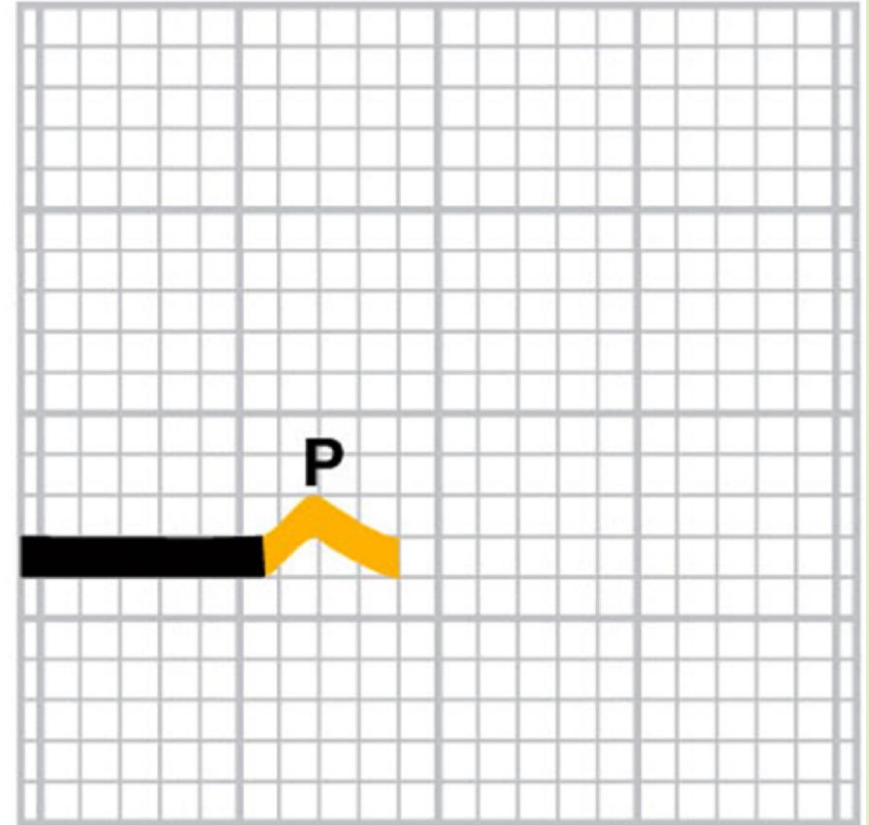
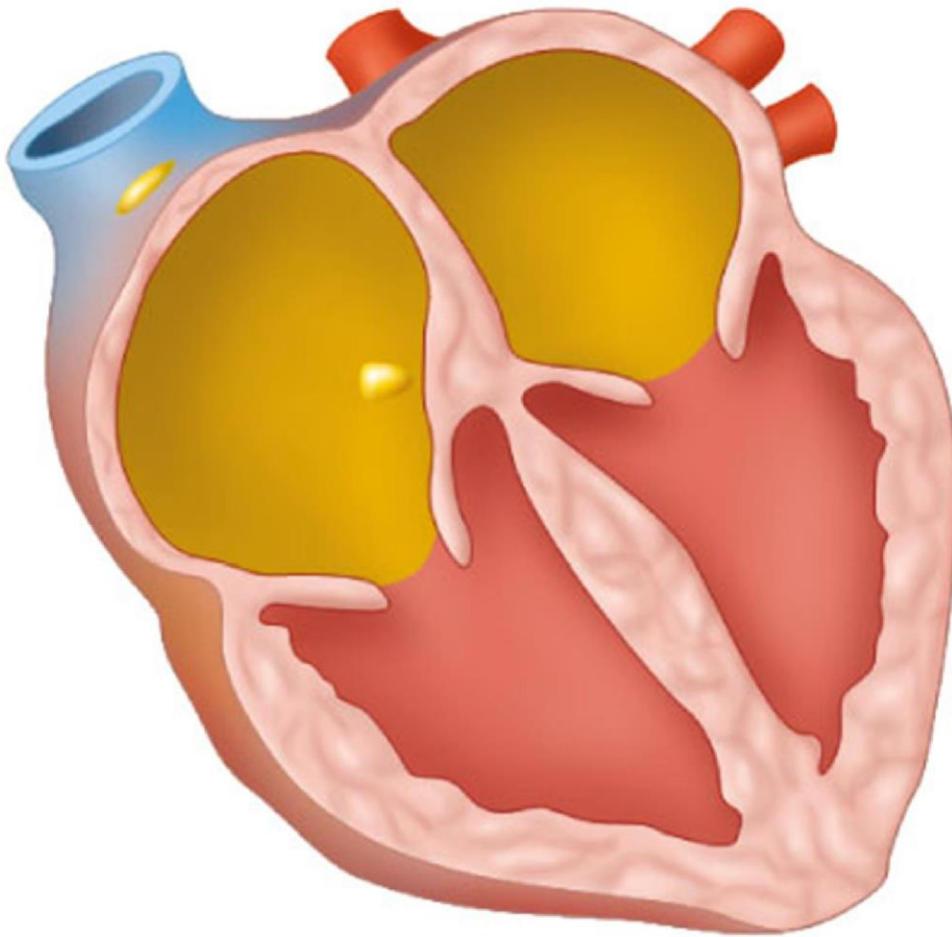


(b)

 Depolarization

 Repolarization



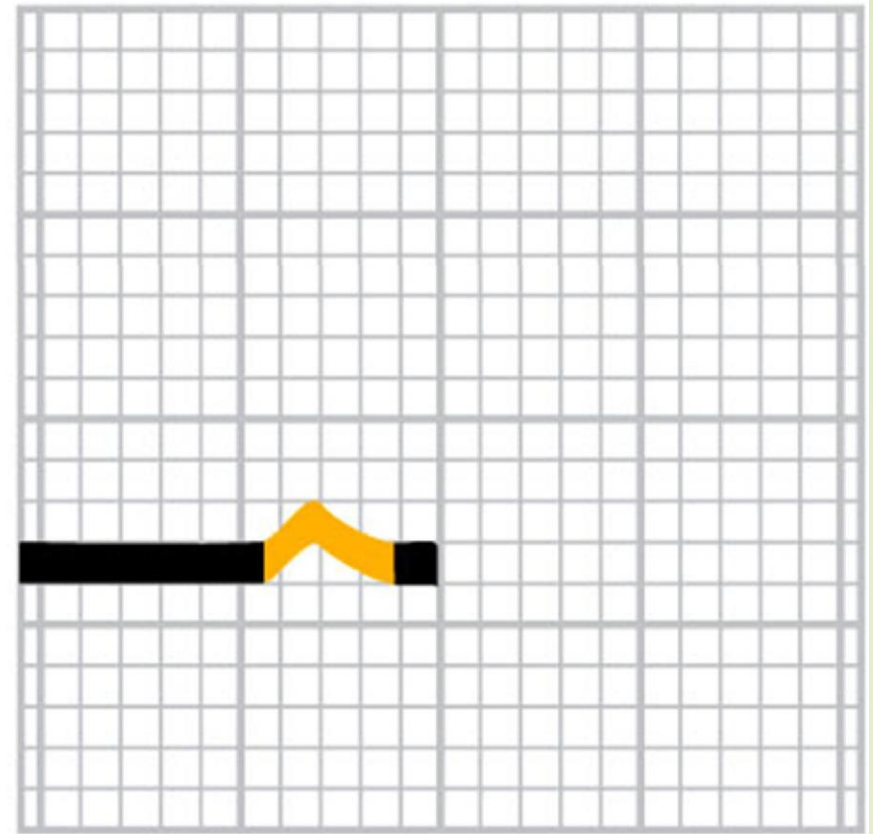
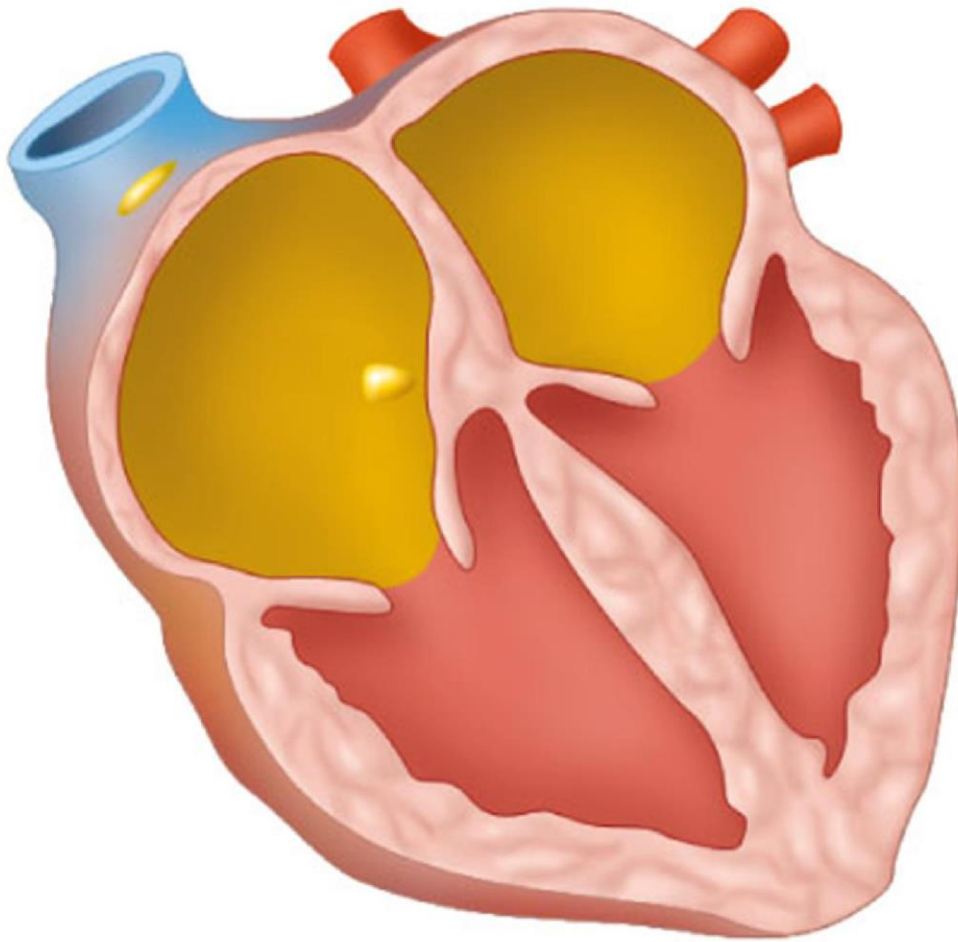


