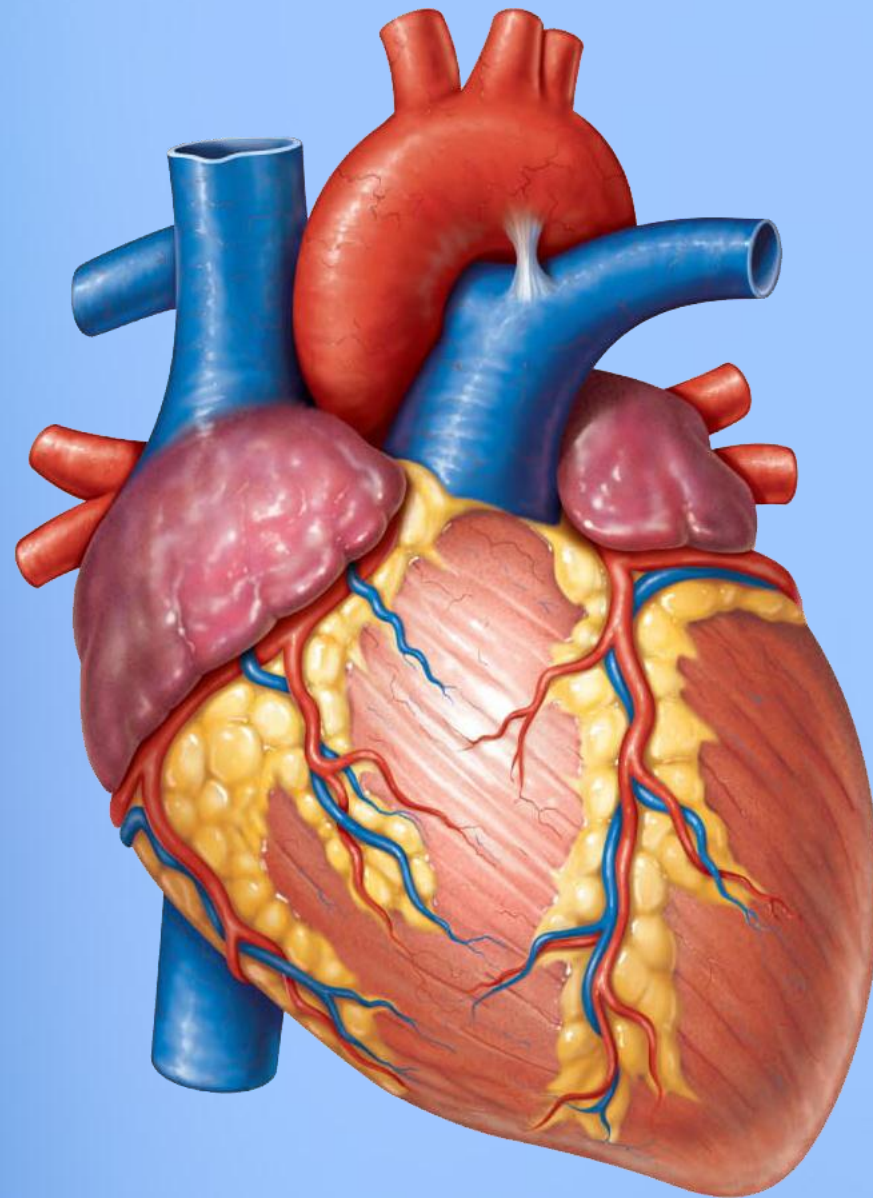


4

ELECTROCARDIOGRAM (ECG)



Cardiovascular Block

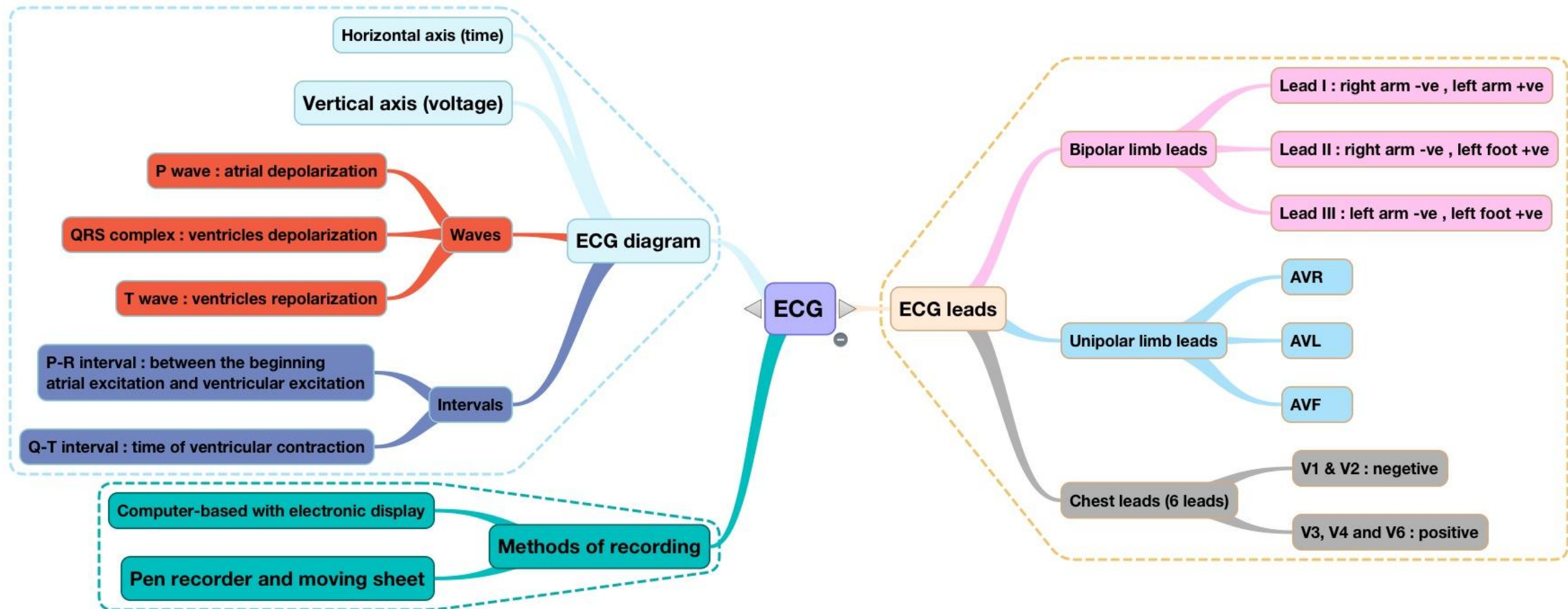
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THE NORMAL ELECTROCARDIOGRAM (ECG)

