University of Al-Ameed
College of Pharmacy

Physiology

The Electrocardiogram (ECG or EKG)

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The Electrocardiogram (ECG)

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The electrical activity of the heart produces potentials at body surfaces that can be recorded by placing surface electrodes.

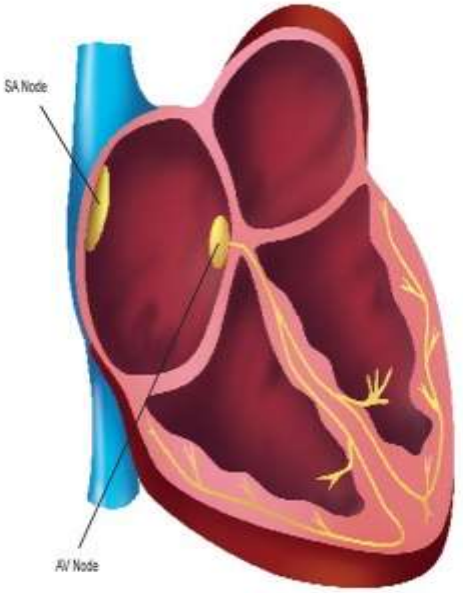
The electric currents pass from the heart into the surrounding tissues and spread to the surface of the body. The cardiac activity is obtained in the standard ECG by using 12 leads, six of which are limb leads and six are chest leads.

The Electrocardiogram (ECG)

The SA (sinoatrial) node generates an electrical signal that causes the upper heart chambers (atria) to contract.

The signal then passes through the AV (atrioventricular) node to the lower heart chambers (ventricles), causing them to contract, or pump.

The SA node is considered the pacemaker of the heart



Clinical application of ECG

*The anatomical orientation of the heart.

* sizes of its chambers.

* A variety of disturbances of rhythm of conduction.

*The extent, location, and progress of ischemic damage to the myocardium.

*The effects of altered electrolyte concentrations (e.g., hyperkalemia).

*The influence of certain drugs (notably digitalis and its derivatives).

The Electrocardiogram (ECG)

Impulse conduction

Sinoatrial node (SA) node

↓

Atrioventricle node (AV)

↓

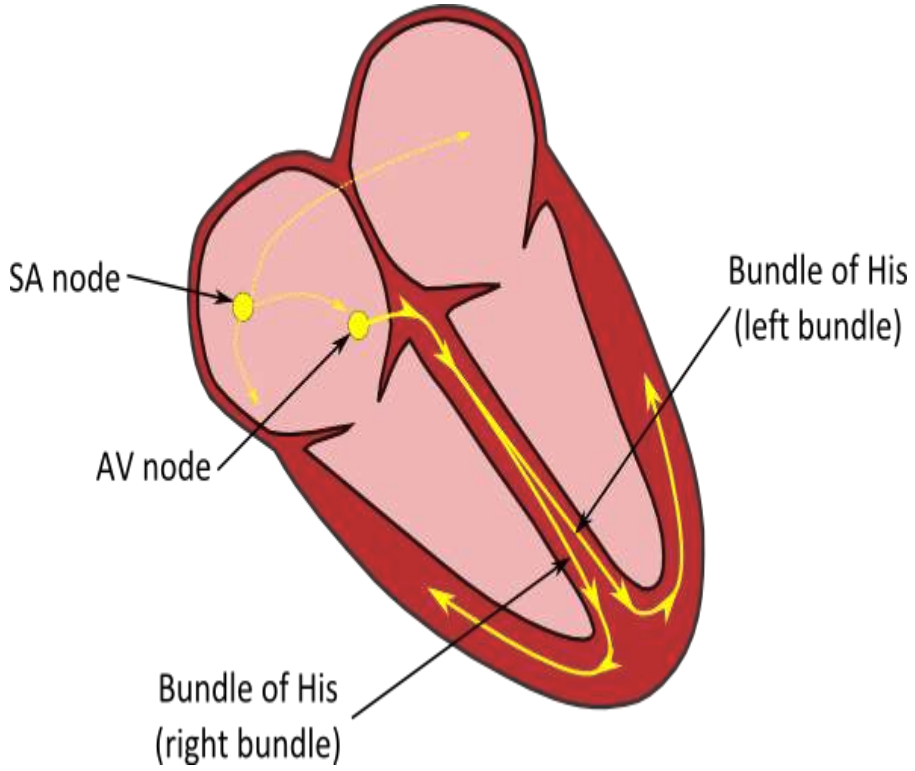
Bundle of His

↓

Bundle branches

↓

Purkunje fibers



The Electrocardiogram (ECG)

