CVS MODULE
PHYSIOLOGY LAB1

ECG

BY

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NORMAL ELECTROCARDIOGRAM (ECG)

✓ **Definition:**

It is the recording of the electrical changes in cardiac muscle (electric currents generated from the cardiac muscle; APs).

✓ **Types:**

1. Direct: in animals recording electrode applied on heart surface.
2. Indirect: recording is done by putting two electrodes on skin.

Significance of ECG:

1. Calculate HR.
2. Determine the rhythm of HR.
3. Diagnose nature of conductivity in AV node via PR interval.

Apparatus: Electrocardiograph

Electrocardiograph is formed of a sensitive galvanometer connected to two electrodes which are in contact with skin of the anterior chest wall, right arm, left arm and left foot. The recording is obtained from certain points on the skin is called a lead. A standard ECG consists of 12 leads that record the same electric cardiac events but from different situations and are helpful in diagnosis and prognosis of many cardiac diseases.

ECG

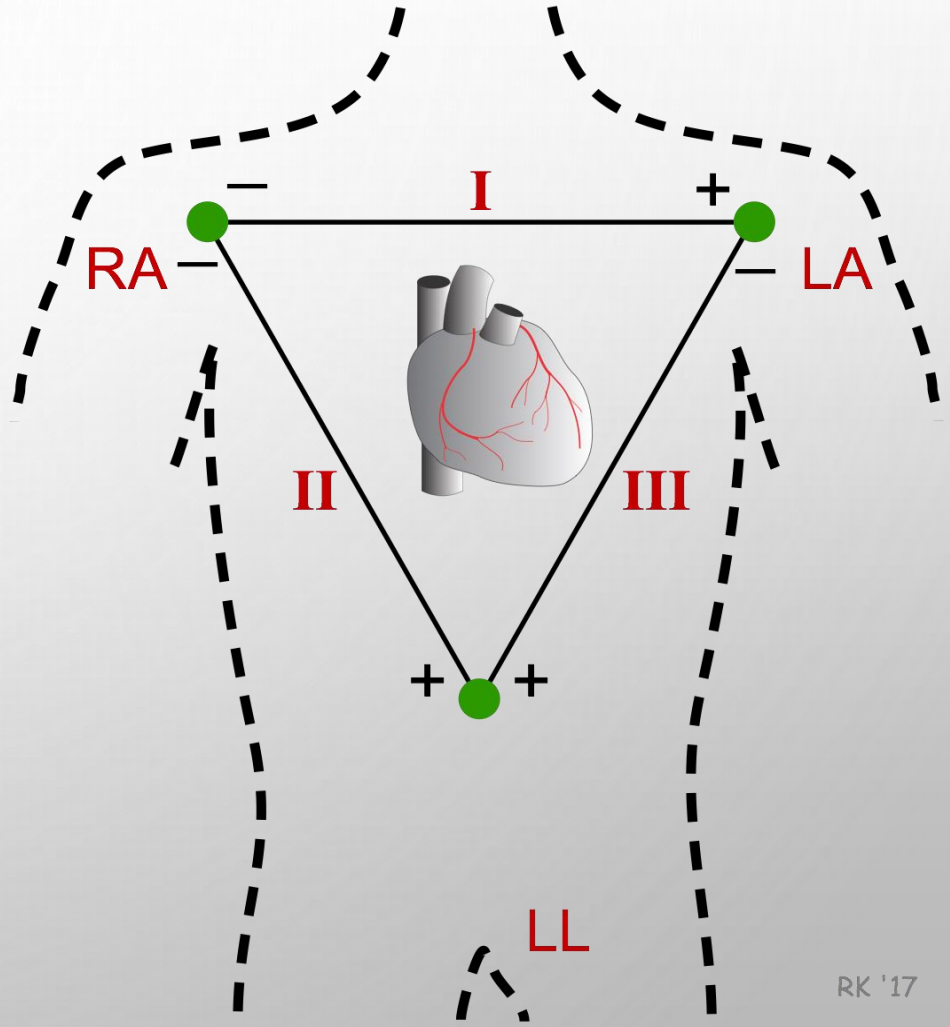
TYPES OF LEADS

Types of leads:

A. Bipolar limb leads

These leads record the potential difference between 2 points on the limbs. There are 3 bipolar limb leads:

- Lead I: This records the potential difference between the left arm (LA) (+ve) and the right arm (RA) (-ve) (LA-RA or VL-VR).
- Lead II: This records the potential difference between the left leg (LL) (+ve) and the RA (-ve) (LL-RA or VF-VR).
- Lead III: This records the potential difference between the LL (+ve) and the LA (-ve) (LL-LA or VF-VL).



