



Ask Mish

NORMAL EKG

■ **EKG: 10 ELECTRODES, MACHINE AND PAPER**



Ask Mish

■ **12 LEADS EKG: 6 LIMB AND 6 CHEST LEADS**

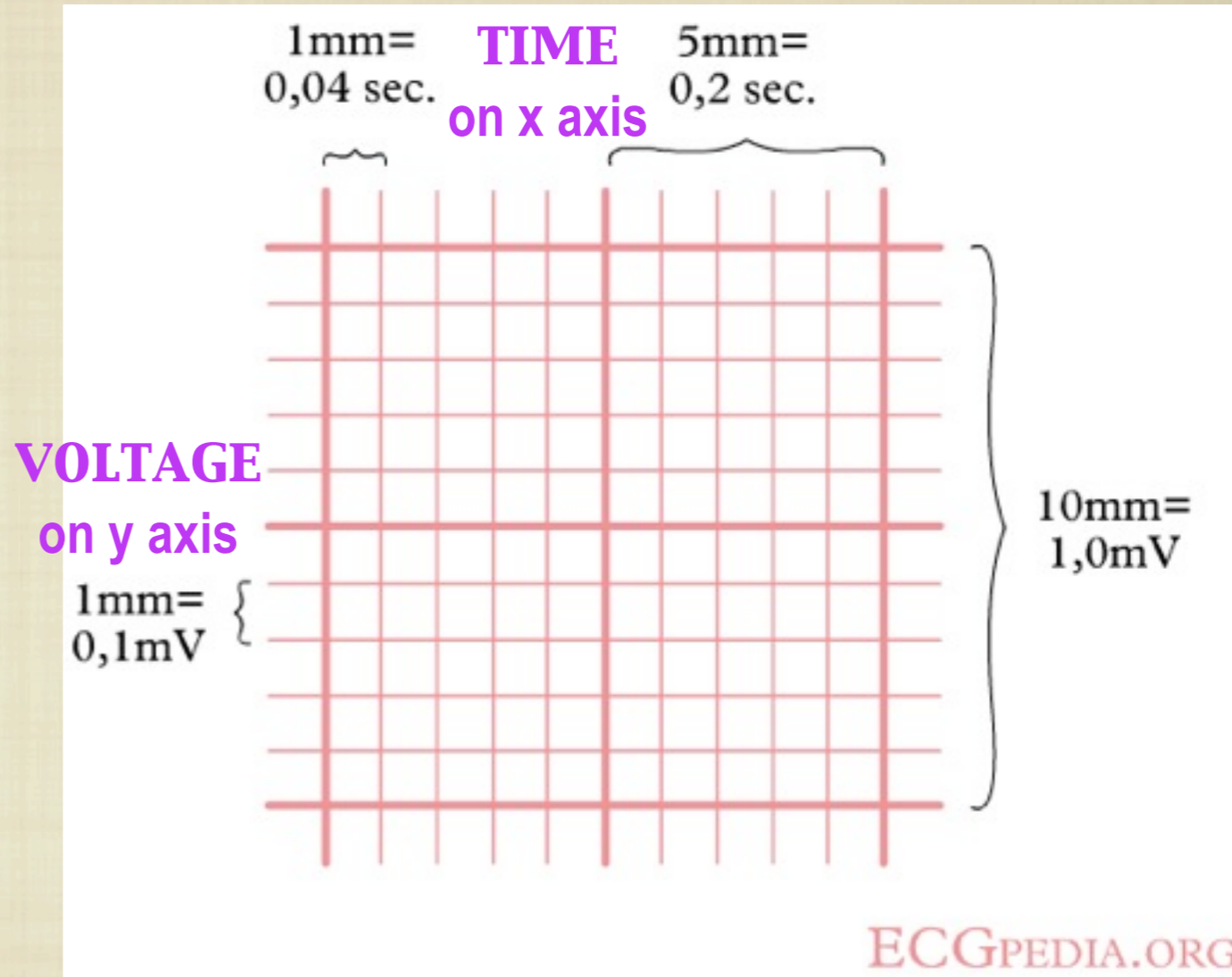
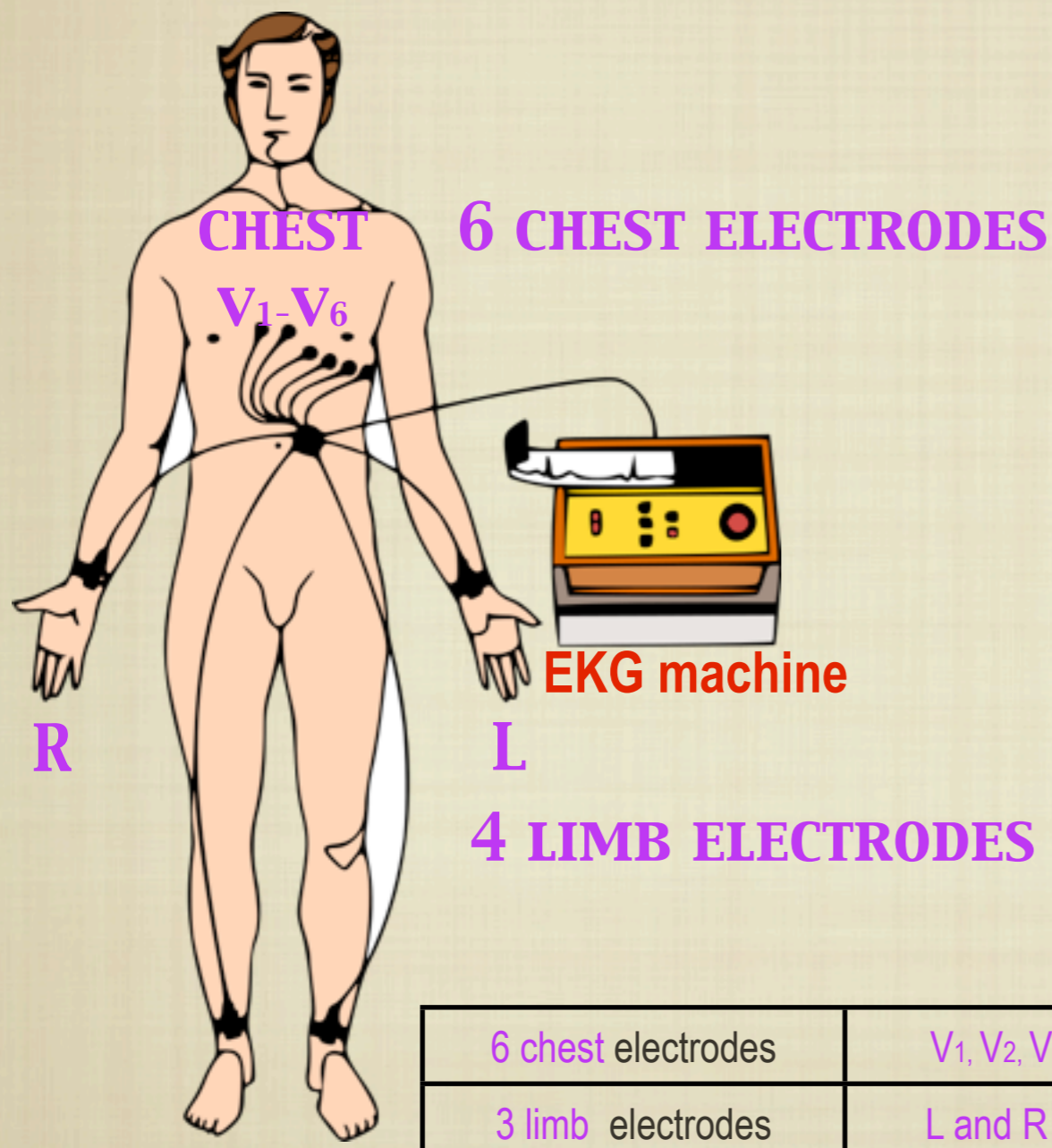
■ **EKG AT REST**