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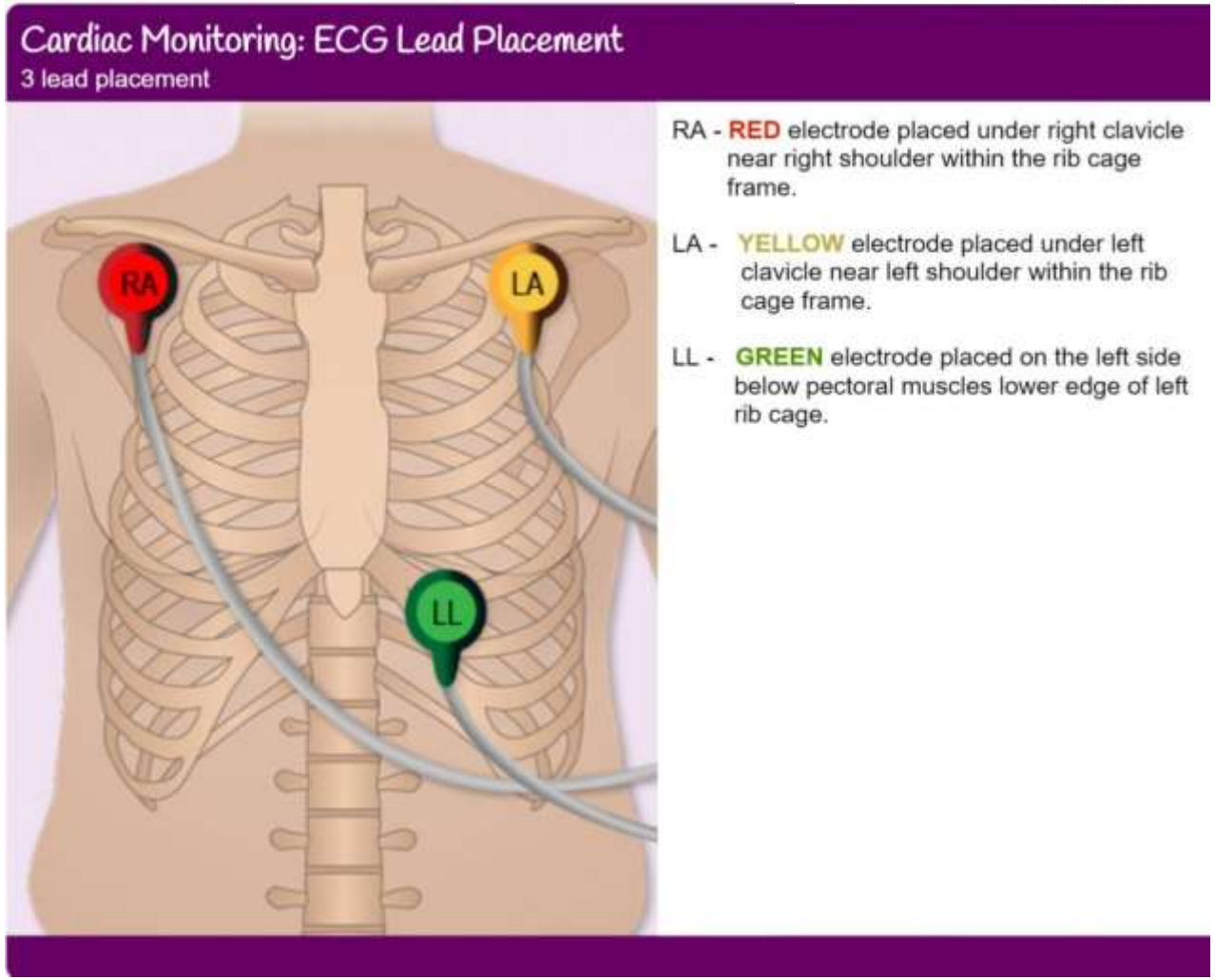
An electrode is a conductive pad that is attached to the skin and enables the recording of electrical currents. An ECG lead is a graphical description of the electrical activity of the heart and it is created by analyzing several electrodes.



The limb and chest electrodes

RA - On the right arm, avoiding thick muscle

LA – On the left arm this time.

RL - On the right leg, lateral calf muscle

LL- On the left leg this time.

The 6 chest electrodes

V1 - Fourth intercostal space, right sternal border.

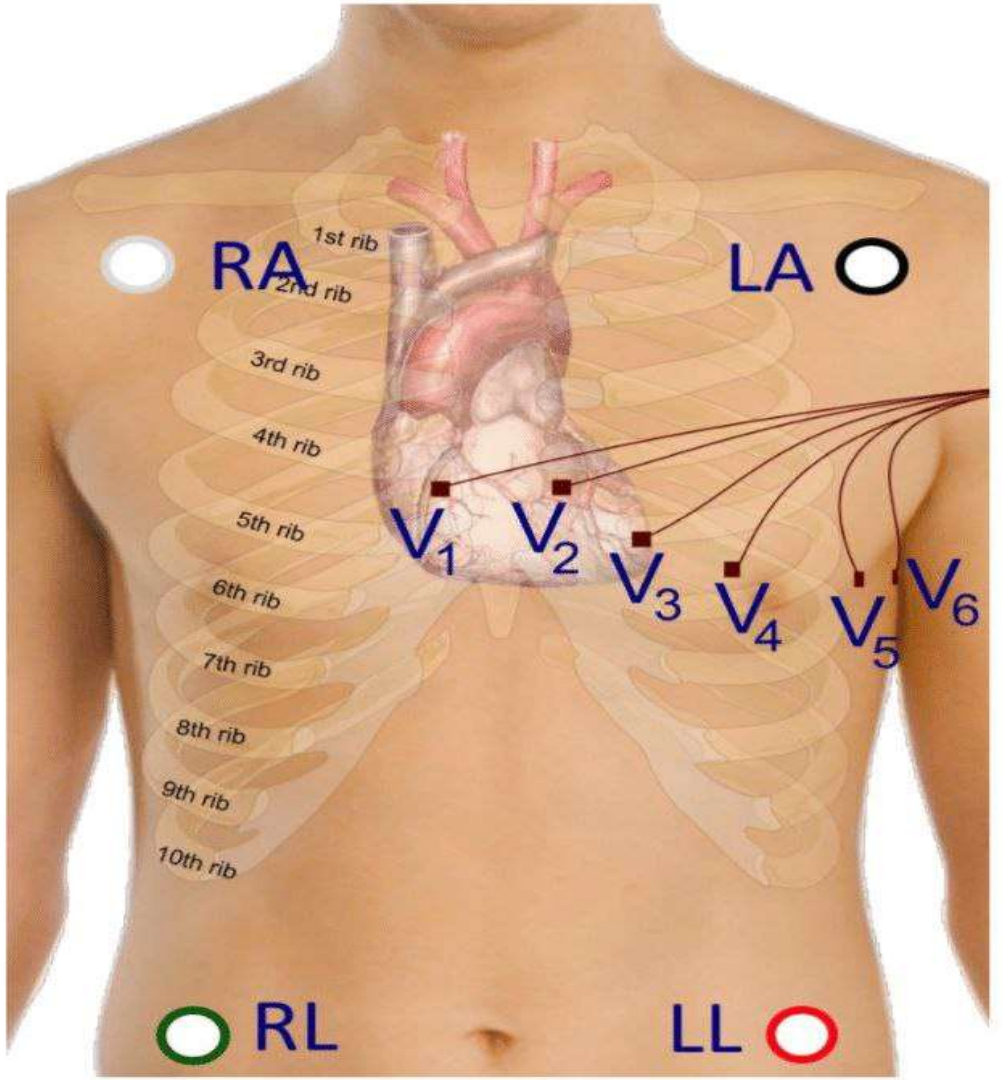
V2 - Fourth intercostal space, left sternal border.

