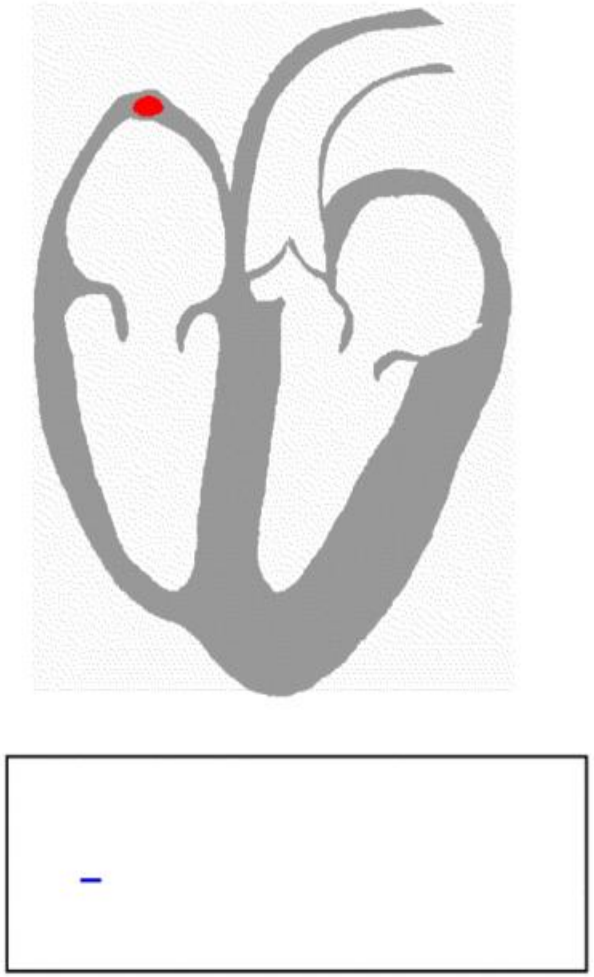
ECG 1

Definition of Electrocardiogram (ECG)



ECG is a modified biphasic record of the electrical activity of the heart during the cardiac cycle.

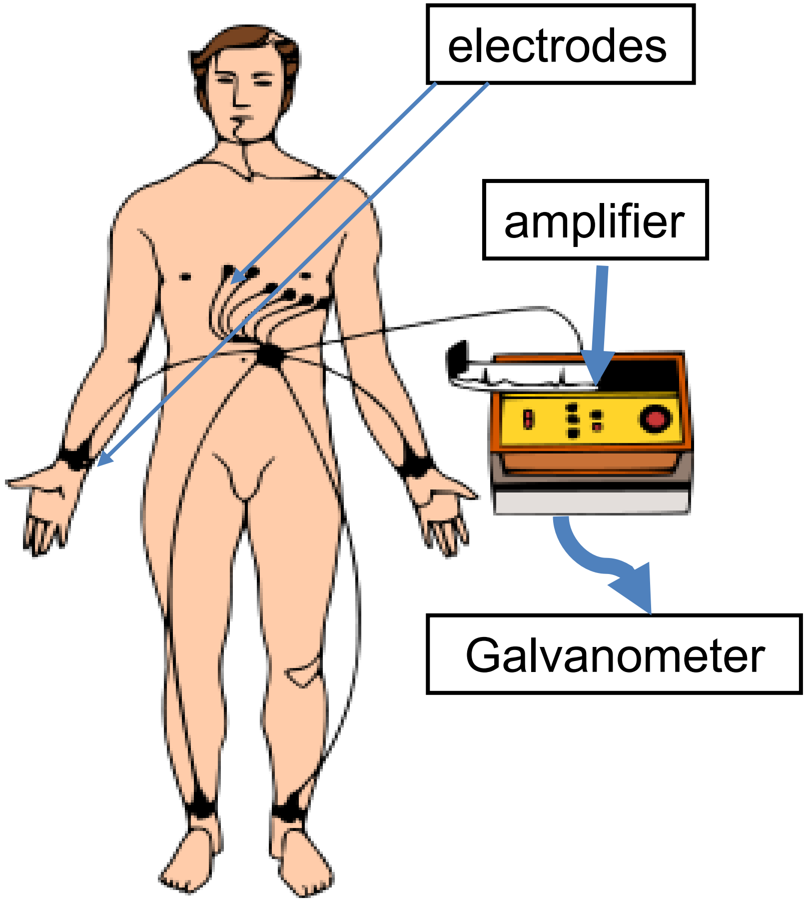
Electrocardiograph (ECG)

Apparatus : Electrocardiograph (ECG)

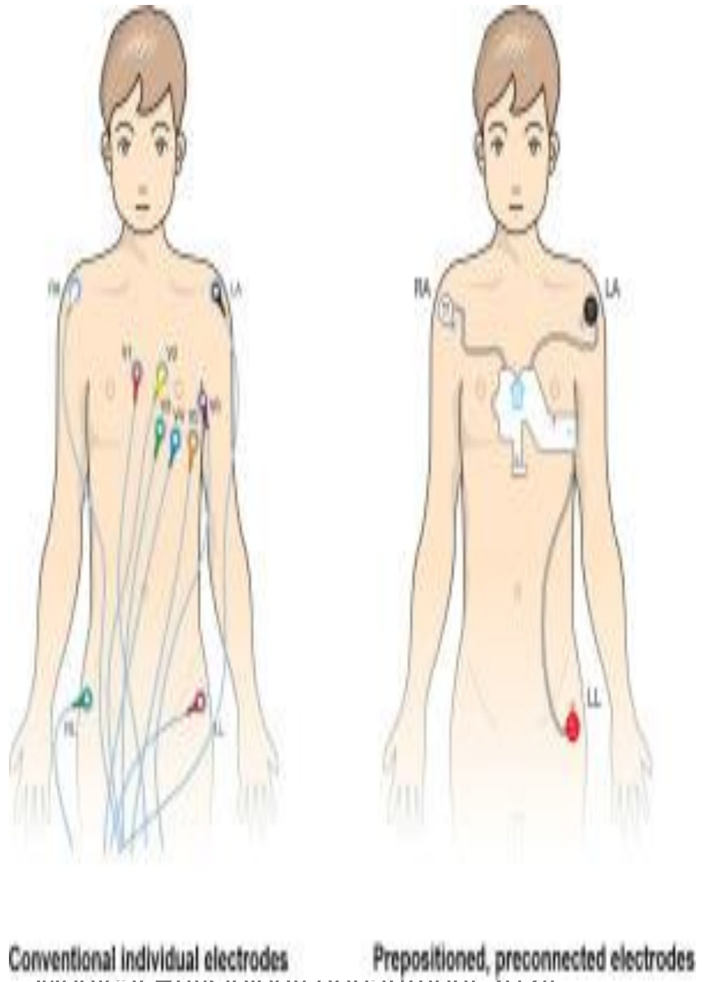
ECG apparatus consists of;

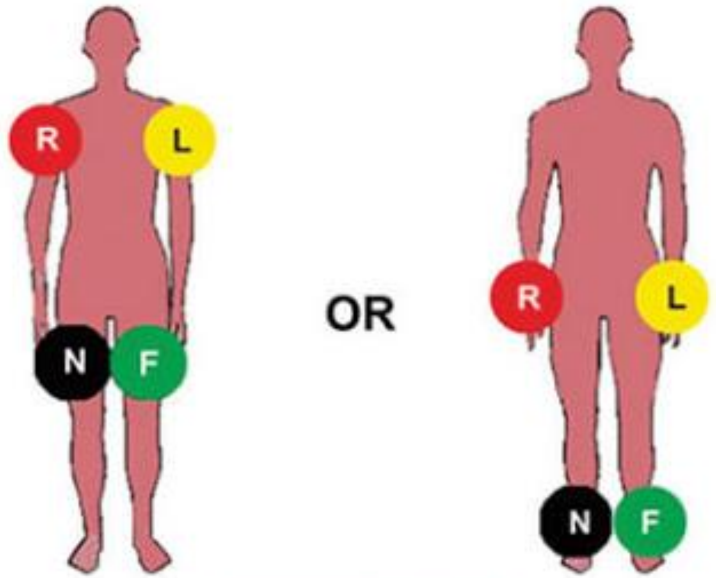
1. Sensitive galvanometer.
2. Amplifier which magnifies potential changes recorded by electrodes of galvanometer.
3. Recording electrodes in which:
   - ❖ **Positive or exploring electrode** is attached to +ve pole of galvanometer.
   - ❖ **Negative or indifferent electrode** is attached to –ve pole of galvanometer.

Galvanometer moves a pen recorder which writes on moving paper film.



Placing of ECG Electrodes




R
L
N
F
OR
R
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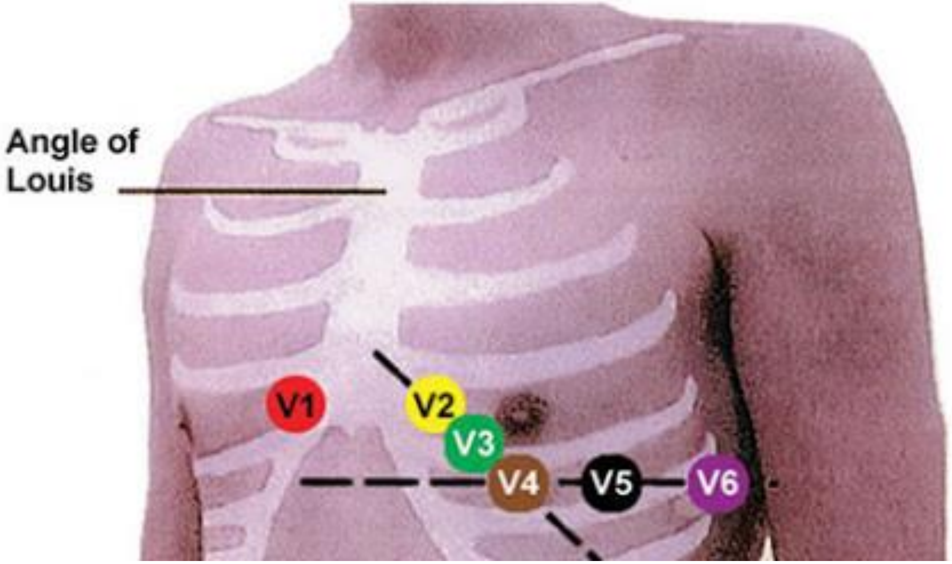
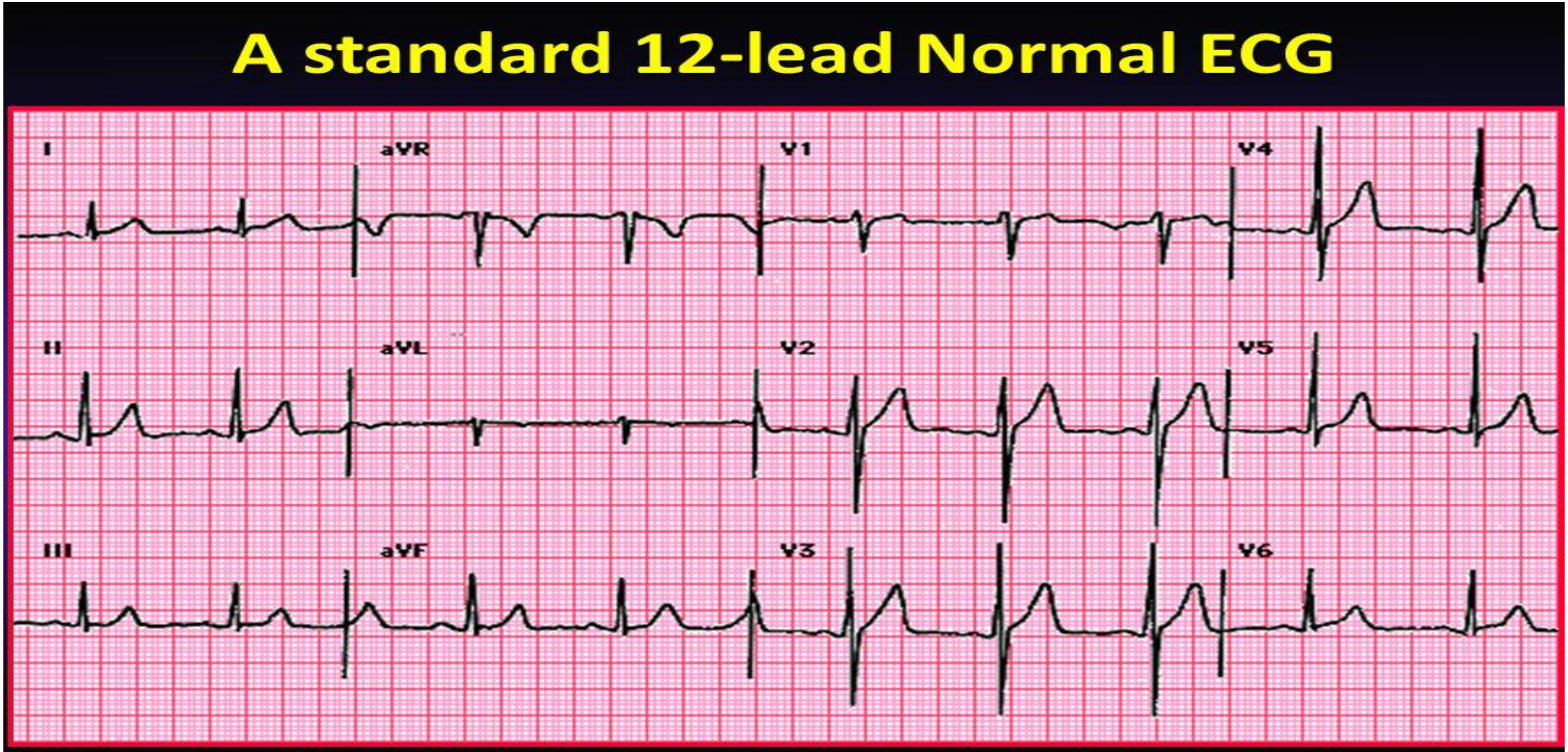
N
F


Angle of
Louis
V1
V2
V3
V4
V5
V6

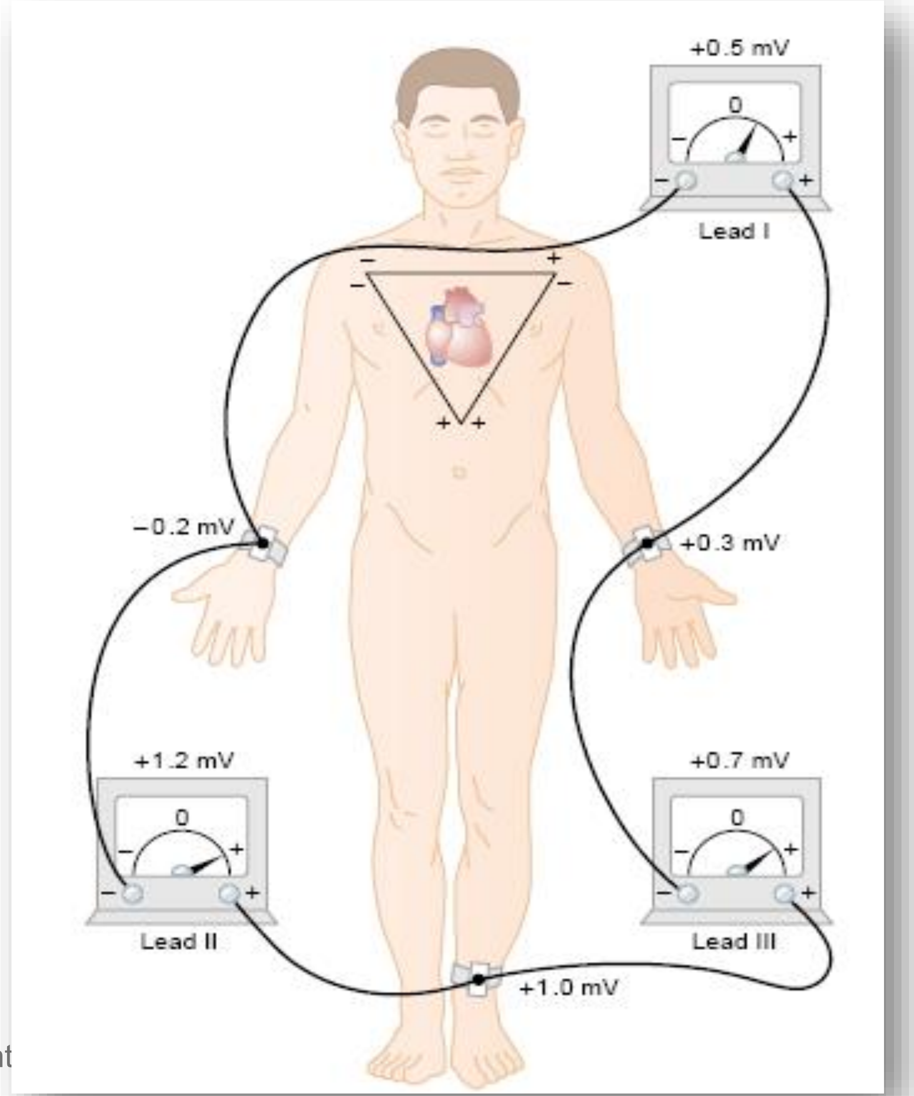
ECG paper


A standard 12-lead Normal ECG
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

Leads

Definition

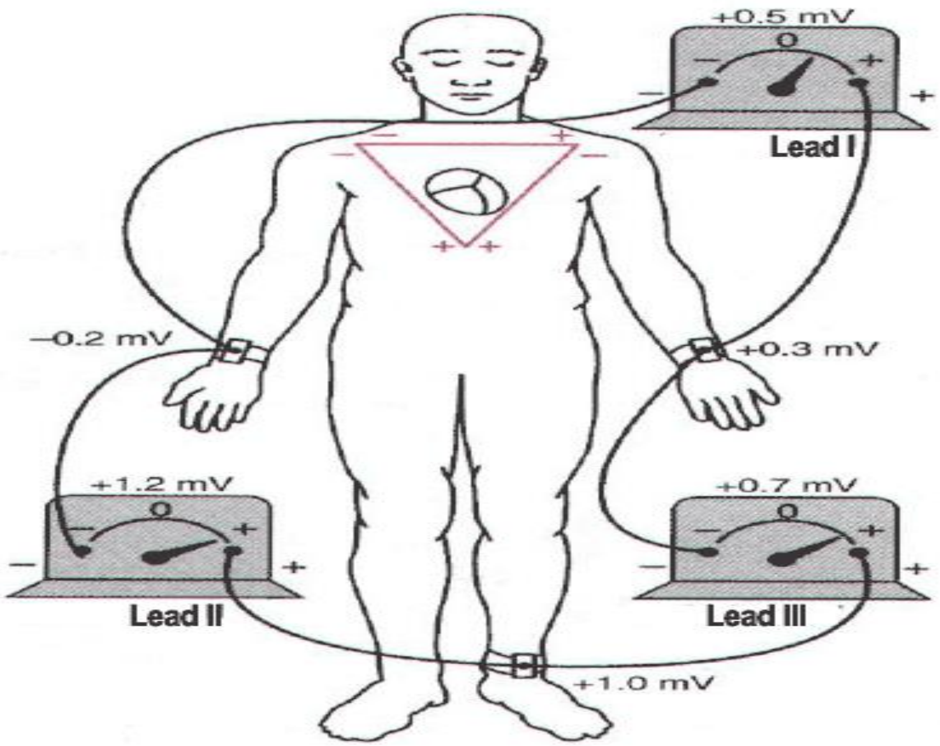
ECG lead is the particular arrangement of 2 electrodes of the ECG galvanometer for recording the cardiac potential.