■ **INTERVALS**

■ **WAVES**

■ **SEGMENTS**

EKG: 10 ELECTRODES AND PAPER



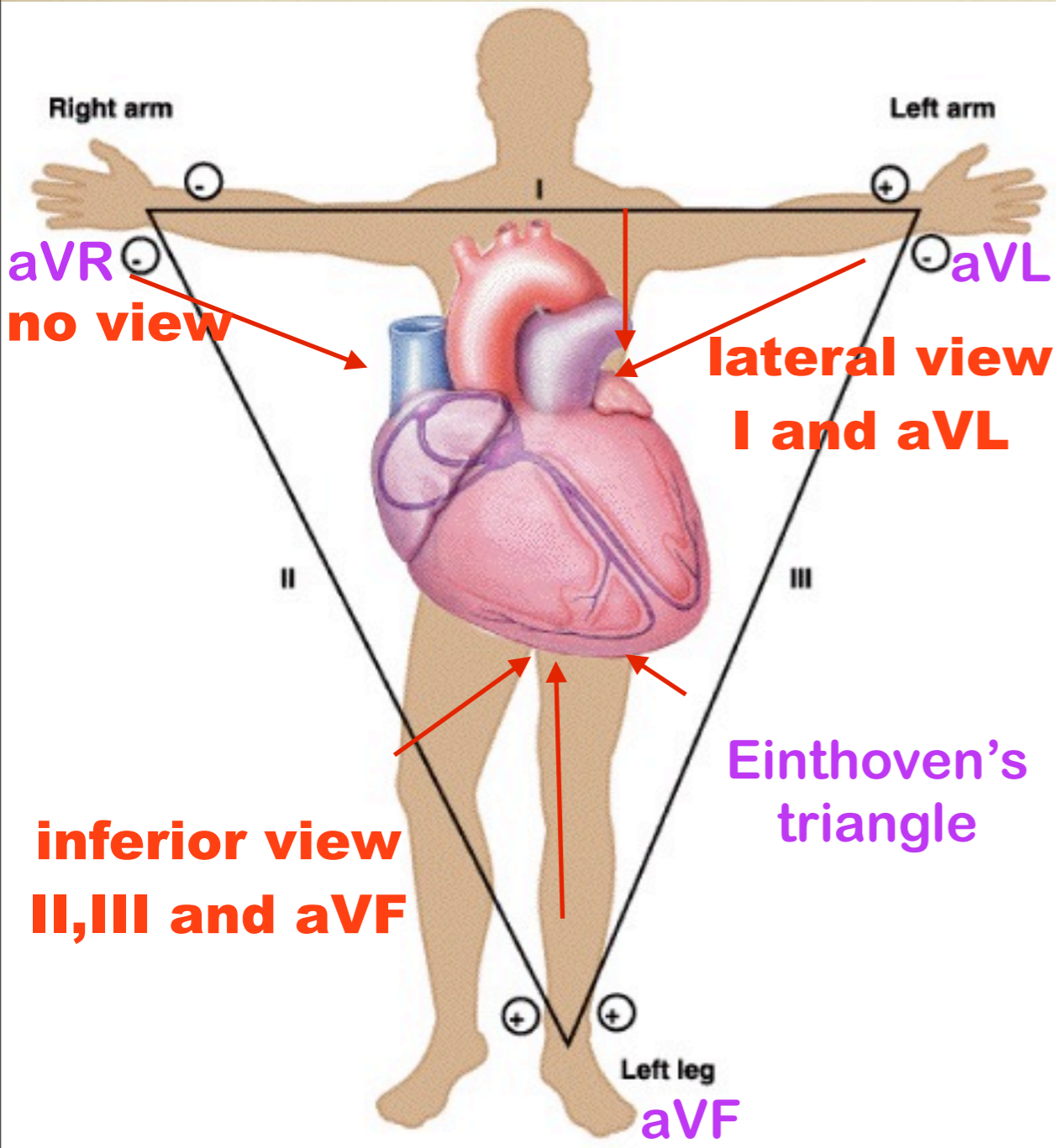
R=ground **L**

| | | |
|--------------------|---|--|
| 6 chest electrodes | V ₁ , V ₂ , V ₃ , V ₄ , V ₅ , V ₆ | detect action potentials from antero-posterior plan of the heart |
| 3 limb electrodes | L and R arm, L leg | detect action potentials from frontal plan of the heart |
| 1 limb electrode | R leg | non-detector, represents the ground |

12 LEADS EKG: 6 LIMB LEADS



Ask Mish

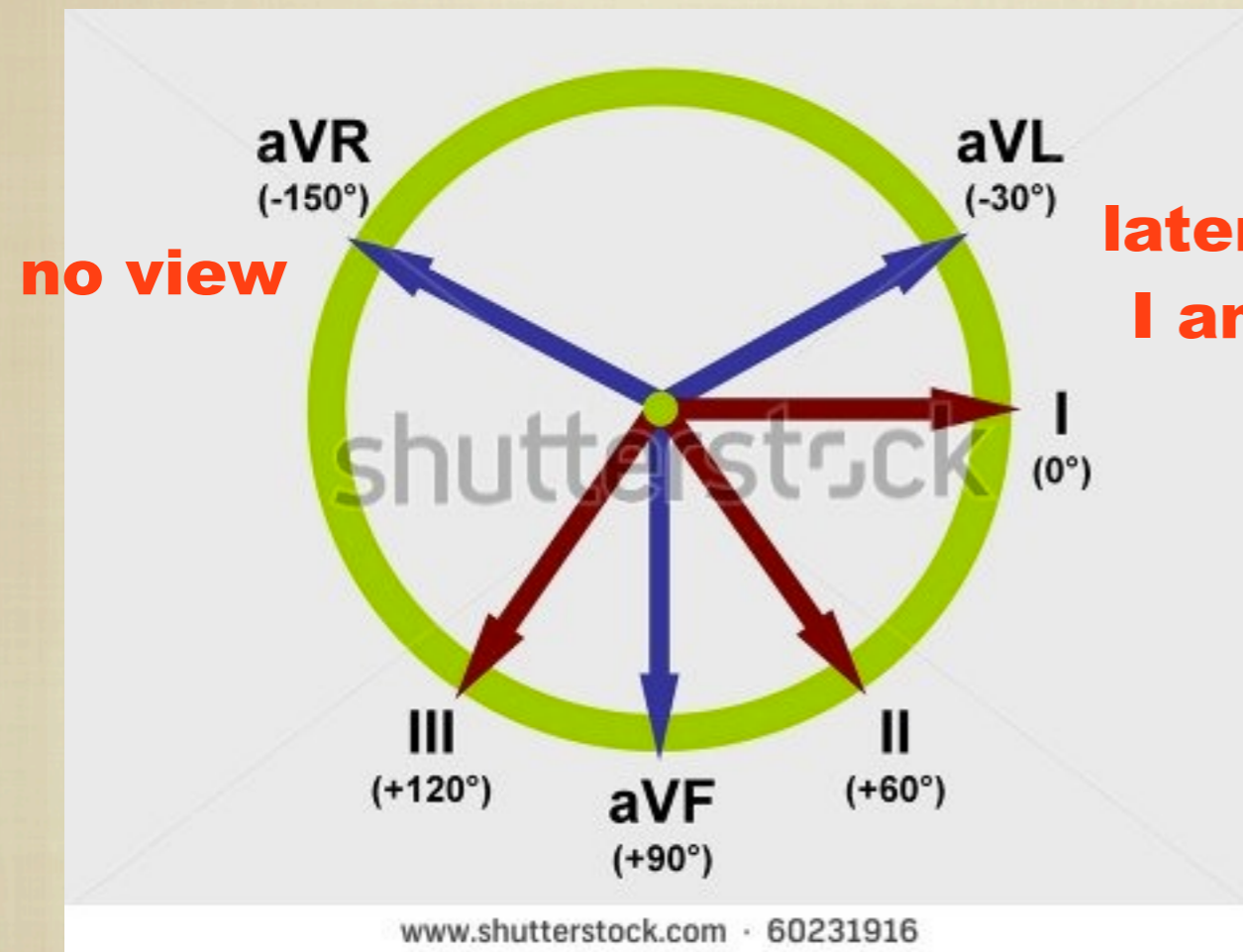


| | |
|--------------------------------|--|
| LEADS (12) 6 limb + 6 chest | 12 views of different anatomic parts of the heart obtained from 9 detectors (electrodes) |
| LIMB LEADS (6) red arrows | 6 views of different anatomic part of the heart from 3 limb electrodes; possible by adding lead I, II, and III obtained by 3 imaginary lines through electrodes (Einthoven's triangle) |
| LEAD I bipolar | machine combines information from 2 poles: L and R arms |
| LEAD II bipolar | machine combines information from 2 poles: R arm and L leg |
| LEAD III bipolar | machine combines information from 2 poles: L arm and L leg |
| LEAD aVL unipolar | aV = augmented voltage; voltage coming only from one arm (L in this case) needs to be boosted cos it's far from heart |
| LEAD aVR unipolar | information comes from the R arm |
| LEAD aVF unipolar | information comes from the L leg |

12 LEADS EKG: 6 LIMB LEADS



Ask Mish



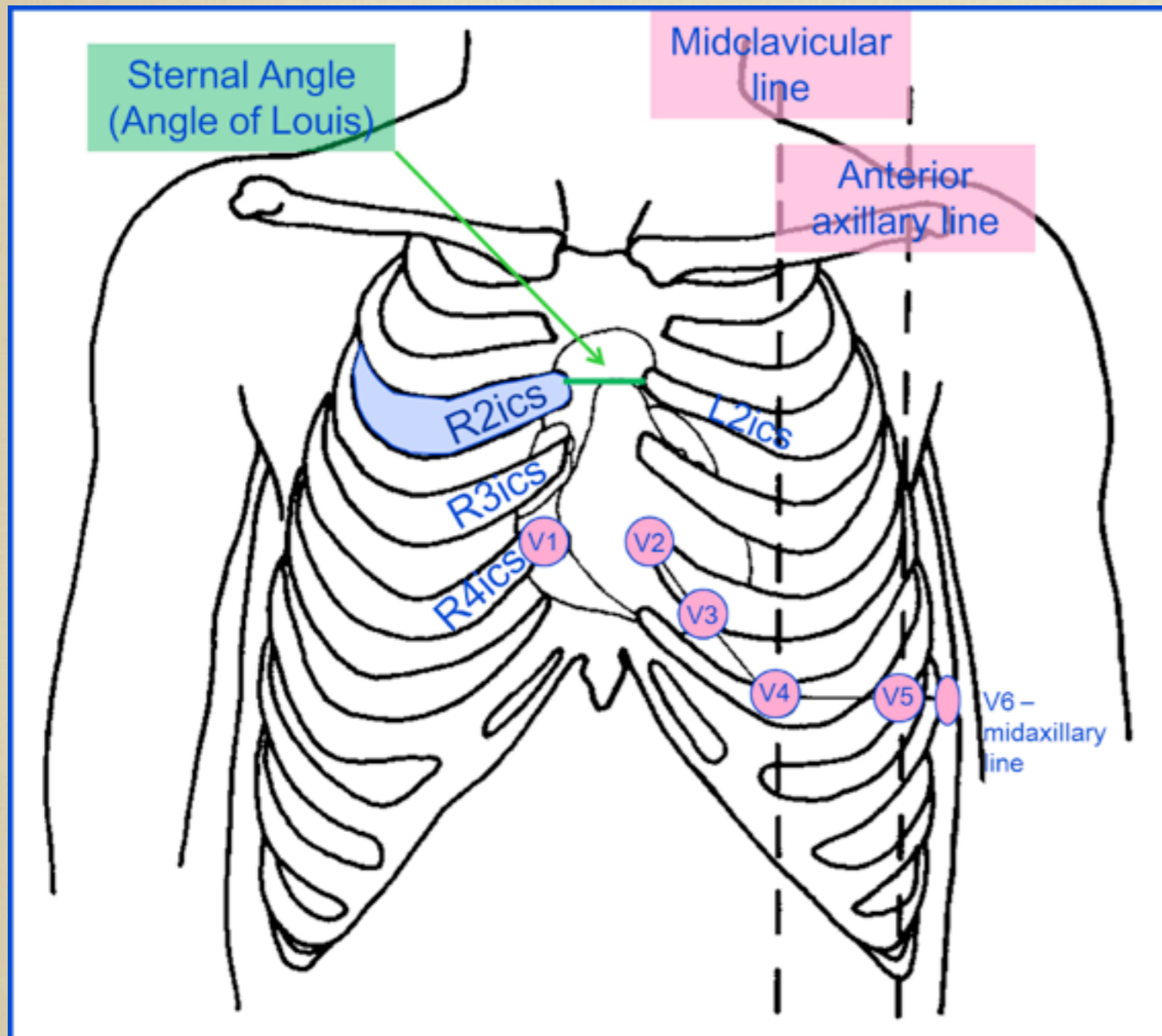
no view

lateral view
I and aVL

inferior view
II, III and aVF

- Moving the limb leads to a center we obtain the angles btw frontal heart views
- By convention, + is the direction of AP propagation (up to down) in the heart; negative is the opposite

