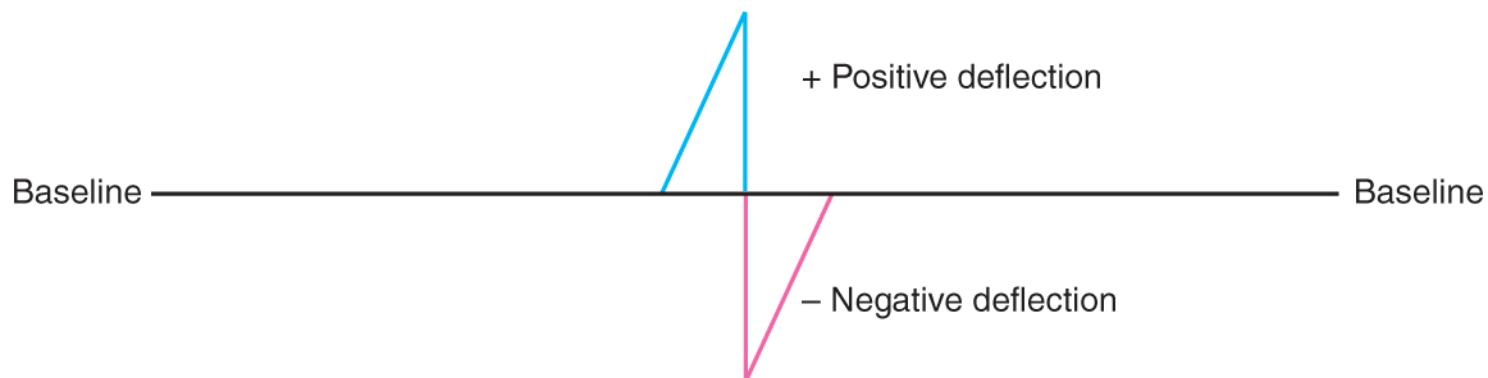




ECG Components

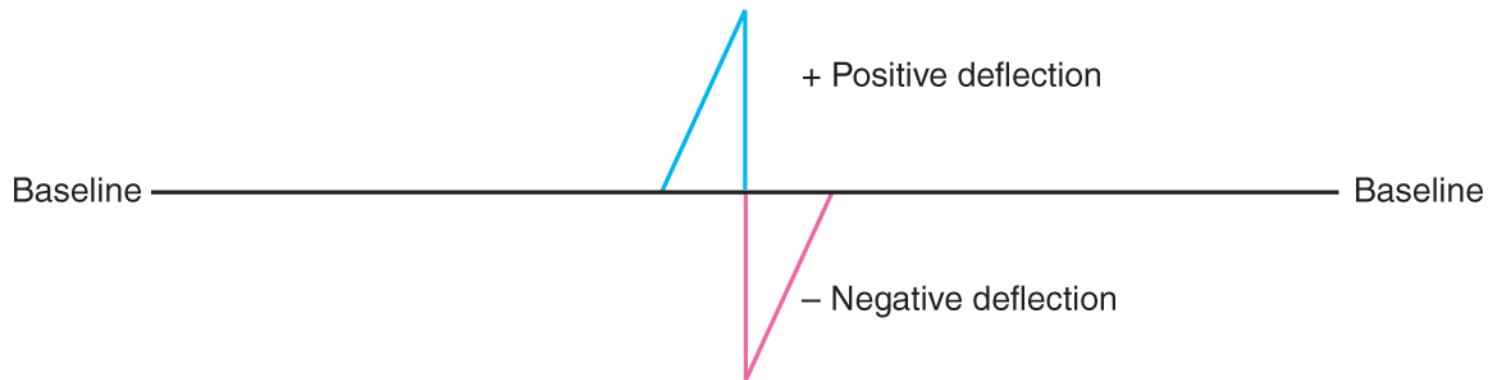
Baseline

- Straight line, without any waves, that can be seen on either the monitor or graph paper
 - Isoelectric line
 - No electrical activity in cardiac tissue
 - Where all waves begin and end