1

- The **depolarization** wave spread through the heart

2

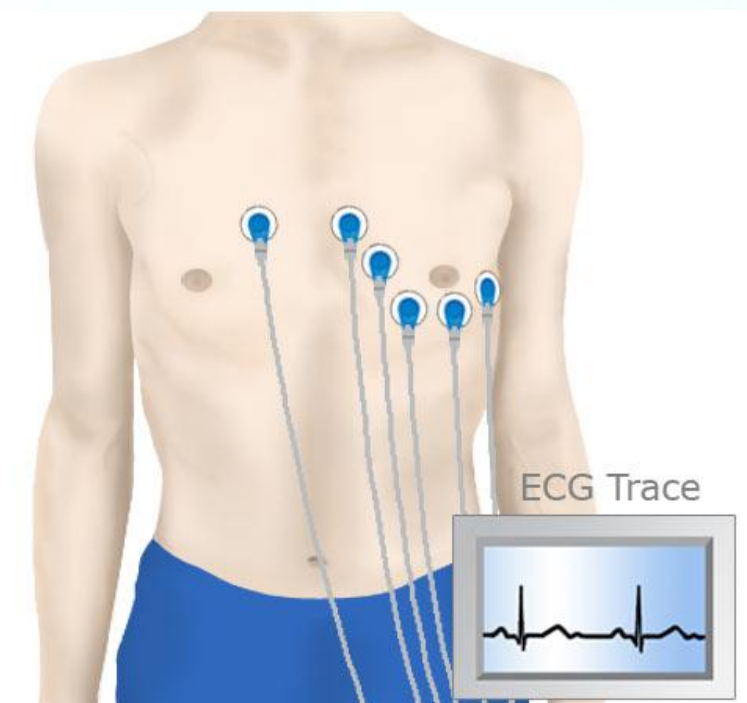
- **electrical** currents pass into the surrounding tissue

3

- Part of the current reaches the **surface** of the body

The Electrocardiogram (ECG) is a recording of the **electrical** activity of the heart

The **electrical potentials** generated by these currents can be recorded from **electrodes** placed on the skin opposite the heart



Interval: it is a time duration gives a reflection of what's going inside the heart

❖ **P wave:** is caused by **atrial depolarization** (systole).

❖ **QRS complex:** is caused by **depolarization** of the **ventricles** (systole).