12 LEADS EKG: 6 CHEST LEADS

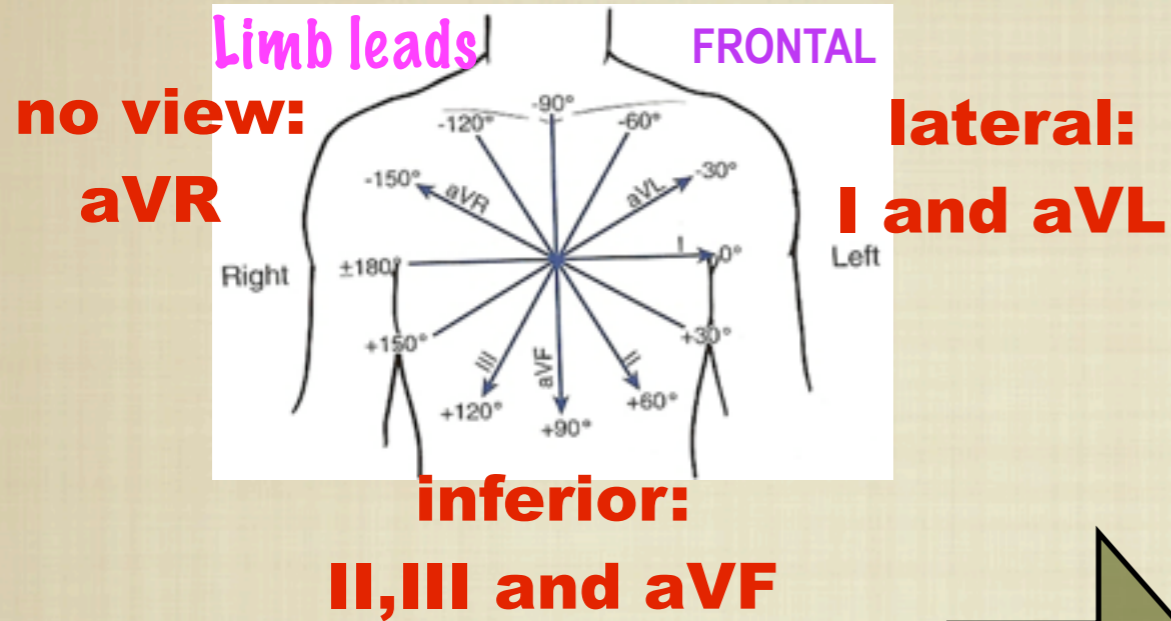


- Position of chest (precordial) leads:
- V1 and V2 on R and L sternal border at level of the 4th rib
- V4, V5 and V6 on the level of the 5th rib as follows
- V4 : midclavicular line
- V6 : midaxillary line
- V5 : midway V4-V6 or anterior axillary line
- V3 : midway V2 - V4

12 LEADS EKG: VIEWS OF HEART

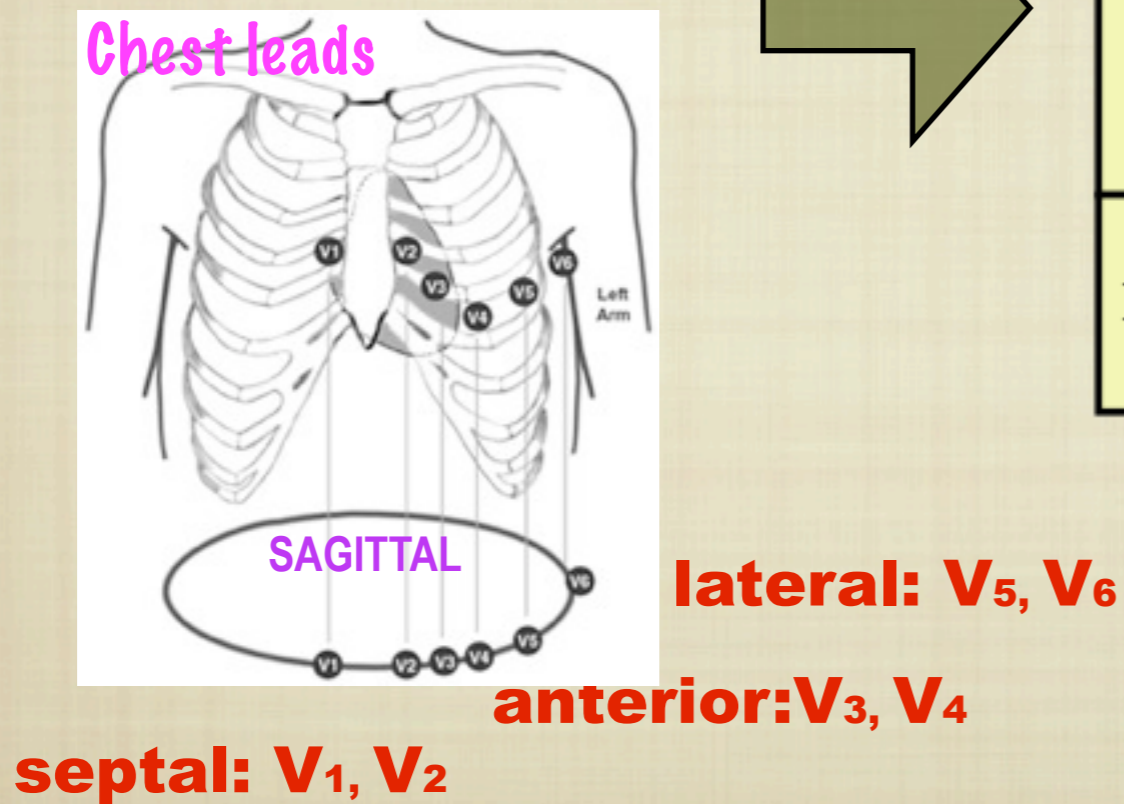


Ask Mish



Leads: name, view and standard color

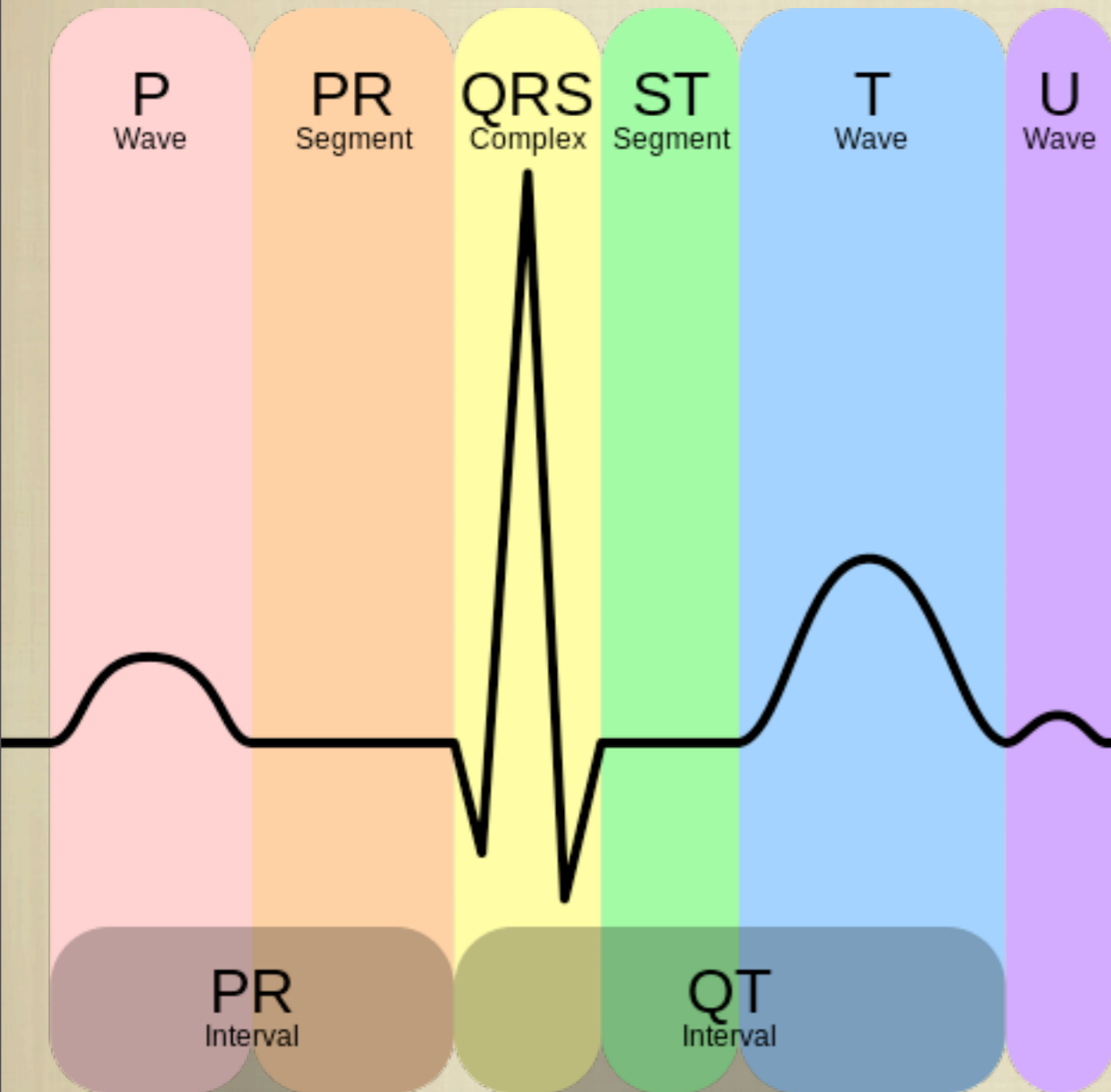
| | | | |
|--------------|--------------|-------------|-------------|
| I Lateral | aVR | V1 Septal | V4 Anterior |
| II Inferior | aVL Lateral | V2 Septal | V5 Lateral |
| III Inferior | aVF Inferior | V3 Anterior | V6 Lateral |