Baseline

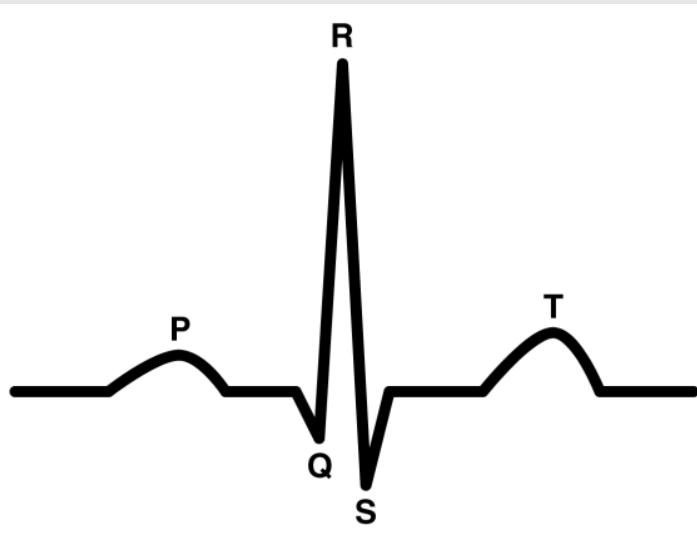
- Deflection above baseline = Positive
- Deflection below baseline = Negative



ECG Components

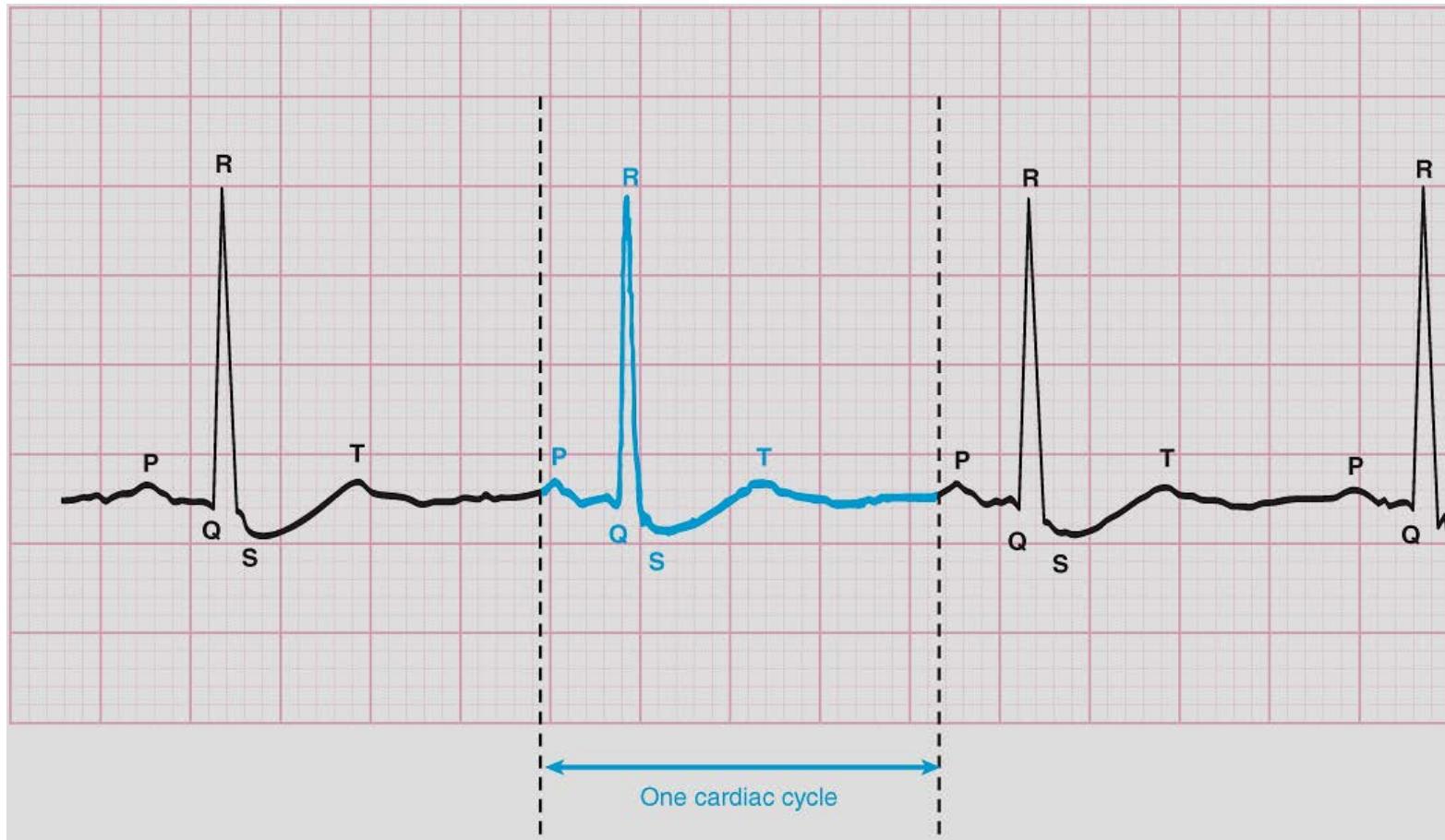
- Each wave represents an electrical impulse
- Heart beat contains 5 major waves:

- P
- Q
- R
- S
- T



- Cardiac cycle = Beginning of one P wave to beginning of next P wave

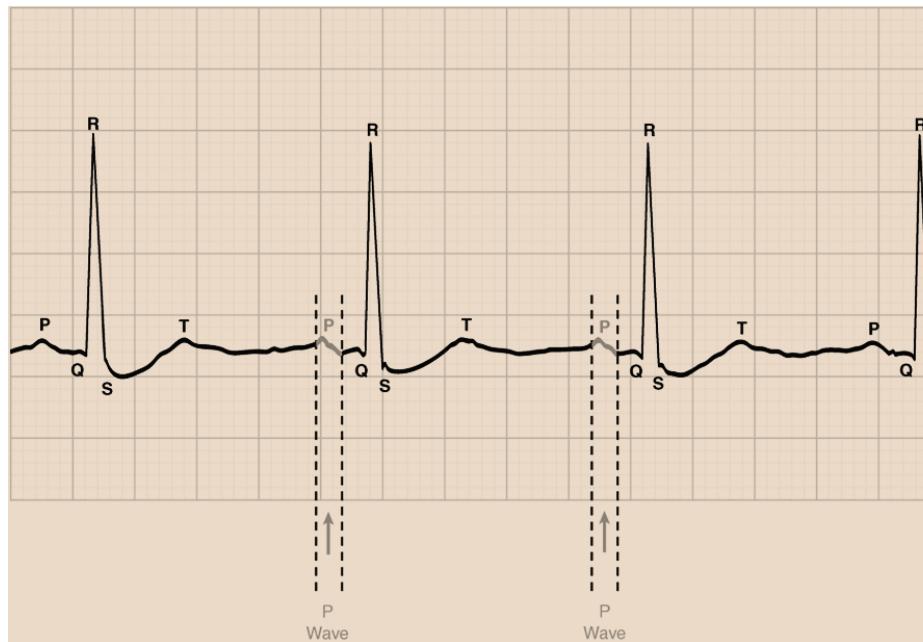
Cardiac Cycle



Waveform Components

- **P wave**

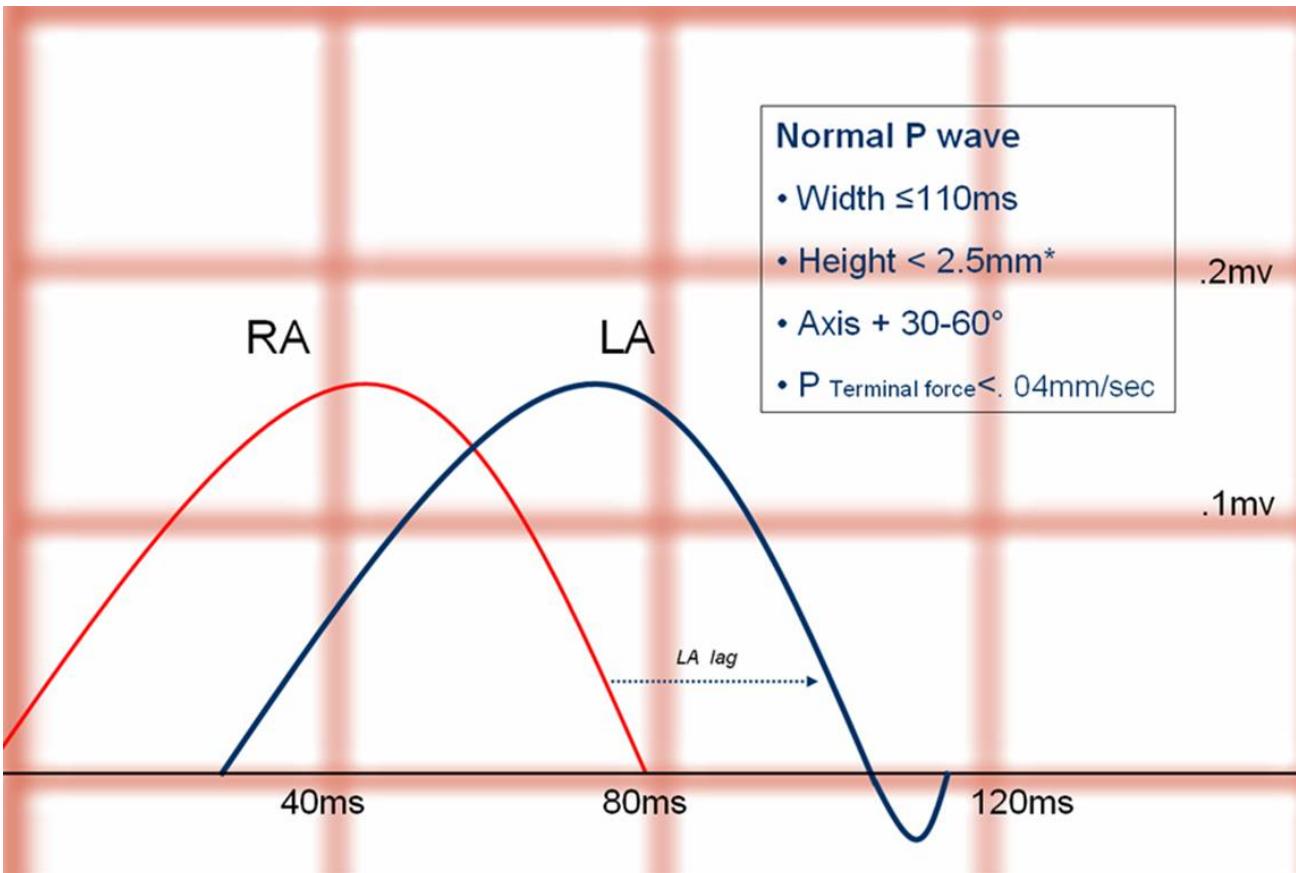
- **First positive deflection before QRS**
- **Signifies depolarization of both right and left atria but don't usually see repolarization on ECG**



Waveform Components

- **P wave**
 - Pacemaker site = SA node
 - Normal sinus P wave represents normal depolarization of atria