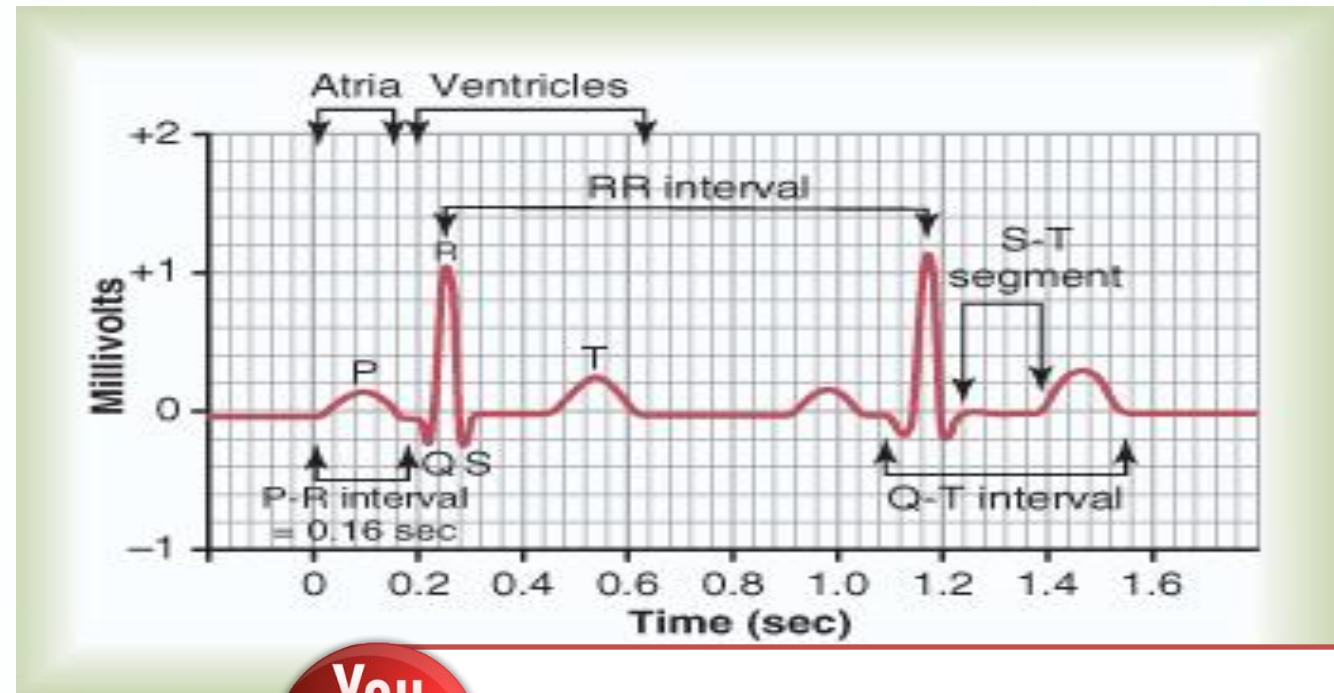
❖ **T wave:** **repolarization** of the **ventricles** (diastole).

❖ Horizontal axis → **Time (seconds)**

Dark lines = 0.2 S

Small line = 0.04 S

25 small lines = 1 S



<http://www.youtube.com/watch?v=4vkbywows-o>

<http://www.youtube.com/watch?v=p4gIT4FuGSE>

the atrial repolarization does not appear in the ECG trace, because it is very small deflection, and it is hidden whit in the trace so ,we can **NOT** record it .

❖ Vertical axis → **Voltage(millivolt)**

5 small lines = 1 mV

P-R interval

- It is the time between the beginning of the *P wave* and the beginning of the *QRS complex*.
- It is the interval between the beginning of electrical **excitation** of the **atria** and the beginning of **excitation** of the **ventricles** .
- The P-R interval is about **0.16 second** .

لتوضيح كيفية حساب المدة الزمنية للفترات من التخطيط:

❖ كل مربع صغير يعادل (0.04)

❖ كل مربع كبير (يحتوي على 5 مربعات صغيرة)

1- نقوم بتحديد الفترة الزمنية المراد حسابها ونحسب كم مربع تحتويه (من بدايتها إلى نهايتها)

2- نضرب عدد المربعات الصغيرة بالقيمة (0,04) وبذلك نكون حصلنا على مدة الفترة .

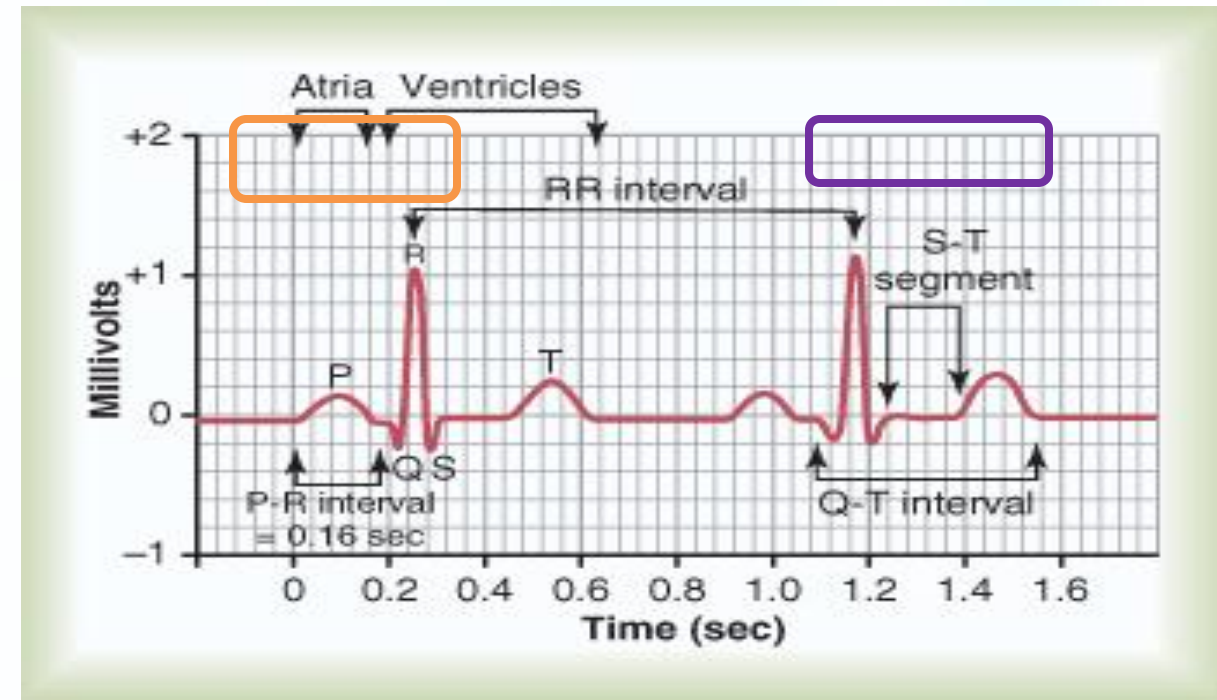
مثال: لحساب P-R نلاحظ أن الفترة تقع بين 4 مربعات صغيرة مما يعني :

عدد المربعات * (0,04) = 0,04 * 4 = 0,16 ثانية

القيم: 0,16 و 0.35 هي القيم الطبيعية للفترات لو زادت أو نقصت دل ذلك على خلل .