V3 - Midway between V2 and V4.

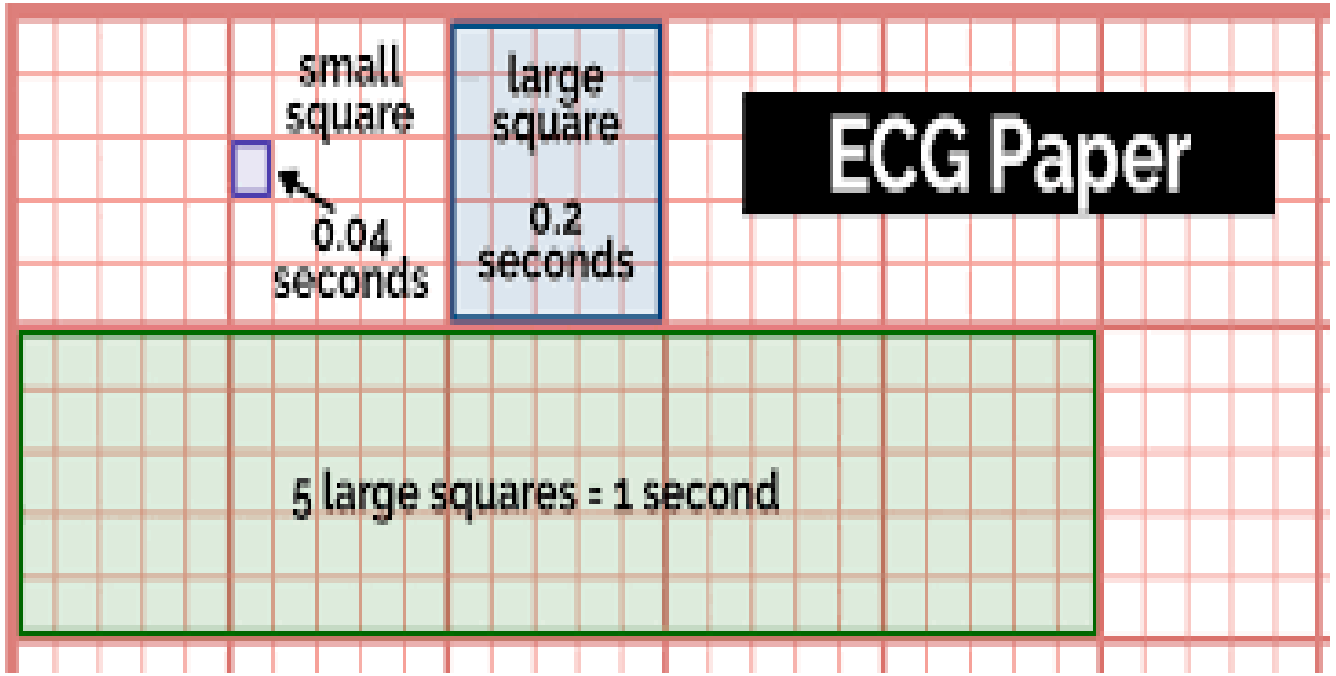
V4 - Fifth intercostal space, left midclavicular line.

V5 - Level with V4, left anterior axillary line.

V6 - Level with V4, left mid axillary line.