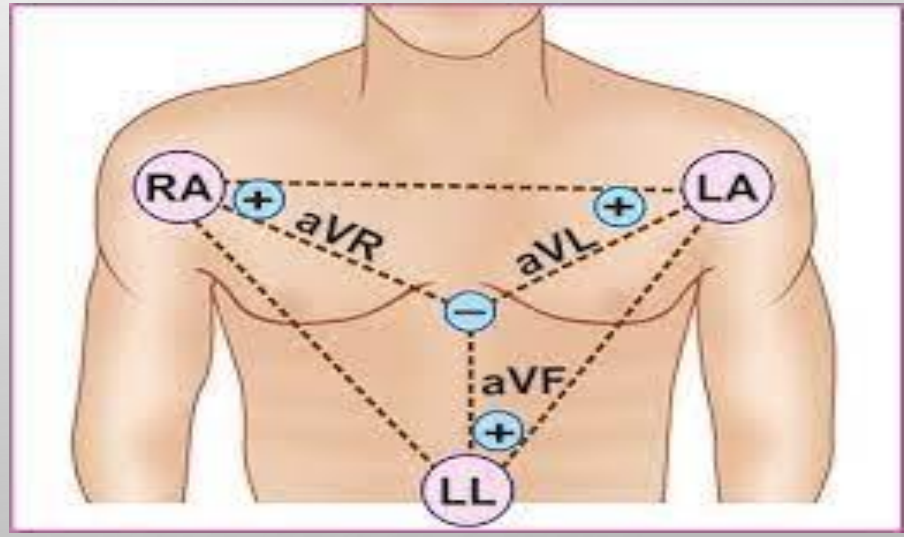
B. Unipolar leads: these measure the absolute (actual) potential at a certain point.

1. Augmented unipolar limb leads: (augmented voltage leads)

These measure the absolute (i.e. actual) potential at one point on a single limb. This is carried out by applying one electrode from the ECG apparatus to one limb (exploring electrode, +ve electrode) while the other electrode (- ve electrode) is connected to the other 2 limbs with equal resistance to make their potential equals zero. Thus, this electrode is called indifferent electrode.

There are 3 unipolar limb leads:

- aVL → measures the potential at the LA.
- aVR → measures the potential at the RA.
- aVF → measures the potential at the LF.