Q-T interval

- **Contraction** of the **ventricles** last from the beginning of the *Q wave* to the end of *the T wave* .
- Q-T interval is the time from the beginning of the *Q wave* to the end of the *T wave* .
- Q-T interval is about **0.35 second** .



Heart Rate

The heart rate is the **repetition** of the time interval between two successive **heartbeats**.

If the interval between 2 beats is 1 second the heart rate is 60 beats per minute

Normal heart rate = 60 -100 bpm

METHODS FOR RECORDING ELECTROCARDIOGRAMS

- 1-Computer-based and electronic display
- 2-Pen recorder and a moving sheet.

لحساب معدل نبضات القلب في الدقيقة الواحدة من التخطيط :

❖ بحساب عدد المربعات الواقعة بين موجتي QRS متتاليتين بمعنى نبدا الحساب من Q للموجة الاولى وننتهي عند S للموجة الثانية .

❖ نستخدم في الحساب إما المربعات الكبيرة أو المربعات الصغيرة على حسب التخطيط .

1- لو استخدمنا المربعات الصغيرة نجري العملية الحسابية التالية :
1500/عدد المربعات

2- لو استخدمنا المربعات الكبيرة (كل مربع كبير يحتوي 5 مربعات صغيرة)

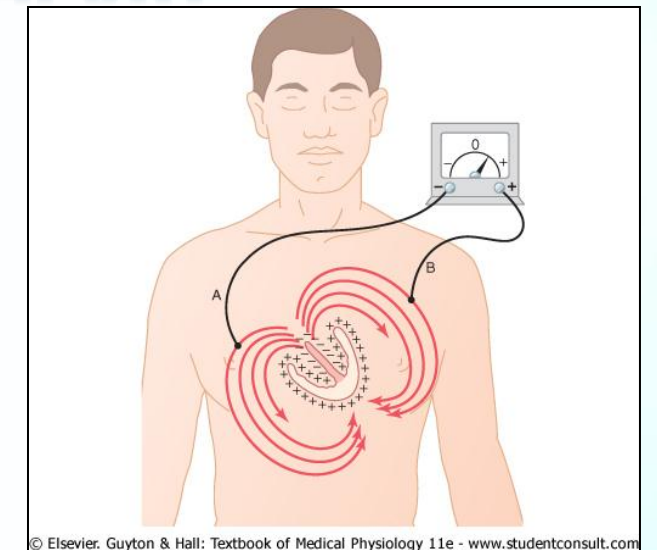
نجري العملية الحسابية التالية : 300/عدد المربعات
مثال :

باستخدام المربعات الكبيرة :
نفرض ان عدد المربعات 5 سيكون معدل النبض : $60 = 5/300$ نبضة بالدقيقة

باستخدام المربعات الصغيرة (25مربع) : $60 = 25/1500$ نبضة بالدقيقة

FLOW OF THE ELECTRICAL CURRENT IN THE HEART

- In normal ventricles, current flows from **negative** to **positive** from the **base** of the heart toward the **apex** (action potential).
- The first area that depolarizes is the **ventricular septum**. (from SA node toward AV node)
- Current flows from the **electronegative** inner surface of the heart to the **electropositive** outer surface (from the **base** of the heart to the **apex**).
- An electrode placed near the **base** of the heart is **electronegative**, and near the **apex** is **electropositive**



The ECG Leads

BIPOLAR LIMB LEADS

Lead: two wires and their electrodes to make a complete circuit. There are 3 types:

1. The Bipolar Limb Leads: (I, II, III)
2. Chest Leads: (V1, V2, V3, V4, V5, V6)
3. Augmented Unipolar Limb Leads (aVR, aVL, aVF).

Bipolar limb leads

Bipolar: means that the ECG is recorded from two electrodes

Lead I:

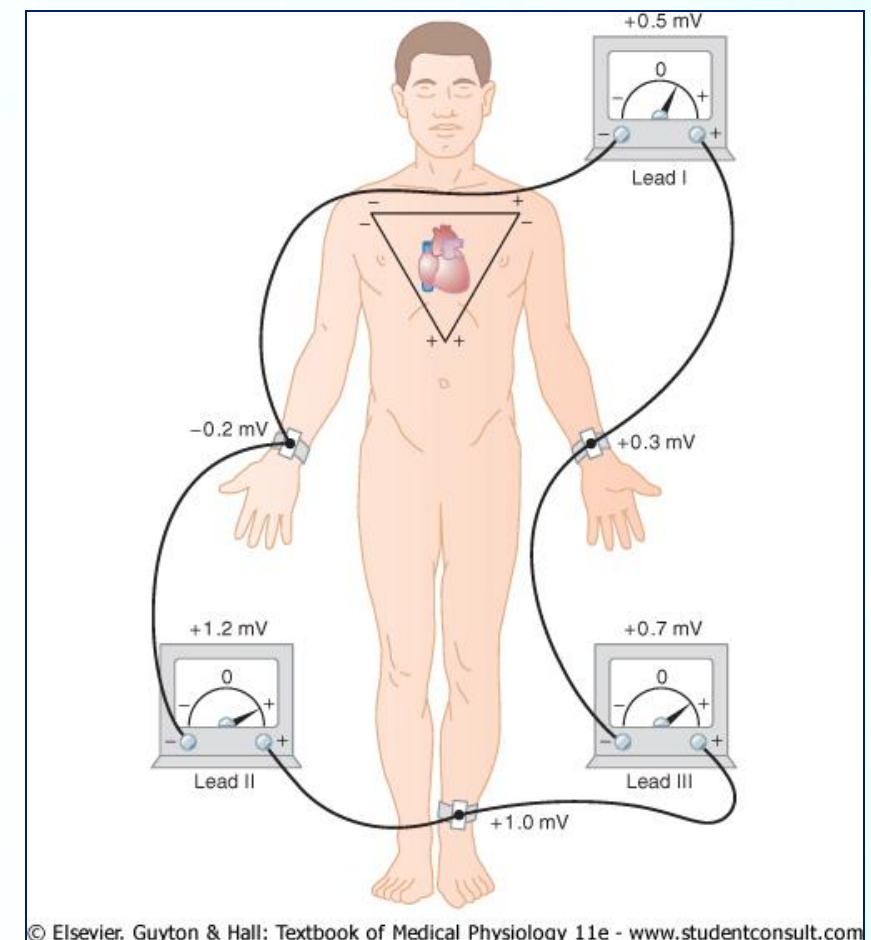
The right arm : -ve
The left arm: +ve

Lead II:

The right arm: -ve
The left leg: +ve

Lead III:

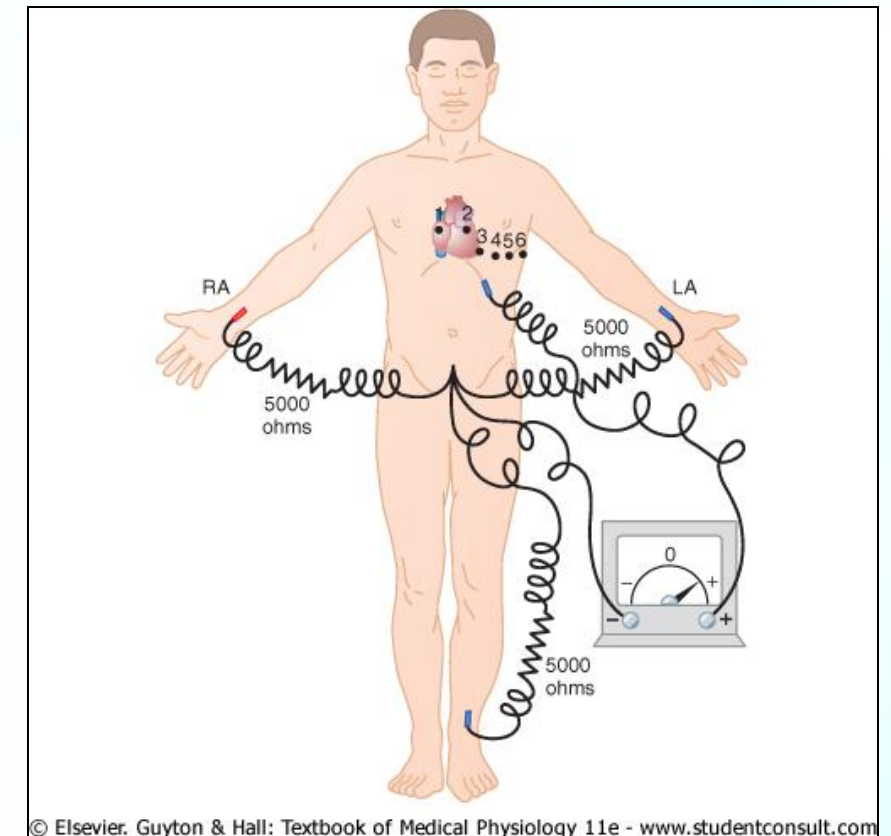
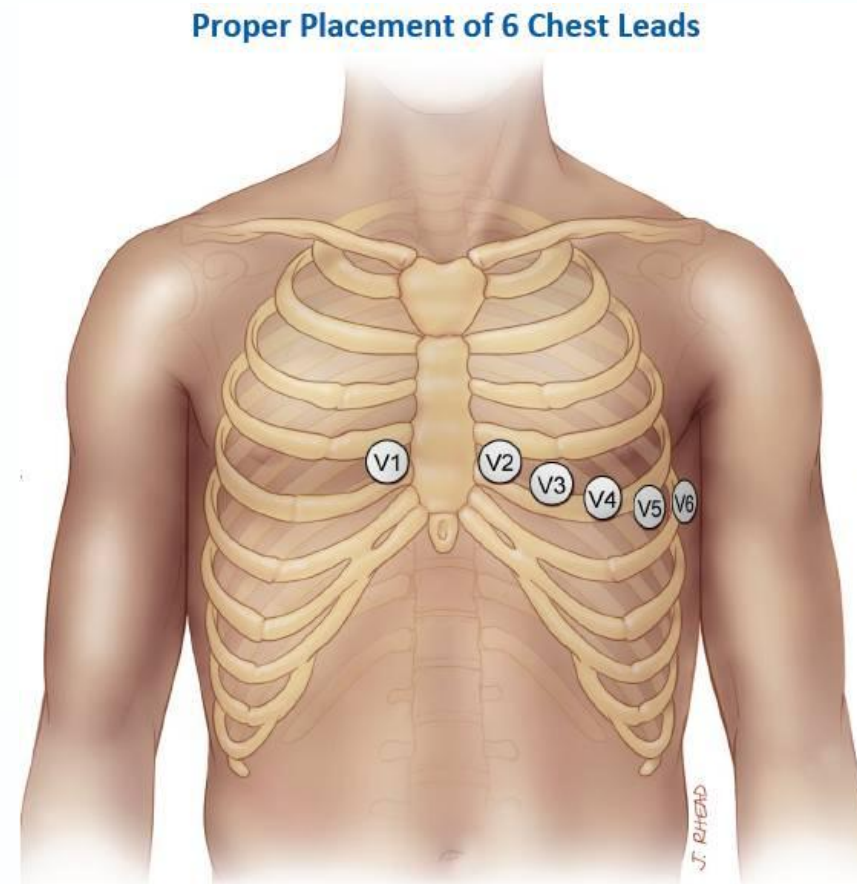
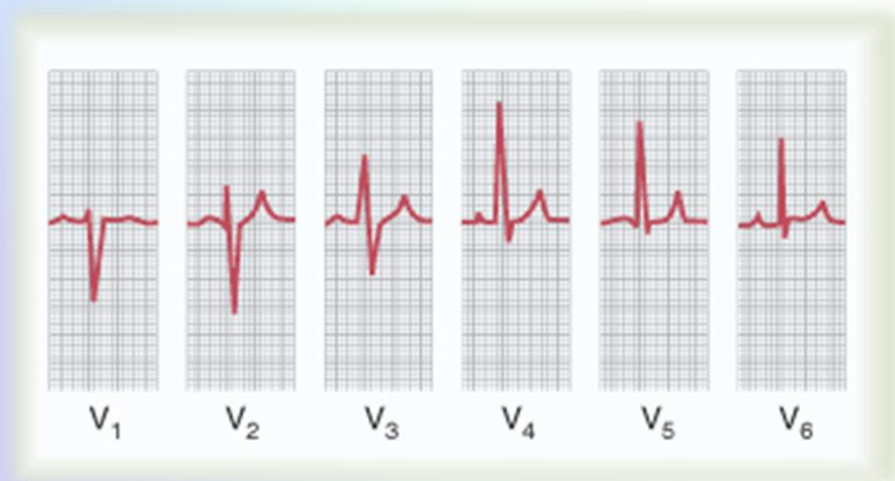
The left arm: -ve
The left leg: +ve



CHEST LEADS

Recorded from the anterior surface of the chest (V1, V2, V3, V4, V5, V6)

- Positive electrode on the chest.
- The *indifferent electrode* is the negative electrode connected to the right arm, left arm, and left leg.
- **V1 and V2:** QRS are mainly **negative** because the chest leads are nearer to the base of the heart.
- **V3, V4 and V6** are mainly **positive** because the chest electrode are nearer to the apex.

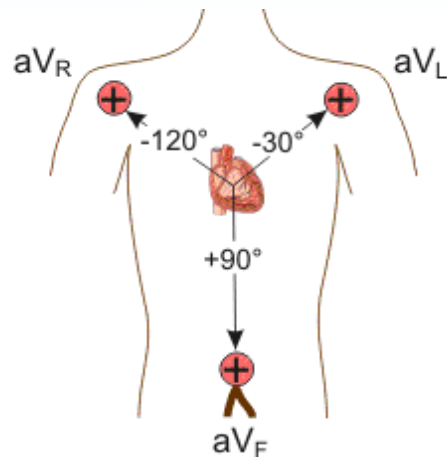


AUGMENTED UNIPOLAR LIMB LEADS

Another system of leads in wide use is AULL. The two limbs are connected to the negative terminal of the ECG, and the third limb is connected to the positive

When the positive terminal is on:

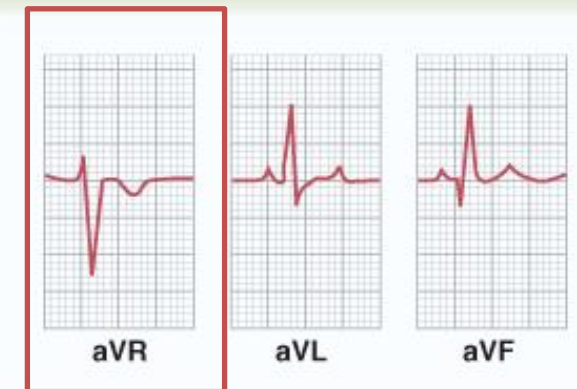
Right arm, the lead is called aV_R



Left arm, the lead is called aV_L

Left Leg, the lead is called aV_F

Notice that aVR is inverted



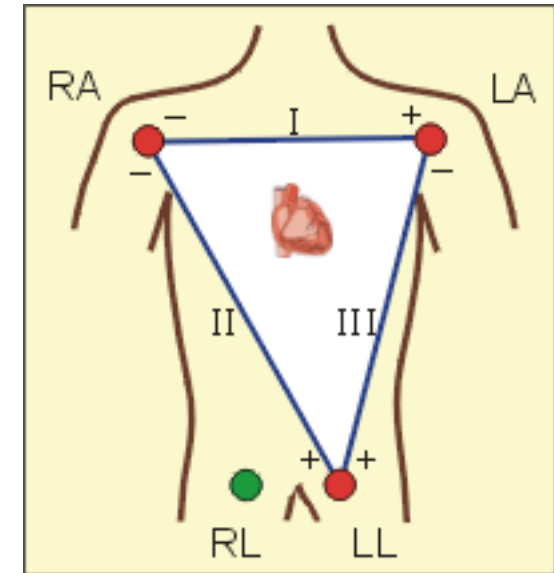
ECG is used for

- Heart rate
- Normal intervals
- Rhythm
 - Regular
 - Single p-wave precedes every QRS complex
 - P-R interval is constant and within normal range
- Cardiac axis Axis

EINTHOVEN'S TRIANGLE AND LAW

Einthoven's triangle

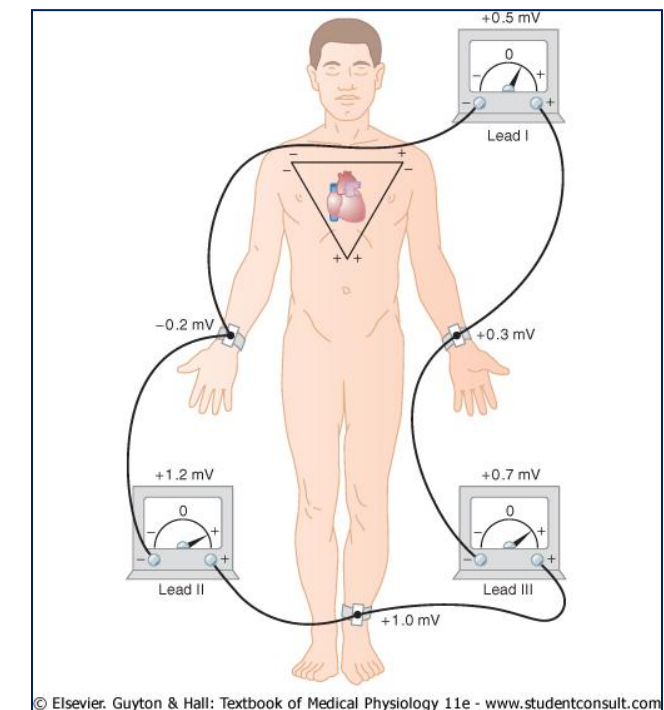
is drawn around the area of the heart. The two apices at the upper part of the triangle represent the points at which the two arms connect electrically. The lower apex is the point at which the left leg connects



Einthoven's Law

if the electrical potential of any two of the three bipolar limb leads are known, the third one can be determined mathematically by summing the first two (note the +ve and -ve signs)

$$\text{Lead I} + \text{Lead III} = \text{Lead II}$$



Questions

Q1: Which device is used to evaluate or record the electrical activity of the heart ? with 2 of its clinically methods ?

ECG :

- 1- Computer-based and electronic display.
- 2- Pen recorder and a moving sheet.

Q2: What is the definition of the Heart rate ?

It is the repetition of the time interval between two successive heartbeats.

Q3: Which wave is caused by the repolarization of the ventricles ?

T wave.

Q4: Describe the P-R interval and how much time does it remain?

It is the time between the beginning of the P wave and the beginning of the QRS complex. **(lasts for 0.16 sec)**

Q5: Describe the voltage and the limbs which are involved in the "Lead I, II, III".

I: Right arm **-ve** , Left arm **+ve**.

II: Right arm **-ve** , Left leg **+ve**.

III: Left arm **-ve** , Left leg **+ve**.

Q6: In normal ventricles, where current flows come from ?

from the inner surface which is negative (base) , to the outer surface which is positive (apex).

Q7: V1 & V2 are mainly negative in chest lead , why ?

They are mainly negative because the chest leads are nearer to the base of the heart.

Q8: If we have these information (Lead II = 2) and (Lead III = 8) , how can we find (Lead I) ? find it.

Einthoven's Law "Lead I + Lead III = Lead II"

so , $X + 8 = 2$ -----> $X = -6$

Questions

Q9: In the diagram of the ECG try to answer these questions :

A - The Horizontal axis describes what ? unit ?

B - The Vertical axis describe what ? unit ?

C - How many small lines are needed for 1 mV ?

D - How many small lines are needed for 0.6 sec ?

E - How many dark lines are needed for 1 sec ?