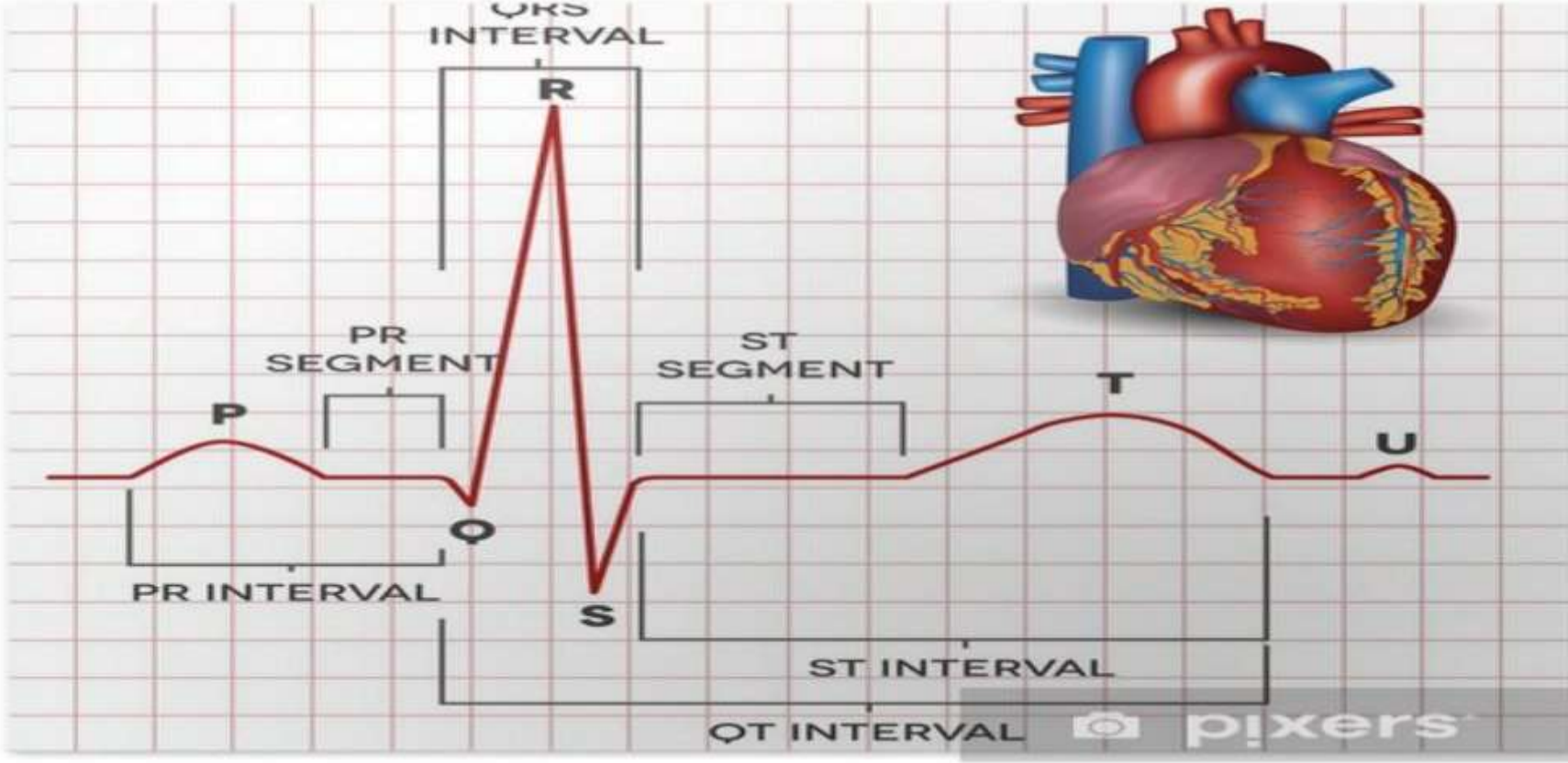


ECG paper

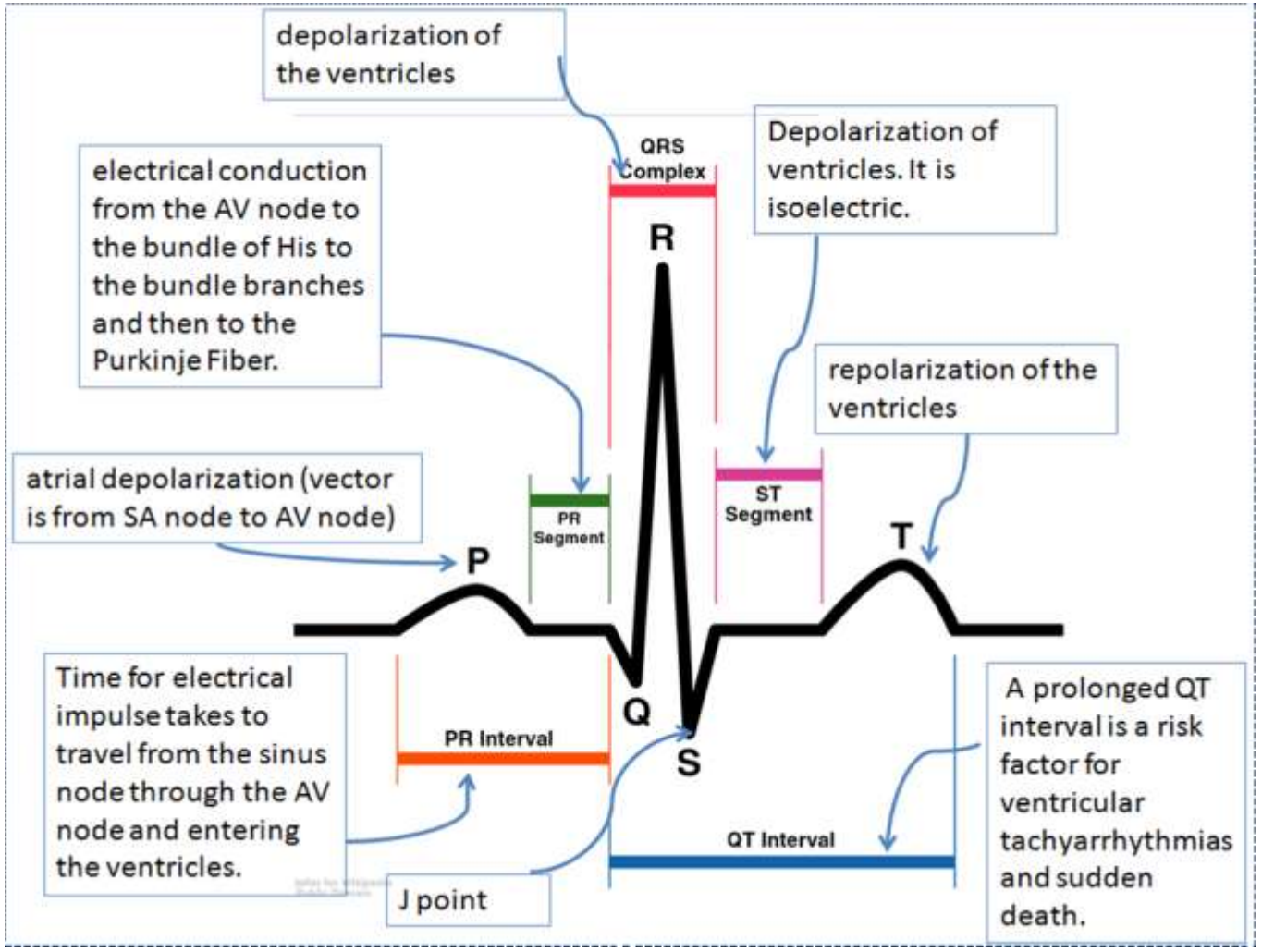

small square
0.04 seconds
large square
0.2 seconds
ECG Paper
5 large squares = 1 second

How does an ECG work?

The ECG works mostly by detecting and amplifying the tiny electrical changes on the skin that are caused when the heart muscle "depolarizes" during each heart beat.



How does an ECG work?



Action potential

Stimulus starts the rapid change in voltage or action potential. sufficient current must be administered to the cell in order to raise the voltage above the threshold voltage to start membrane depolarization.

Depolarization is caused by a rapid rise in membrane potential opening of sodium channels in the cellular membrane, resulting in a large influx of sodium ions.

Membrane Repolarization results from rapid sodium channel inactivation as well as a large efflux of potassium ions resulting from activated potassium channels.