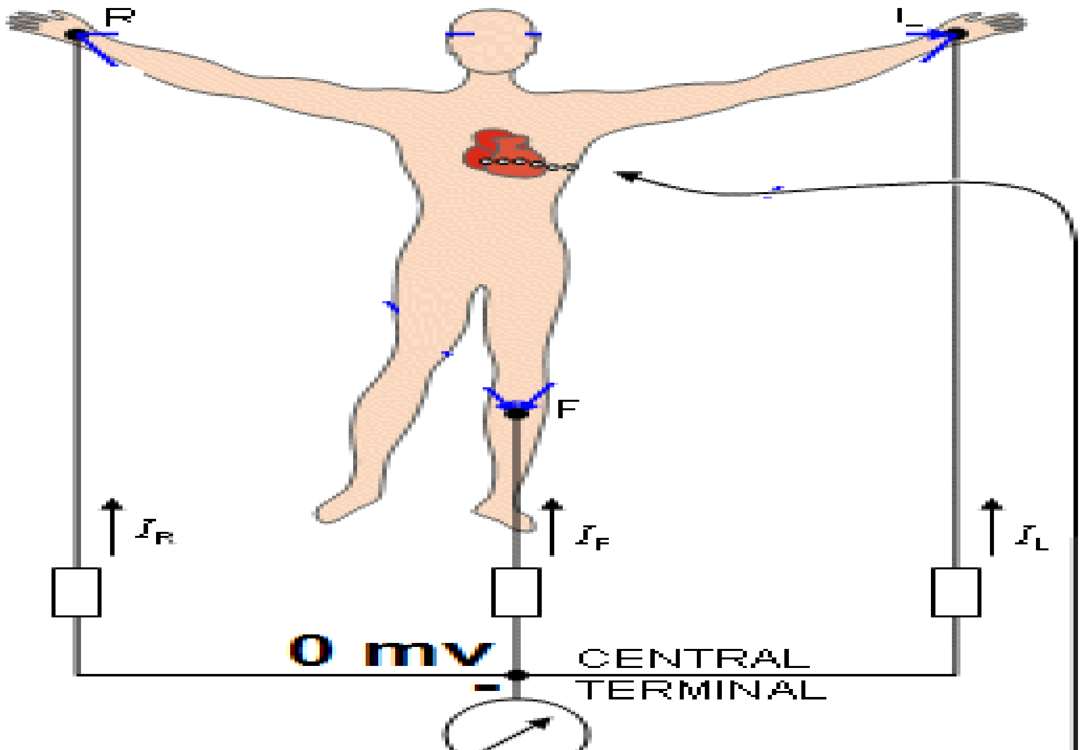
Leads (12)

- Types :

Bipolar Limb leads (3)



Unipolar leads (9)

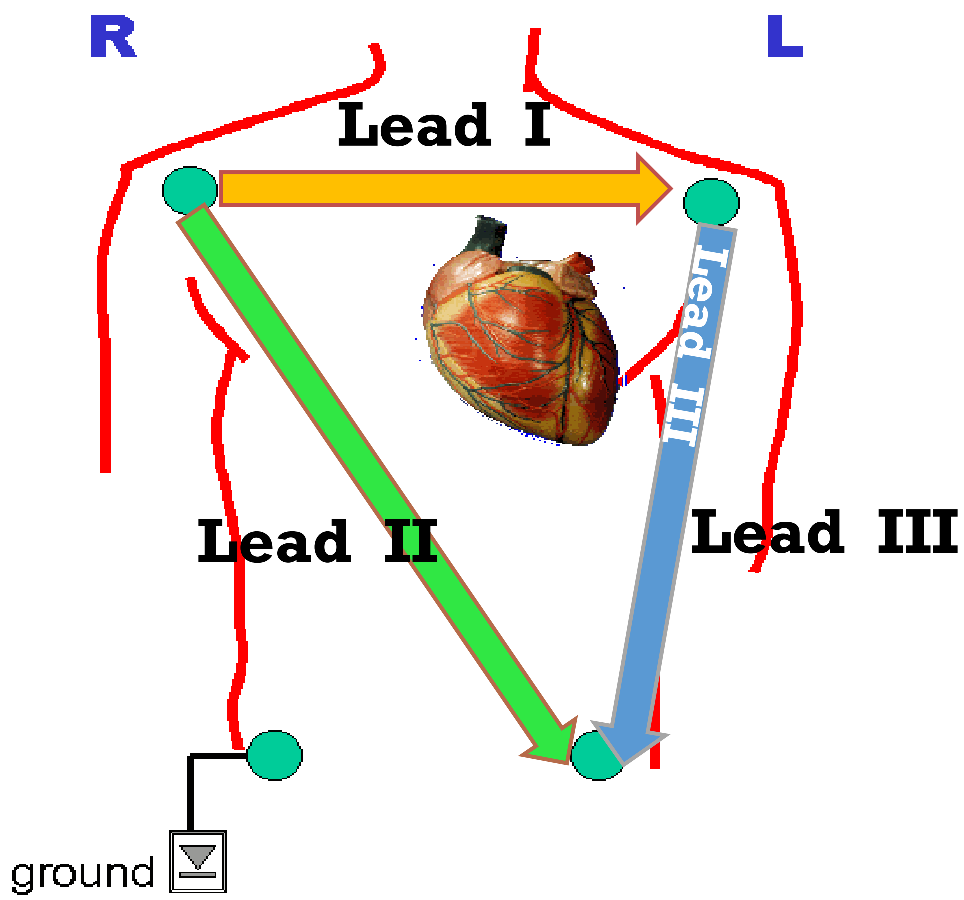


Bipolar Limb Leads

Lead I (RA (-) and LA (+))

Lead II (RA (-) and LF (+))

Lead III (LA (-) and LF (+))



Unipolar Limb Leads

- They measure the potential at limbs (RA, LA and LF)

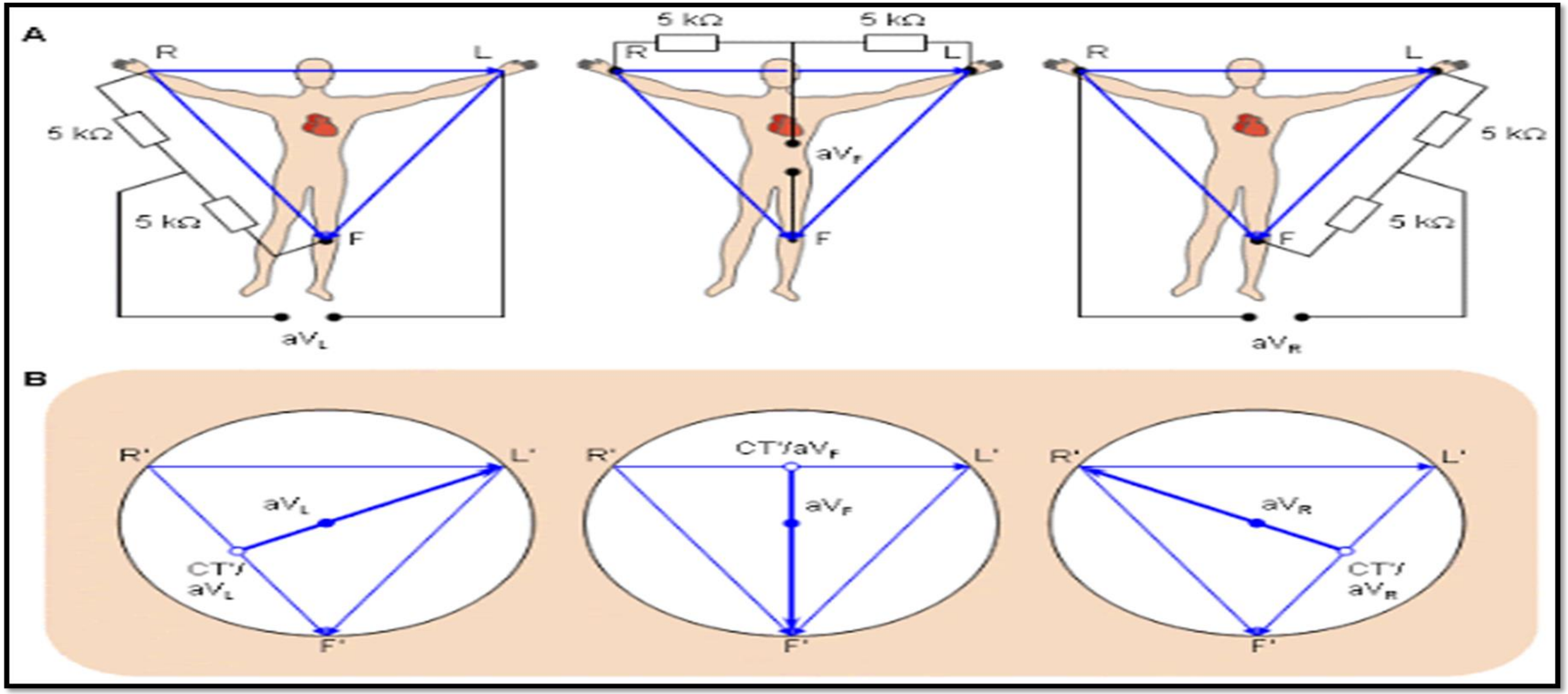
- The voltage of potentials recorded by these leads is weak, so it must be augmented to form **aVR, aVL, and aVL**

- This done by disconnection of electrode connected to central terminal to limb to be augmented

- So augmented limb leads record potential difference between one limb (+ve electrode) & other 2 limbs (-ve electrode).

- Augmentation increases the voltage of ECG by 50%.

Augmented Unipolar Limb Leads



6 Unipolar chest Leads

V1 (Rt 4th intercostal space)

V2 (Lt 4th intercostal space)

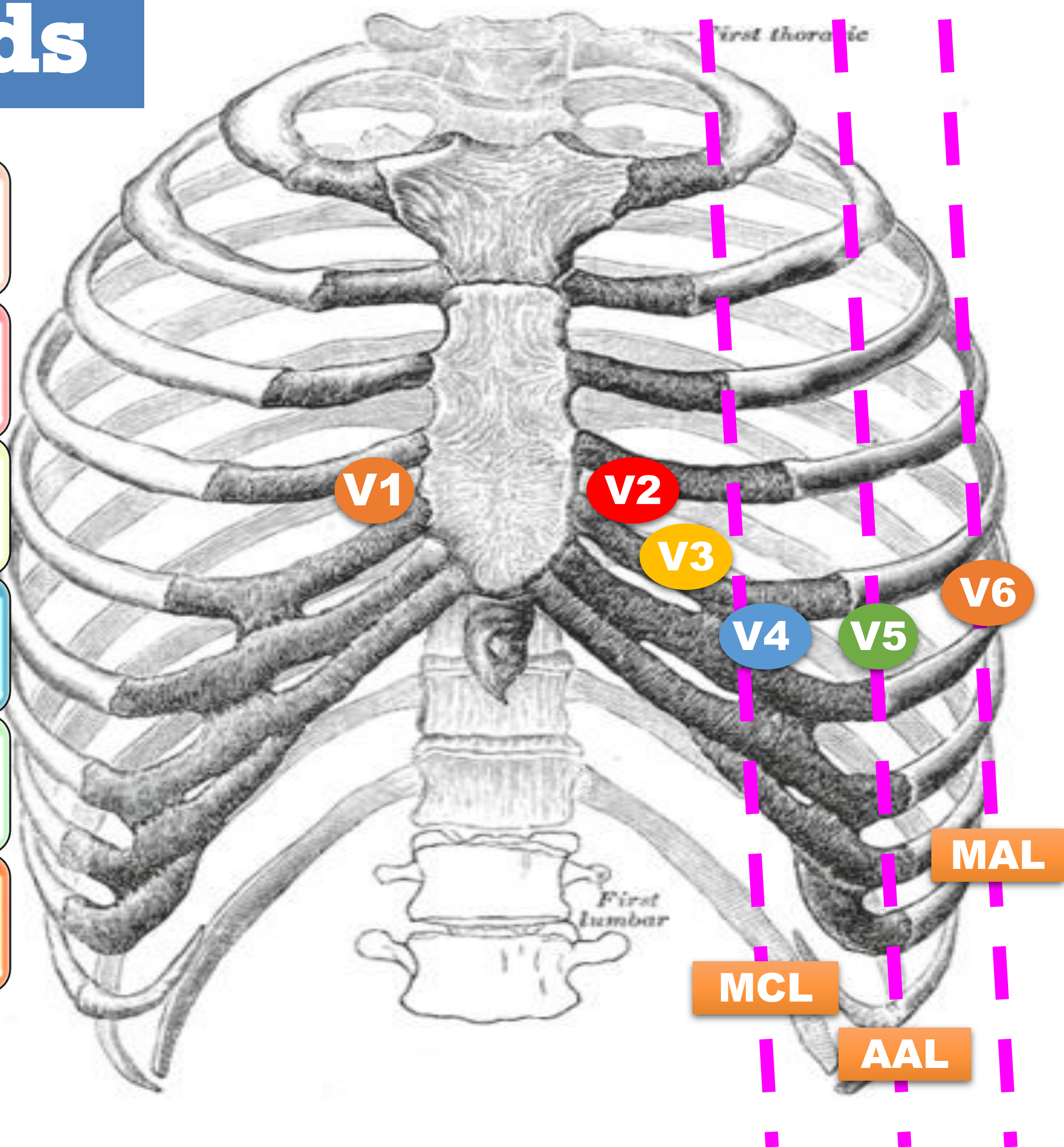
V3 (midway between V2 and V4)

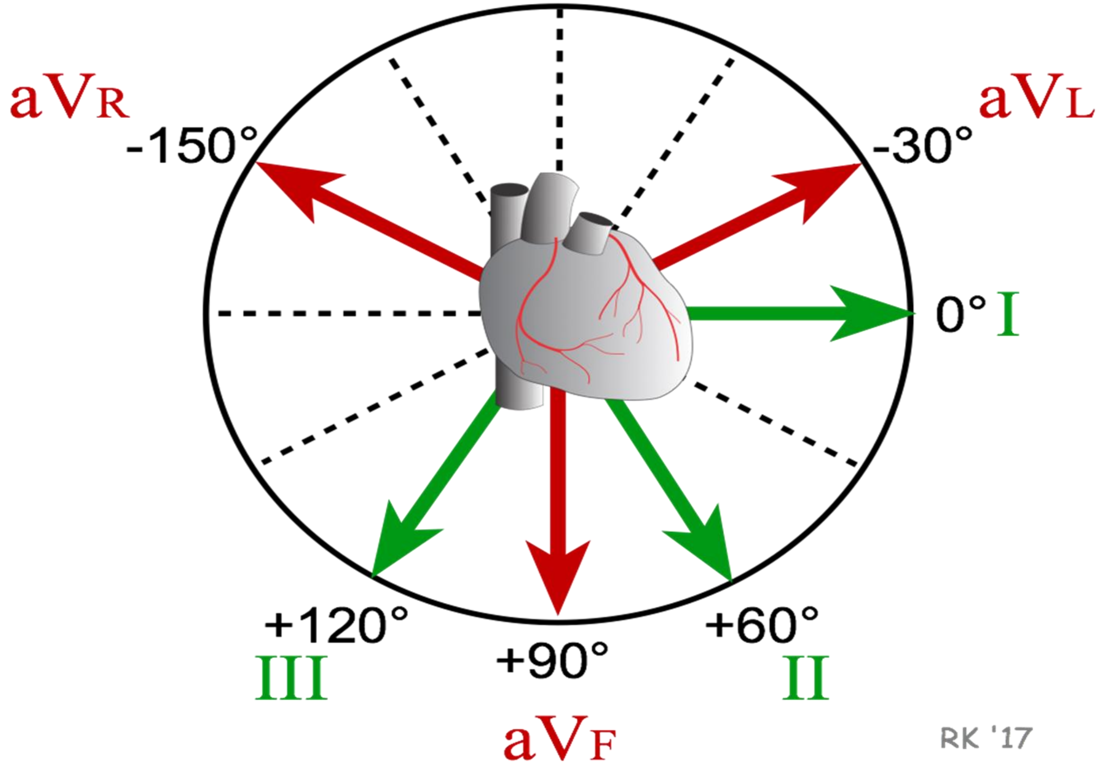
V4 (Lt 5th intercostal space midclavicular line

V5 (Lt 5th intercostal space anterior axillary line)

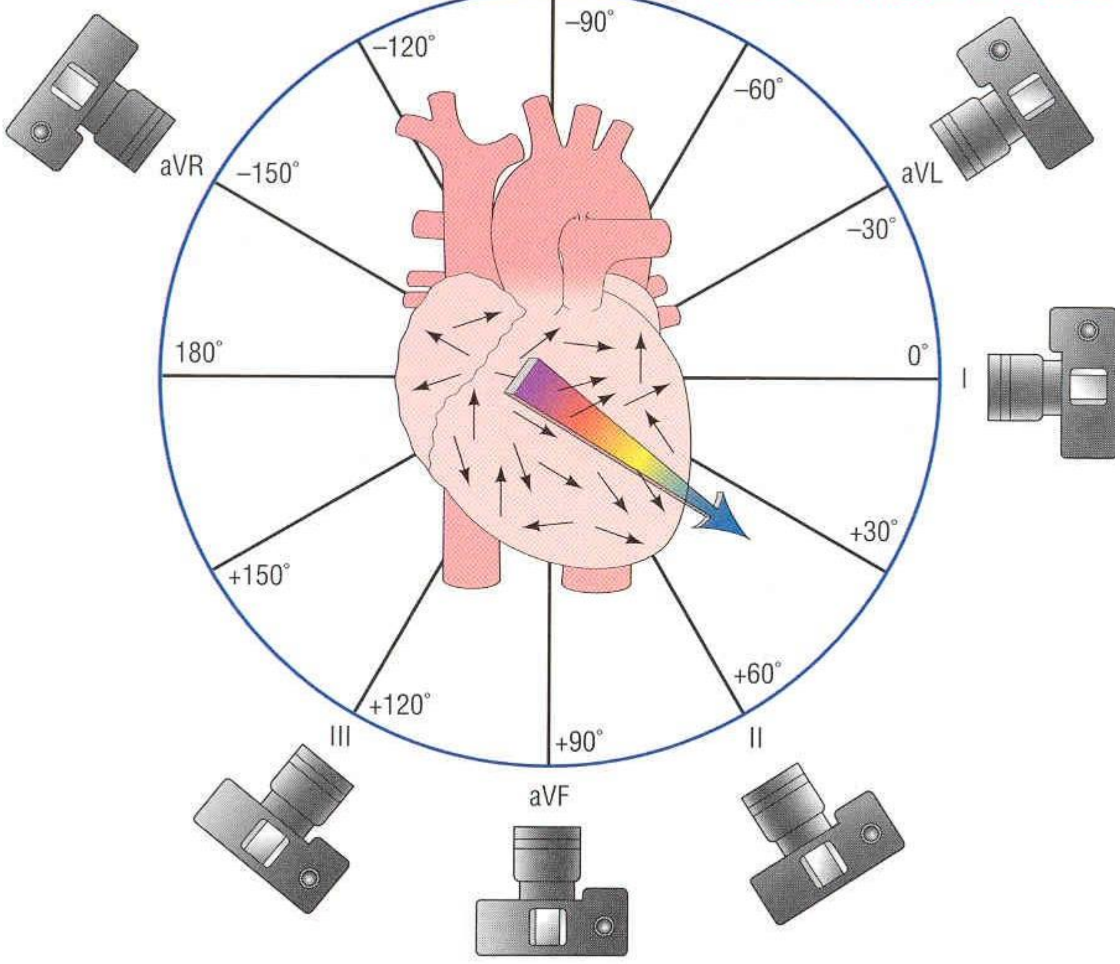
V6 (Lt 5th intercostal space midaxillary line)

N.B. there are 2 added chest leads; **V7**= 5th intercostal space at posterior axillary line and **V3R** on Rt side of chest comparable to V3

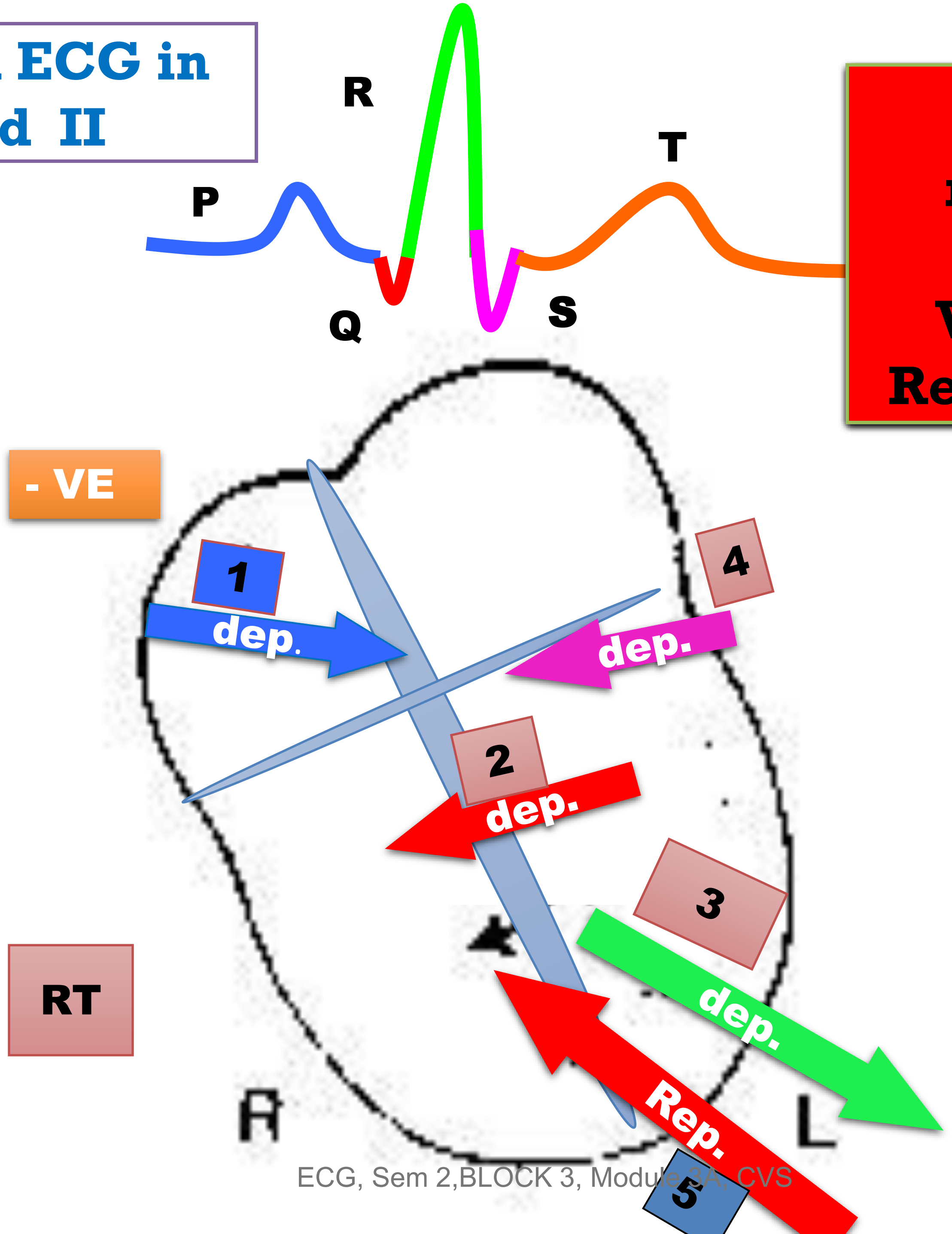




عمل جهاز رسم القلب تصوير كهرباء القلب من عدة زوايا



Normal ECG in Lead II



T wave represents

Ventricular Repolarization

Normal ECG

The ECG consists of;

