

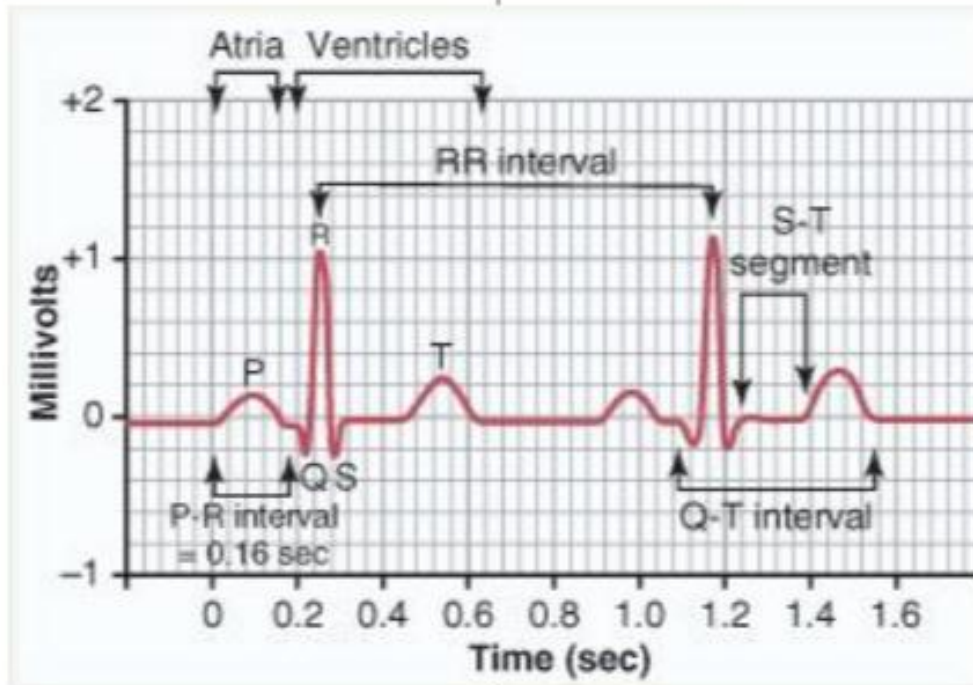


*Physiology*  
OF THE CARDIOVASCULAR SYSTEM

# The Electrocardiogram (ECG)

## The Normal Electrocardiogram (ECG)

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



- P wave: is caused by atrial depolarization
- QRS complex: is caused by depolarization of the ventricles
- T wave: repolarization of the ventricles

- 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

- The vertical calibration lines: Voltage(millivolt) : 5 small lines = 1 mV
- The horizontal calibration lines: Time (seconds) : -1 inch(25 small lines) = 1 second -Each inch is divided by 5 dark vertical lines -The interval between the dark lines= 0.2 second -thin line=0.04 second

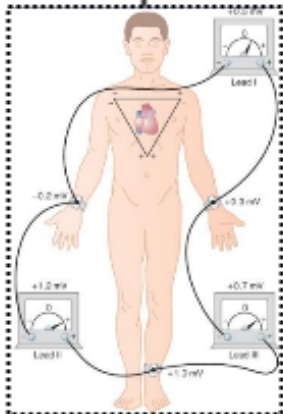
- Contraction of the ventricles last from the beginning of the Q wave to the end of the T wave
- Q-T interval is the time from the beginning of the Q wave to the end of the T wave
- Q-T interval is about 0.35 second

# Flow of Electrical current in the Heart

## The ECG Leads

- In normal ventricles, current flows from negative to positive from the base of the heart toward the apex
- The first area that depolarizes is the ventricular septum
- 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

- 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



### The 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

- \*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:
  - the right arm (aVR)
  - The left arm (aVL)
  - The left leg (aVF)
- All are similar to the standard limb leads
- aVR lead is inverted