EKG: COMPONENTS & DESCRIPTION



Ask Mish

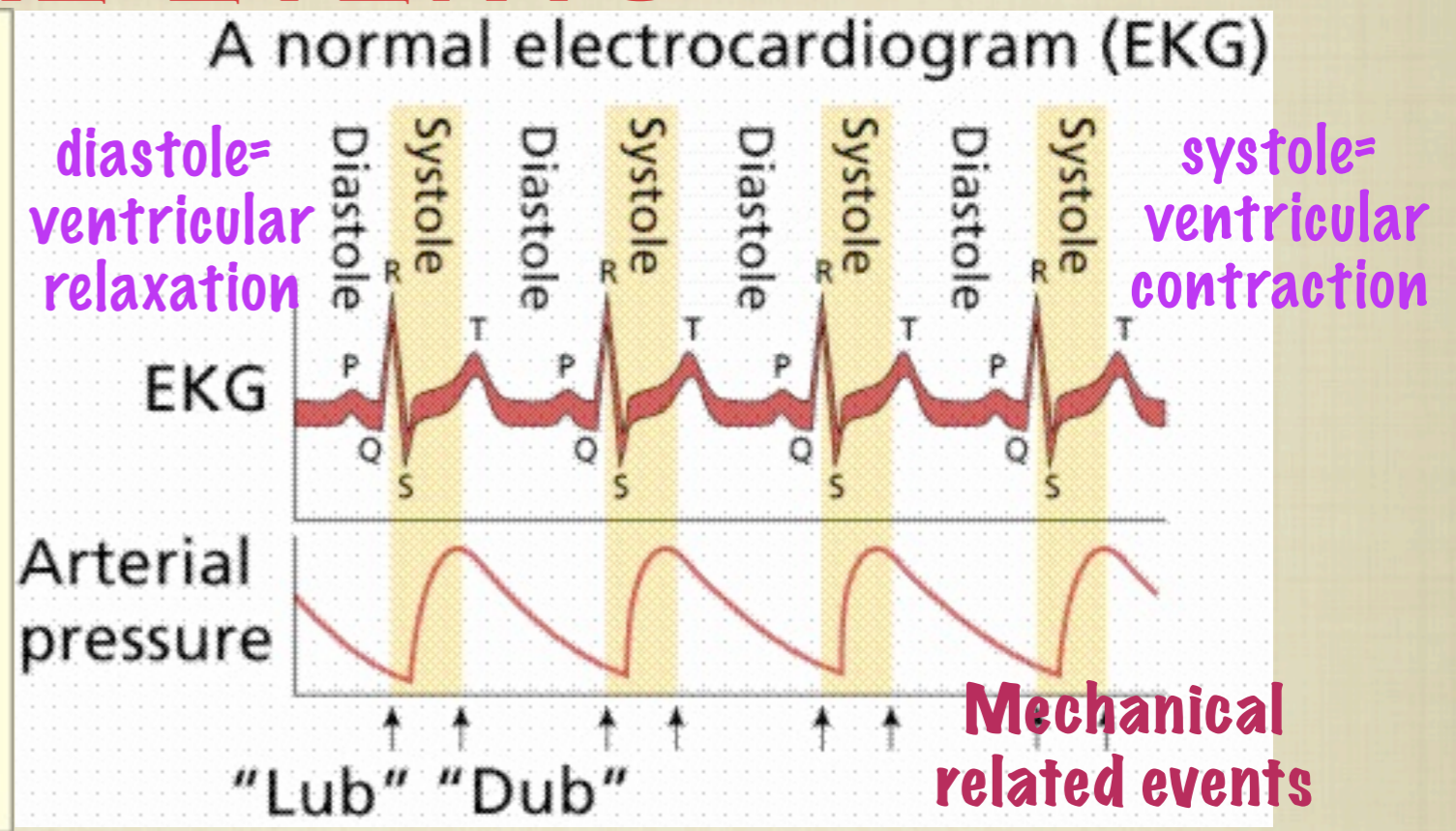
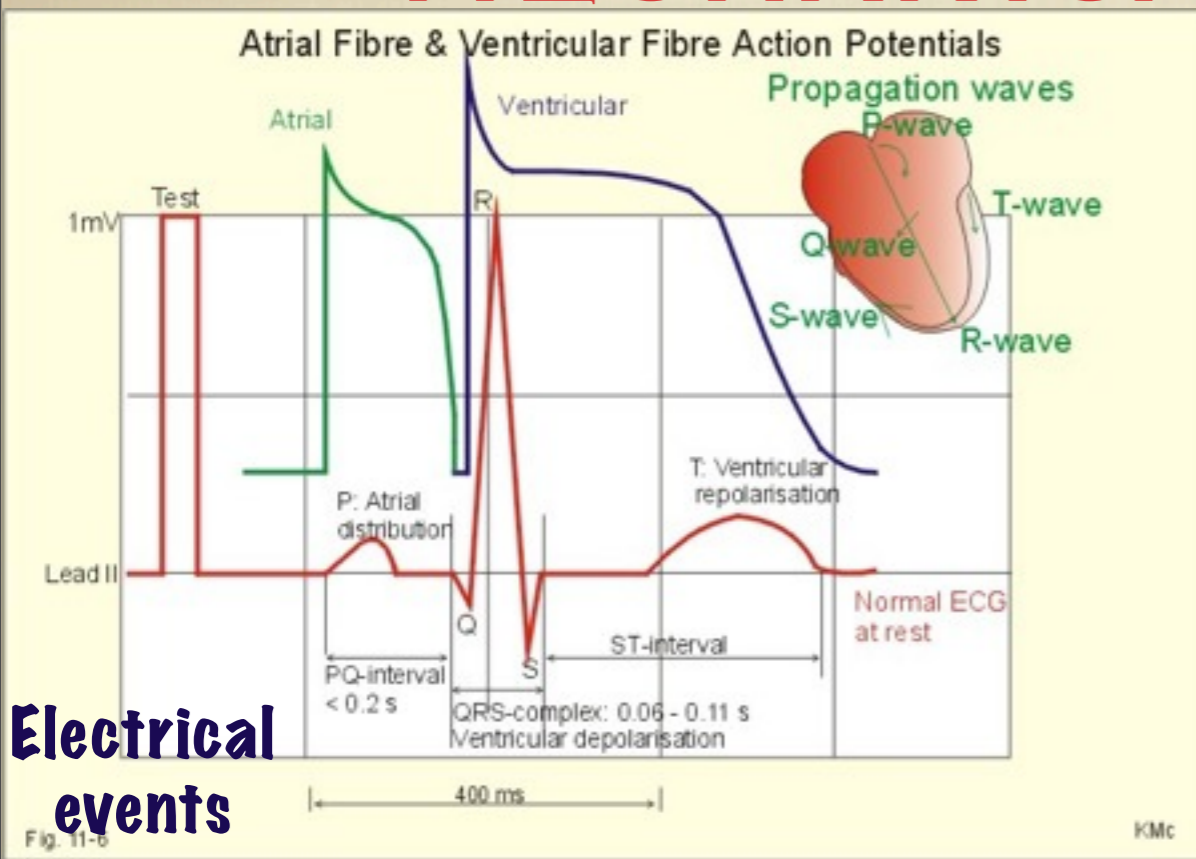


| | |
|-------------|--|
| wave | deflection up/down |
| segments | horizontal lines btw waves |
| interval | wave(s) + segment(s) |
| P wave | atrial depolarization |
| QRS complex | ventricular depolarization |
| T wave | ventricular repolarization |
| U wave | not known; after repolarization |
| PR segment | short AP block at AV node |
| ST segment | time btw ventricular depol. and repolarization |