A) waves:

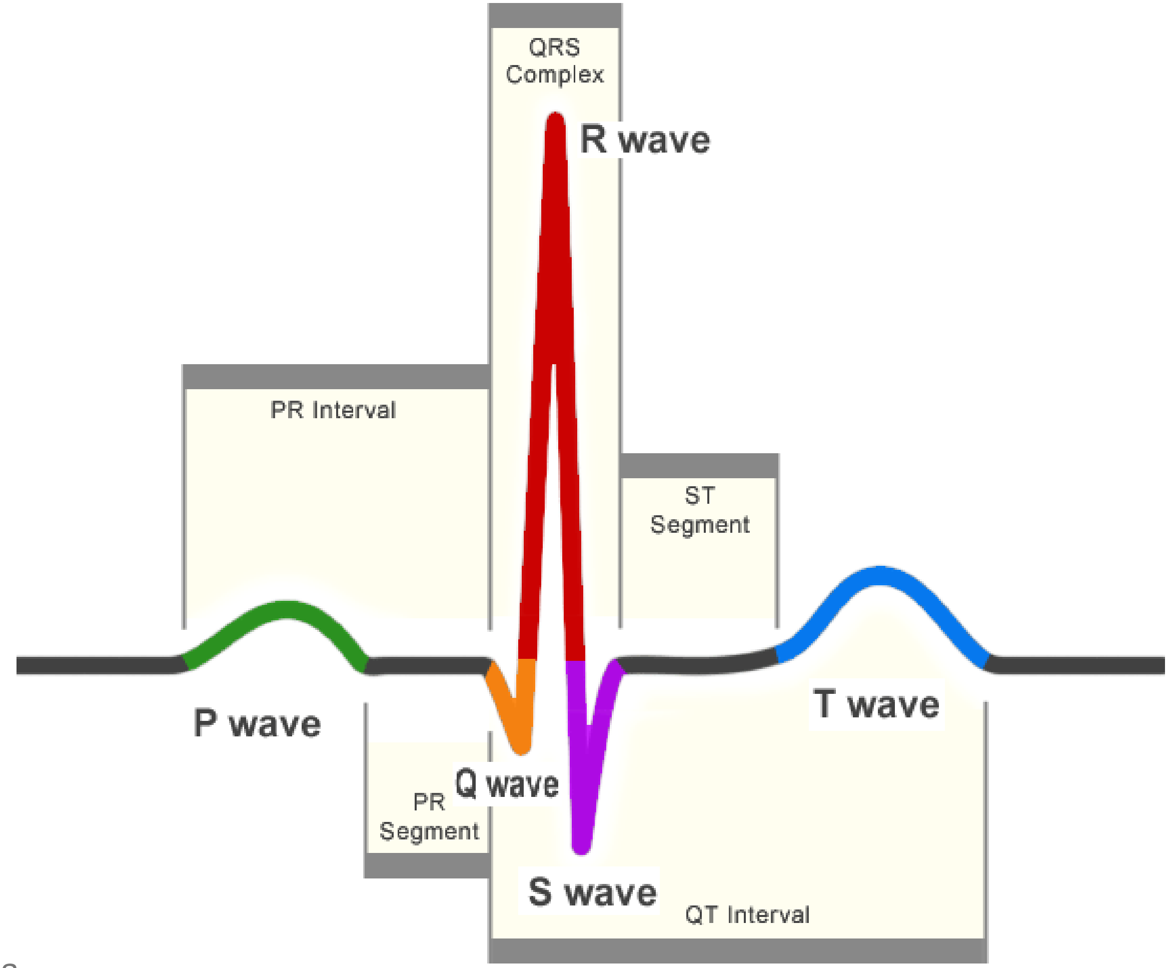
1- the P wave: represents atrial depolarization.

2- the QRS complex: represents ventricular depolarization.

3- the T wave: represents ventricular repolarization

B) S-T segment: isoelectric

C) P-R and Q-T intervals:



How to comment on ECG ??

1- Calibration or standardization of ECG

2- Calculation of HR

3- Comment on Rhythm

4- Comment on Waves of ECG

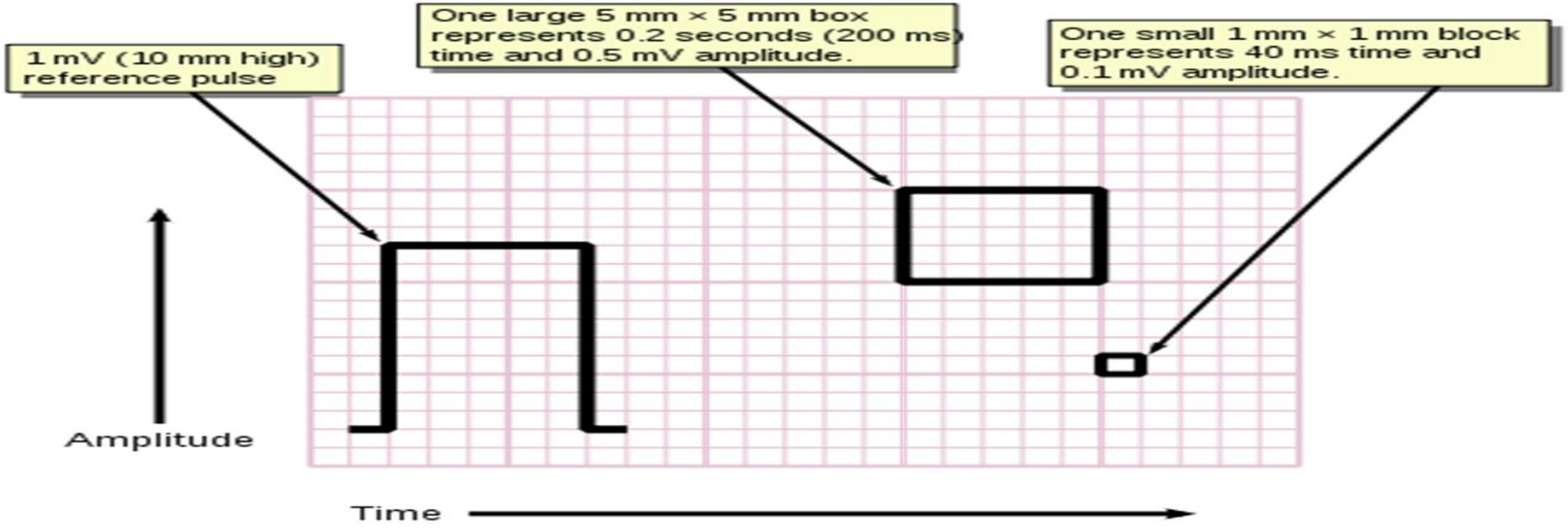
5- Comment on segments

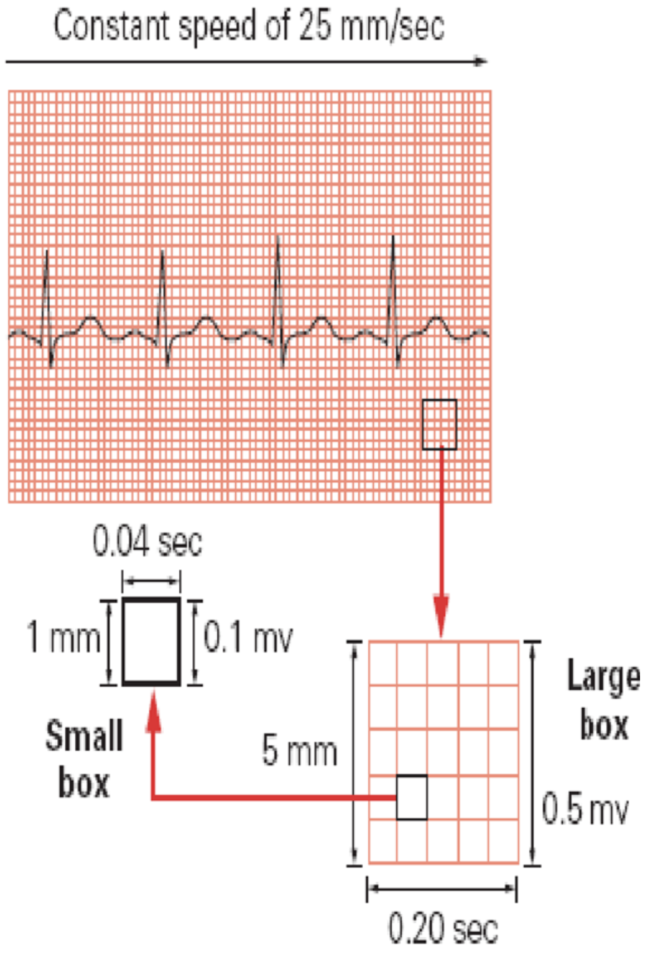
6- Comment on intervals

7- Comment on Axis

1- Calibration of ECG Paper

- ECG paper is composed of a number of 1 and 5 mm squares. It calibrated so that,
- Each small square (horizontal)= 0.04 sec.
- Each small square (vertical)= 0.1 mv.

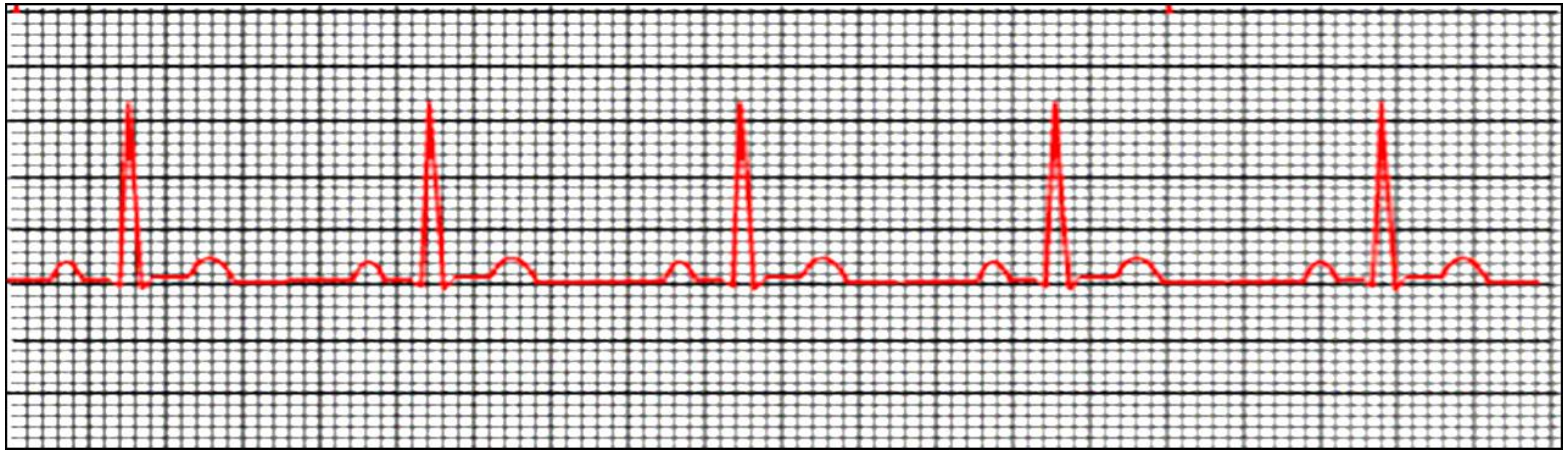




2- How to Calculate HR

- By counting the number of small squares between 2 successive R
- divide 1500/no of small squares.
- Or, divide 300/no. of big squares between 2R.

N.B: This method is not accurate in the presence of disturbance of cardiac rhythm (dysrhythmia).



No. of SS= 20 , so HR = 1500/20 = 75 beat / min

Calculate heart rate from the following ECG records:

HR = ??

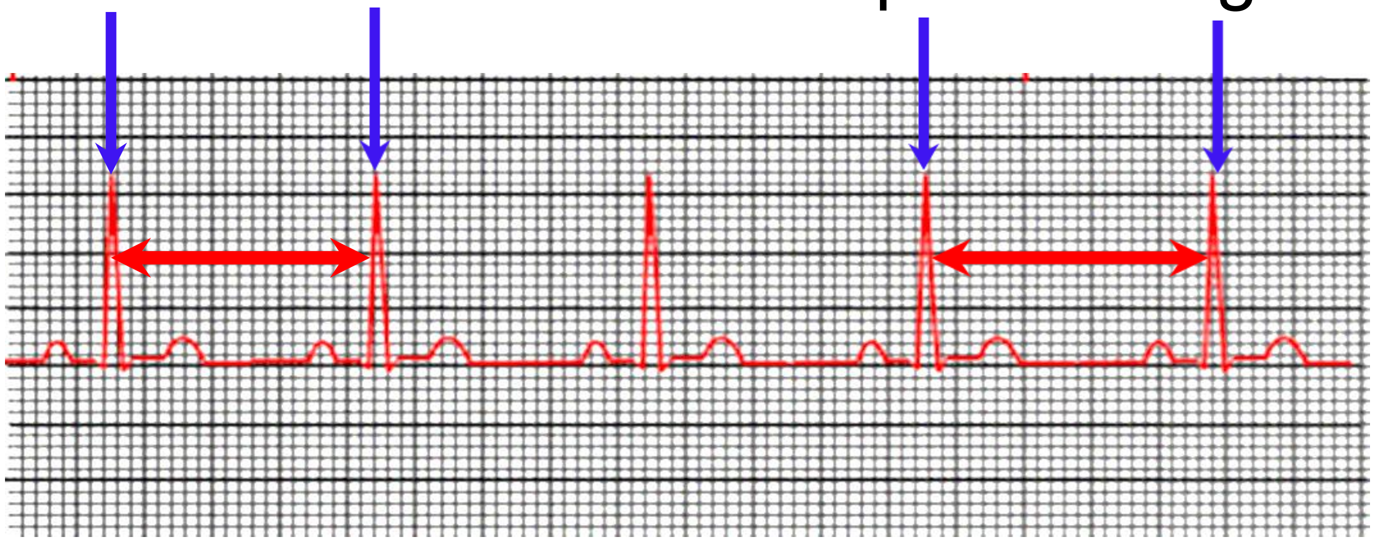
HR = ??

3- How to Comment on Rhythm

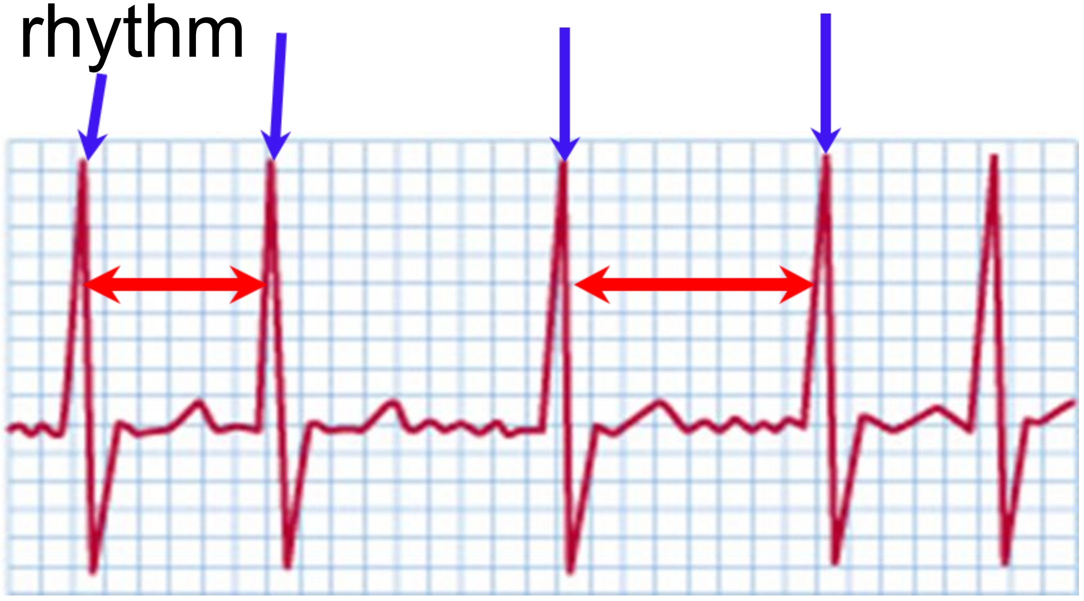
- Measure the distance ( ) 2 successive R waves and compare it with the distance ( ) another 2 successive R waves, if;

  Equal → regular rhythm

  Unequal → irregular rhythm

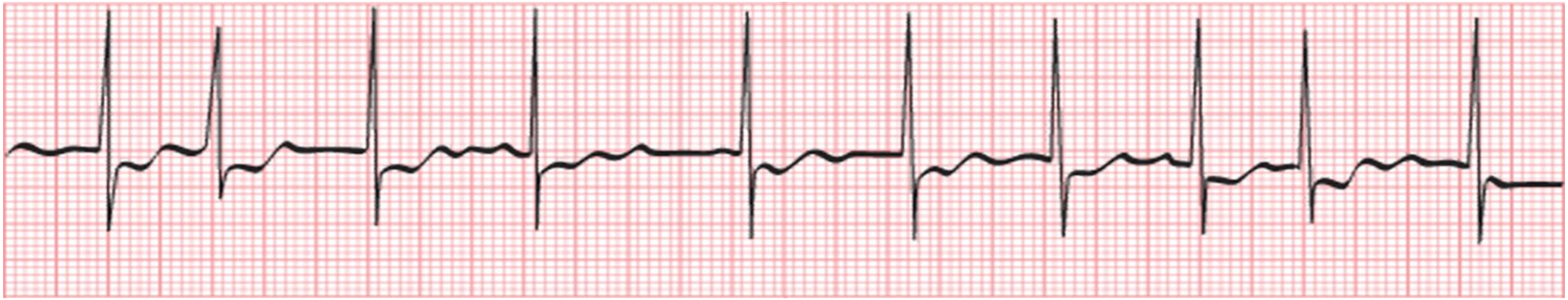


No. of SS= 20 No. of SS= 20



No. of SS= 27 No. of SS=38

Comment on the rhythm of the following ECGs:



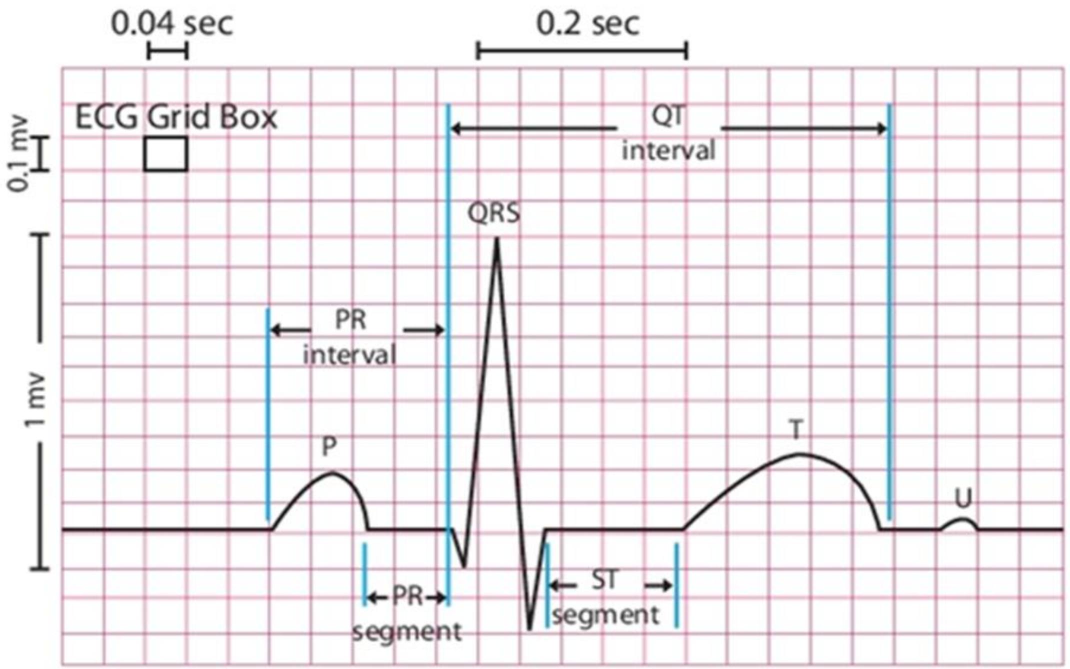
A.