(c) P wave: Atria depolarize and contract

 Depolarization

 Repolarization

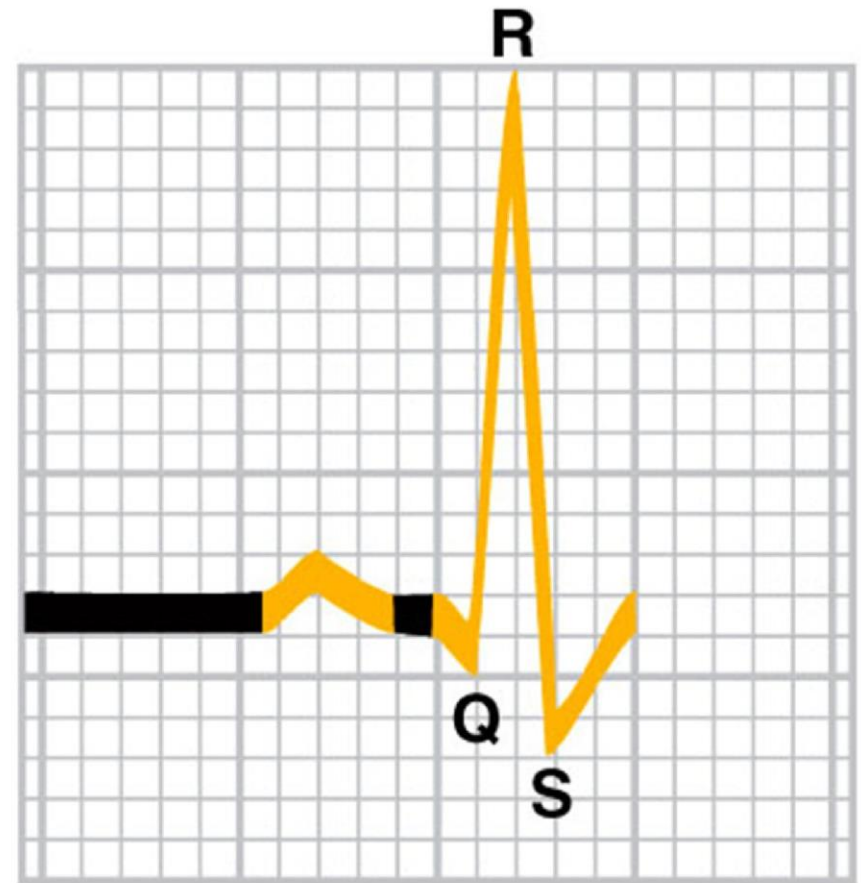
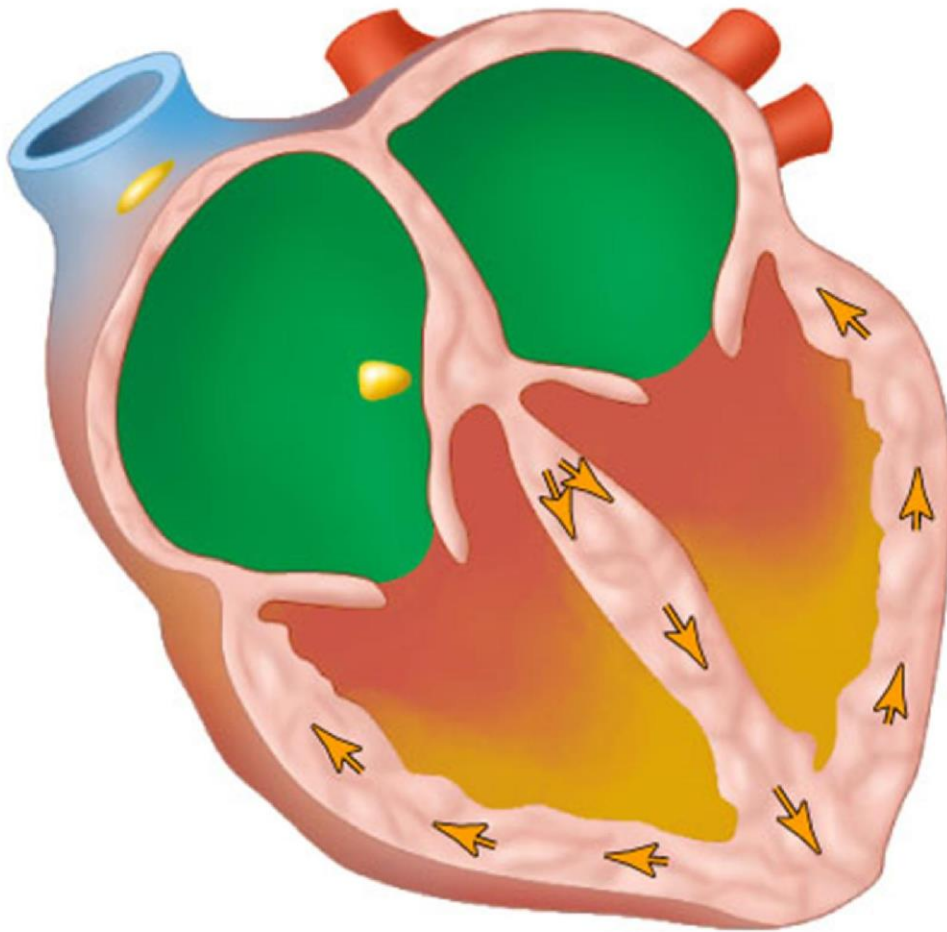




(d)