 - Depolarization begins near SA node and progresses across atria from right to left and downward
 - Normal P wave is well rounded and 2 small boxes or less in height on graph paper

P Wave



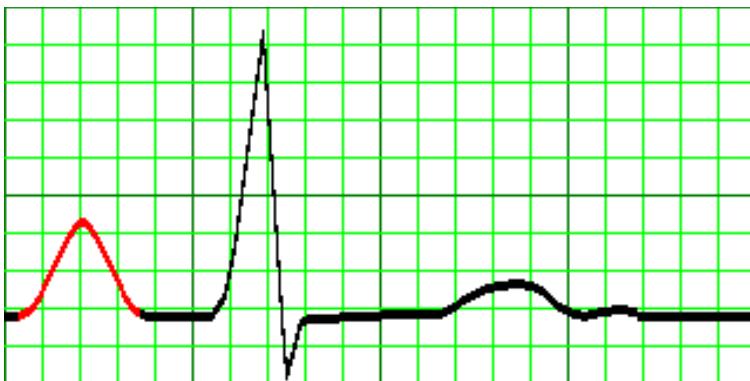
- Normal P waves are rounded contour ,
- It can be up to 2.5mm in lead II and in V1 it is < 1.5mm .
- Usually unimodal with a single peak , can be bimodal with a small notch.
- Normally the inter peak distance (Notch) will be less than 40ms.
- Biphasic P waves are seen mainly in lead V1.
- Normal P terminal force is .1mv/.04sec