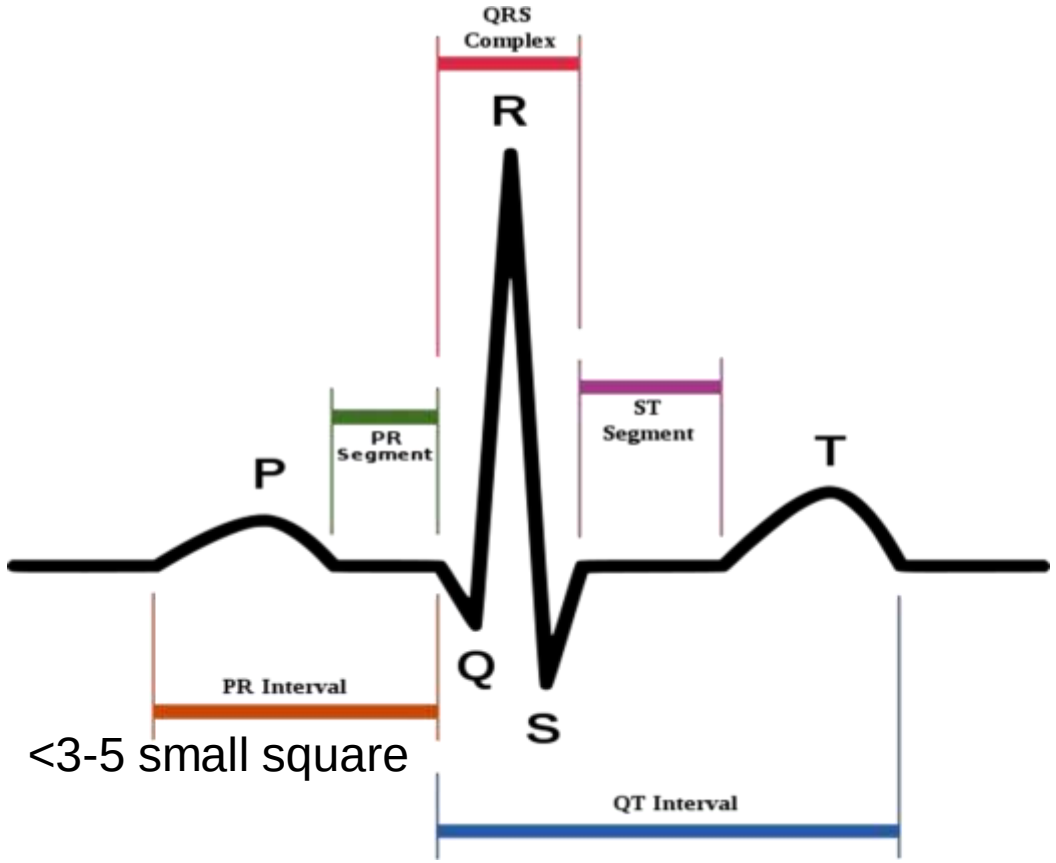
Action potential

Hyperpolarization is a lowered membrane potential caused by the efflux of potassium ions and closing of the potassium channels.

Resting state is when membrane potential returns to the resting voltage that occurred before the stimulus occurred.

The Electrocardiogram (ECG)

<3 small square



<3-5 small square

< 2 large square

RATE

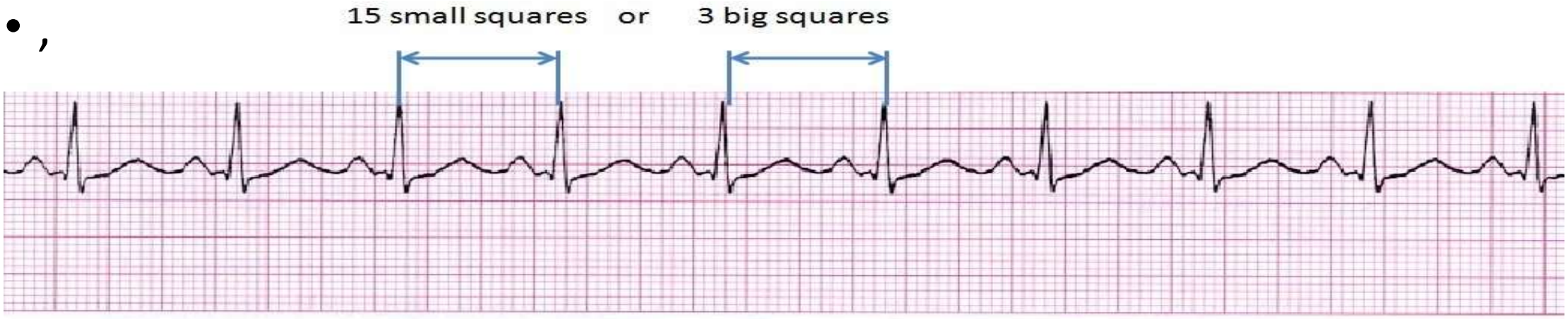
- RATE
- CALCULATING RATE

$$\text{Rate} = \frac{300}{\text{the number of } \textbf{BIG SQUARE} \text{ between R-R interval}}$$

$$\text{Rate} = \frac{1500}{\text{the number of } \textbf{SMALL SQUARE} \text{ between R-R interval}}$$