 Depolarization

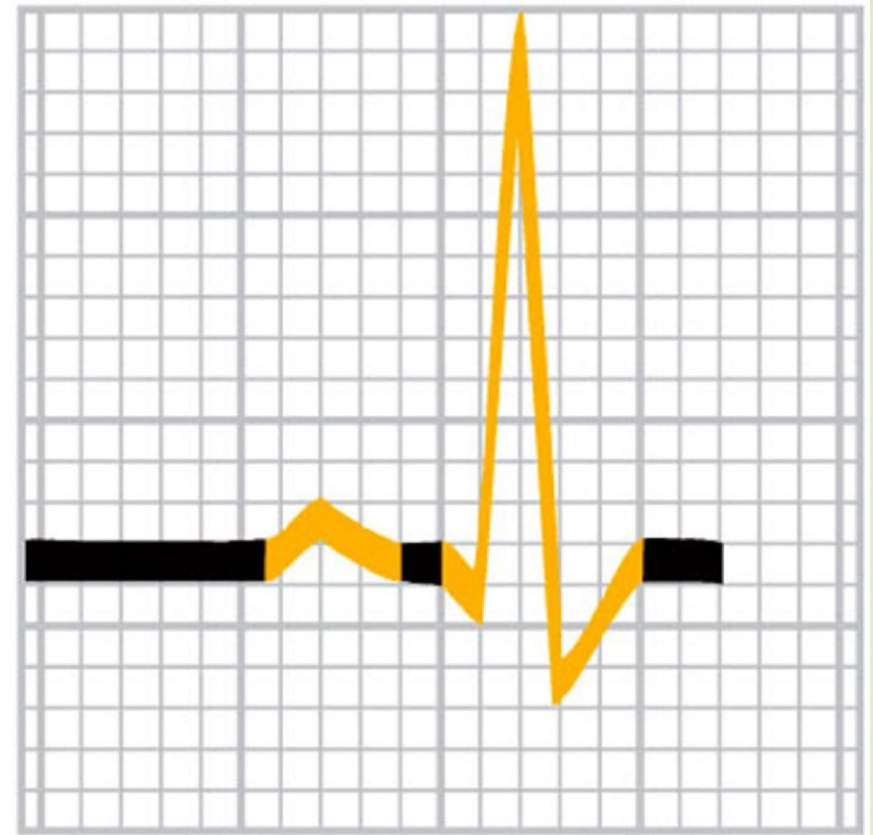
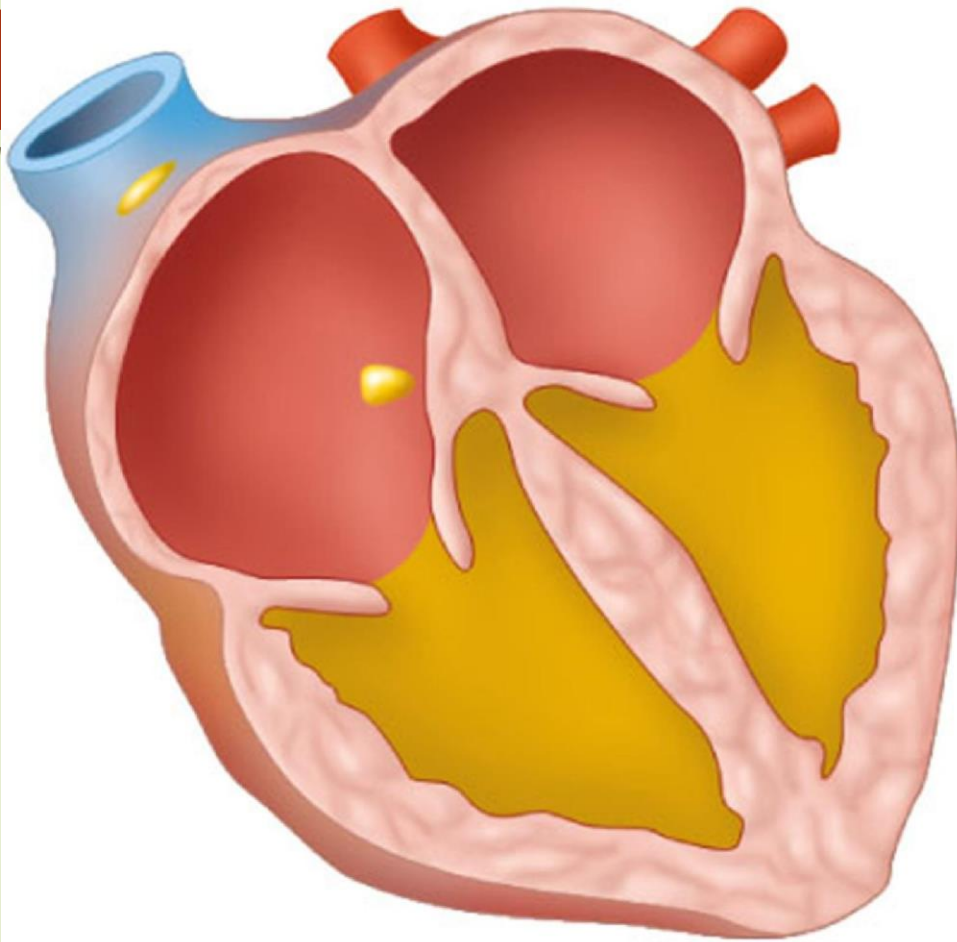
 Repolarization



(e) QRS complex: Ventricles depolarize and contract

 Depolarization

 Repolarization

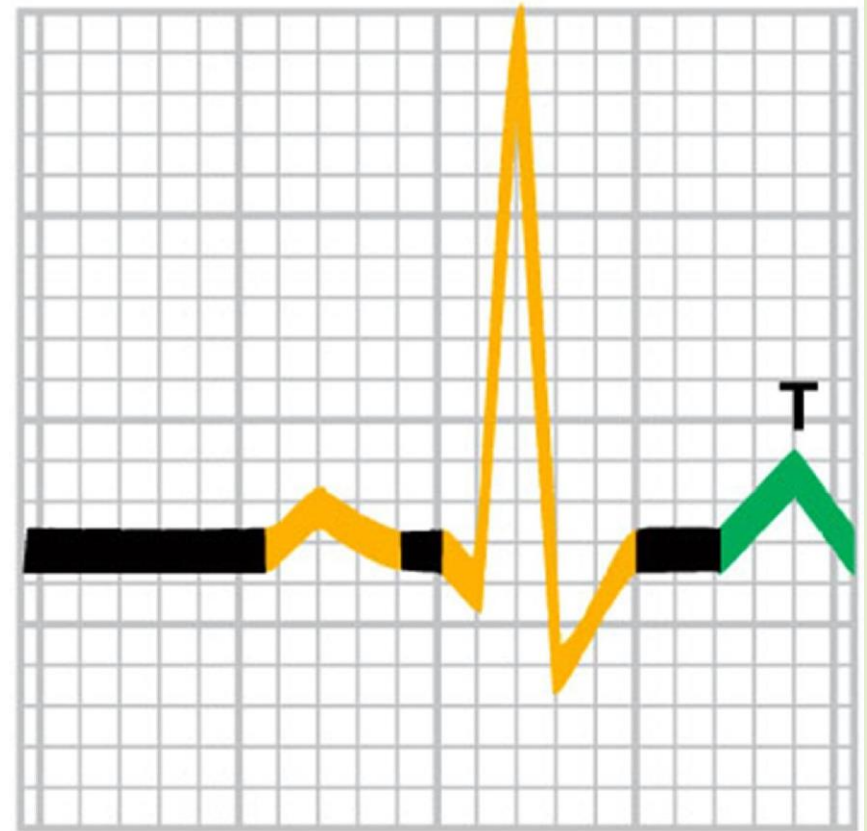
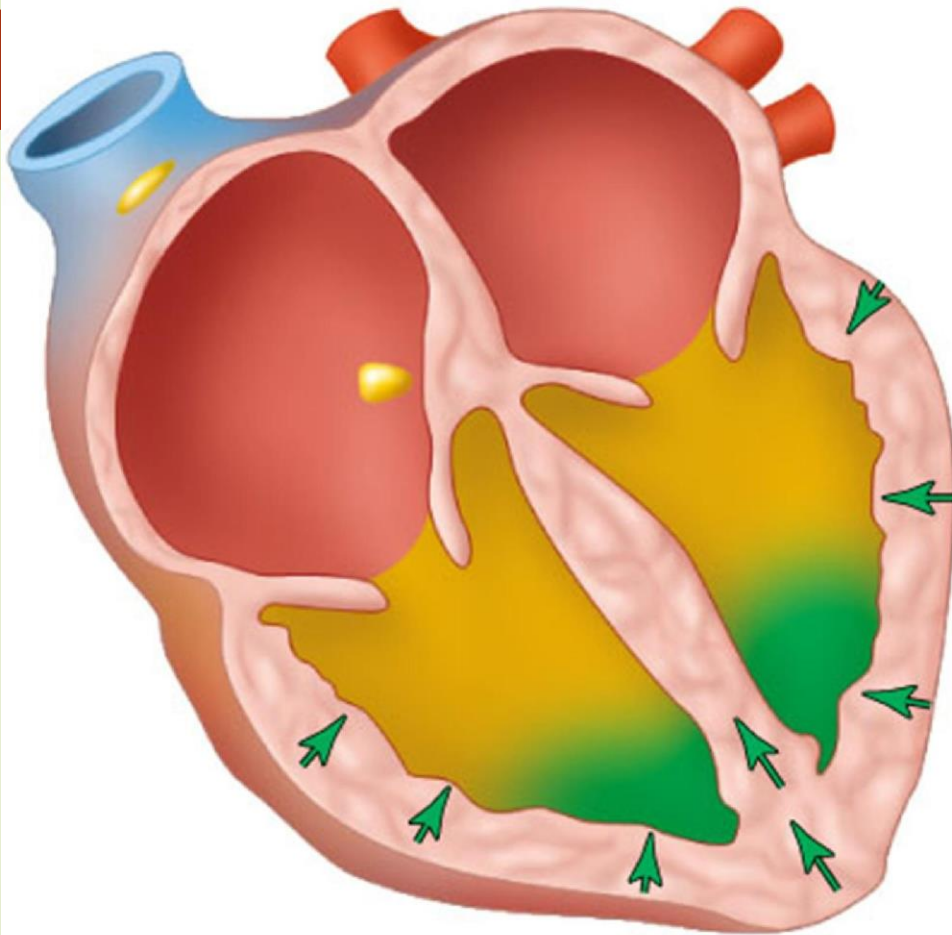