EKG: RELATED ELECTRICAL & MECHANICAL EVENTS



Ask Mish



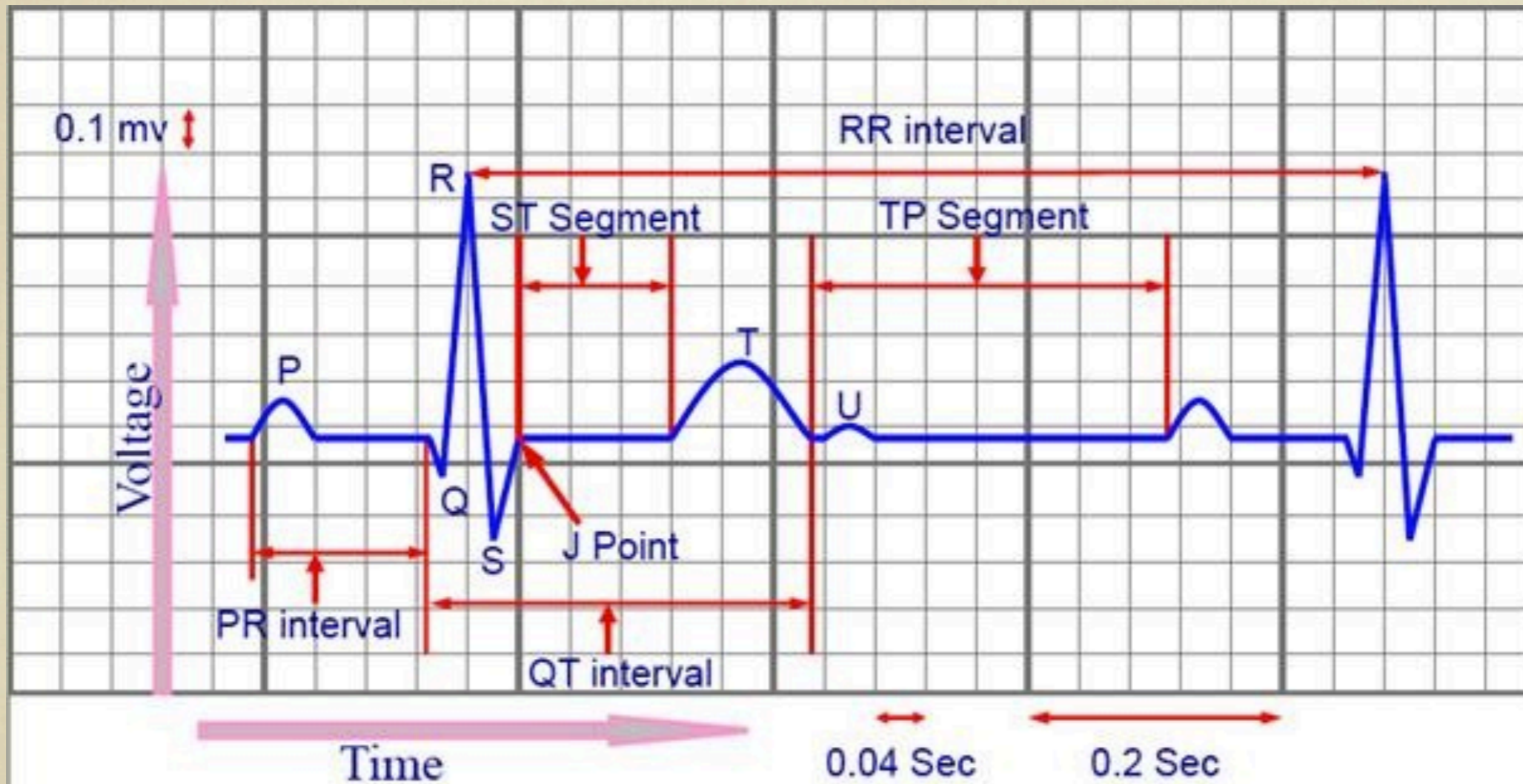
| EKG | ELECTRICAL EVENTS | MECHANICAL related EVENTS |
|-------------|----------------------------|--|
| P wave | ATRIAL depolarization | ATRIAL contraction; VENTRICULAR relaxation |
| QRS complex | VENTRICULAR depolarization | VENTRICULAR contraction |
| T wave | VENTRICULAR repolarization | VENTRICULAR relaxation |

EKG AT REST: INTERVALS



Ask Mish

DURATION OF THE EKG MAIN INTERVALS AND QRS COMPLEX



- PR interval 0.12 – 0.20 sec
- QRS duration 0.08 – 0.10 sec

- QT interval 0.4 – 0.43 sec
- RR interval 0.6 – 1.0 sec

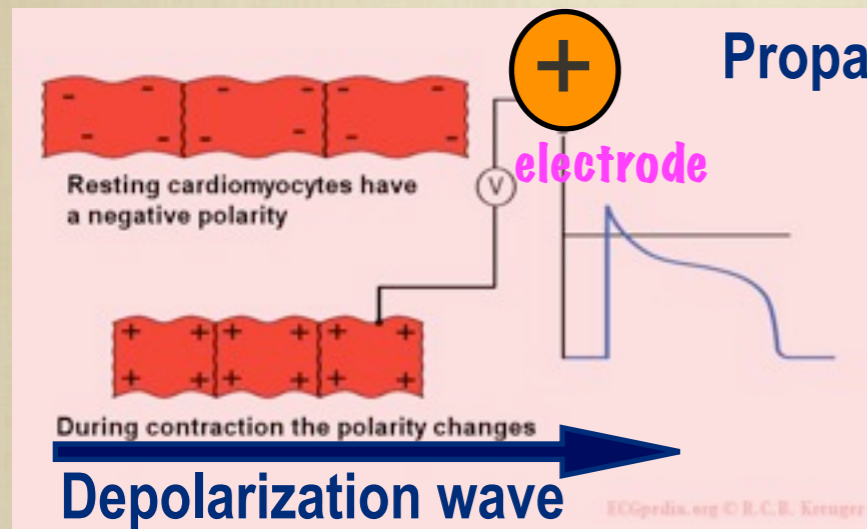
EKG: DEPOLARIZATION WAVES



Ask Mish

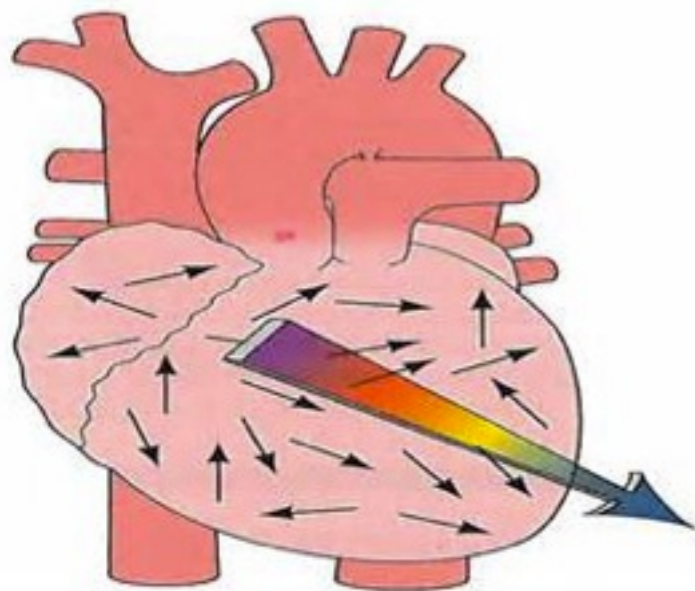


Depolarized cell

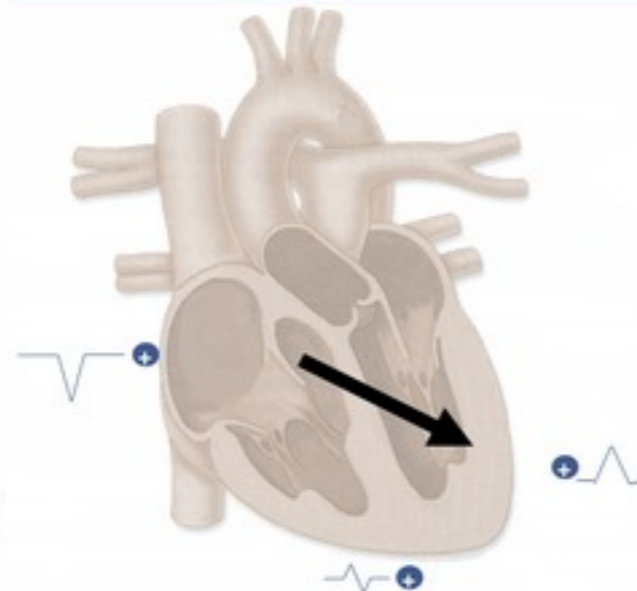


Propagation direction

- Depolarization: cell **more positive inside** than outside.
- Negative charges propagate toward positive electrode.
- Summing up all the individual directions of depolarization we obtain a **summation (integral) vector** of depolarization.
- If the vector is **toward** the electrode, the wave registered on EKG is **up**, if **away** from the electrode, the wave is **down** and if **perpendicular** to the electrode the wave is **biphasic**
- the **peak** of the wave = tissue **fully depolarized** and the **isoelectric line** = all **charges** reached the electrode and were **neutralized**.