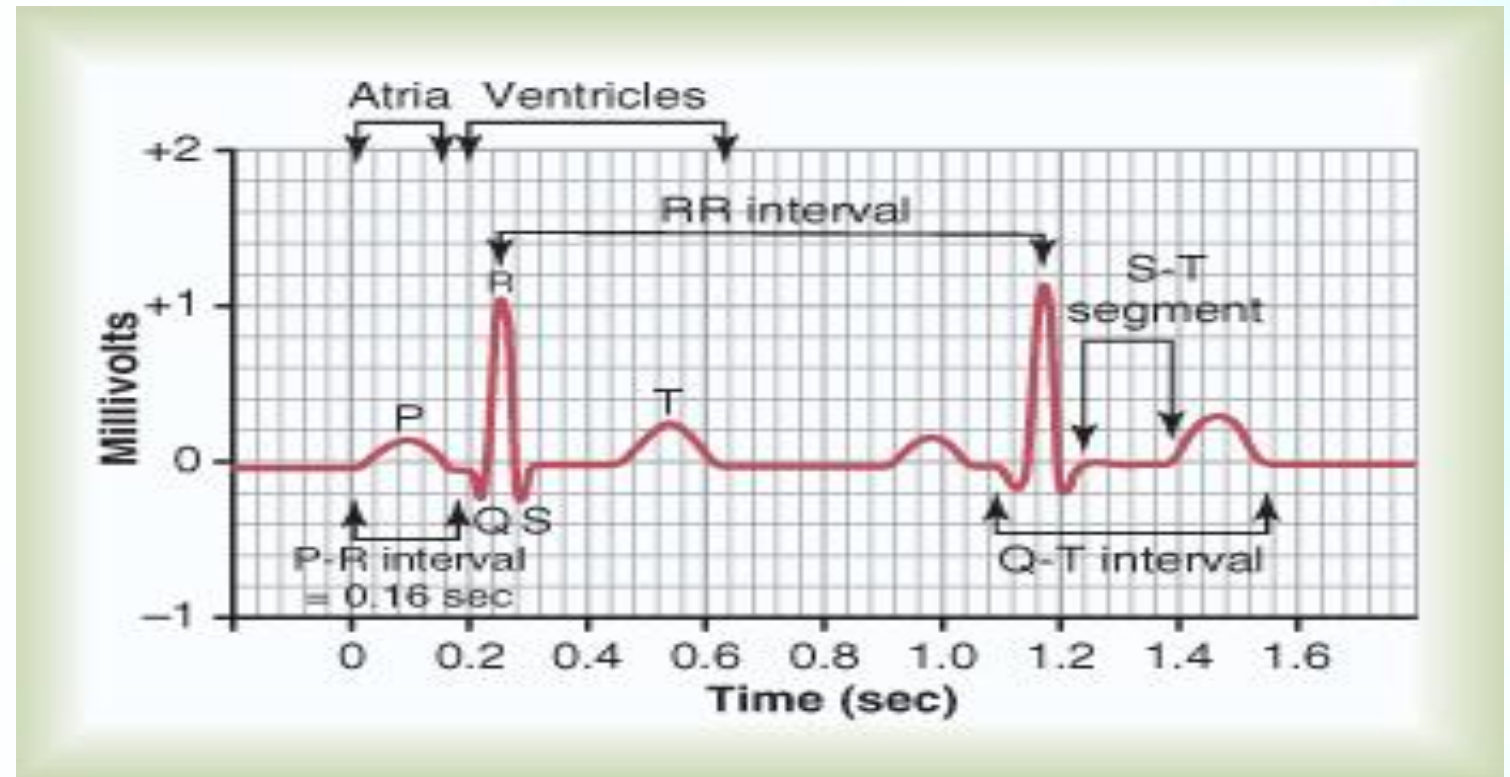
A - Time (sec).

B - Voltage (mV).

C - 5 small lines.

D - 15 small lines.

E - 5 dark lines.



MCQS

1-How much interval between the dark line?

- A-0.04 second
- B-0.2 second
- C-1 second
- D-0.16 second

2-Time between the beginning of electrical excitation of the atria and the beginning of excitation of the ventricles?

- A-S-T segment
- B-Q-T interval
- C-P-R interval
- D-R-R interval

3-Where is Contraction of the ventricles can see in ECG ?

- A-From P wave to R wave
- B-From Q wave To R wave
- C-From S wave to T wave
- D-From Q wave T wave

4-If the interval between 4 beats is 2 second the heart rate per minute is:

- A- 120 beats
- B- 60 beats
- C-40 beats
- D-130 beats

5-How much square in normal P-R interval ?

- A-5 square
- B-4 square
- C- 6 square
- D- 3 square

6-During Flow of Electrical current in the Heart rate An electrode placed near the apex is:

- A-electronegative
- B-electropositive
- C-Mixed charge
- D-No charge

7-According to the Bipolar Limb Leads , the lead the record left leg and left arm is :

- A-Lead II
- B-Lead III
- C-Lead I
- D-Both A&B

8-Which one of chest lead QRS are mainly negative ?

- A-V4
- B-V3
- C-V2
- D-V6

9-One of the Augmented Unipolar Leads always goes Downward :

- A. Right arm
- B. Left Arm
- C. Left leg
- D. Right leg

Ans: 1-B, 2-C, 3-D, 4-A, 5-B, 6-B, 7-B, 8-C, 9-C

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