(f)

 Depolarization

 Repolarization



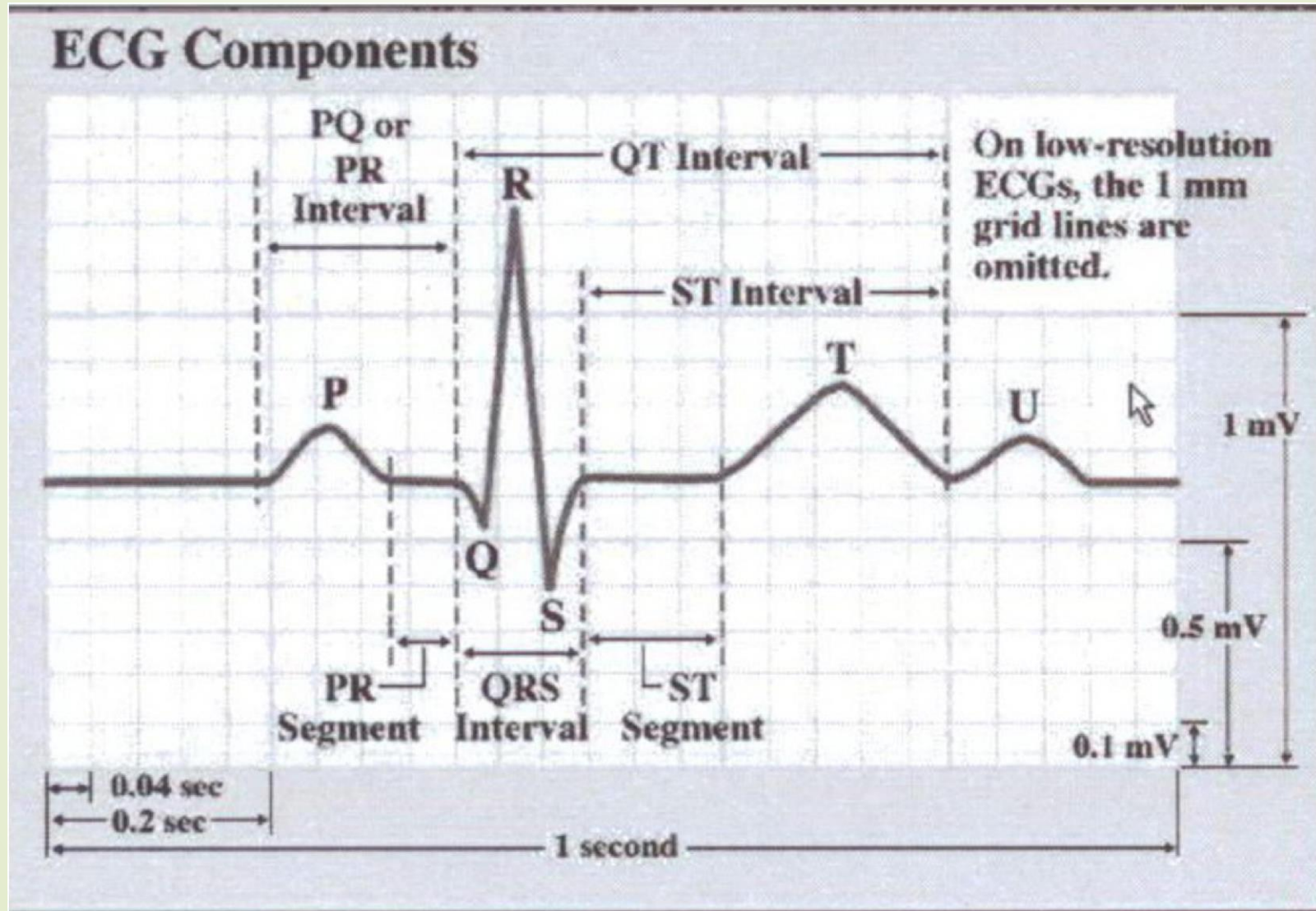


(g) T wave: Ventricles repolarize and relax

 Depolarization

 Repolarization

# Cardiac Intervals





# Different Segments of ECG

**P wave:** the *sequential* activation (depolarization) of the right and left atria

**QRS complex:** right and left ventricular depolarization (normally the ventricles are activated *simultaneously*)

**ST-T wave:** ventricular repolarization

**U wave:** origin for this wave is not clear - but probably represents "after depolarization's in the ventricles

**PR interval:** time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)

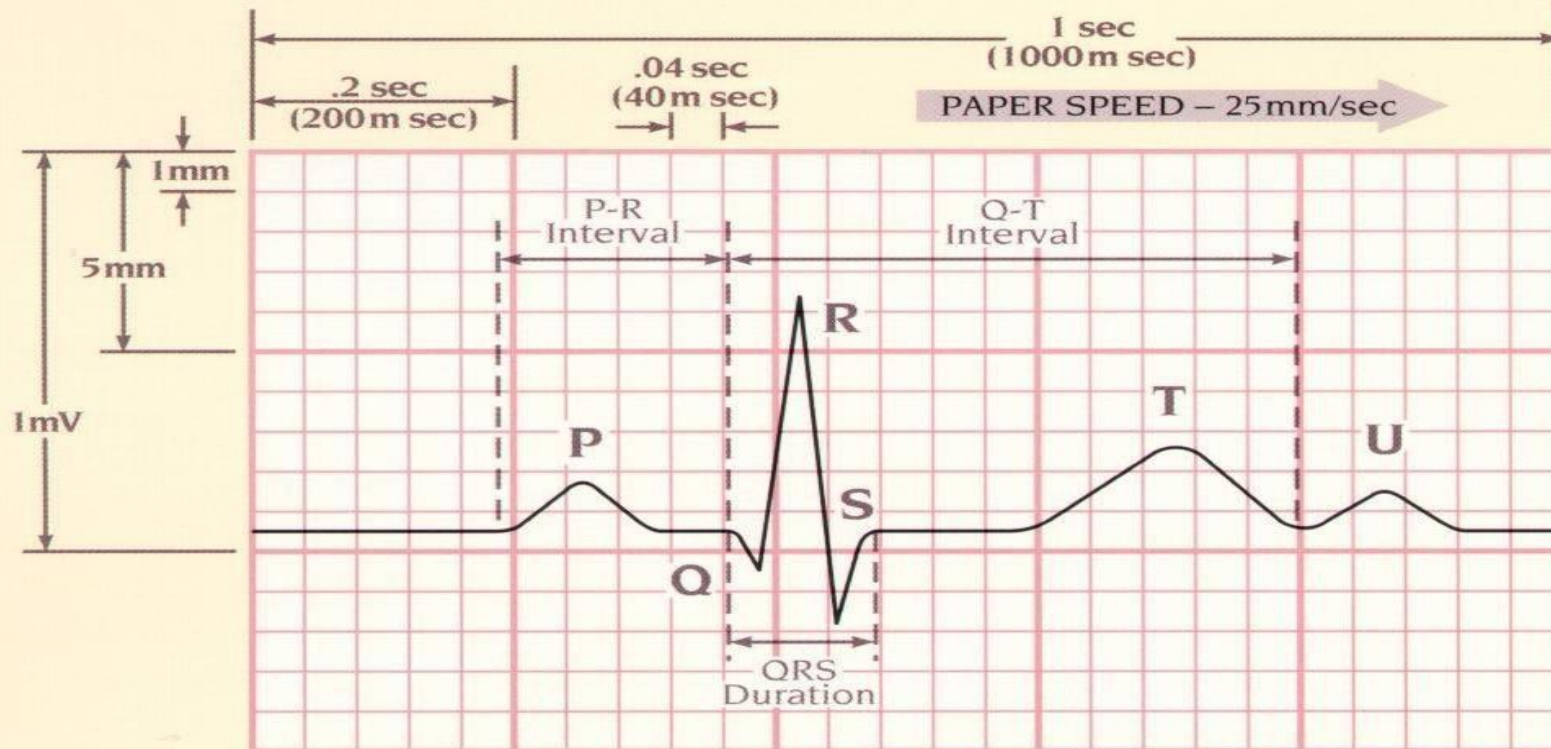
**QRS duration:** duration of ventricular muscle depolarization

**QT interval:** duration of ventricular depolarization and repolarization

**RR interval:** duration of ventricular cardiac cycle (an indicator of ventricular rate)

**PP interval:** duration of atrial cycle (an indicator or atrial rate)

# How to Read an ECG



VERTICAL AXIS	1 Small Square = 1mm (0.1mV)