RATE

- ,

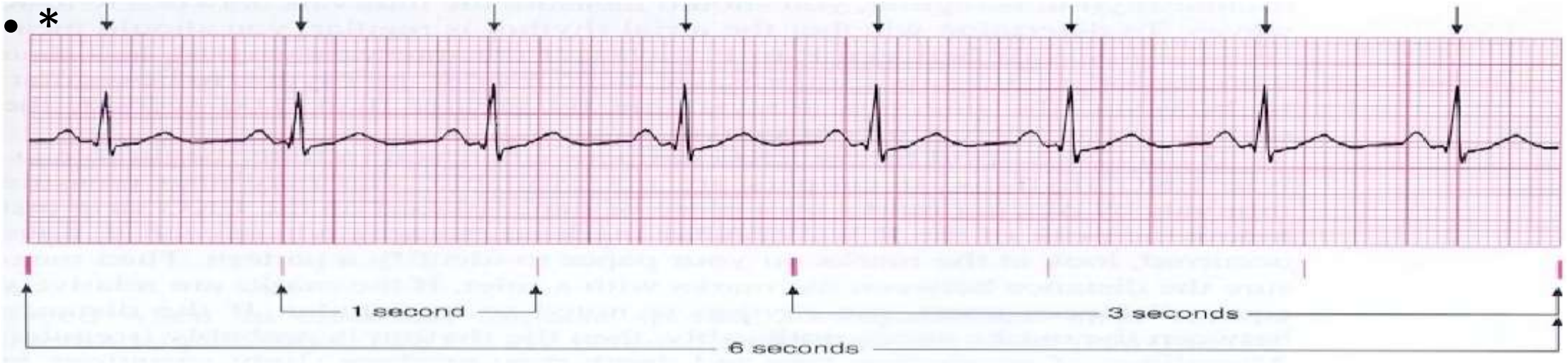


Rate = 300/3
=100

Or rate = 1500/ 15 = 100

RATE

- *



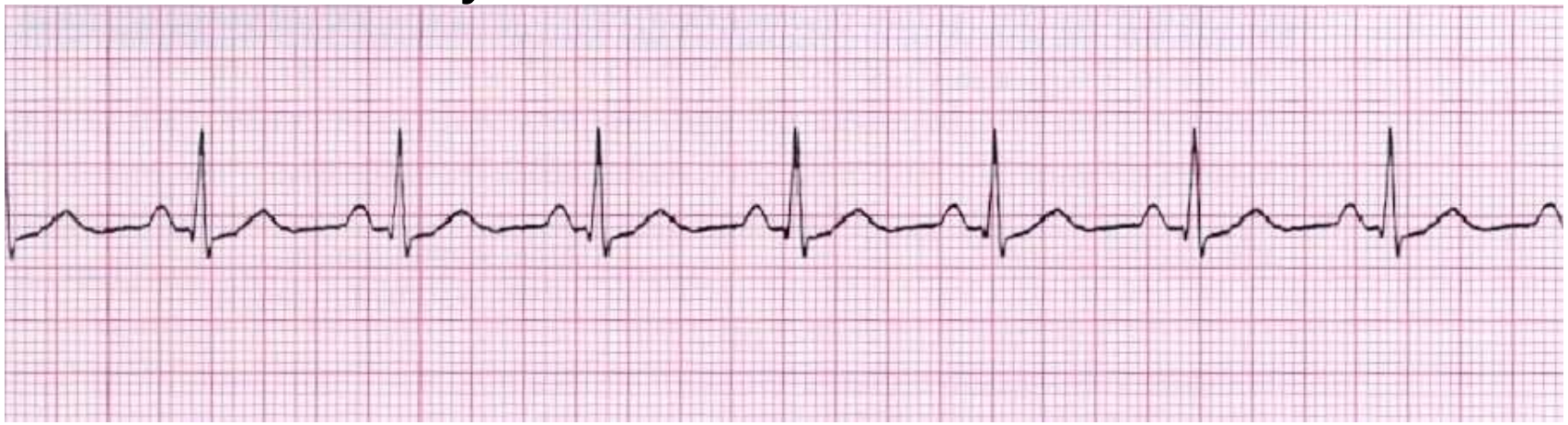
There are 8 waves in this 6-seconds strip

Rate = (Number of waves in 6-second strips) x 10

8* 10 = 80

RHYTHM

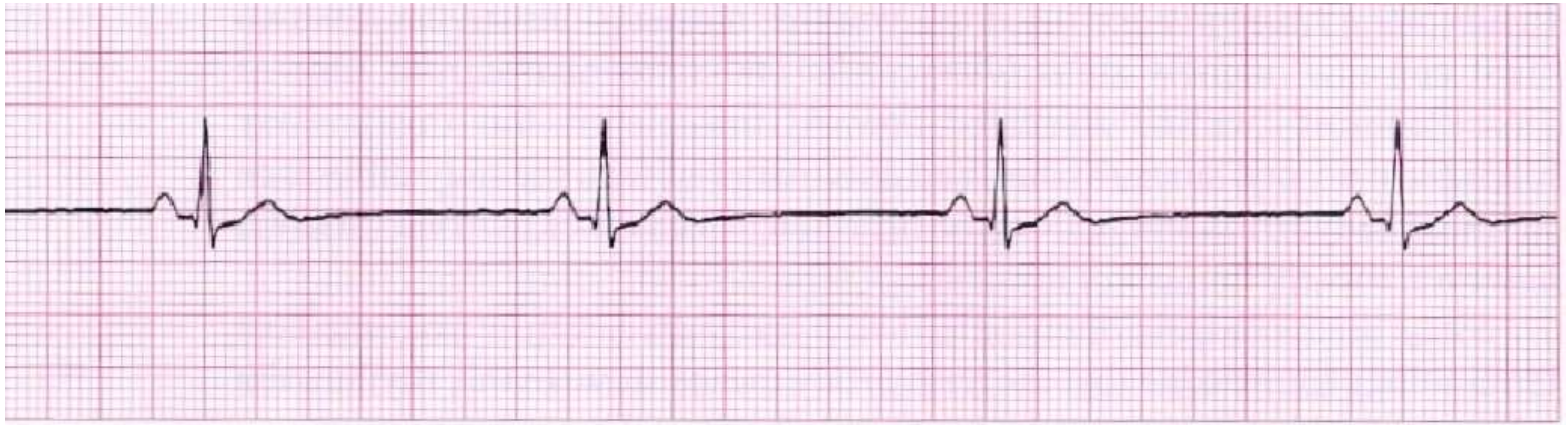
- **Normal Sinus Rhythm**



- ECG rhythm characterized by a usual rate of anywhere between 60-99 bpm, every P wave must be followed by a QRS and every QRS is preceded by P wave. Normal duration of PR interval is 3-5 small squares.