P Wave

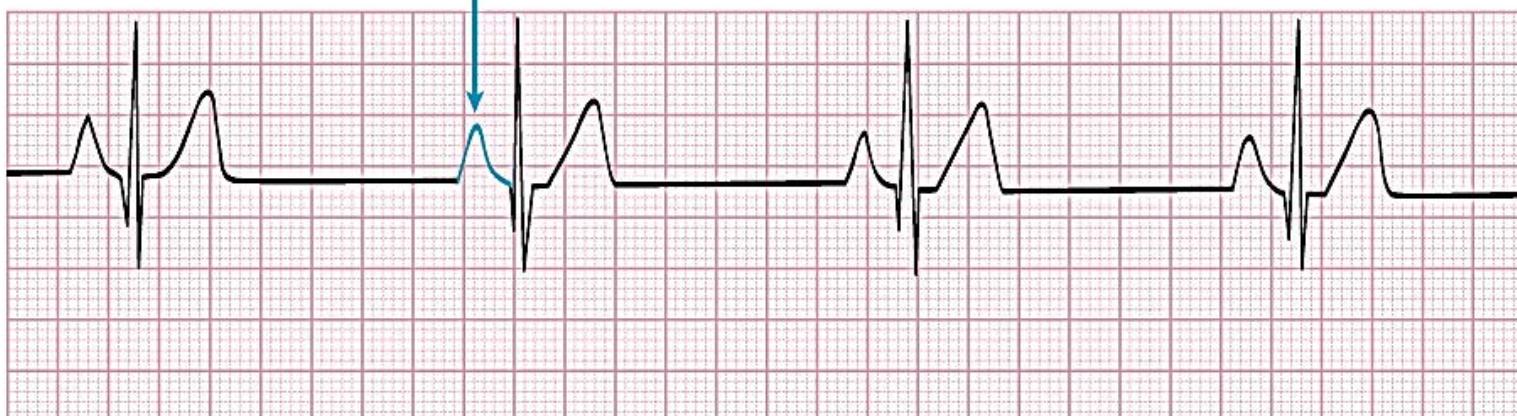
- **Types of abnormal P waves:**
 - Peaked = More than 2 small boxes in height
 - Notched = “M” shaped
 - Inverted = Negative deflection below baseline
 - Absent
 - Biphasic/Diphasic = Both above and below baseline
- **Significance of abnormal P waves: Depolarization of altered, damaged, or abnormal atria has occurred**