	1 Large Square = 5mm (0.5mV)
	2 Large Squares = 1mV

HORIZONTAL AXIS	1 Small Square = .04 sec (40 m sec)
	1 Large Square = .2 sec (200 m sec)
	5 Large Squares = 1 sec (1000 m sec)

# Heart rate from the ECG strip

- When the rhythm is regular, the heart rate is 300 divided by the number of large squares between the QRS complexes.
- For example, if there are 4 large squares between regular QRS complexes, the heart rate is 75 ( $300/4=75$ ).

# Heart rate from the ECG strip

- To estimate the rate for an irregular rhythm, Count the number of R waves in a 6 second strip and multiply by 10.
- For example, if there are 7 R waves in a 6 second strip, the heart rate is 70 ( $7 \times 10 = 70$ ).

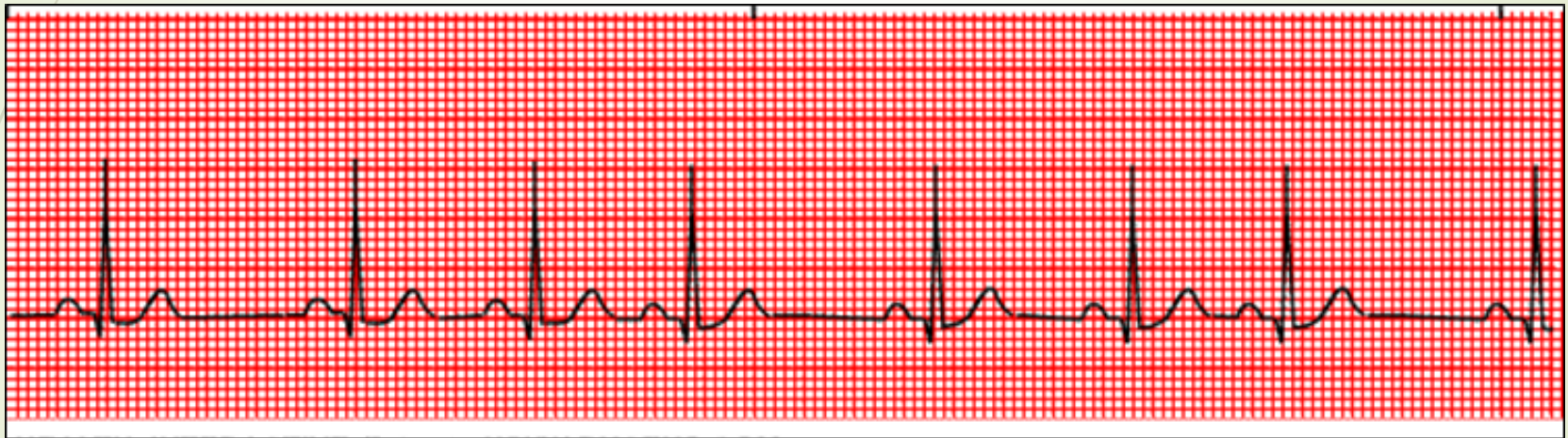


# Abnormal ECG Deflection Wave Patterns





# Sinus Arrhythmia



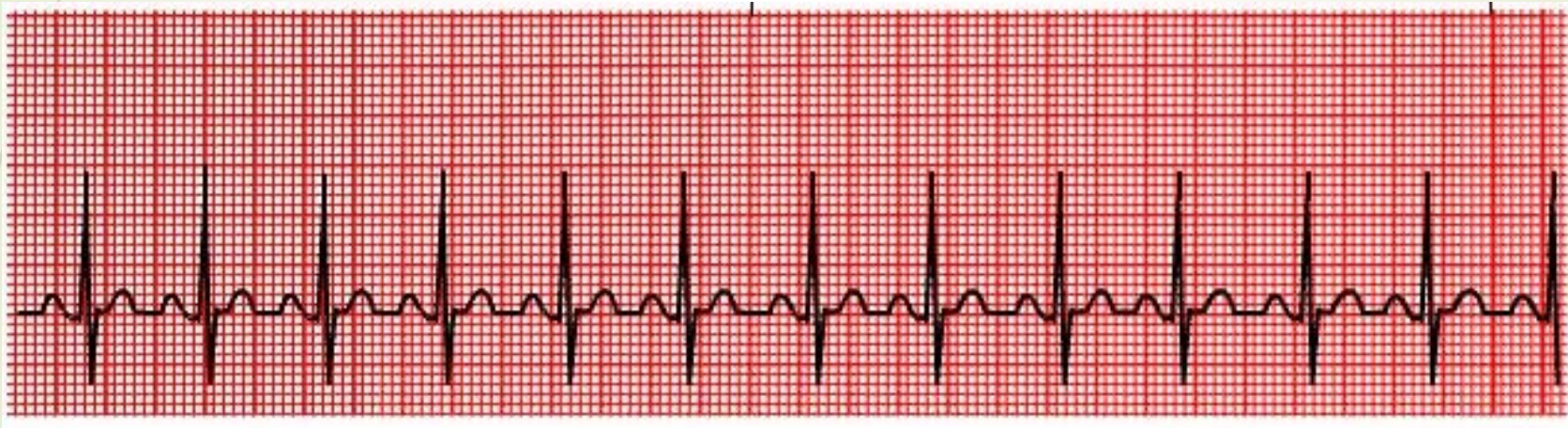
Sinus arrhythmia means there is an irregularity in the heart rhythm, originating at the sinus node.

# Sinus Bradycardia



Rate = 40-59 b.p.m.