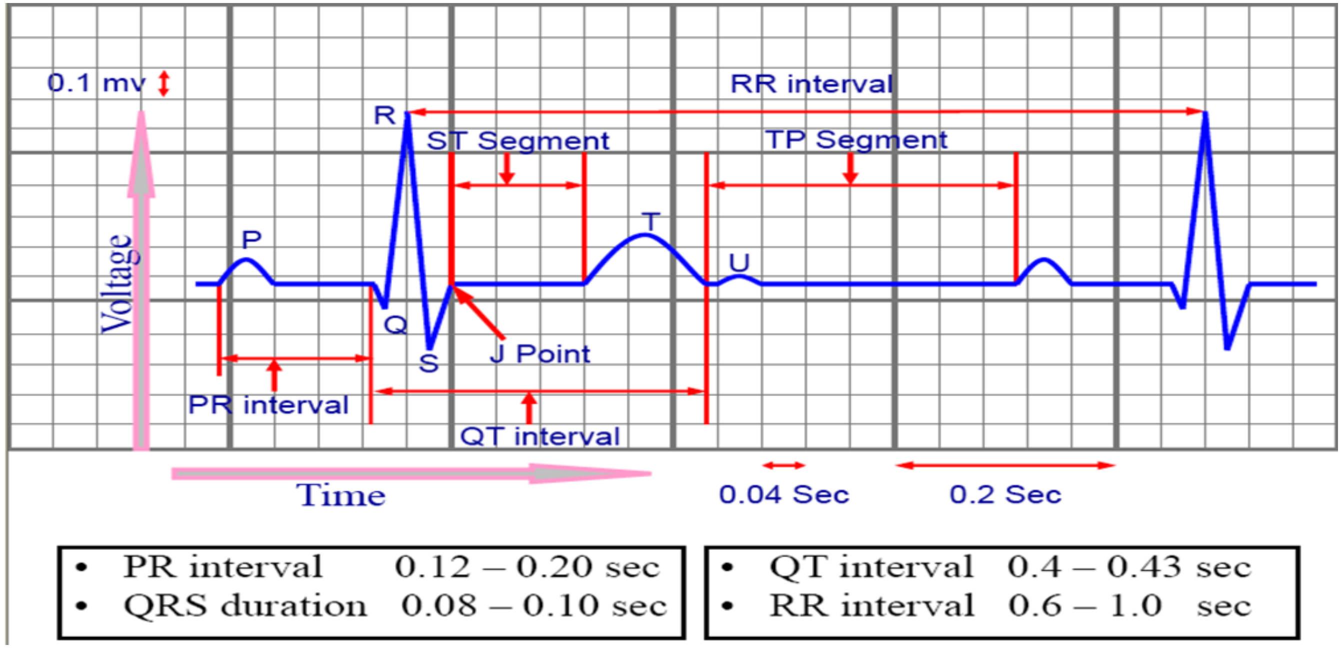
B.

5&6- How to comment on ECG segments and Intervals

S-T segment P-R interval Q-T interval

a) S-T segment: normally is isoelectric compared to TP segment.



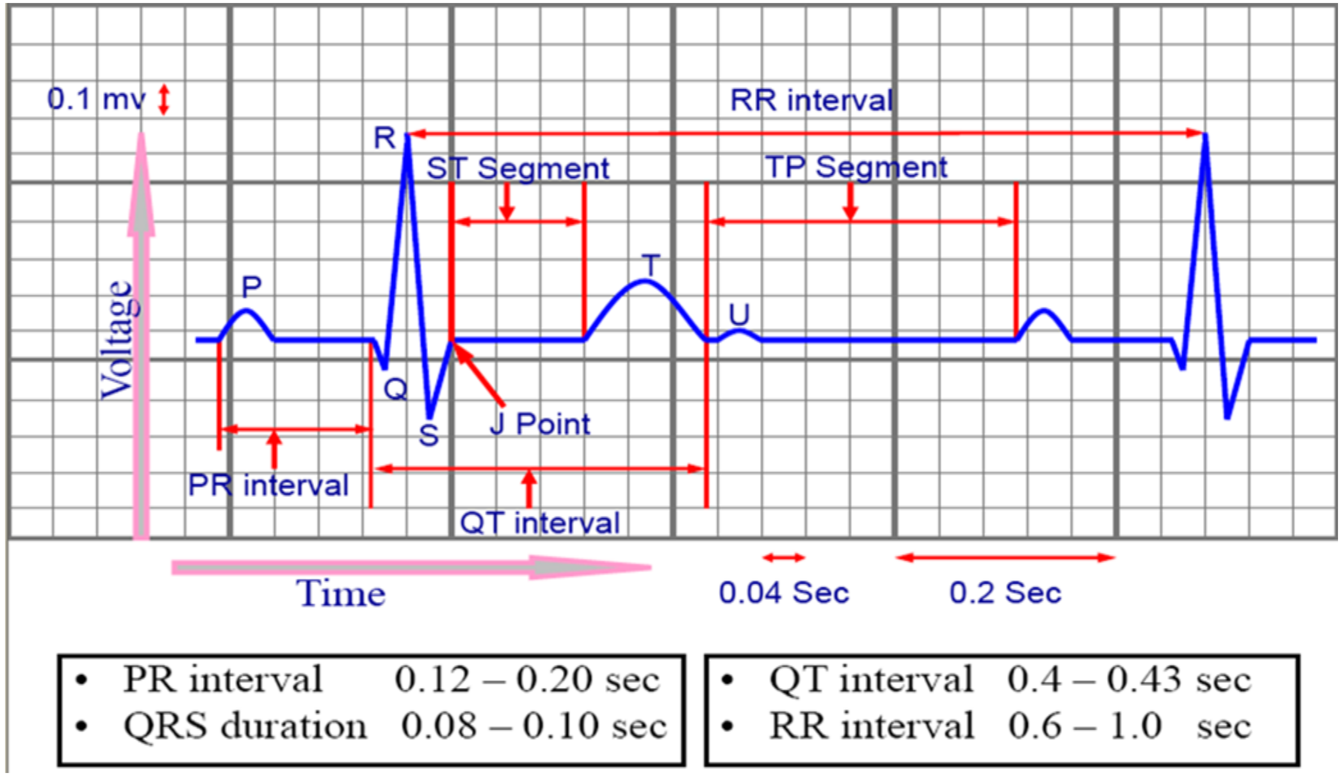


5&6- How to comment on ECG segments and Intervals

b) P-R interval:

It represents the time of conduction of impulse from SAN to ventricles

Normally 0.12 to 0.2 sec



c) Q-T interval:

is the interval from beginning of Q to the end of T.

normally = 0.4 sec.

- Significance: it represents the time needed for ventricular depolarization & repolarization of ventricular muscle.

Heart sounds

Methods of Detection of Heart Sounds

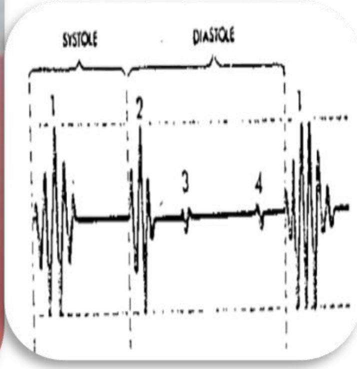
a)Stethoscope:

2 sounds are only audible by stethoscope

b) Phonocardiograph:

records for 4 sounds → phonocardiogram

(It consists of a specialized microphone that placed on the chest; the heart sounds can be amplified and recorded by a high speed recording apparatus. The recording is called a phonocardiogram, and the heart sounds appear as wave).



Stethoscope

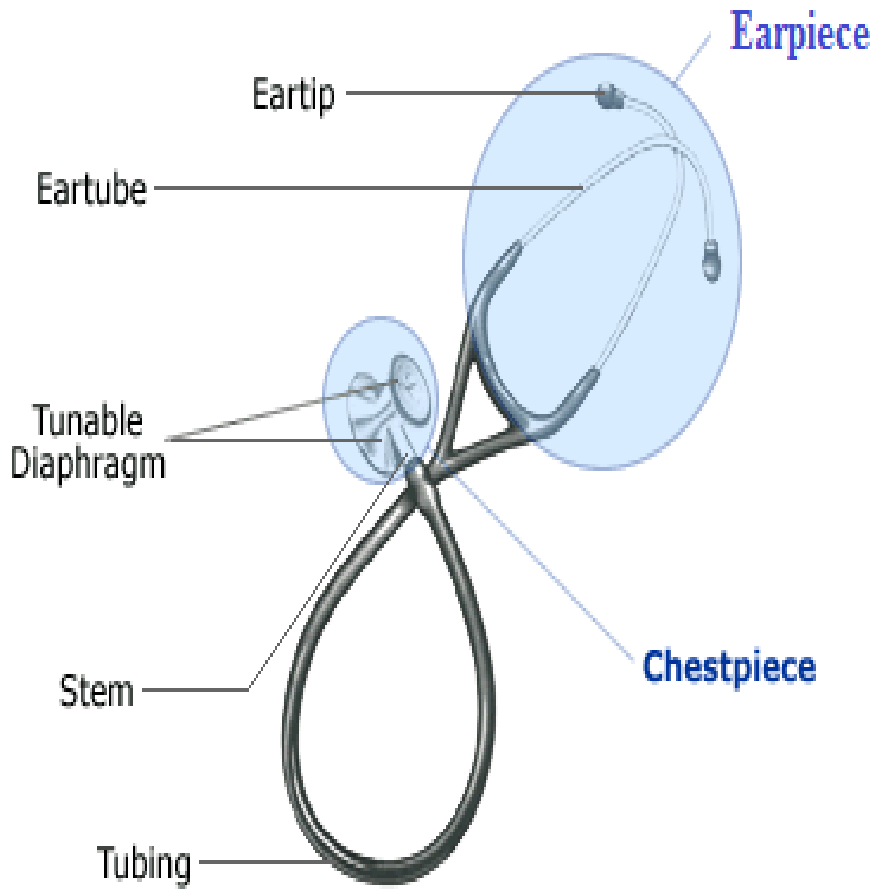
a. **Chest piece** → consists of 2 parts

Cone of bell → for low pitched sounds

Diaphragm →for high pitched sounds

b. **Ear pieces**.

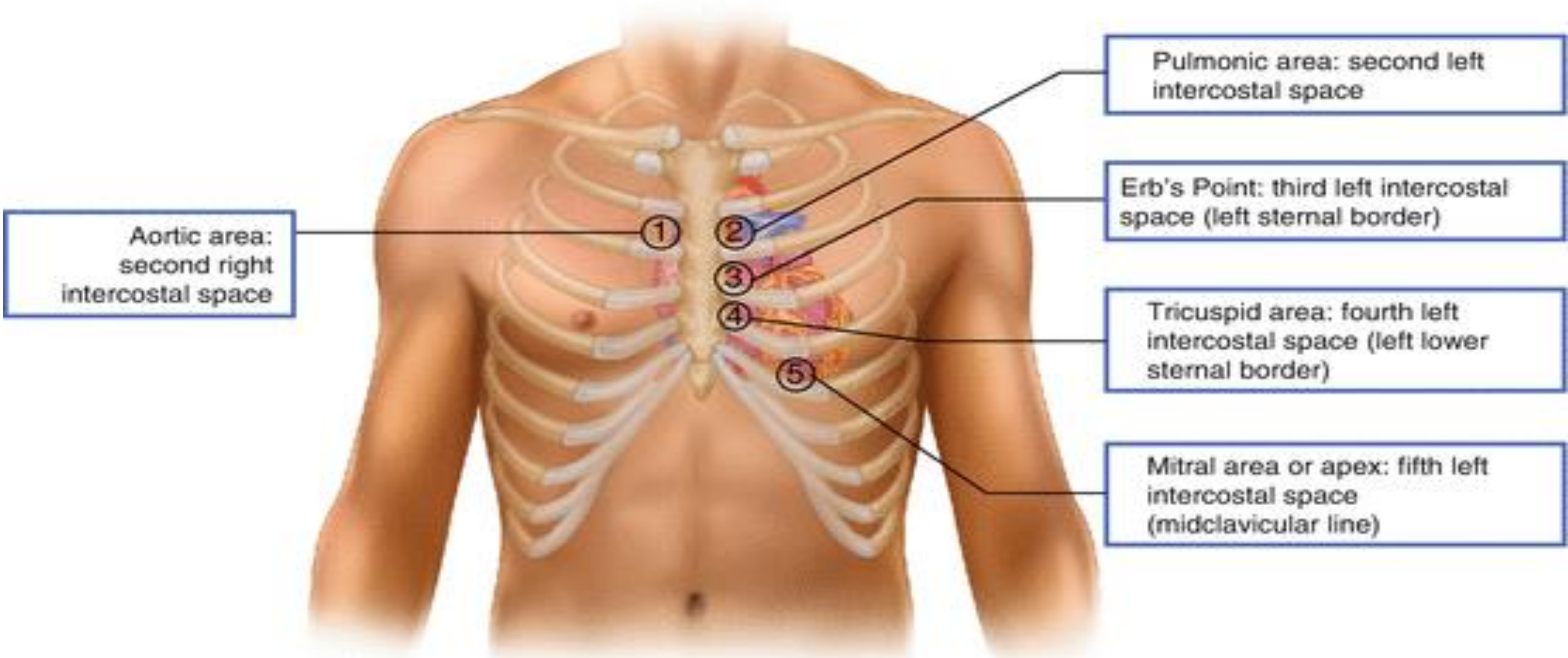
c. **Rubber tube** (50-75 cm).



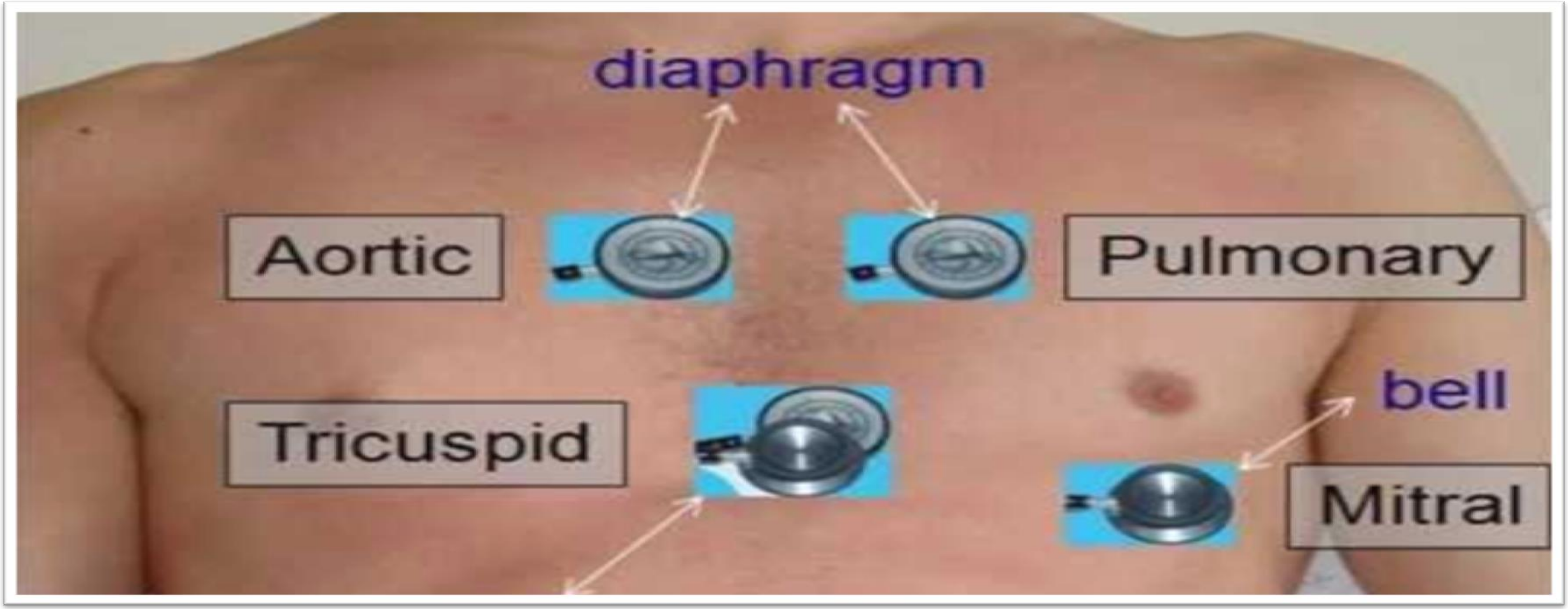
Uses of stethoscope:

1. Auscultation of heart sounds.
2. Auscultation of breath sounds
3. Auscultation of intestinal sounds
4. Measurement of ABP.

Auscultatory areas of the heart



Auscultatory areas of the heart



Normal Heart Sounds

	S_1
Duration	0.15 second
Relation to cardiac cycle	•Isometric contraction phase •Maximum ejection phase
Causes:	3 components: a-Valvular component (sudden closure of AV valves) b-Ventricular component c-Vascular component:
Characters	•Soft and low pitched (25-40 Hz) sound. •Heard as the word Lub by the stethoscope.
Auscultatory sites	a- Mitral area (M): left 5th intercostal space at MCL b-Tricuspid area (T): left 4th intercostal space near sternum

Normal Heart Sounds

	S_2
Duration	0.1 second.
Relation to cardiac cycle	•Isometric relaxation phase
Causes:	sudden closure of semilunar valves (aortic and pulmonary)
Characters	•Sharp and high pitched (50 Hz) •Heard as the word Dub by stethoscope.
Auscultatory sites	a- Aortic area (A): 2nd right intercostal space near sternum b- Pulmonary area (P): 2nd left intercostal space near sternum

Pulmonary Function Tests

Pulmonary Function Tests

- These tests are divided into 2 groups :

Static tests(volume based and slow)