Summation vector

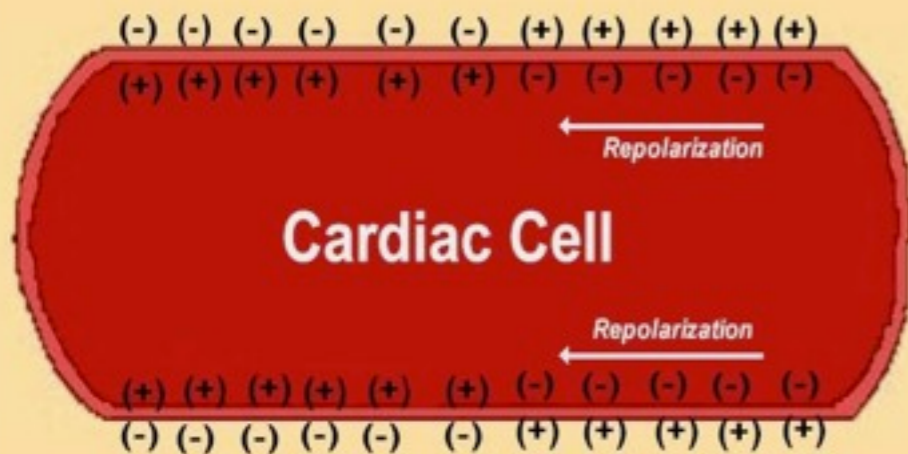


Waves up, down, biphasic

EKG: REPOLARIZATION WAVES



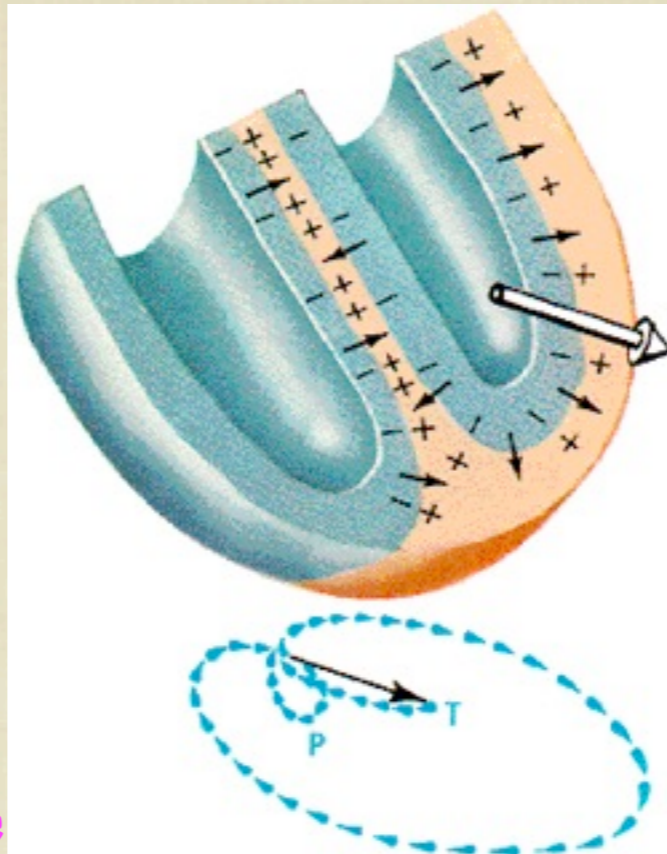
Ask Mish



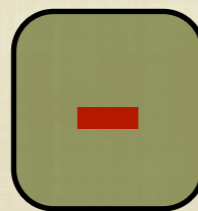
Repolarization wave



electrode



Repolarization summation vector



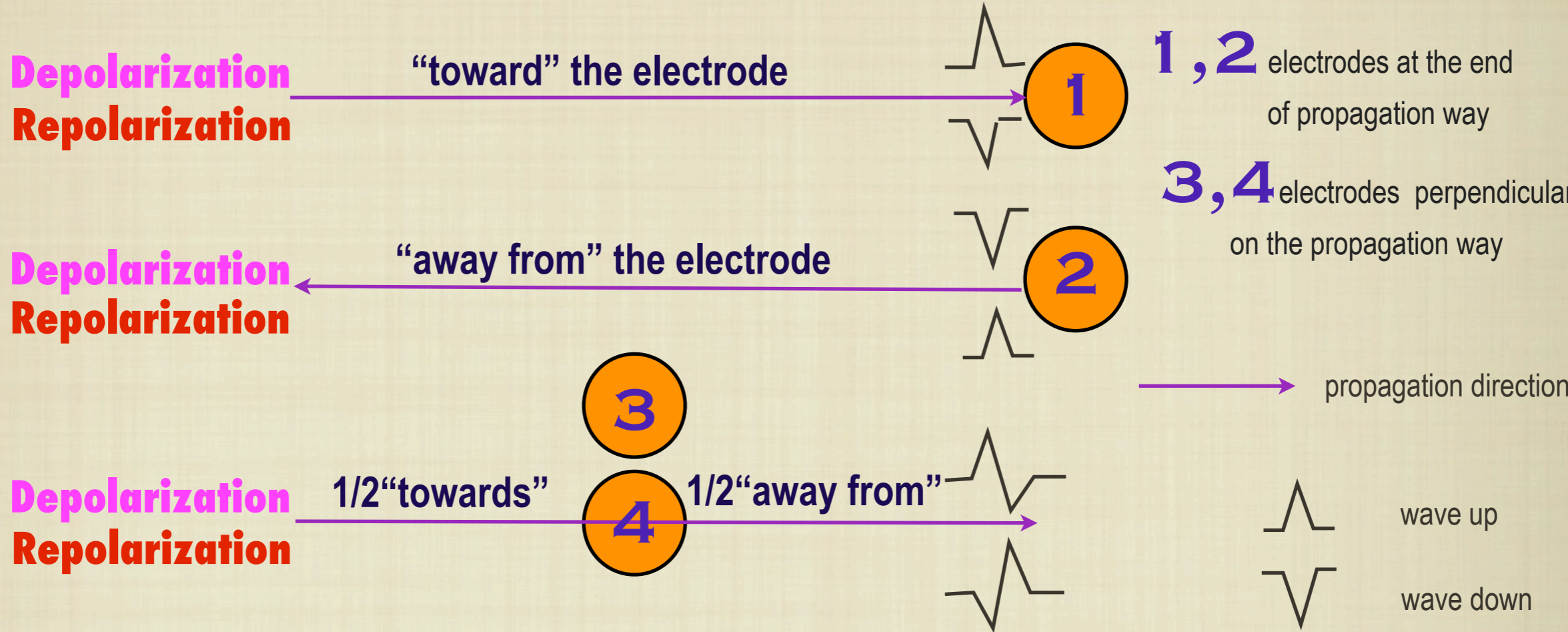
Repolarized cell

- Repolarization: comes after depolarization and cell turns **negative** inside from positive.
- Repolarization begins where the depolarization ends up and goes all the way back until all the tissue(cells) is fully repolarized.
- Despite **reverse polarity** during repolarization, the **summation vector points the same direction as the depolarization one**, so the repolarization wave (T wave) points in the same direction as the depolarization one(R wave).

EKG AT REST: ALL WAVES (1)



Ask Mish

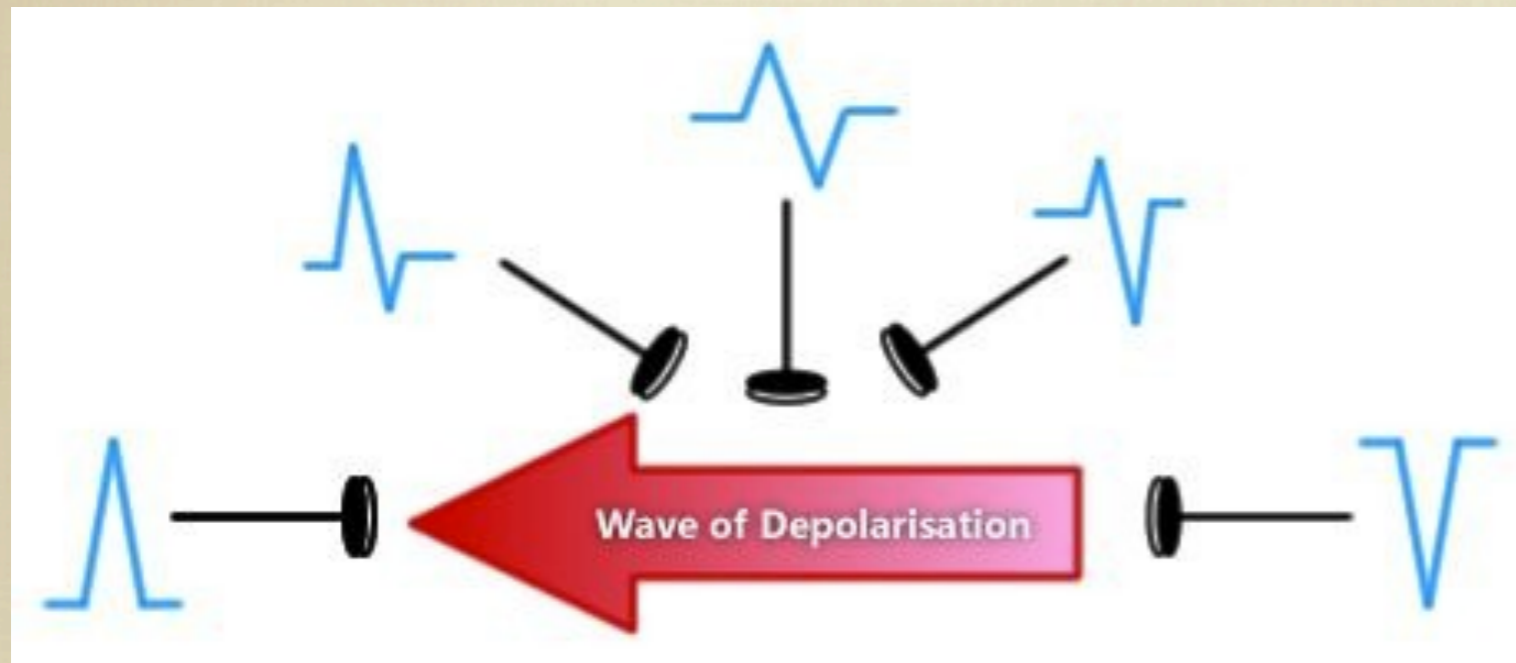


| EKG waves | Depolarization wave | Repolarization wave |
|-------------------------|----------------------------|---------------------|
| toward the electrode | UP (positive deflection) | DOWN |
| away from electrode | DOWN (negative deflection) | UP |
| reaching electrode | isoelectric line | isoelectric line |
| electrode perpendicular | biphasic | biphasic |

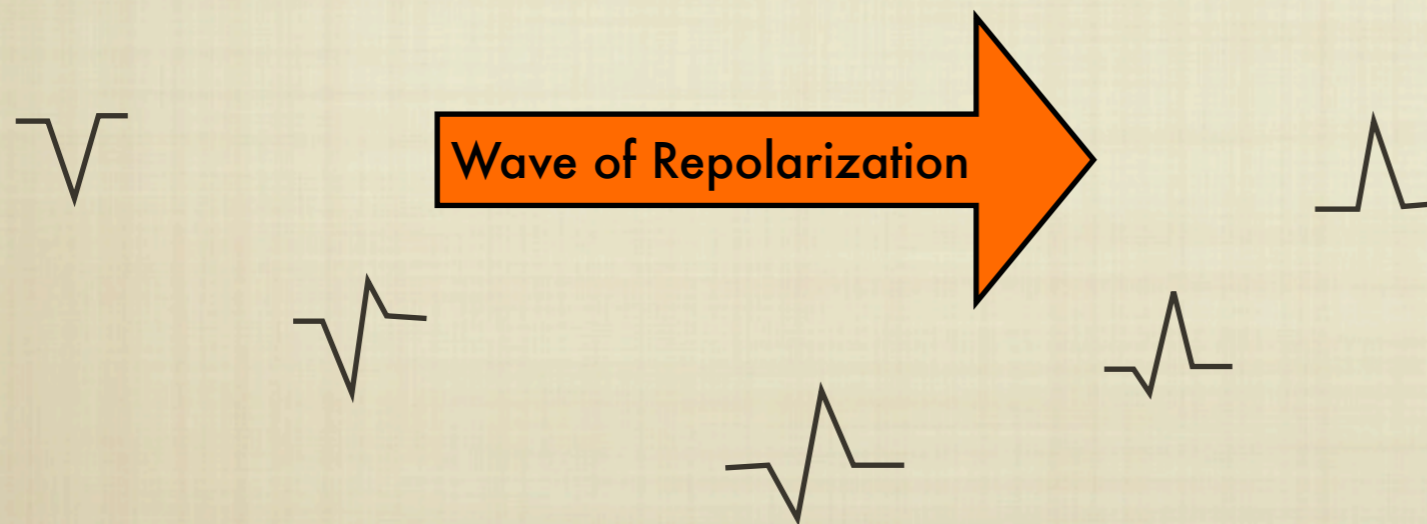
EKG AT REST: ALL WAVES(2)