# Sinus Tachycardia



Rate = 101-160 b.p.m.



# Sinus Arrest



Pause > 3 seconds



# Atrial Flutter



Heart's upper chambers (atria) beat too quickly. This causes the heart to beat in a fast, but usually regular, rhythm.

# Atrial Fibrillation (A-fib)



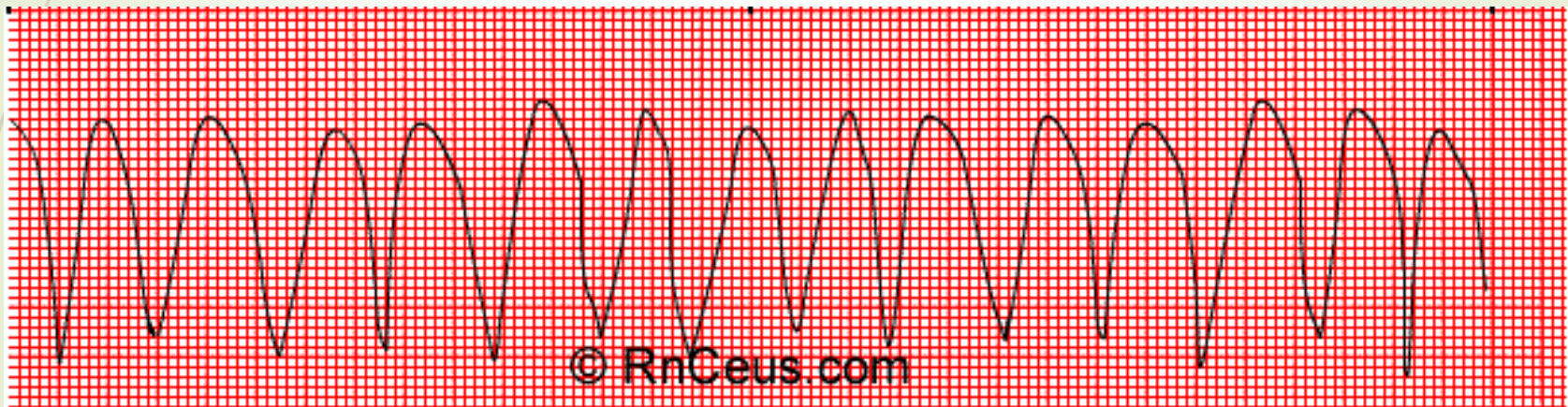
An irregular and often very rapid heart rhythm- the heart's upper chambers (the atria) beat chaotically and irregularly.

# AV Block



Partial or complete interruption of impulse transmission from the atria to the ventricles.

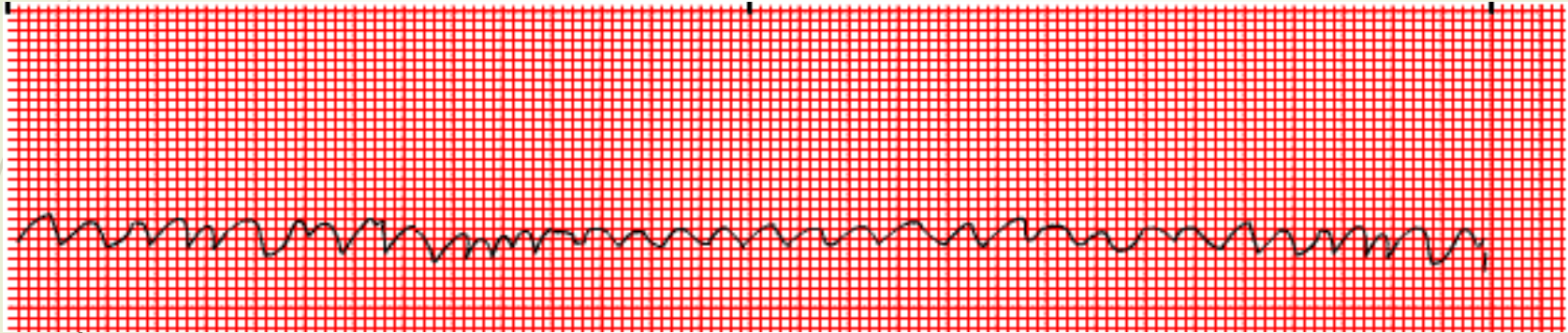
# Ventricular Tachycardia (V-tach)



A wide QRS complex heart rhythm- a QRS duration beyond 120ms

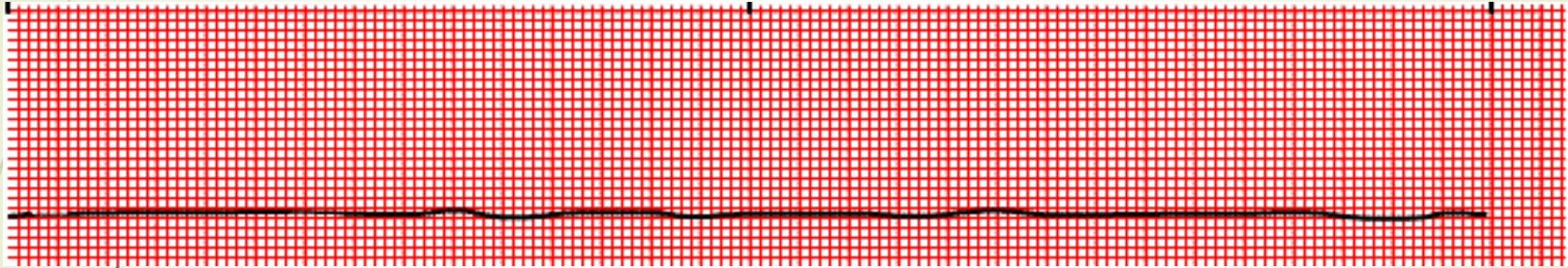


# Ventricular Fibrillation (V-fib)



Disordered electrical activity causes the heart's lower chambers (ventricles) to quiver, or fibrillate, instead of contracting (or beating) normally.

# Asystole



Informally referred to as "flatline", represents the cessation of electrical and mechanical activity of the heart.

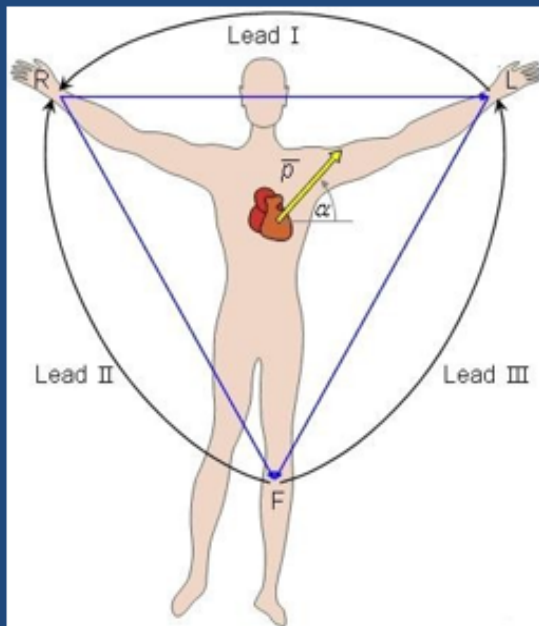
# ECG Leads

ECG is recorded as the difference between two potentials on the body surface, called an "ECG lead". Each lead is said to look at the heart from a different angle.