Dynamic tests (time based ,flow dependent , forced and need exertion)

static Pulmonary Function Tests


Micro Medical

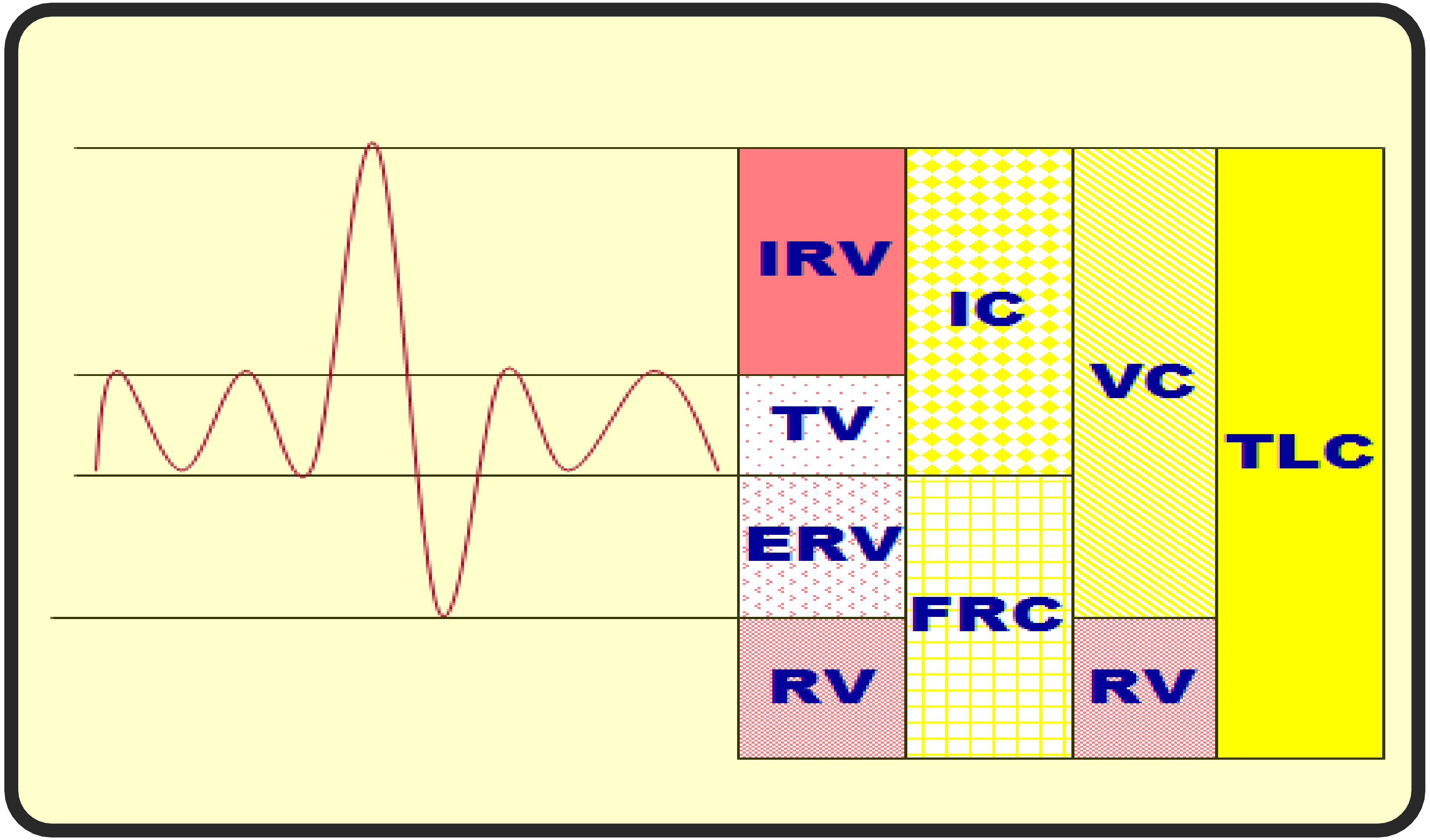
Spirogram

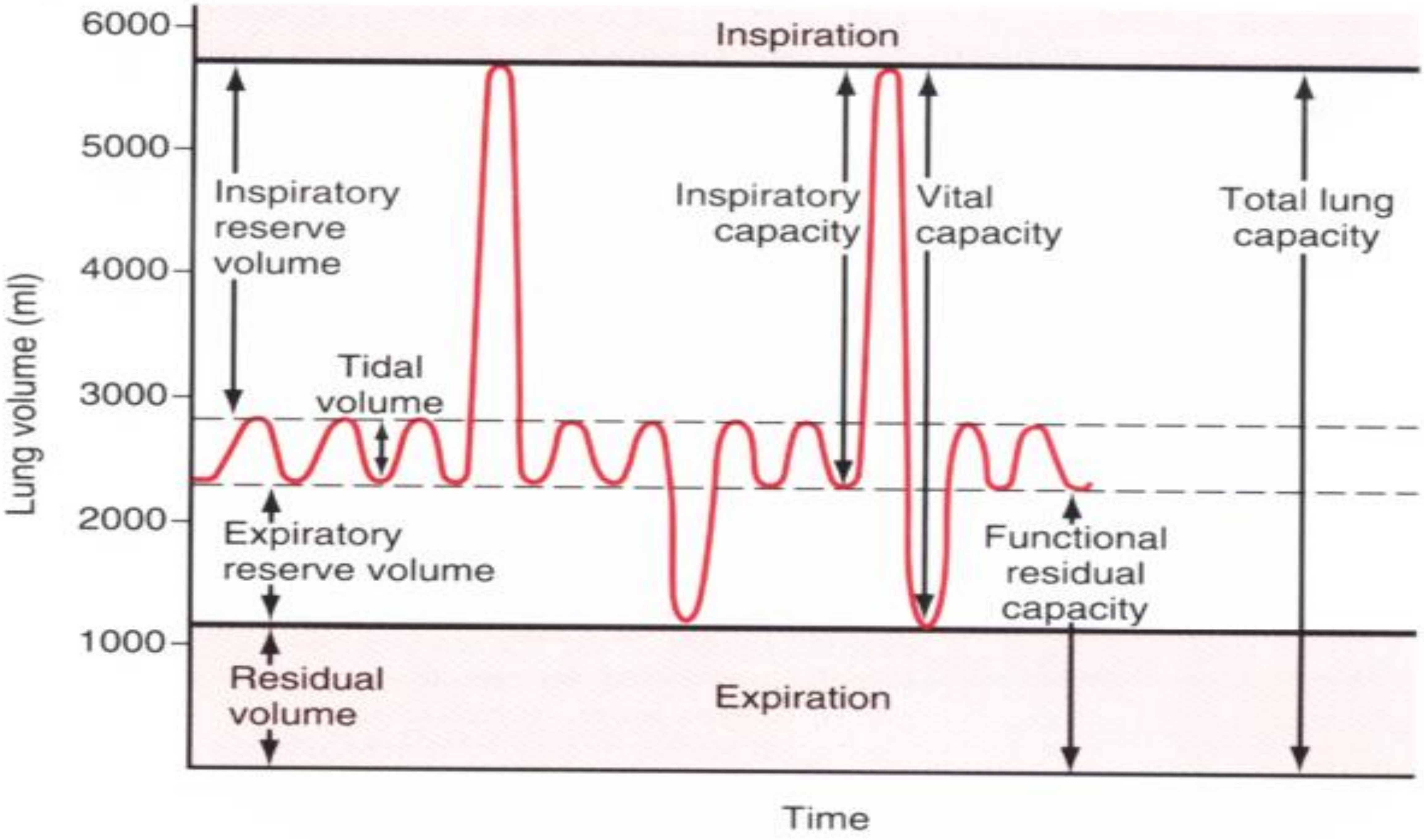
Spirogram

- It is the record of lung volumes and capacities

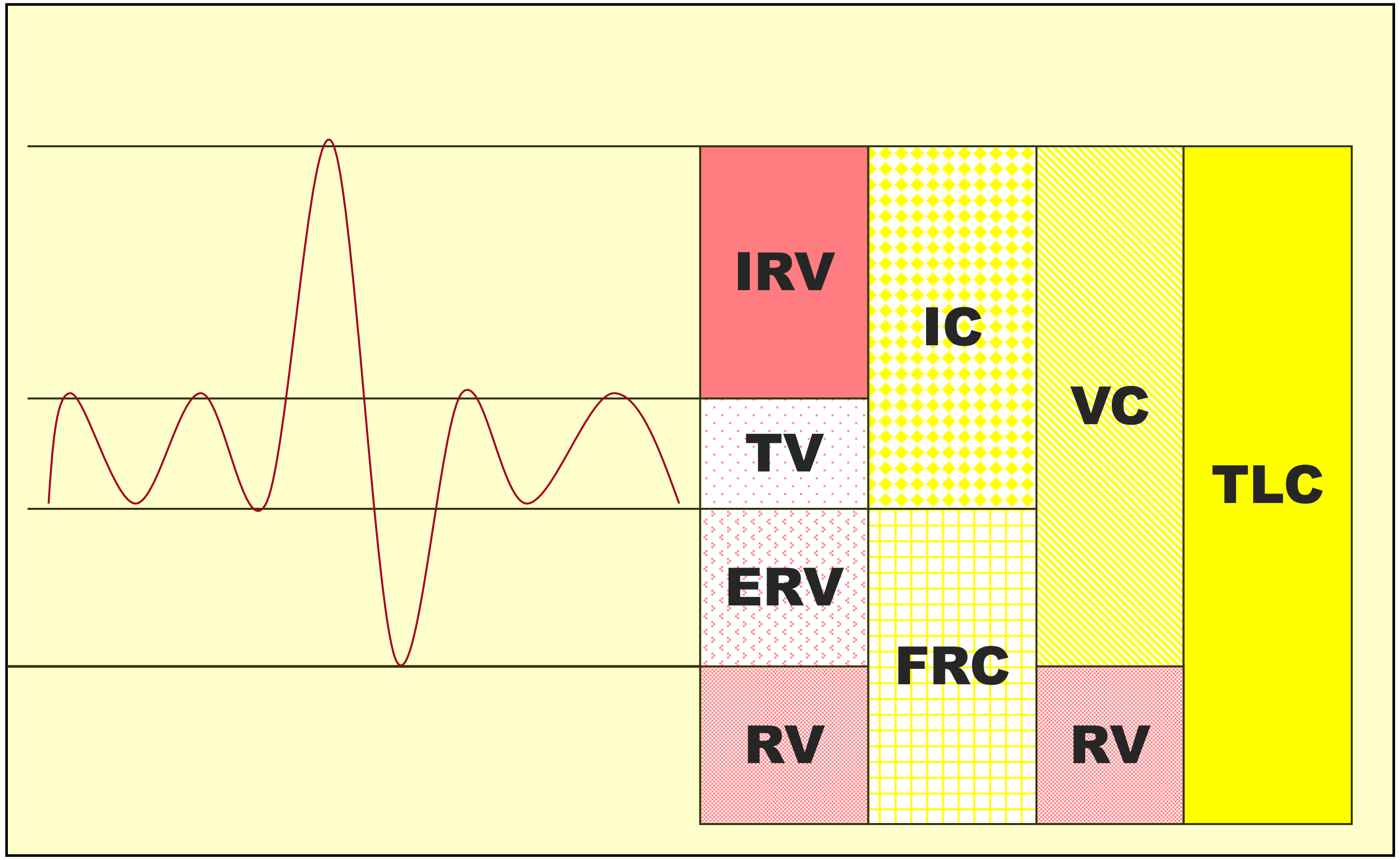
❑ **4 Volumes**

❑ **5 Capacities;** Sum of 2 or more lung volumes




6000
5000
4000
3000
2000
1000
Lung volume (ml)
Inspiration
Inspiratory
reserve
volume
Tidal
volume
Expiratory
reserve volume
Residual
volume
Inspiratory
capacity
Vital
capacity
Total lung
capacity
Functional
residual
capacity
Expiration
Time

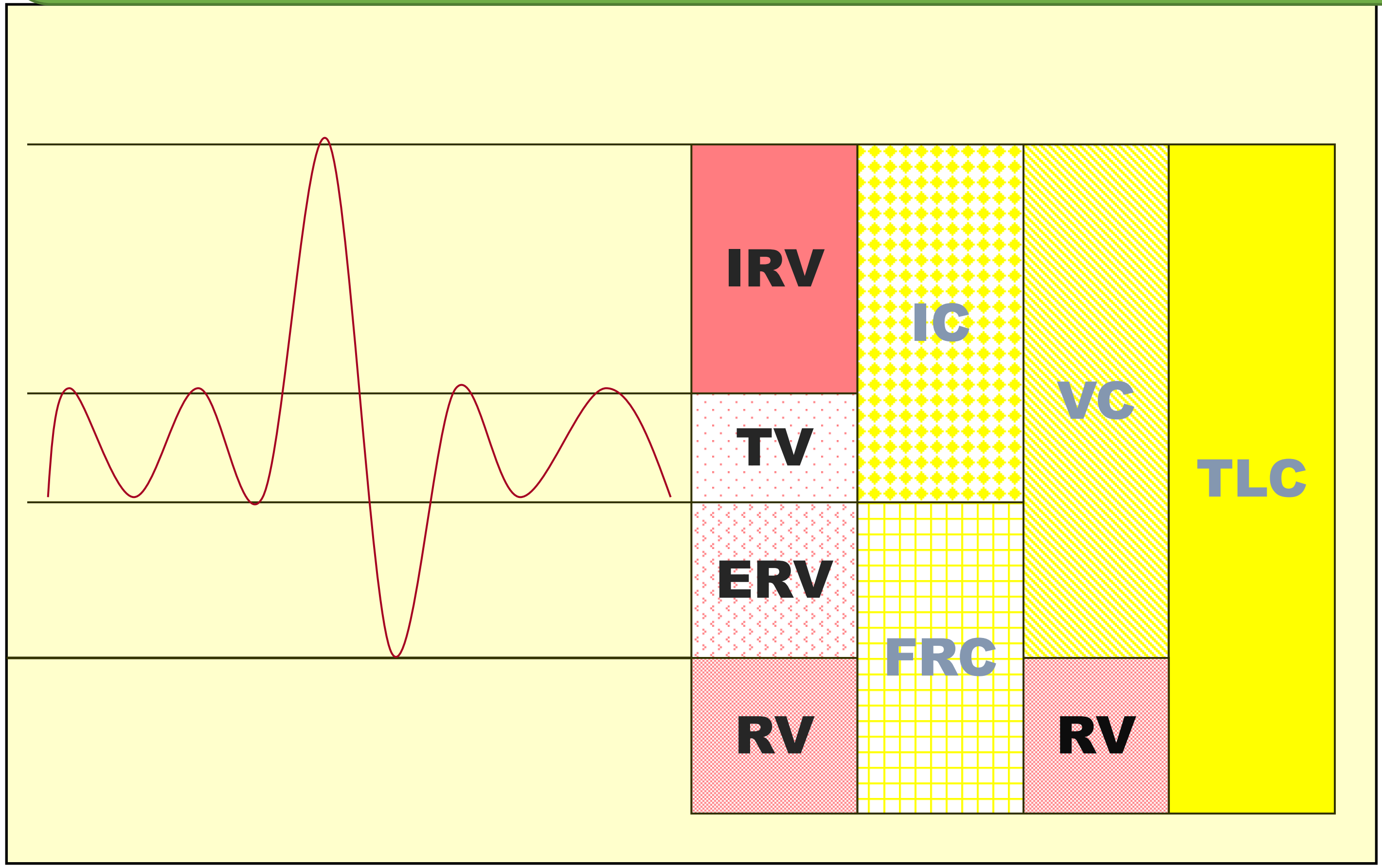
Tidal Volume (TV)



- Volume of air that can be inspired or expired during normal quiet breathing.

- **<u>Value</u>**: 500 ml

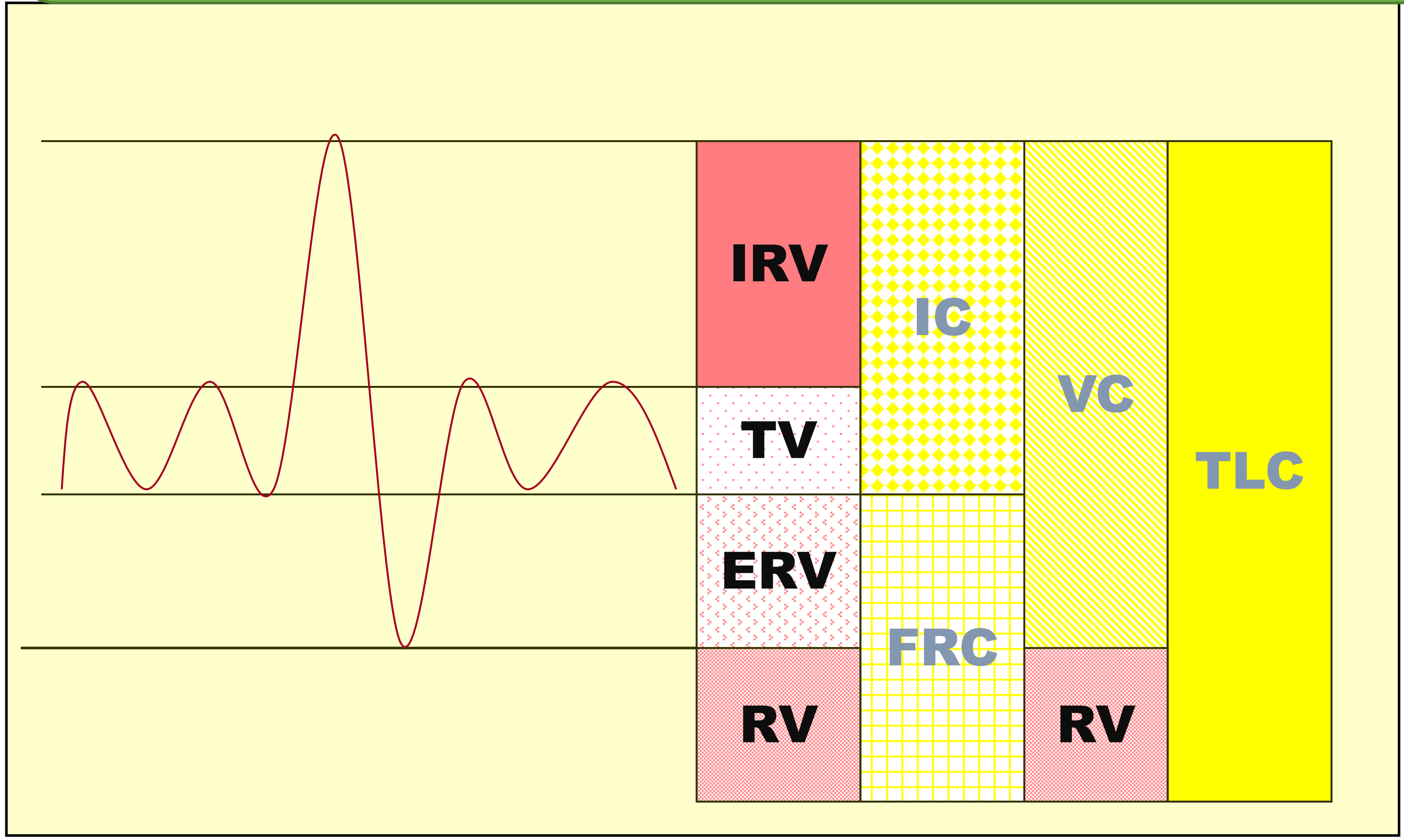
Inspiratory Reserve Volume (IRV)



- The maximum amount of air that can be inspired by forced inspiration after the end of normal inspiration

- **Value**: 3000 ml

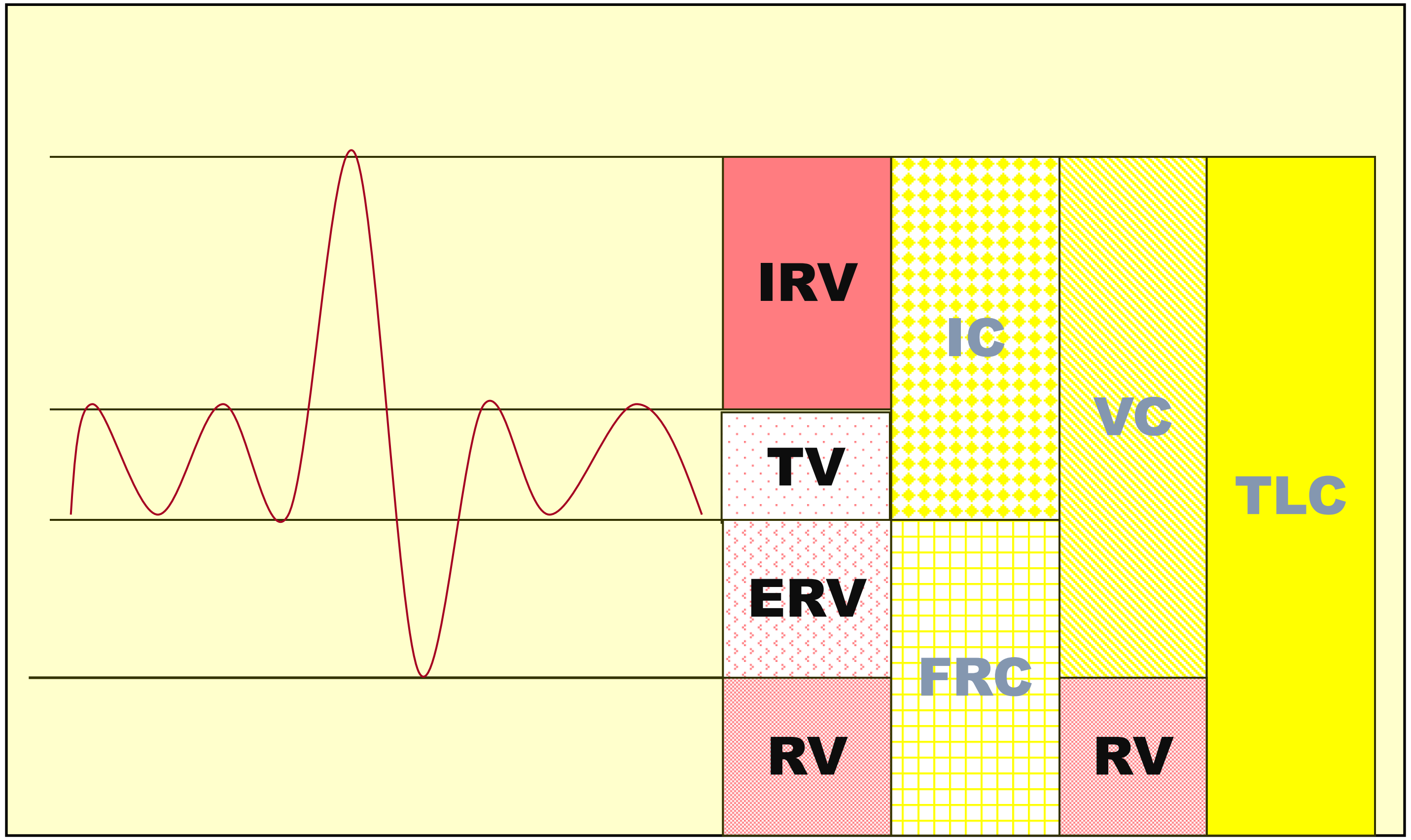
Expiratory Reserve Volume (ERV)



- Maximum amount of air that can be expired by forced expiration after the end of normal expiration.