RHYTHM

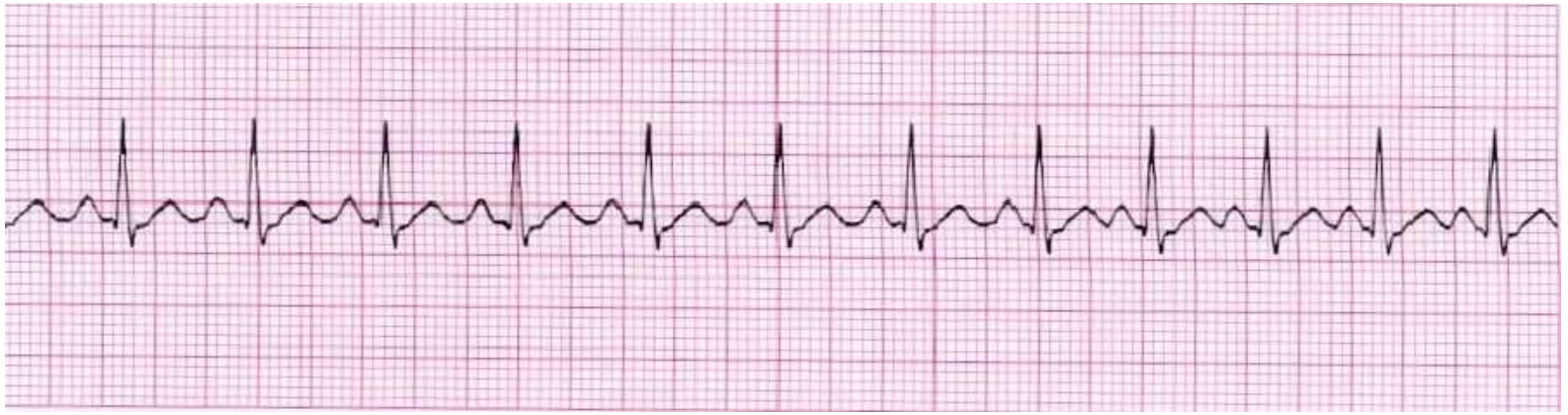
Sinus Bradycardia



Rate < 60bpm, otherwise normal

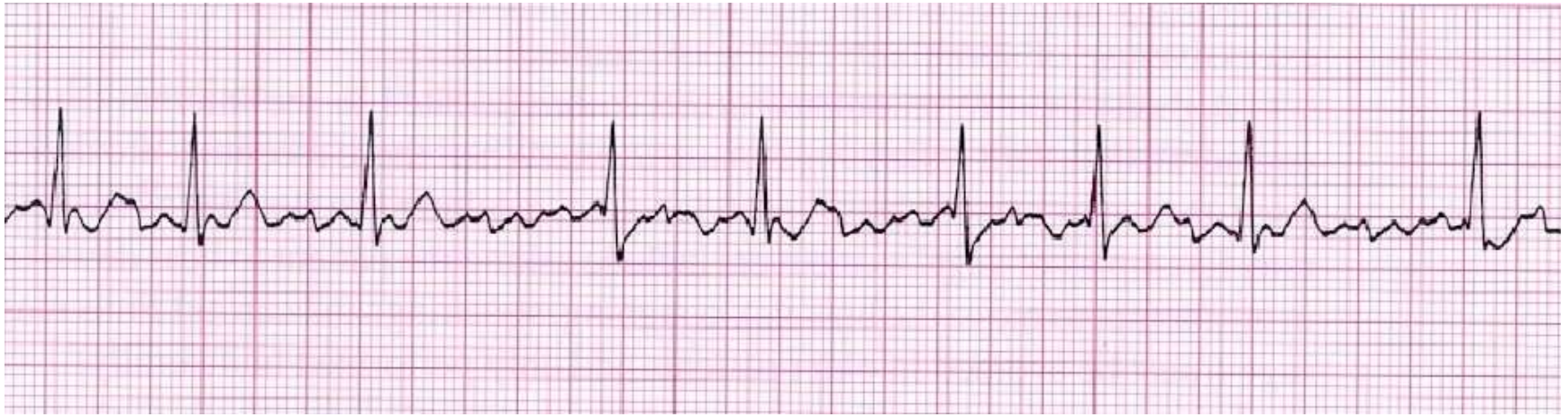
RHYTHM

Sinus Tachycardia



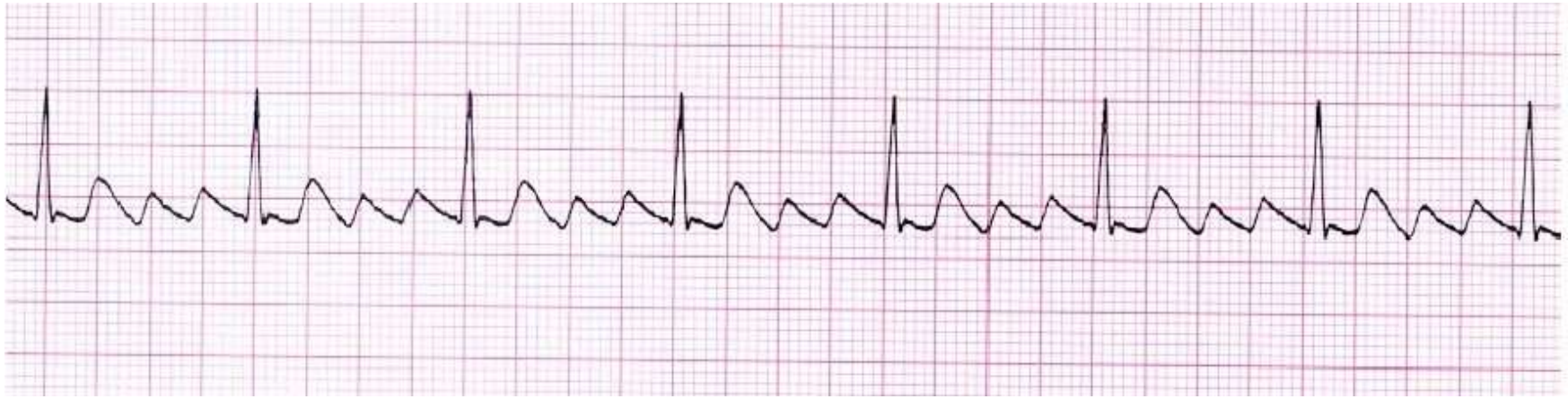
RHYTHM

Atrial Fibrillation



A-fib is the most common cardiac arrhythmia involving atria.
Rate= ~150bpm, irregularly irregular, baseline irregularity, no visible p waves, QRS occur irregularly with its length usually < 0.12s