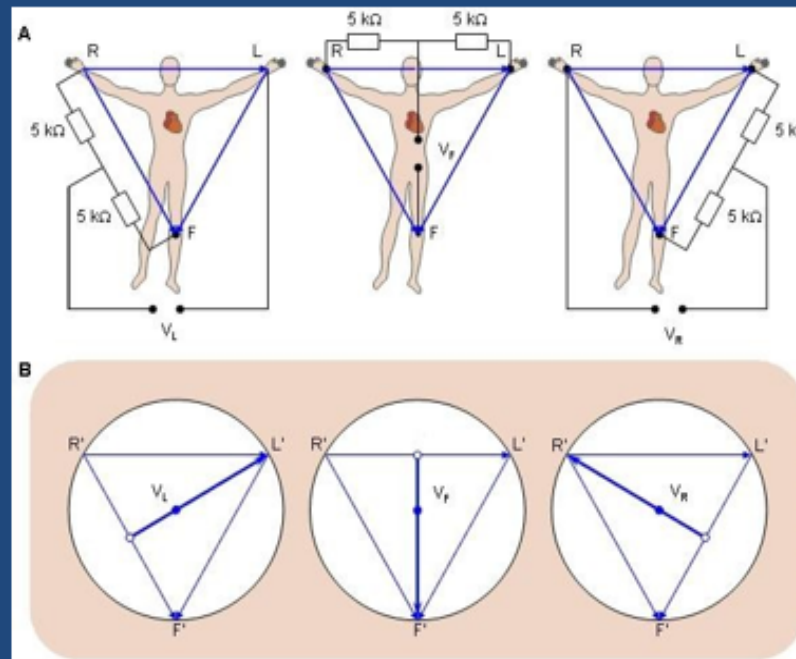
## 12-Lead ECG measurement

- Most widely used ECG measurement setup in clinical environment
- Signal is measured non-invasively with 10 electrodes
- Well-known measurement and diagnosis practices

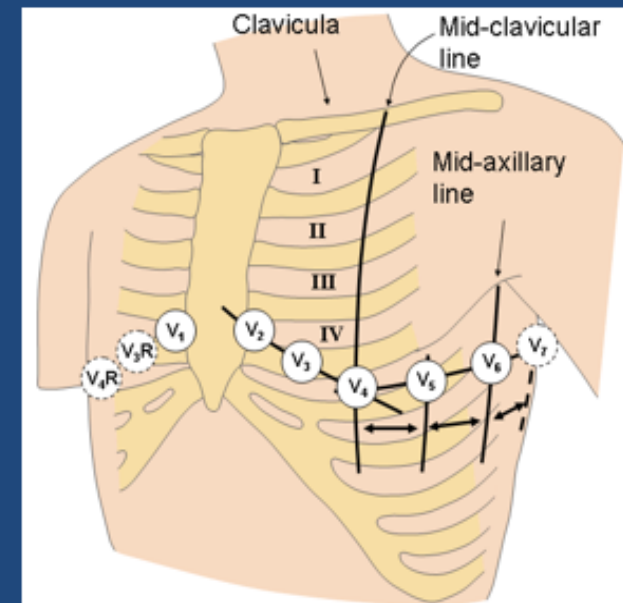
Einthoven leads: I, II & III

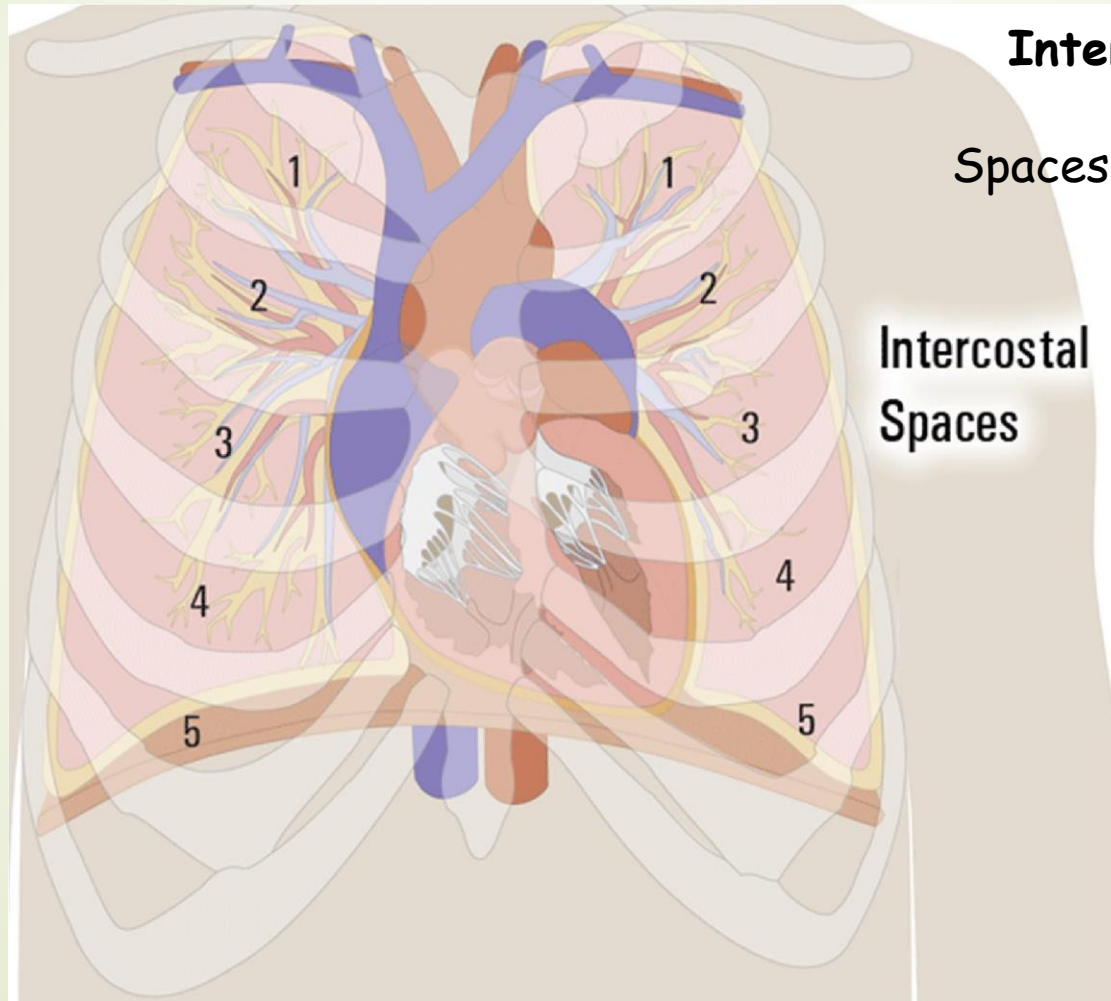


Goldberger augmented leads:  $V_R$ ,  $V_L$  &  $V_F$



Precordial leads:  $V_1$ - $V_6$



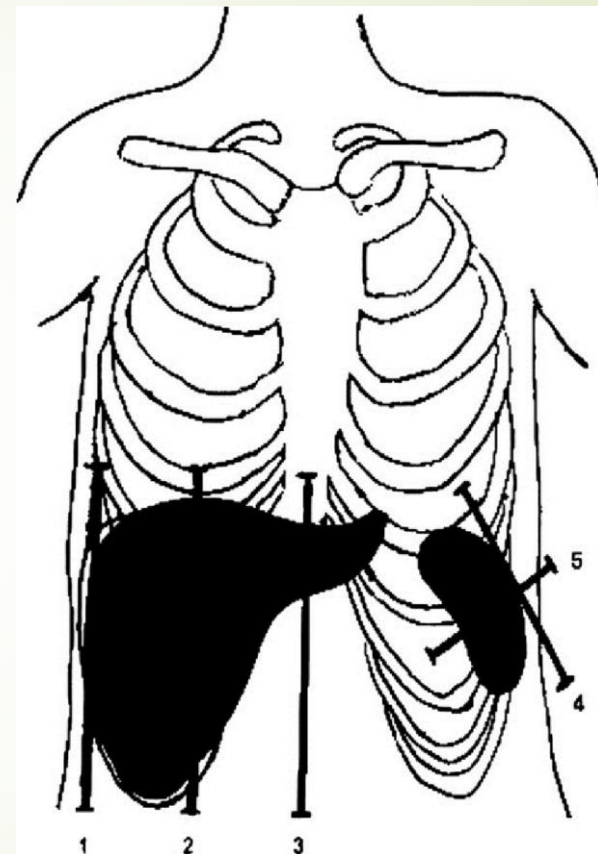
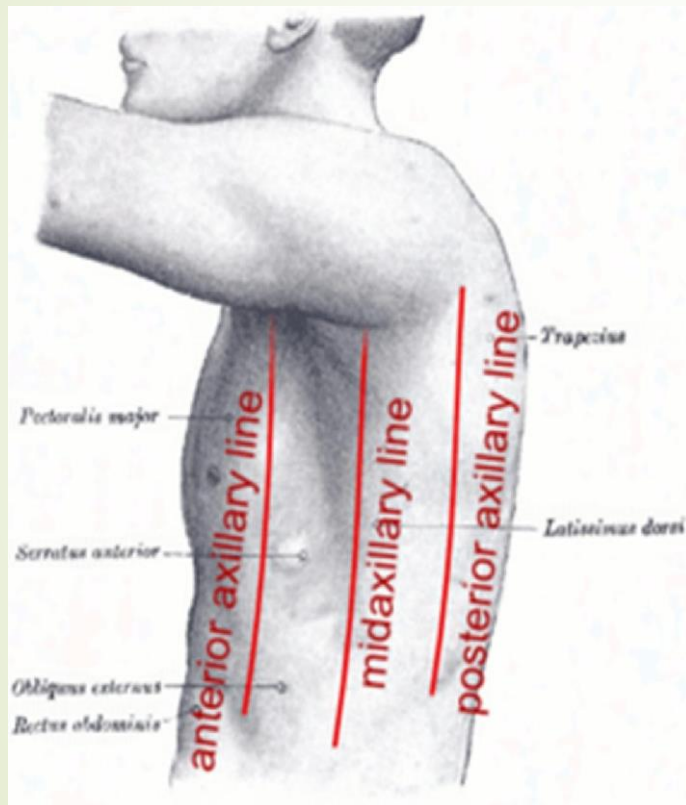