- **Value**: 1000 ml

Residual Volume (RV)



- Volume of air remaining in the lungs after the end of forced expiration
- **<u>Value</u>**: 1200 ml

Residual volume

- **Definition:** It is the volume of air that remains in the lung after forced expiration. It is about 1200 ml.

- **This air leaves the lung only after opening the chest.**
- **Significance :**
  1. aerate blood between breathes →prevents marked changes in blood gases.
  2. The ratio of RV/TLC is important clinically =25-30%.

  - ↑in conditions with difficult expiration as in: **bronchial asthma and emphysema.**
- **Measurement:** Helium dilution method.

Minimal air

* *It is the volume of air remaining in the lungs after opening the chest and expelling the residual volume.

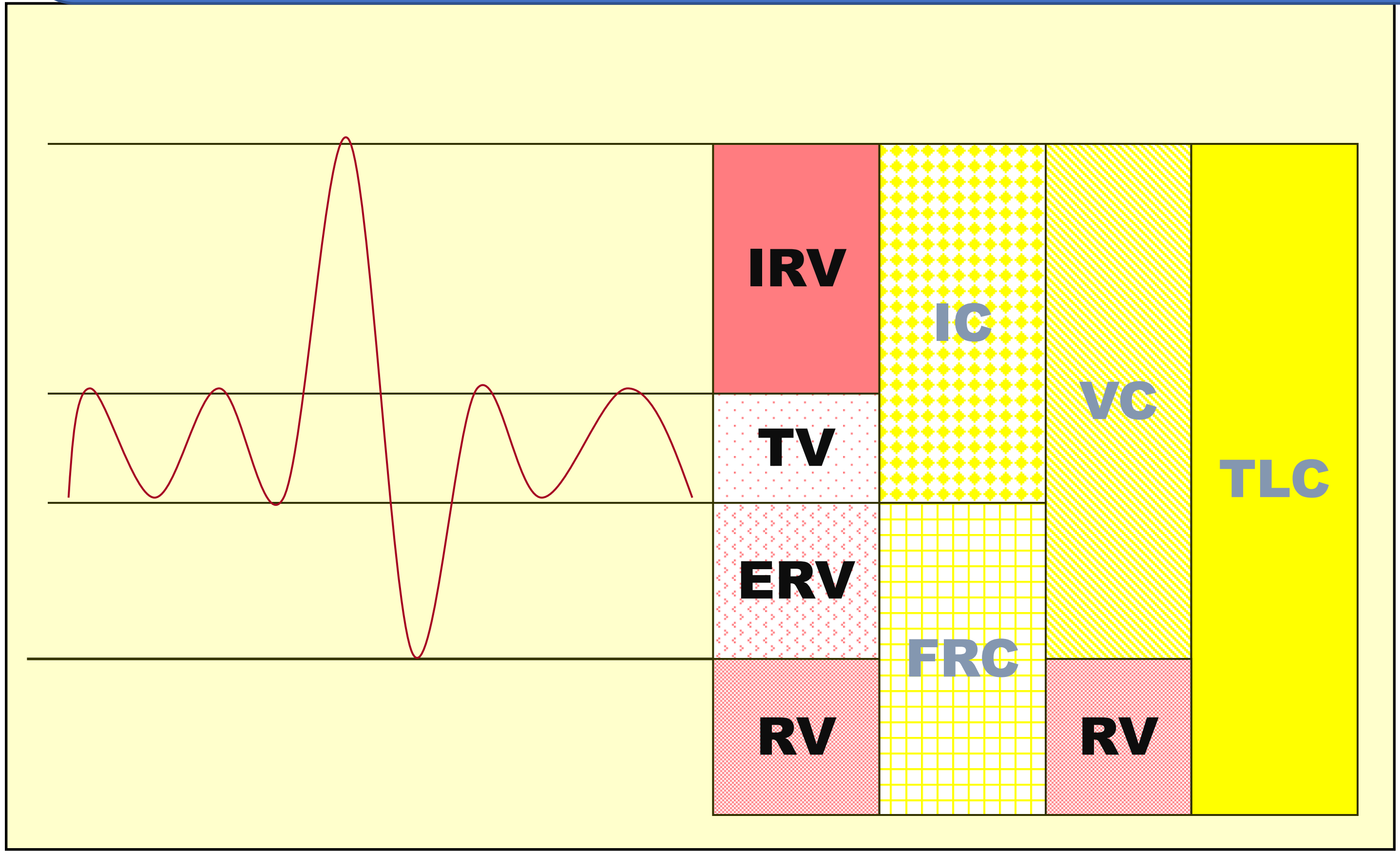
*It is the air that enters the lung with **the first breath**
it has a **Medicolegal Importance to**
determine whether the newborn was born live or dead.

*If a piece of lung floats, minimal air is present →the infant respire then died.

*If it does not float→ infant born dead.

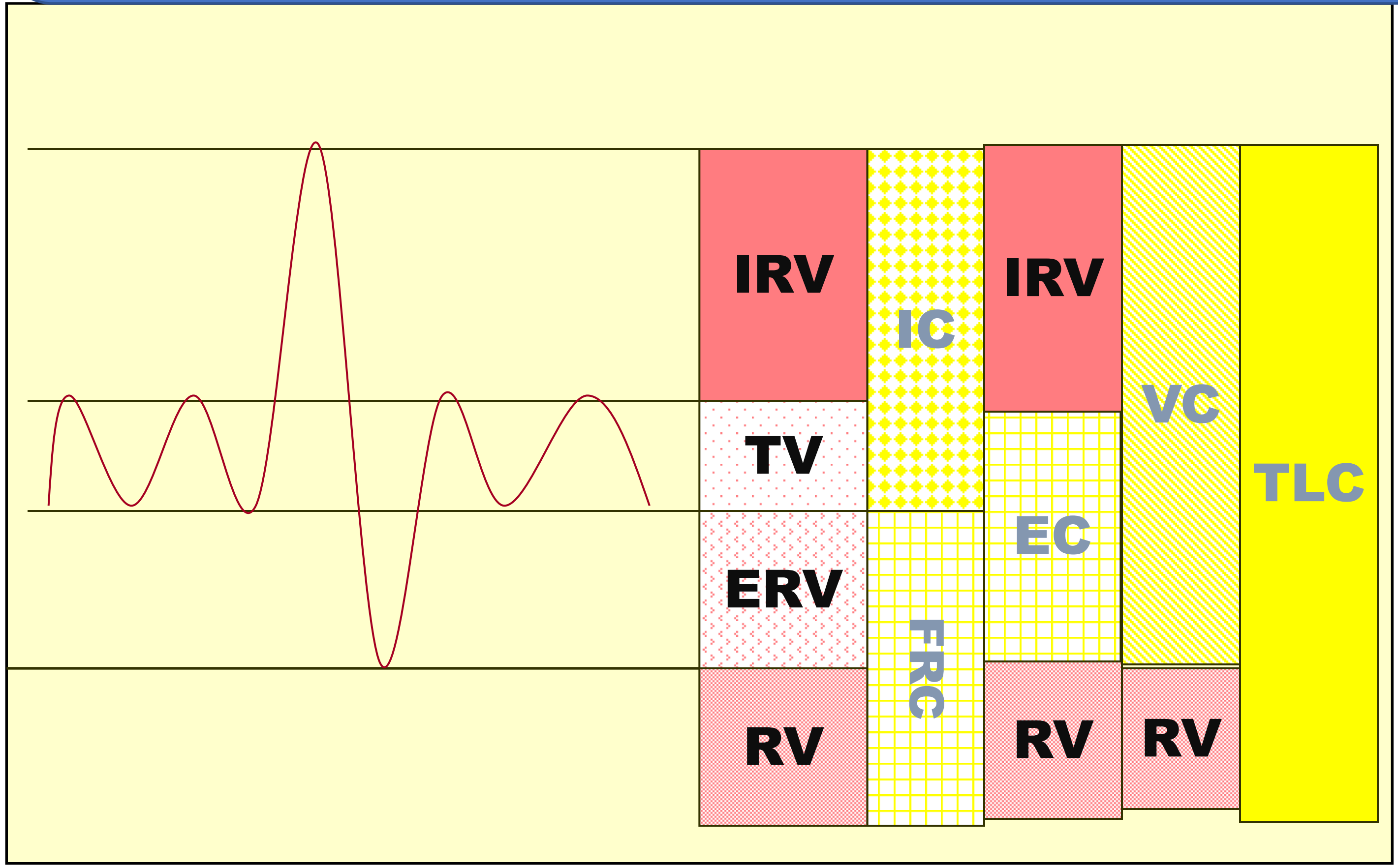
Lung Capacities (sum of 2 or more lung volumes)

Inspiratory Capacity (IC)



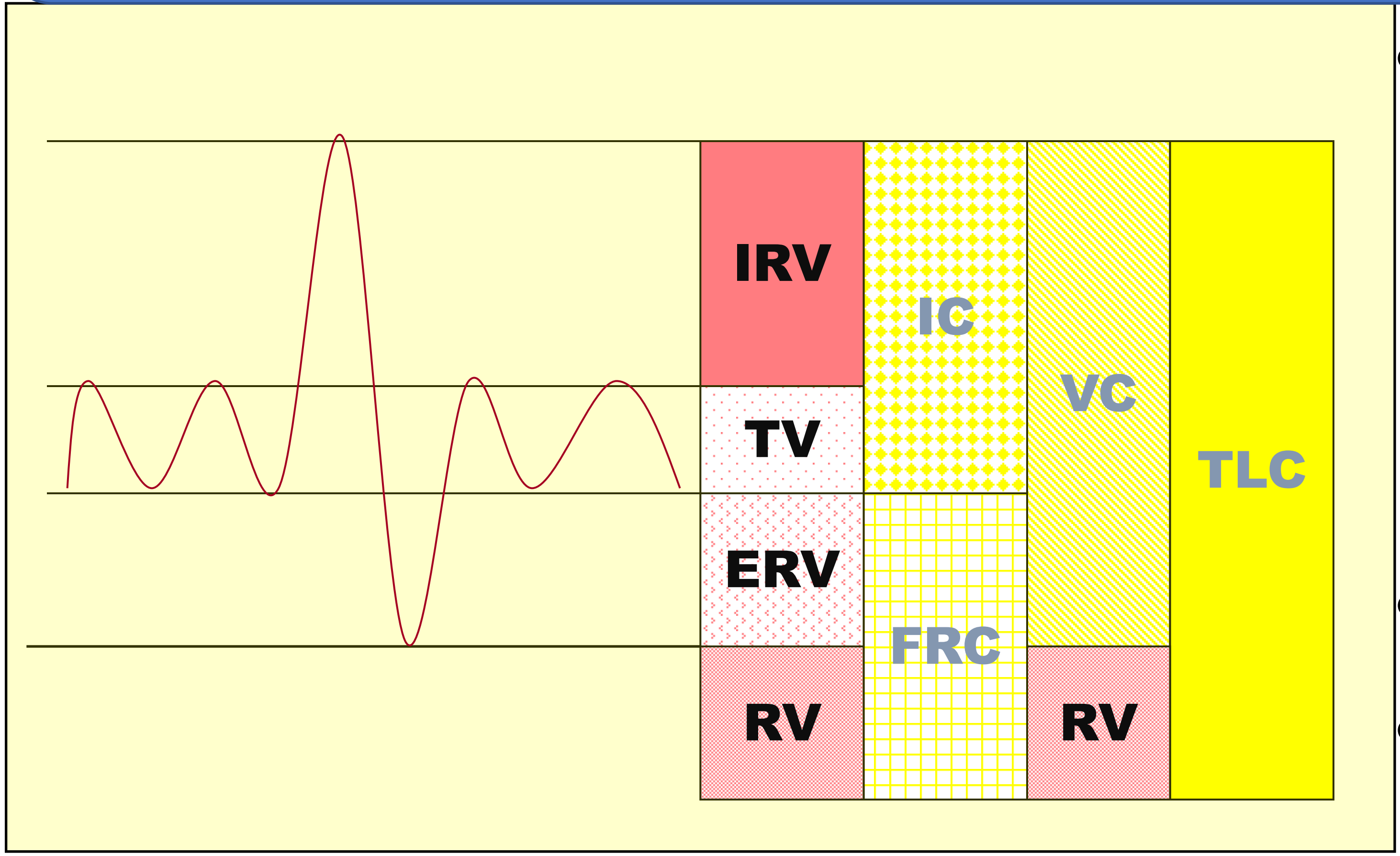
- Maximum amount of air that can be inspired by forced inspiration after the end of normal expiration.
- IC = IRV + TV
- **<u>Value</u>**: 3500 ml

Expiratory Capacity (EC)



- Maximum amount of air that can be expired by forced expiration after the end of normal inspiration.
- EC = ERV + TV
- **Value**: 1500 ml

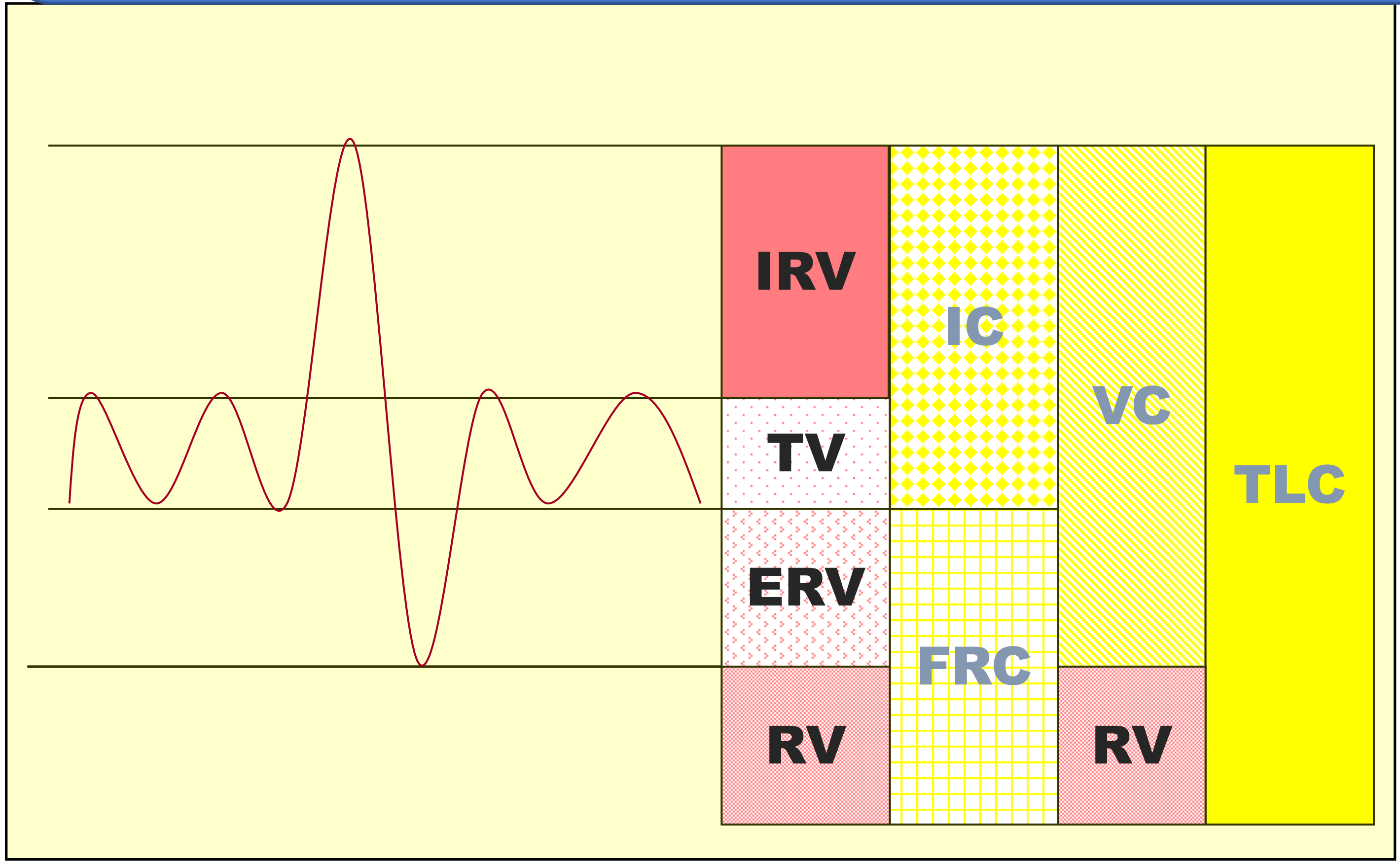
Vital Capacity (VC)



- Volume of air that can be expired by forced expiration after forced inspiration.

- VC = IRV + TV + ERV
- **<u>Value</u>**: 4500 ml

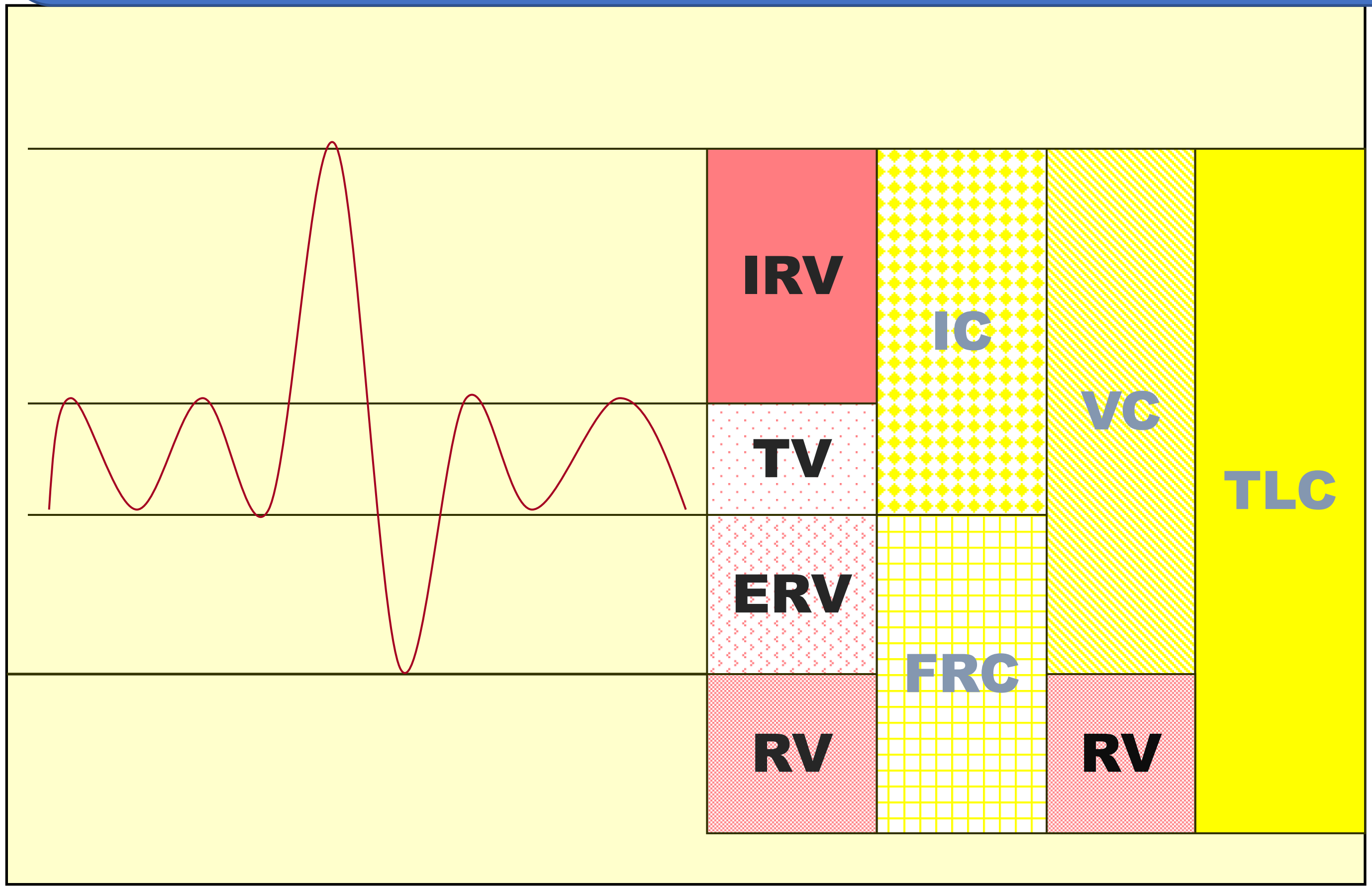
Functional Residual Capacity (FRC)



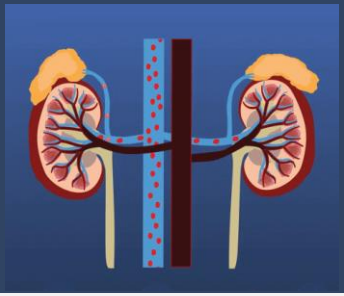
- Volume of air that can be remaining in the lung after normal expiration.