Ask Mish



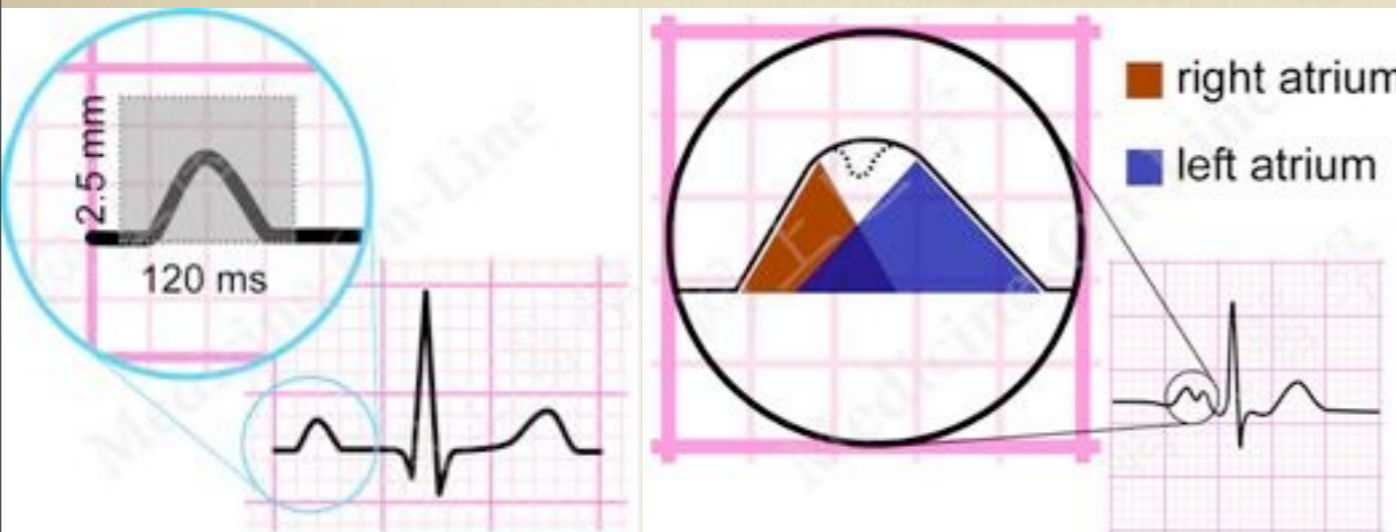
- Electrodes placed in btw those situated on the propagation wave and perpendicular on the propagation wave produce **various shaped waves** related to the location of the electrode: on the direction of depolarization/ repolarization or away from it.



EKG AT REST: P WAVE



Ask Mish



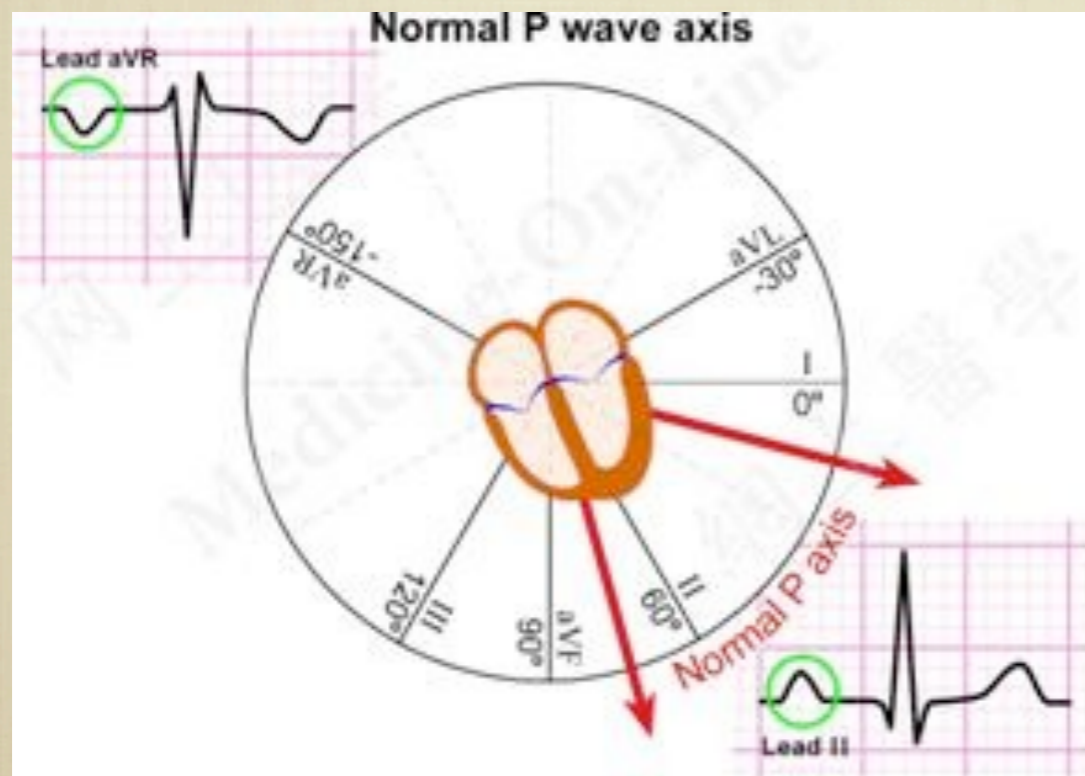
■ P wave= atrial depolarization

■ Amplitude of P wave < 2.5 mV (2.5 mV = 2.5 small squares); Duration of the P wave < 120 ms

■ Since right atrium depolarizes before left atrium, P wave first half is right atrial depolarization and second half is left atrium depolarization

■ Atrial depolarization vector normal range is 30-75 degrees.

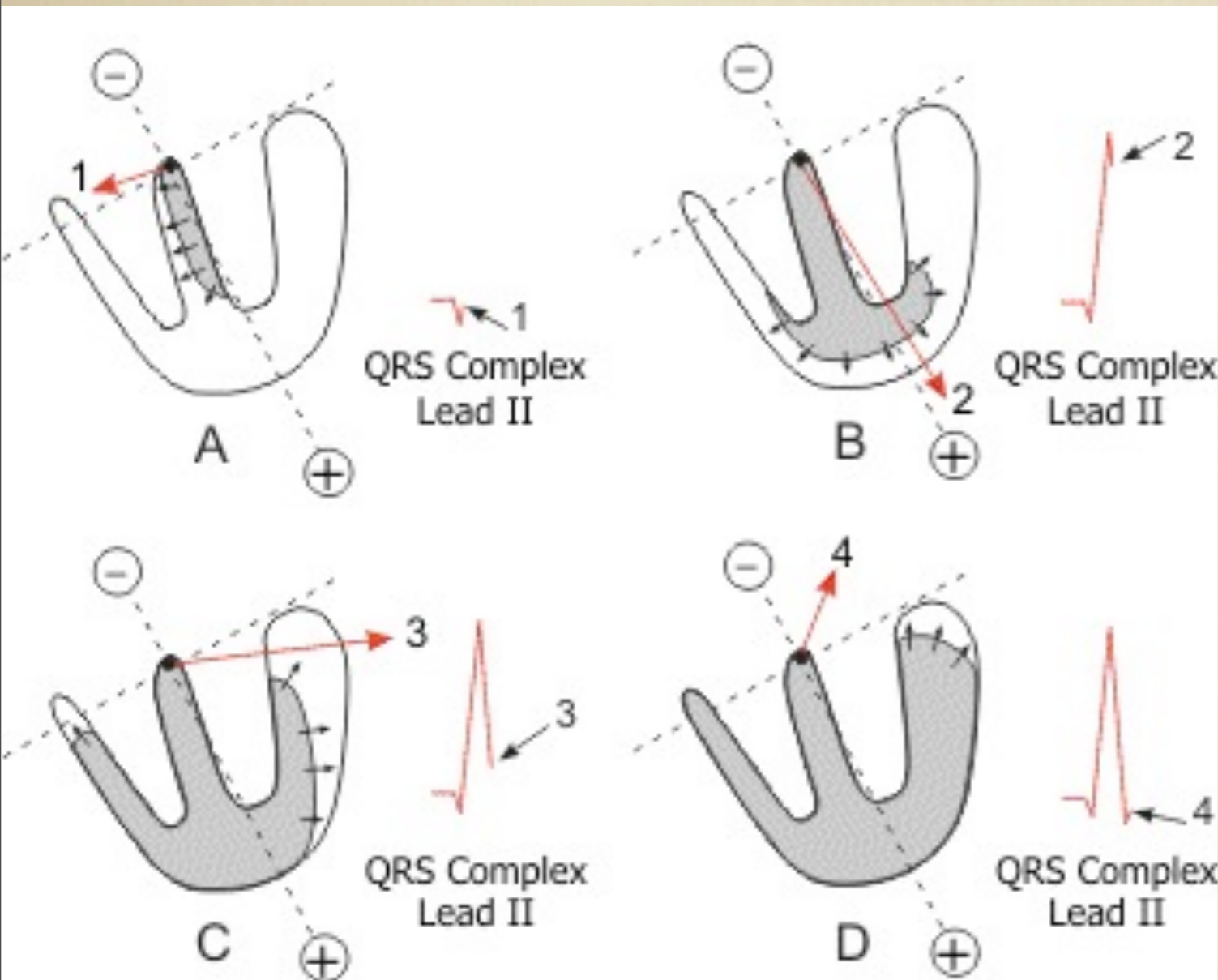
■ P wave is normally + in lead II, - in lead aVR and biphasic or negative in lead III