## Intercostal Spaces

Spaces between the ribs

Intercostal  
Spaces





1 anterior axillary line (AAL),

### Chest leads

**V1:** 4th intercostal space , right sternal edge.

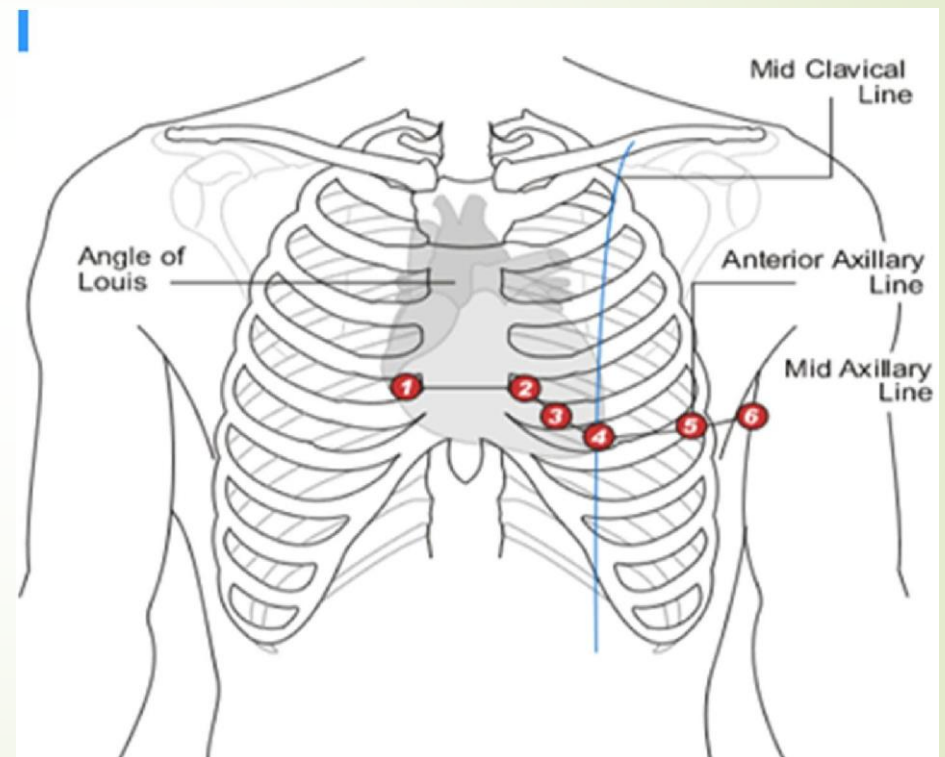
**V2:** 4th intercostal space, left sternal edge.

**V3:** between the 2nd and 4th electrodes.

**V4:** 5th intercostal space in the midclavicular line.

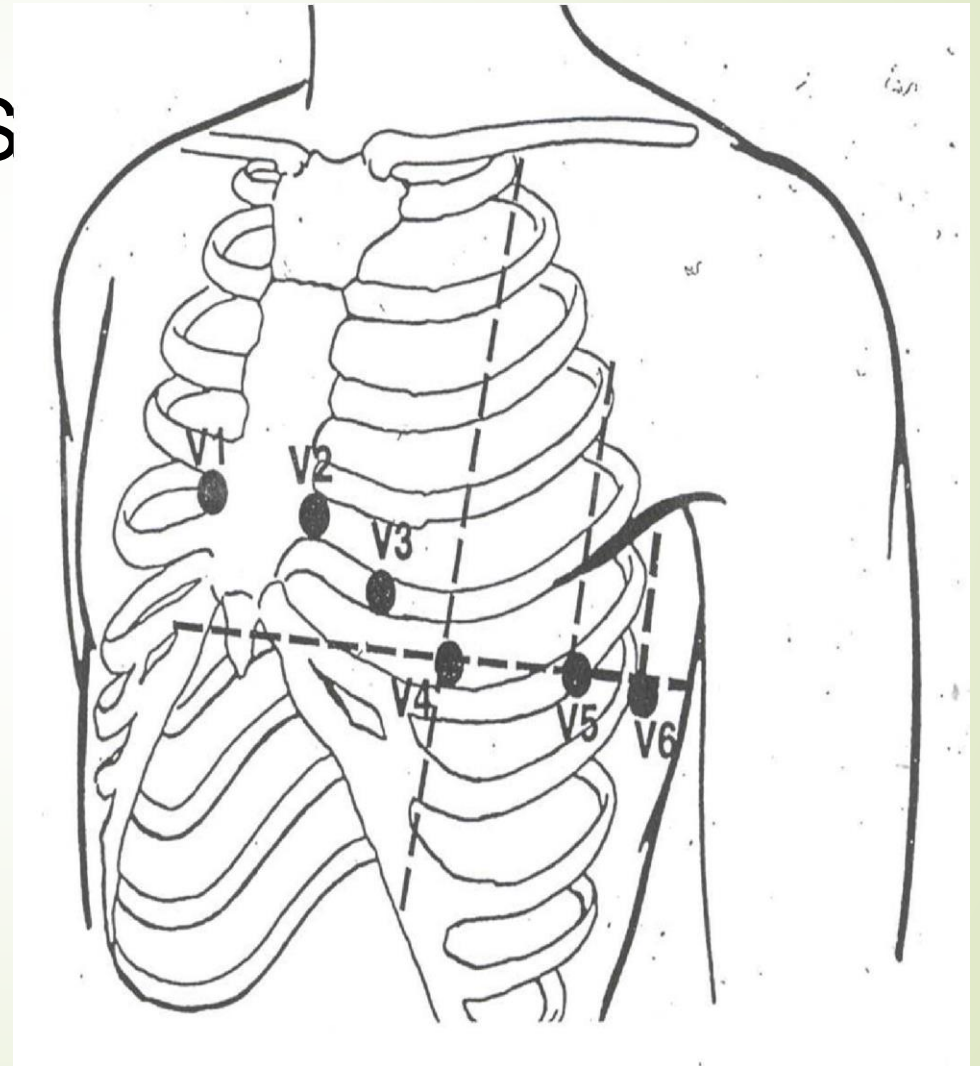
**V5:** on 5th rib, anterior axillary line.

**V6:** in the midaxillaryline.



# CHEST LEADS

- 6 UNIPOLAR LEADS
- V1
- V2
- V3
- V4
- V5
- V6



# CHEST LEADS

The chest electrodes are labelled “V” and are numbered from 1 to 6.

- The placement of these electrodes needs to be exact to give the optimum information as possible.
- If the electrodes are placed incorrectly on the chest, the tracing will reveal duplication of some information, while other areas will not be represented properly.