- FRC = ERV + RV
- **Value**: 2200 ml

Total Lung Capacity (TLC)



- Volume of air remaining in the lungs after a maximum inspiration.
- TLC = IRV + TV + ERV + RV
- **Value**: 5700 ml



Renal function Tests -1-

Renal Function Tests

1- Tests depending upon urine analysis.

2- Tests depending upon blood analysis.

3- Tests depending upon analysis of both blood and urine.

4- Radiological tests

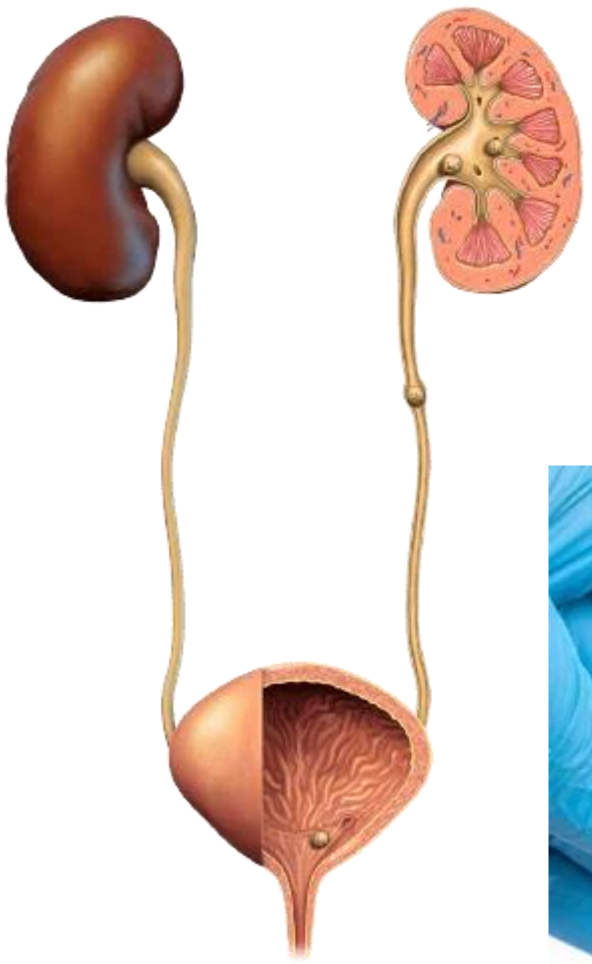
(C) combined urine & blood tests: (clearance tests)

Clearance tests

Significance

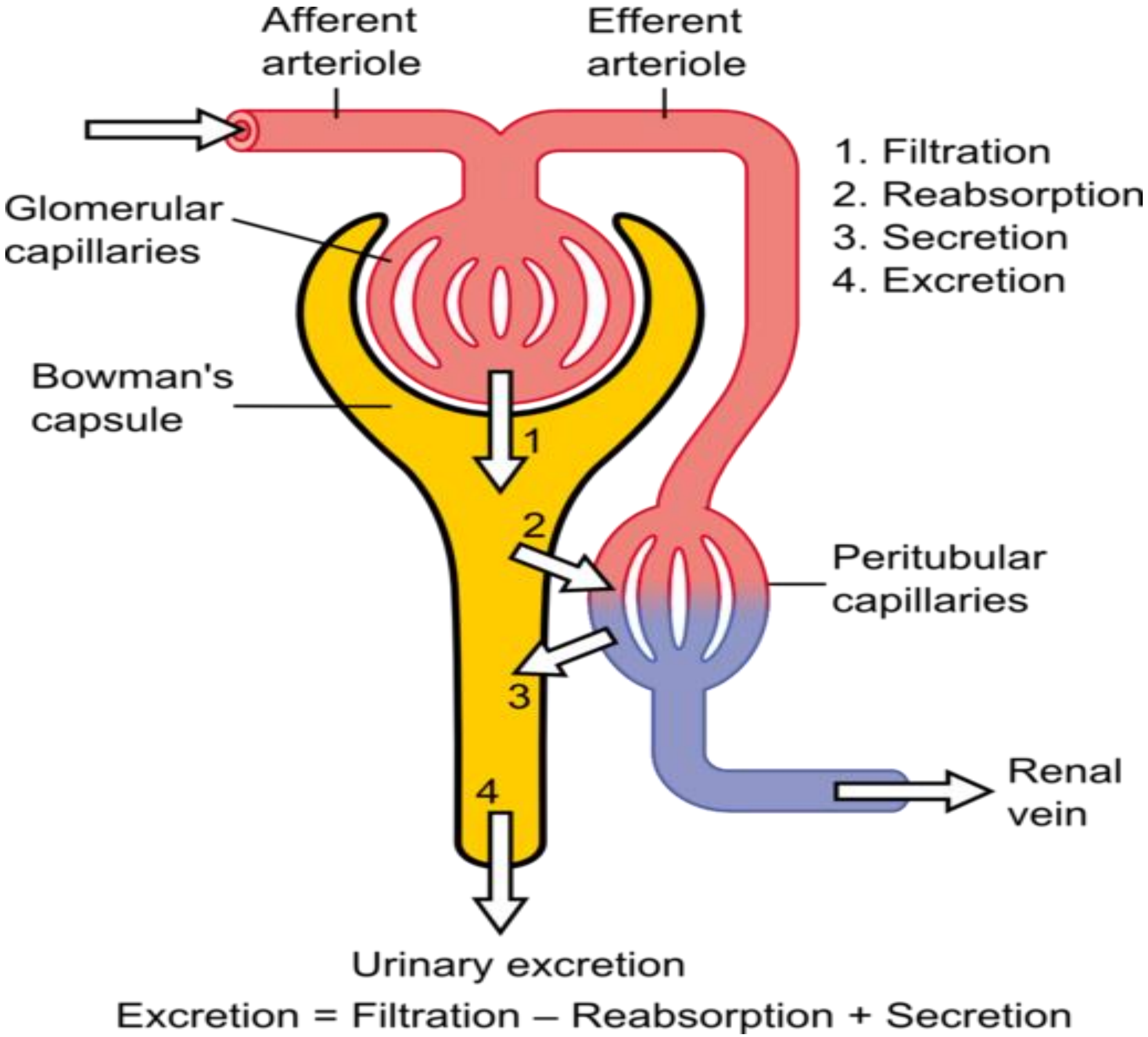
- These tests become abnormal at the early stages of renal failure
- Determine the degree of renal dysfunction.
- Non-invasive.

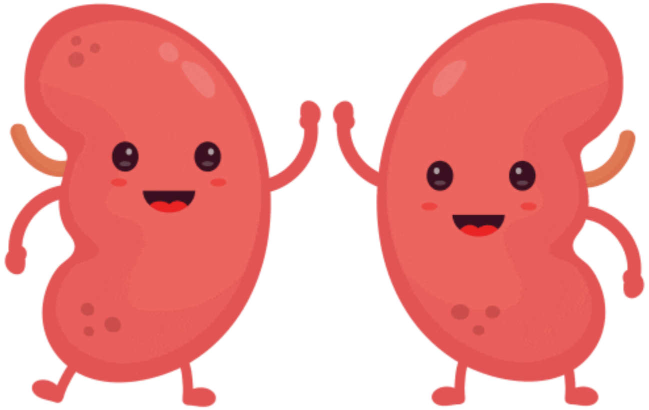
Combined urine & blood tests:

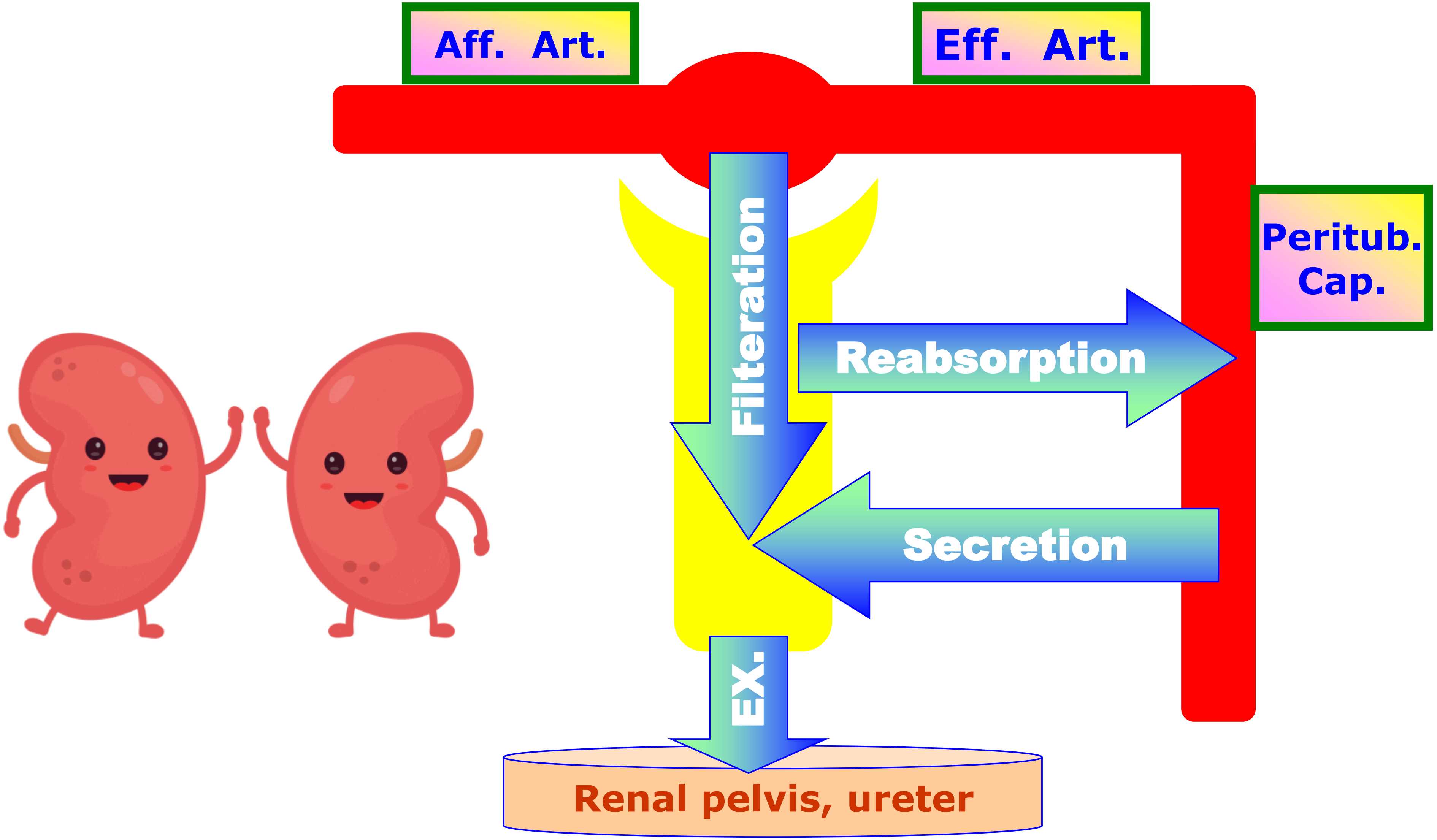


Renal clearance

Kidney function

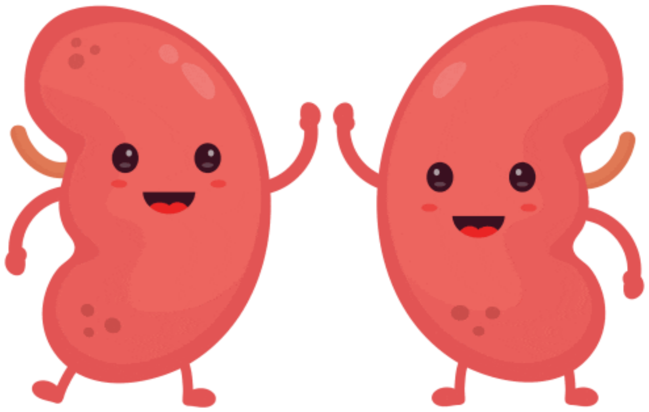


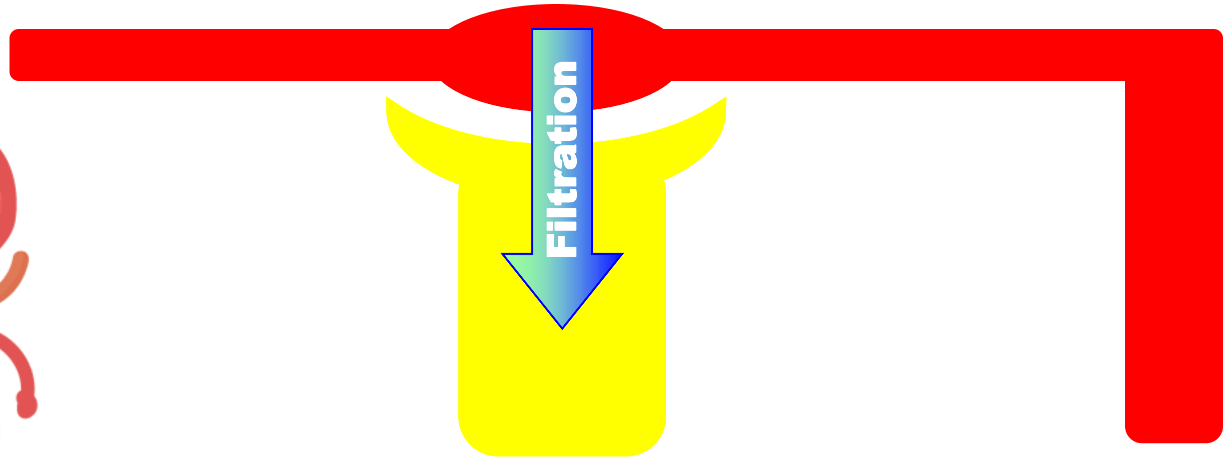




Urinary excretion = Glomerular filtration – Tubular reabsorption + Tubular secretion

Glomerular Filtration Rate (GFR)



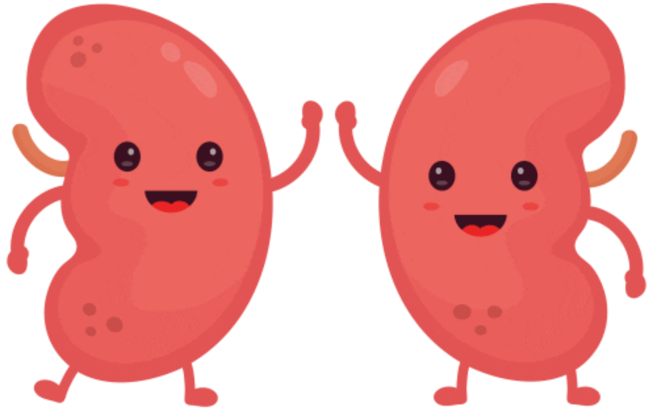


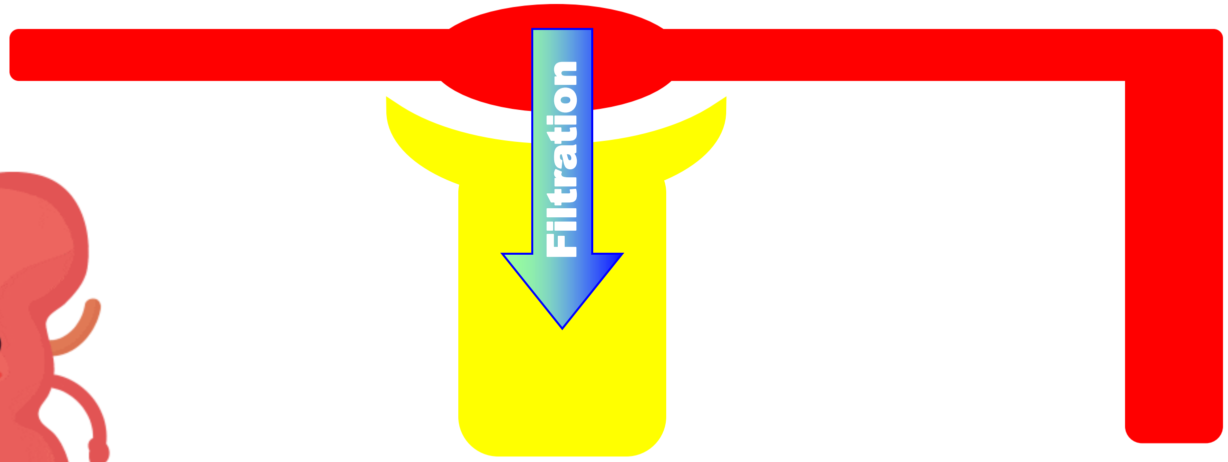
Glomerular Filtration Rate (GFR) :

volume of plasma filtered by both kidney per unit time.

(Ml\min)

Filtered load (amount)



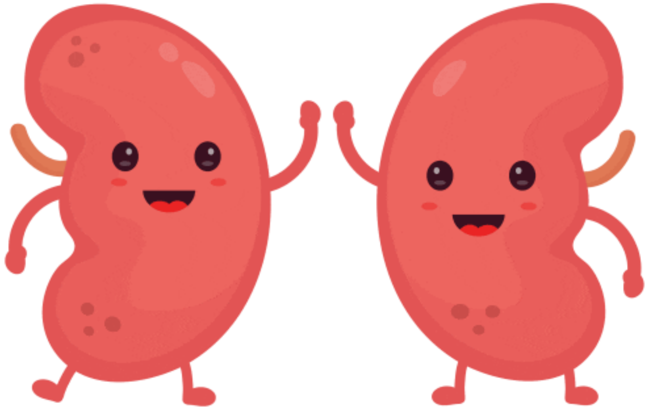


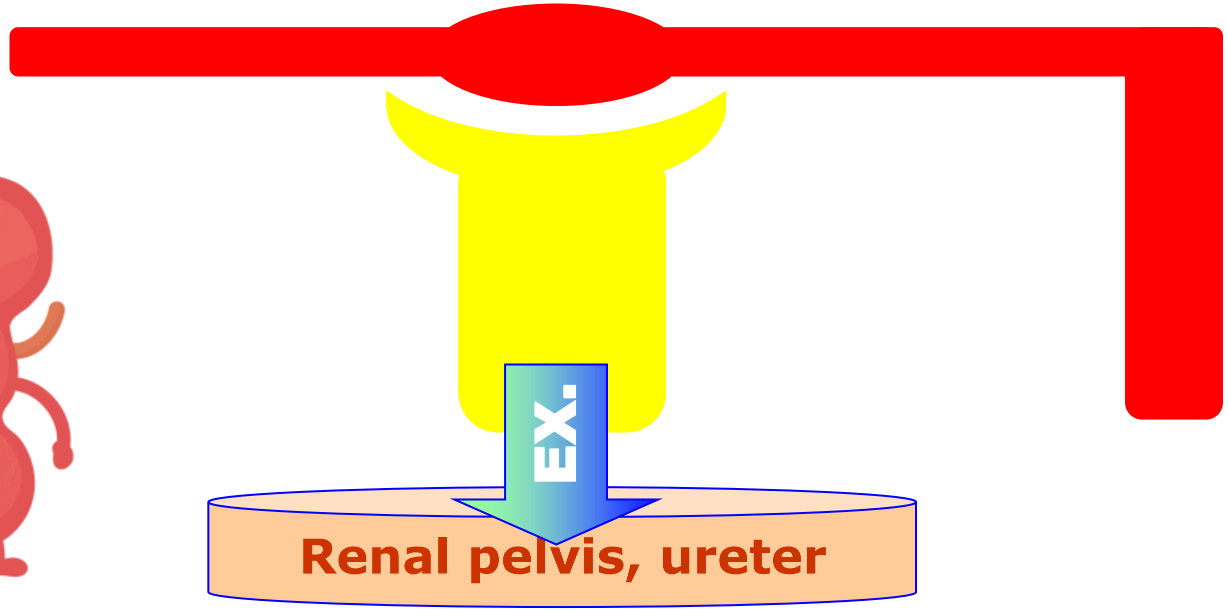
Filtered load:

The amount of substance filtered in Bowman's space in unit time (mg/min)

= GFR X Px

Excretion rate (amount)





Excretion rate:

it is the amount of substance excreted in urine / min

volume (urine) x concentration

$$V^0 \times U_x$$

excreted amount = filtered amount	→ substance is not reabsorbed nor secreted as creatinine or inulin
excreted amount < filtered amount	→ substance is partially reabsorbed as urea.
excreted amount > filtered amount	→ substance is secreted as PAHA.