EKG AT REST: QRS COMPLEX(1)



Ask Mish

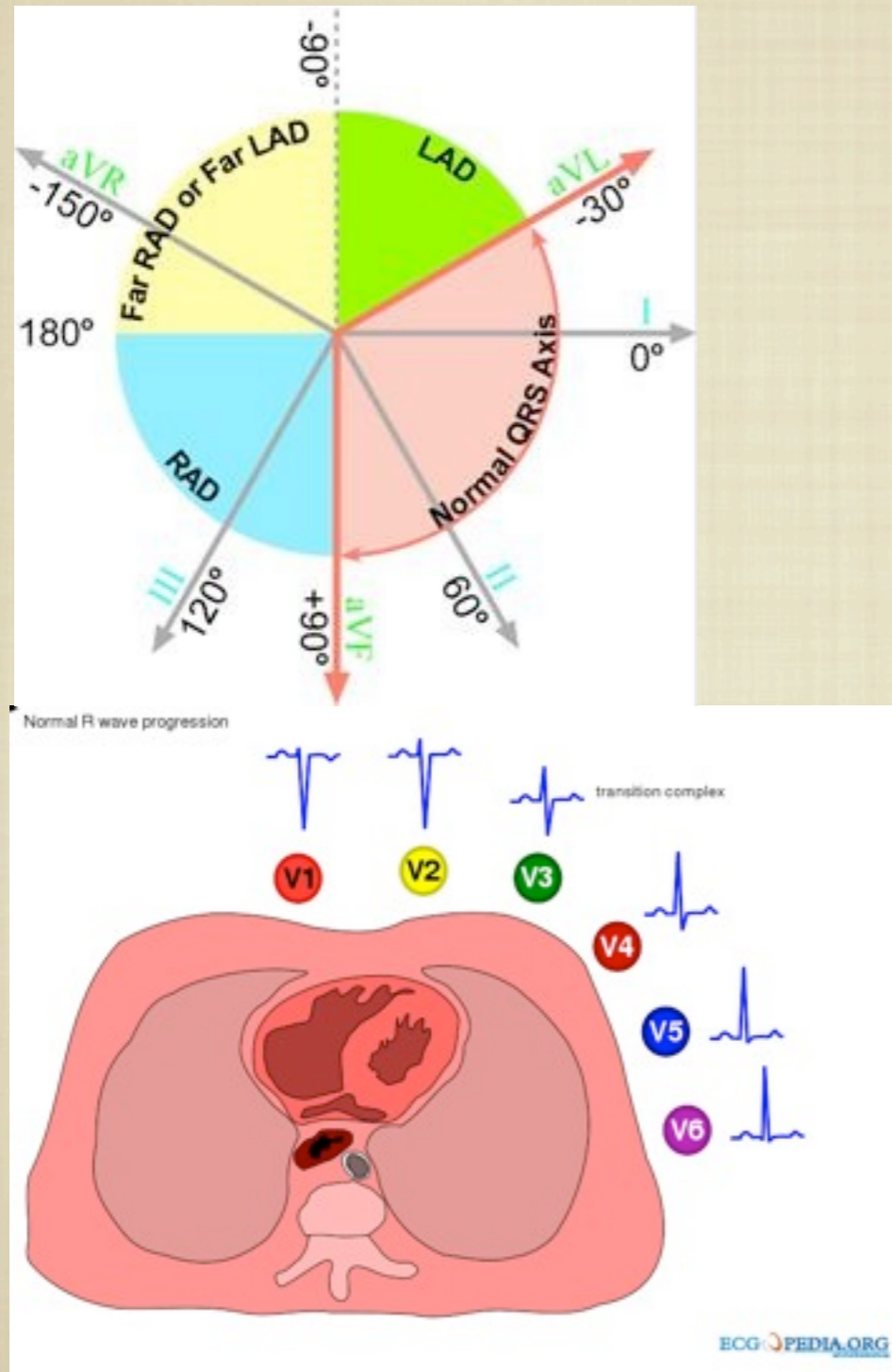


- Q wave represents septal (wall btw R & L ventricles) depolarization. This is the beginning of ventricular depolarization.(1)
- It is propagated from left to right.
- The septal depolarization is initiated by the action potential arrived at the septal fascicle of left bundle branch (LBB)
- Q wave appears as a negative deflection in lateral, inferior and anterior leads with an amplitude < 0.1 mV
- Sometimes Q wave is not visible on a normal EKG

EKG AT REST: QRS COMPLEX(2)



Ask Mish

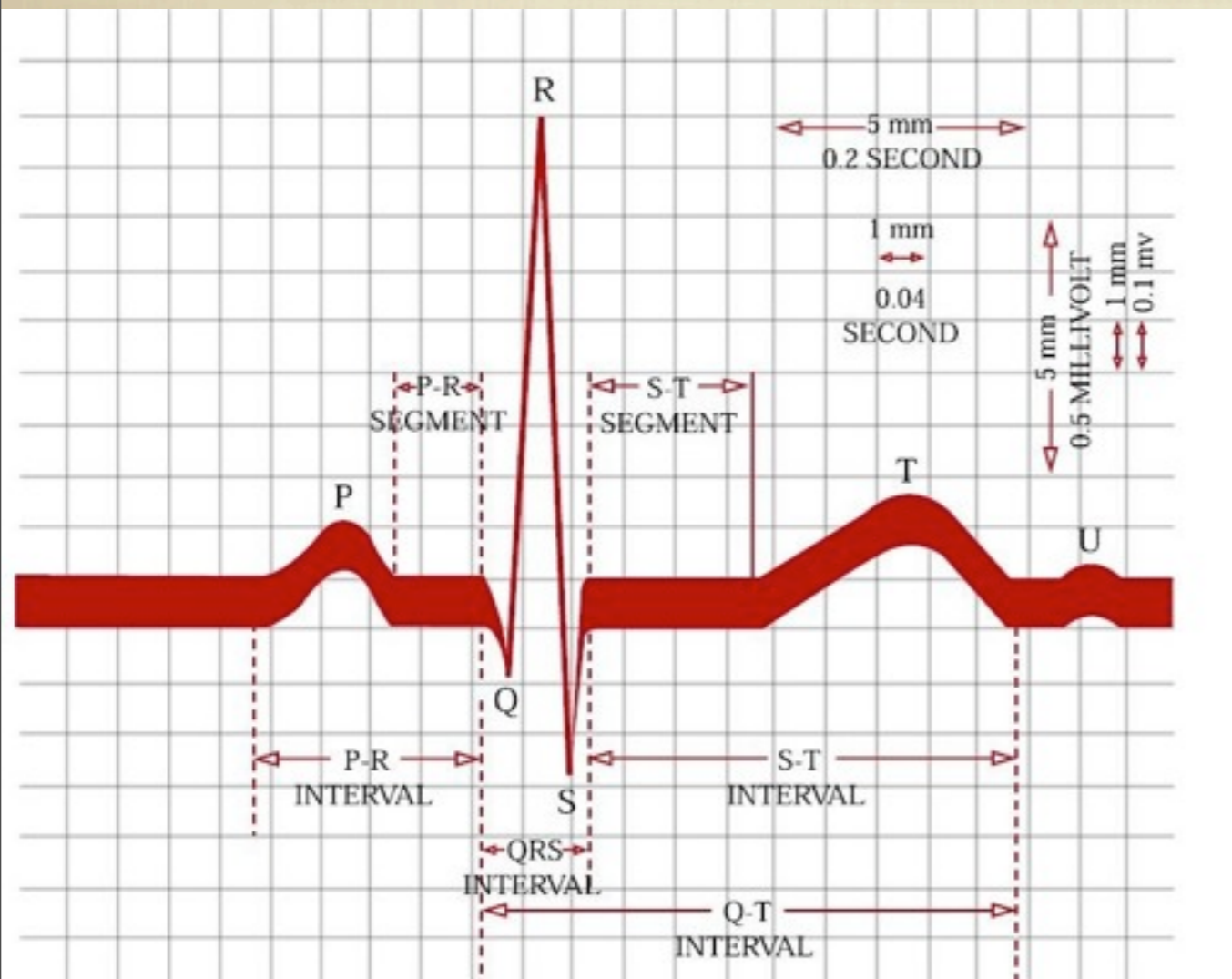


- RS represents **VENTRICULAR MUSCLE depolarization**. R is the positive deflection and S the negative one.
- Left Ventricle is more massive than the right one and the average vector points left, anywhere from **-30 to +90 degrees**. So R (positive) waves will be found in the inferior and lateral leads while S(negative wave) in aVR for ex.
- In sagittal plan: **V1 and V2** covers the **R ventricle** while **V5 and V6** the **L ventricle**. So an S wave will appear in the first 2 V leads and an R in the last 2 V leads. V3 and V4 are biphasic and called transition zone.
- The progressively increasing R wave from right to left in the precordial leads is known as **R-wave progression**
- **QRS amplitude >> P wave amplitude** due to much more muscle mass of the ventricles in comparison with the atria generating a greater action potential

EKG AT REST: SEGMENTS



Ask Mish



- **PR segment** represents the time from the end of atrial depolarization and the beginning of ventricular depolarization.
- **Normal PR: 0.12-0.2s.**
- **ST segment** represents the time from the end of ventricular depolarization and the beginning of the ventricular repolarization.