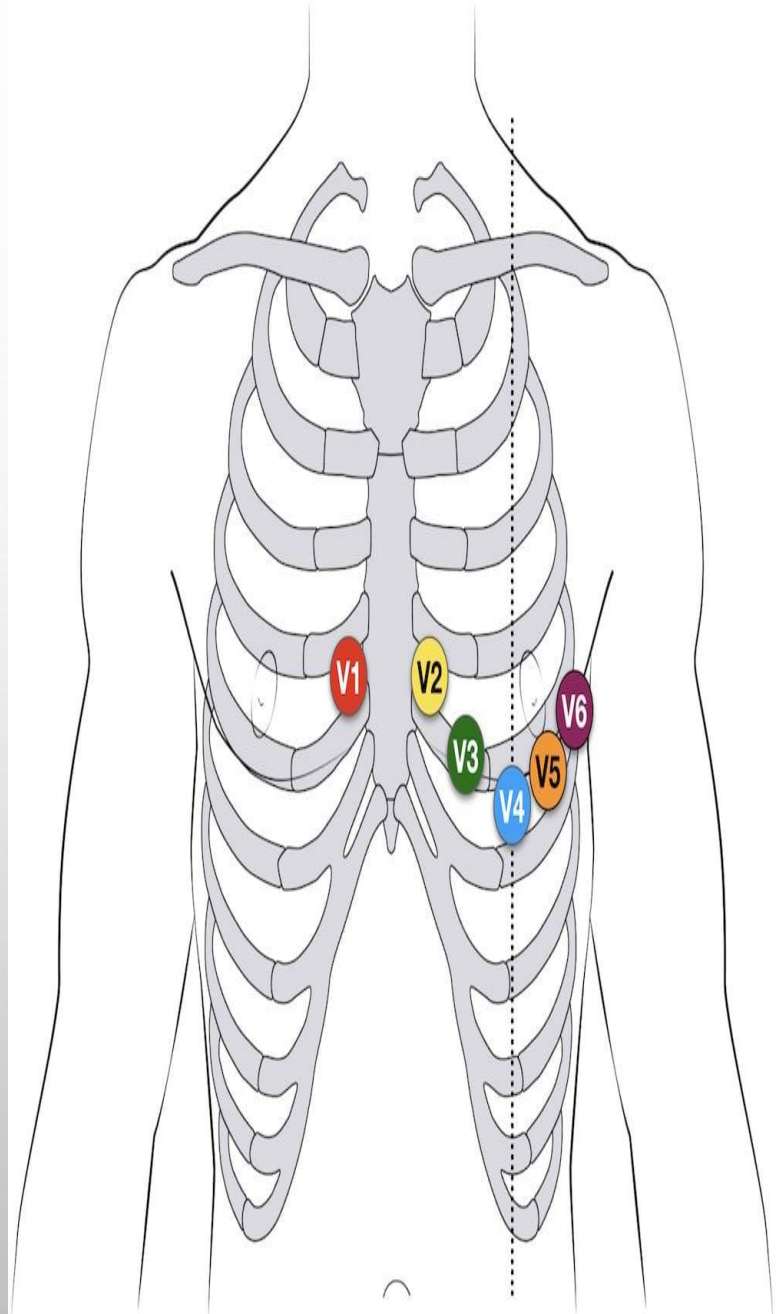


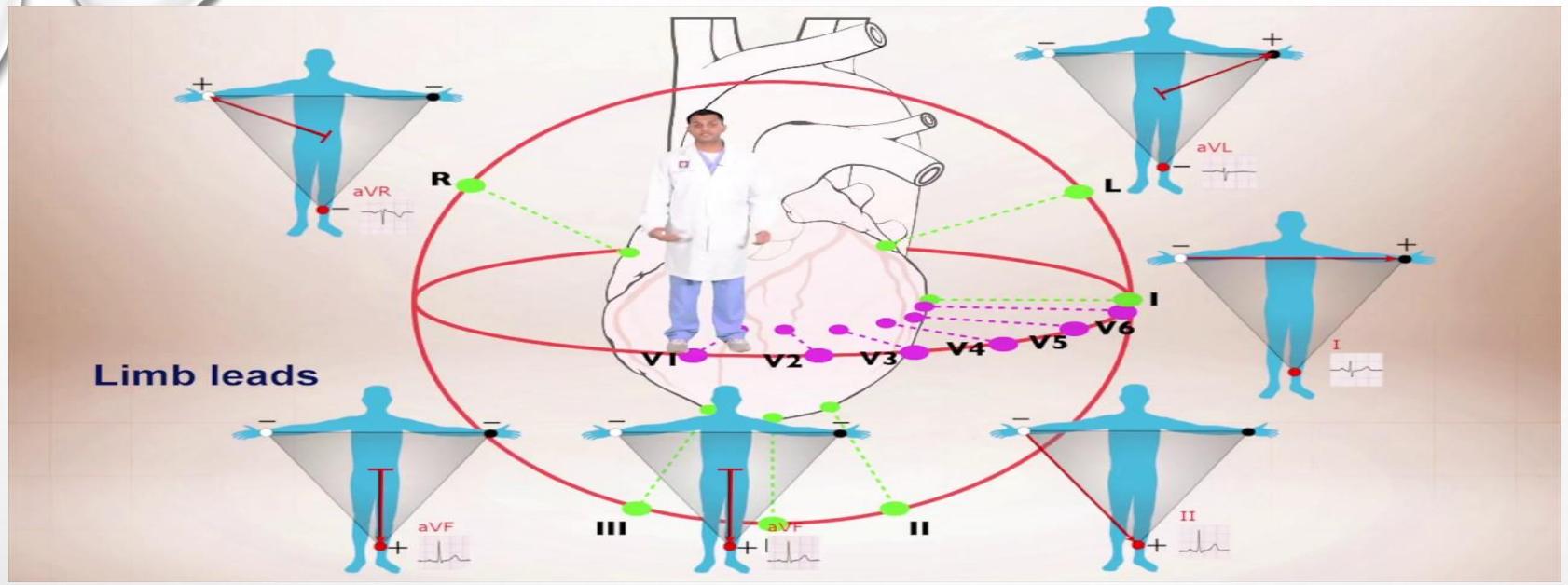
2. Unipolar chest (precordial) leads:

These are similar to unipolar limb leads except that they measure the potential at one point on the anterior chest wall through the exploring electrode and the indifferent electrode is connected to the 3 limbs.

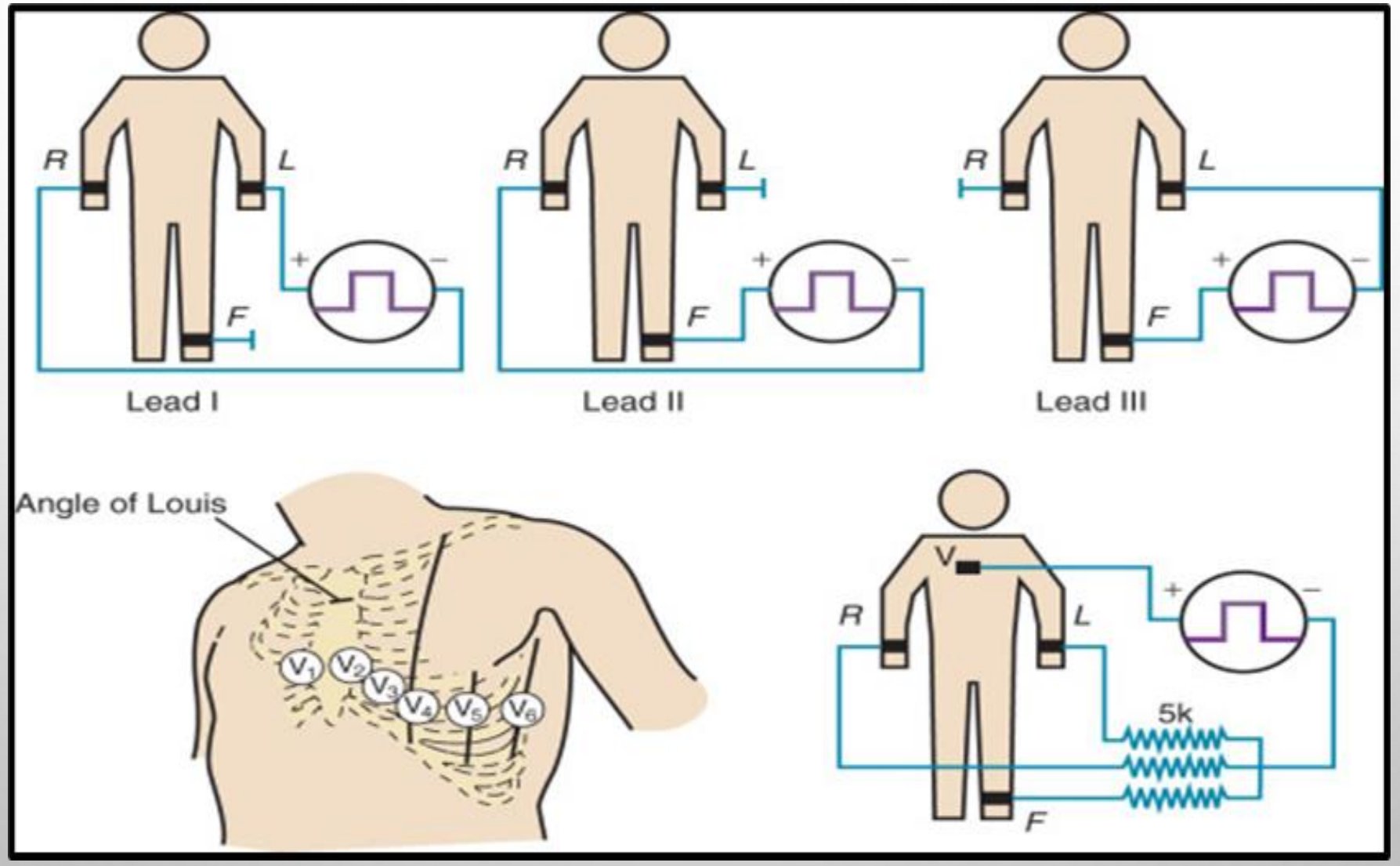
There are 6 unipolar chest leads:

- V1: placed on the Rt side of the sternum at the level of 4th intercostal space.
- V2: placed on the Lt side of the sternum at the level of 4th intercostal space.
- V3: between V2 and V4.
- V4: placed on the Lt 5th intercostal space mid-clavicular line.
- V5: placed on the Lt 5th intercostal space anterior axillary line.
- V6: placed on the Lt 5th intercostal space mid- axillary line.

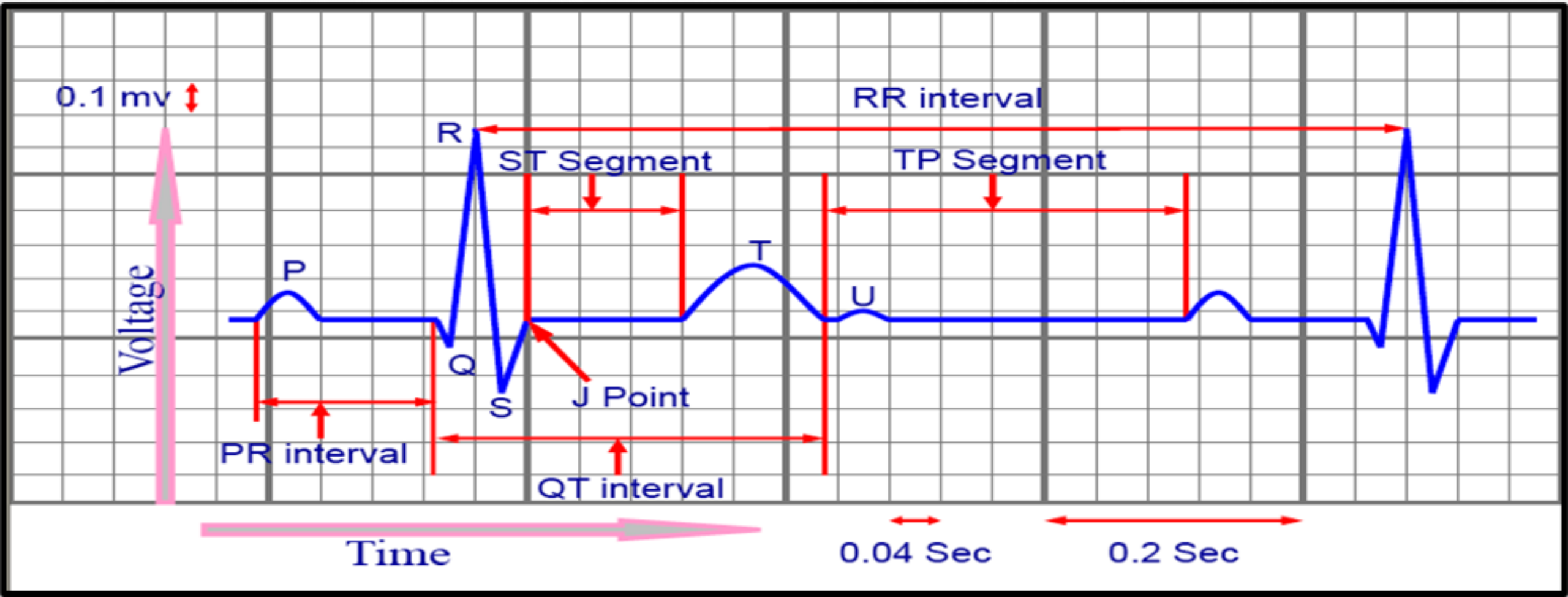




VIEWS REFLECTED ON A 12-LEAD ECG	LEAD	VIEW OF THE HEART
	Standard limb leads (bipolar)	
	I	Lateral wall
	II	Inferior wall
	III	Inferior wall
	Augmented limb leads (unipolar)	
	aV_R	No specific view
	aV_F	Inferior wall
	aV_L	Lateral wall
	Precordial, or chest, leads (unipolar)	
	V_1	Septal wall
	V_2	Septal wall
	V_3	Anterior wall
	V_4	Anterior wall
	V_5	Lateral wall
	V_6	Lateral wall