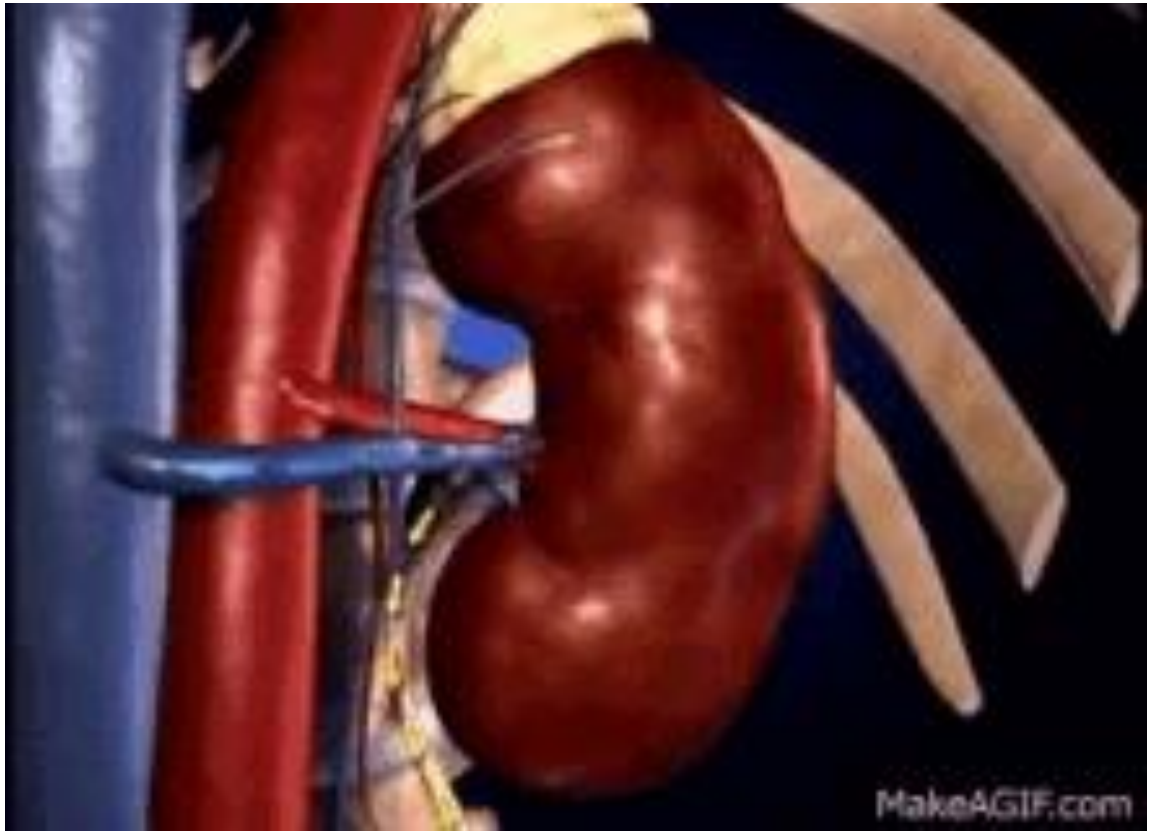
Plasma Clearance

Clearance of a certain substance

Definition: **(C x)**

the volume of plasma cleared from this substance per unit time (minute).

Units: ml/min or liter/day.

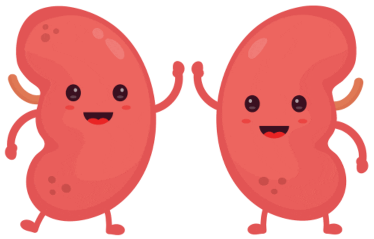


Plasma Clearance

CX (Clearance of sub. x) = $\frac{U_x \cdot V^o}{P_x}$

This means that

CX = $\frac{\text{Excretion rate of substance}}{\text{plasma concentration of this substance}}$



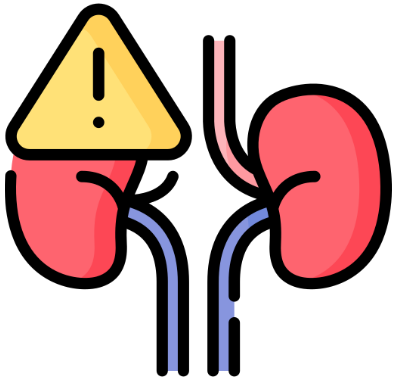
Plasma Clearance

Example:

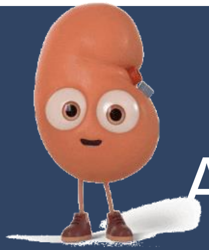
If plasma [Na+] = 140 m.Eq/L.

Urinary [Na+] = 700 m.Eq/L.

Urine flow rate v° = 1 ml/min.



What is the clearance of Na+?



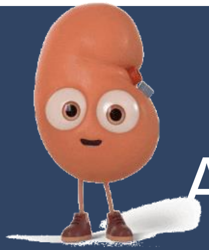
Uses of clearance as a renal function test:

According to substance selected; clearance may be used for:

Glomerular filtration rate (GFR):	• Clearance of inulin or creatinine.
Renal plasma flow (RPF):	• Clearance of PAH.

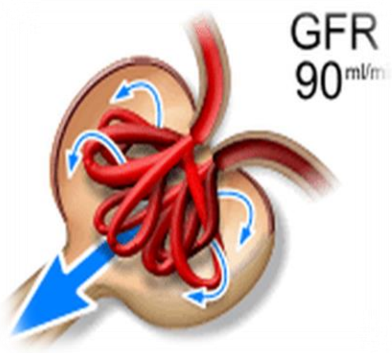
Uses of clearance as a renal function test:

According to substance selected; clearance may be used for:



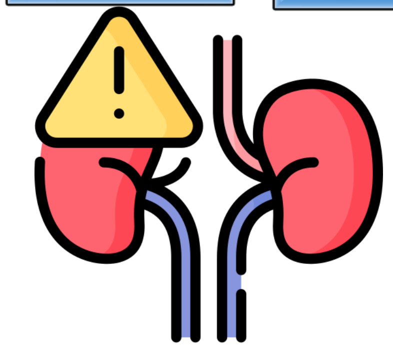
Mode of handling of substance by the kidney:	• Clearance ratio and fraction excretion.
Reabsorptive capacity of renal tubules:	• Transport maximum of glucose (TMG).

1- Measurement Of GFR:



Substance used to measure **GFR** should be

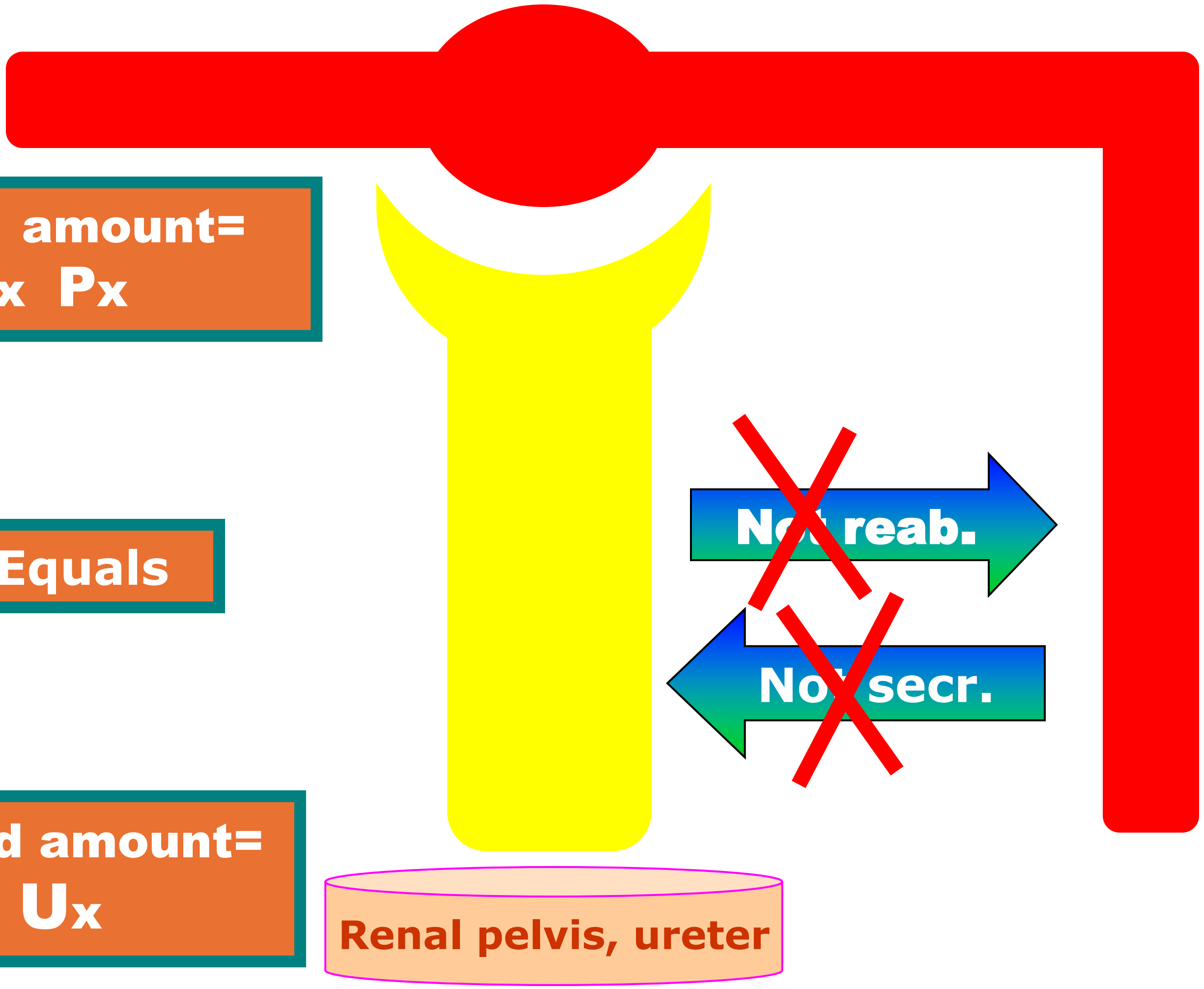
- Non-toxic
- not affect GFR or RPF.
- Not metabolized by the body or the kidney.
- Freely filtered (small molecular weight and not bound to plasma proteins)
- Neither reabsorbed nor secreted.
- Accurately measured in plasma and urine.

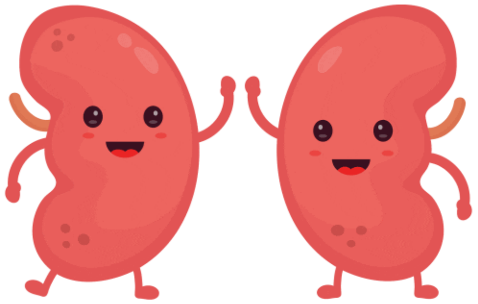


Filtered amount=
$GFR \times P_x$

Equals

Excreted amount=
$V_0 \times U_x$





1- Measurement Of GFR:

This sub. isn't secreted nor reabsorbed so that:

The amount of sub. filtered / min = The amount of sub. excreted / min.

The volume filtered /min (GFR) x conc. Of sub. In filtrate (PX)

=

The volume of urine/min (VO) x conc. Of sub . in urine (UX)

$$GFR \times P_{in} = V^{o} \times U_{in}$$

$$GFR = \frac{U_{in} \cdot V^{o}}{P_{in}} = C_{in}$$

Two Substances Can Be Used For GFR

1- Inulin (Exogenous):

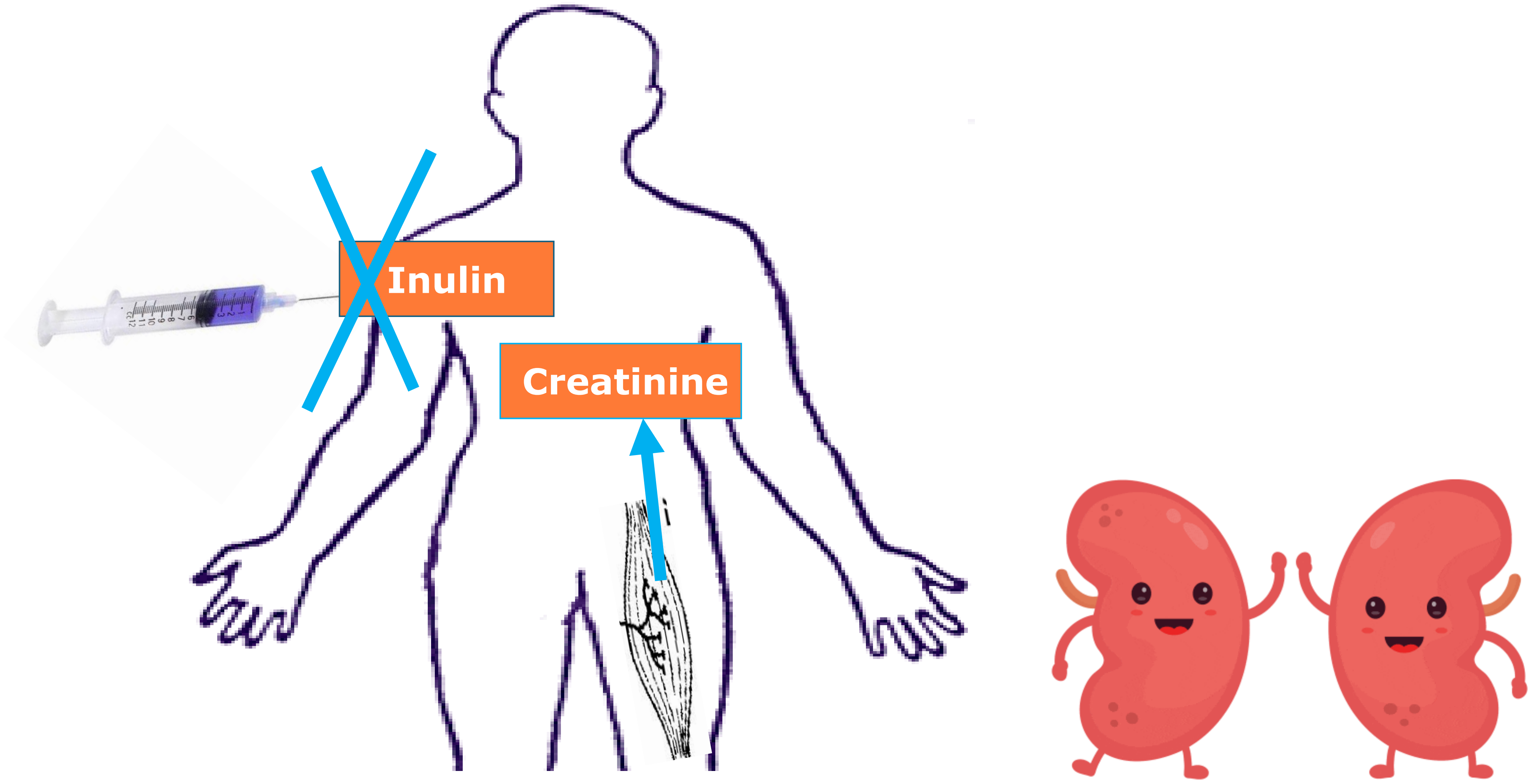
- Polymer of fructose.
- Given by intravenous drip
- GFR = C_{in}= **125 ml./min**.
- **Advantage:** **accurate** hence it is used for experimental studies.
- **Diadvantage:** **Exogenous**

2- Creatinine (Endogenous):

- End product of creatine metabolism in skeletal muscles.
- GFR = C_{Cr}= **140 ml /min**.
- **Advantage**: **Endogenous.** Its **plasma concentration is constant over 24 hours.**
- **Disadvantage**: slightly secreted

so GFR measured by this method is 10% higher than GFR measured by inulin clearance.

Endogenous creatinine instead of exogenous inulin



GFR

Example:

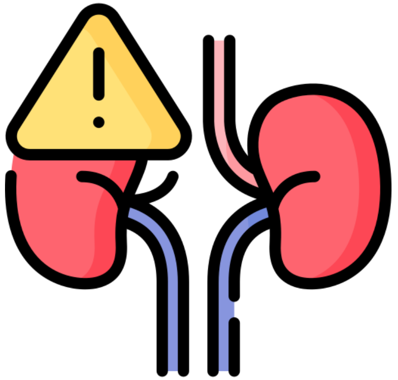
Example:

P_{cr} = 0.02 mg/ml.

V^0 = 1.25 ml/min

U_{cr} = 2 mg/ml

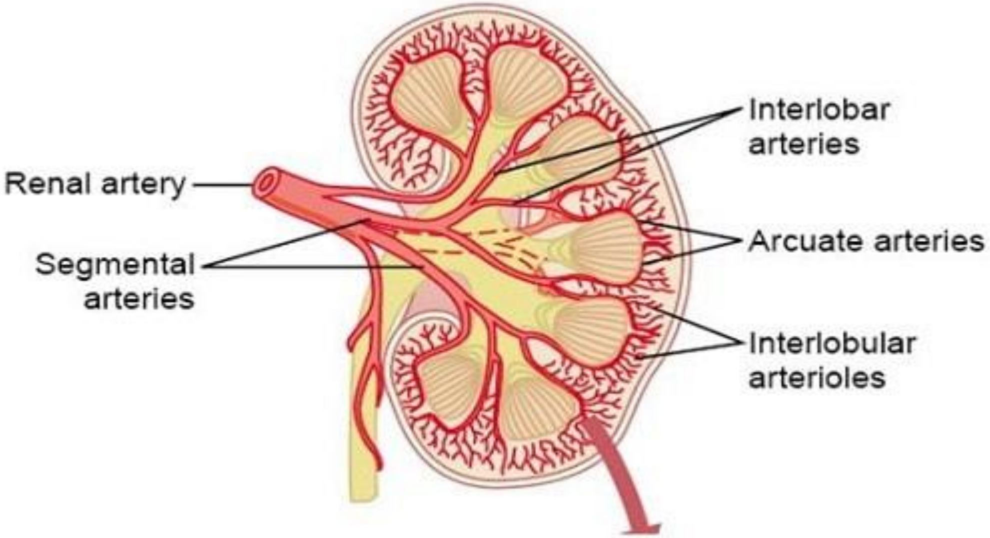
What Is The GFR ?

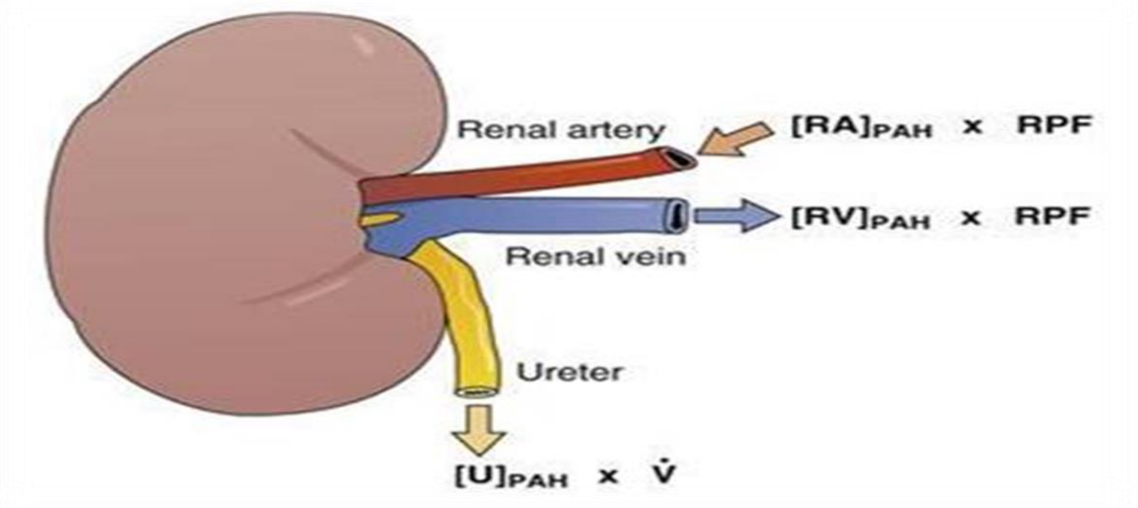


2- Measurement Of renal blood flow (RBF):

Substance used to measure RBF should be

- Non-toxic.
- Does not affect GFR or RPF
- Completely secreted
- Not reabsorbed.
- Accurately measured in plasma and urine.





2- Measurement Of RBF:

The amount of PAHA cleared \ min = The amount of PAHA execrated\ min.

The volume of plasma x conc. of PAH in plasma = the volume of urine x conc. of PAH in urine

RPF (renal plasma flow) x $P_{PAH} = U_{PAH} \times V^{o}$

$$RPF = \frac{U_{PAH} \times V^{o}}{P_{PAH}} = C_{PAH}$$