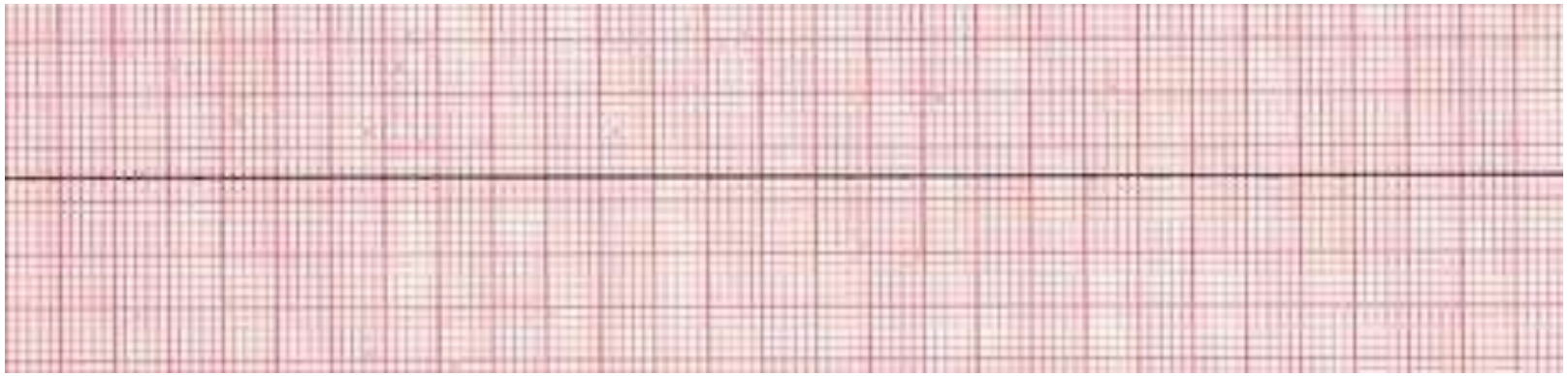
Atrial Flutter



Atrial Rate=~300bpm, similar to A-fib, but have flutter waves, ECG baseline adapts ‘saw-toothed’ appearance’. Occurs with atrioventricular block (fixed degree)

RHYTHM

Asystole



a state of no cardiac electrical activity, hence no contractions of the myocardium and no cardiac output or blood flow.

Rate, rhythm, p and QRS are absent

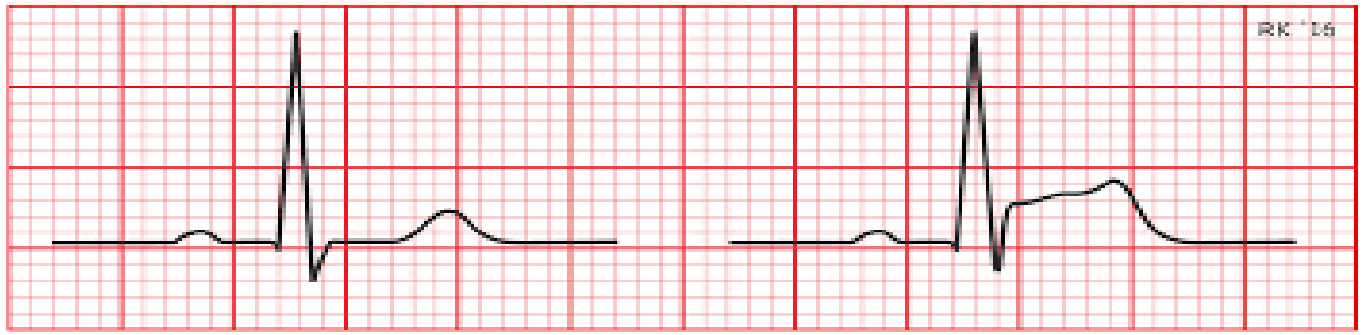
Myocardial infarction

MI

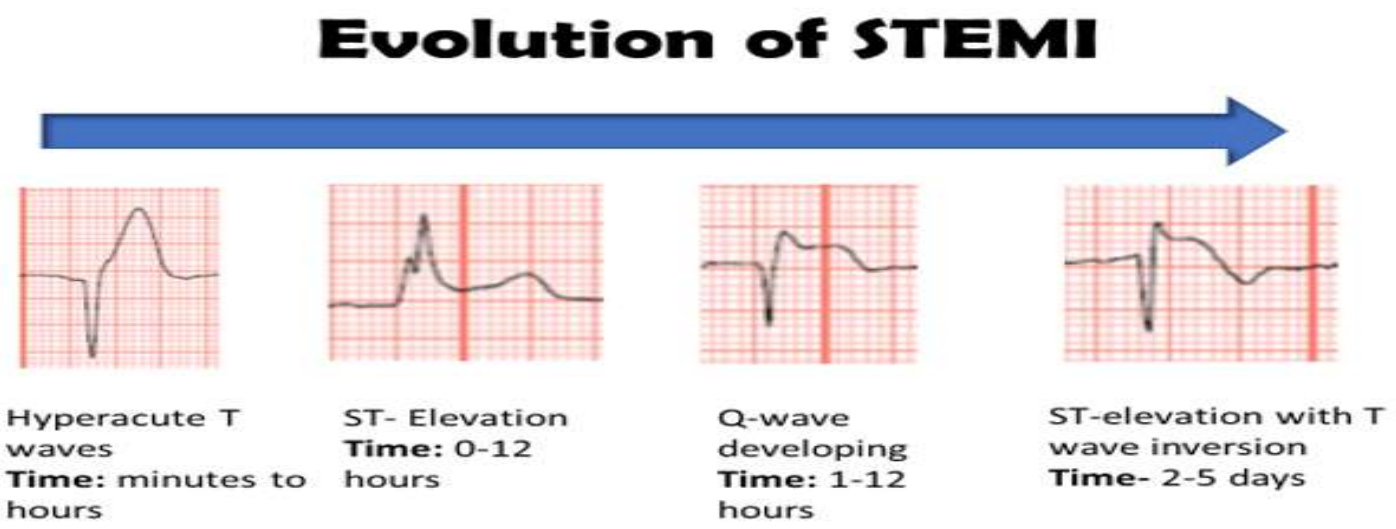
ST Elevation

One way to diagnose an acute MI is to look for Elevation of the ST segment (greater than 1 small box)

in 2 leads is consistent with a myocardial infarction



Myocardial infarction



Thank You