R
L
F
+
−
Lead I
Lead II
Lead III
Angle of Louis
V1
V2
V3
V4
V5
V6
V
5k

Normal ECG


0.1 mv
Voltage
RR interval
R
ST Segment
TP Segment
T
P
U
Q
S
J Point
PR interval
QT interval
Time
0.04 Sec
0.2 Sec

The normal ECG usually consists of 5 main waves:

Three (+ve) waves (P, R, T) & Two (–ve) waves (Q and S).

Sometimes, there is additional wave following T wave called U wave. The Q, R and S waves form a complex called QRS complex.

Waves are separated by segments and each starts and ends at the isoelectric line.

P wave: positive wave

- It represents atrial depolarization.
- It starts 0.02 sec before atrial systole.
- Normally, its amplitude is about 0.1 mv while its duration does not exceed 0.1 second.
- One wave in cardiac cycle.

QRS complex:

- Represents ventricular depolarization.
- Starts before ventricular systole by 0.02 second.
- It’s duration is 0.04-0.08 second
- It’s composed of two negative waves Q&S and one positive R wave.

1. Q wave: Negative wave. Represents depolarization of the interventricular septum, 0.02 sec in duration. May be absent normally.

2. R wave: Positive wave. Represents depolarization of most of the ventricular walls including the apex of the heart. It’s the largest +ve wave (1 mV) in normal ECG. It’s 0.04 sec in duration.

3. S wave: Negative wave. Represents depolarization of the remaining ventricular walls mainly the base of the ventricles. It’s 0.02 sec duration. May be absent normally.

T wave: Positive wave

- Represents repolarization of ventricles.
- It’s 0.2 sec in duration.
- 1/2 R wave in amplitude (0.4 mV).

U wave:

- Small +ve wave that sometimes follows T wave.
- It is probably due to slow repolarization of either the papillary muscles or the Purkinje network (in which duration of AP is longer than in the ventricular myocardium).

N.B.

Atrial repolarization isn’t recorded as it is masked by ventricular depolarization that occurs at the same time and its voltage is very low.

T wave (repolarization) is in the same direction of R wave (depolarization): Because the last part to be depolarized is the first part to repolarize.

Abnormalities of the P wave:

1. Inverted → nodal rhythm.
2. Absent → atrial fibrillation (AF).
3. More than one → atrial flutter.

Abnormalities of the QRS complex:

Occur in cases of ventricular hypertrophy, infarction, extrasystoles, as well as in bundle branch block and most cases of electrolyte disturbance.

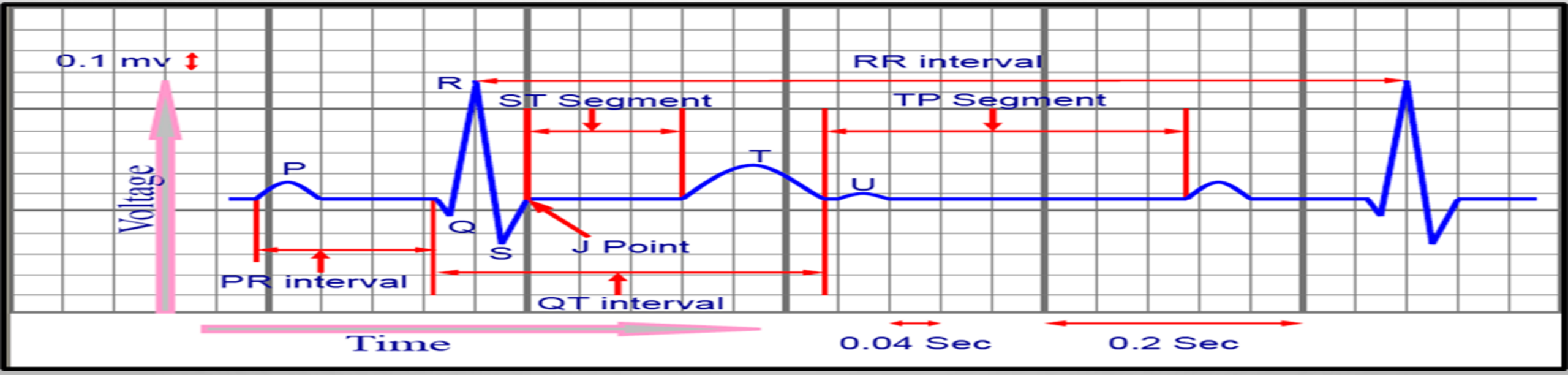
Abnormalities of the T wave:

1. Inverted or isoelectric → e.g. myocardial ischemia.
2. Increased amplitude → e.g. early myocardial infarction (MI) & sympathetic overactivity & hyperkalemia

ECG SEGMENTS AND INTERVALS

What is the difference between segment and interval?

- Segment; is a straight line connecting two waves.
- Interval; includes at least one wave plus the connecting straight line.



ECG INTERVALS AND SEGMENTS

PR interval:

- It's the period between the **beginning of P** wave to the **beginning of QRS** complex or usually the R wave in case of absent Q wave.
- Represents conduction in AV node (i.e. the time between the onset of atrial depolarization (P wave) and the onset of ventricular depolarization (QRS complex).
- Its duration from 0.12 – 0.20 second (< 0.12 second → short PR as in tachycardia OR > 0.20 second → prolonged PR as in bradycardia).

Abnormalities of PR interval:

1. Prolonged PR interval → means delayed conductivity (e.g. first degree HB, bradycardia and increased vagal tone).

2. Short PR interval → means rapid conductivity (e.g. nodal rhythm and tachycardia (sympathetic overactivity)).

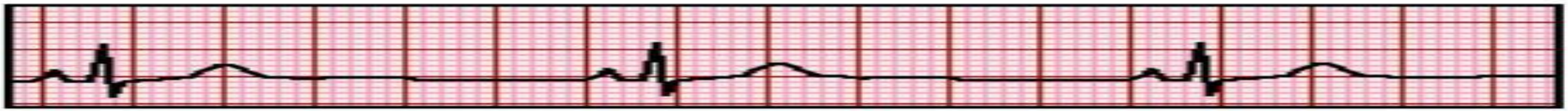
ST Segment:

- It’s the line between **end of S wave and beginning of T wave**.
- During this period the ventricles are completely depolarized so, ST segment is an isoelectric line. Its upward or downward deviation indicates myocardial damage.
- Its duration is 0.1 sec.
- Depressed ST segment → myocardial ischemia while elevated ST segment → myocardial infarction (MI).

CALCULATION OF HEART RATE FROM ECG

- Each large square = 0.2 second, each small square = 0.04 second.
- 1 minute has 300 large squares or 1500 small squares.
- Distance between 2 successive R waves represents 1 beat.
- So, HR = 300/ number of large squares between 2 successive R waves or 1500/ number of small squares between 2 successive R waves.

Rule of 300



(300 / 6) = 50 bpm

If the number of big squares between 2 successive R waves is 5, then the heart rate (HR) in this case will be ……?

ANSWER:
300/5= 60/minute.

RELATION BETWEEN ECG AND VENTRICULAR AP

- ECG waves are produced by the APs generated in the ventricular muscle.
- QRS complex corresponds to the upstroke of the AP (phase 0) i.e. depolarization.
- ST segment to the plateau phase (phase 2).
- T wave to the rapid repolarization phase (phase 3).
- T-P segment to phase 4 of AP.

ECG DURING THE CARDIAC CYCLE

Since the electric events in muscles (including cardiac muscle) precede the mechanical response:

P wave precedes atrial systole and QRS precedes isometric ventricular contraction (each by about 0.02 second).

Also, the summit of R wave coincides with first heart sound while the 2nd heart sound coincides with the end of T wave.


THANK
YOU