Peaked P Wave

- Peaked P waves may indicate enlargement of R atria

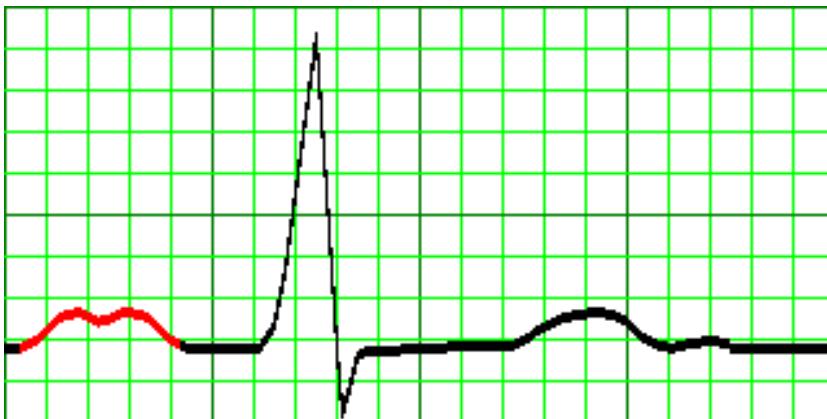


Peaked P wave



Notched P Wave

- Notched P waves may indicate enlargement of L atria

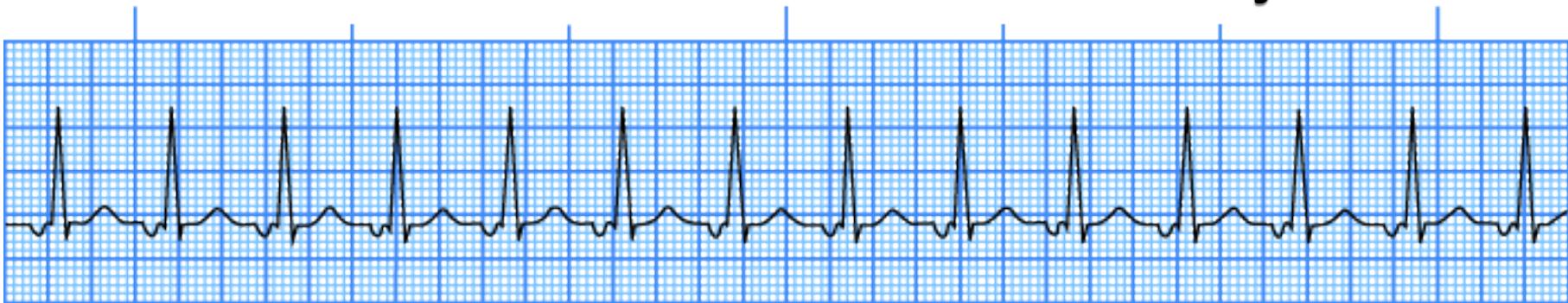


Notched P wave



Negative/Inverted P Wave

- Negative/inverted and absent P waves usually sign of electrical conduction initiated from AV junction



Negative/inverted

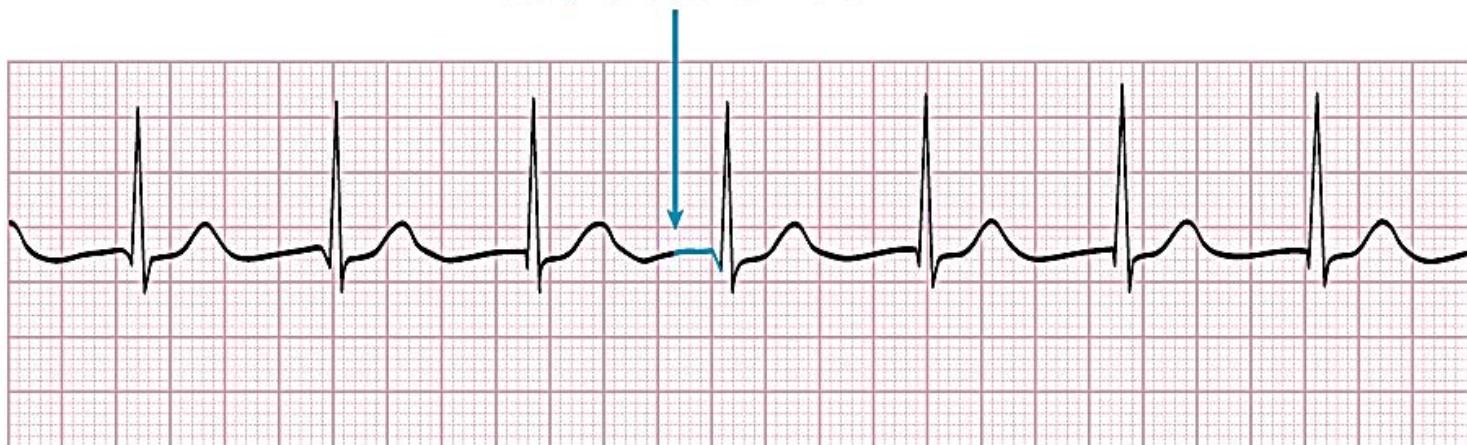


Absent P Wave

- Negative/inverted and absent P waves usually sign of electrical conduction initiated from AV junction

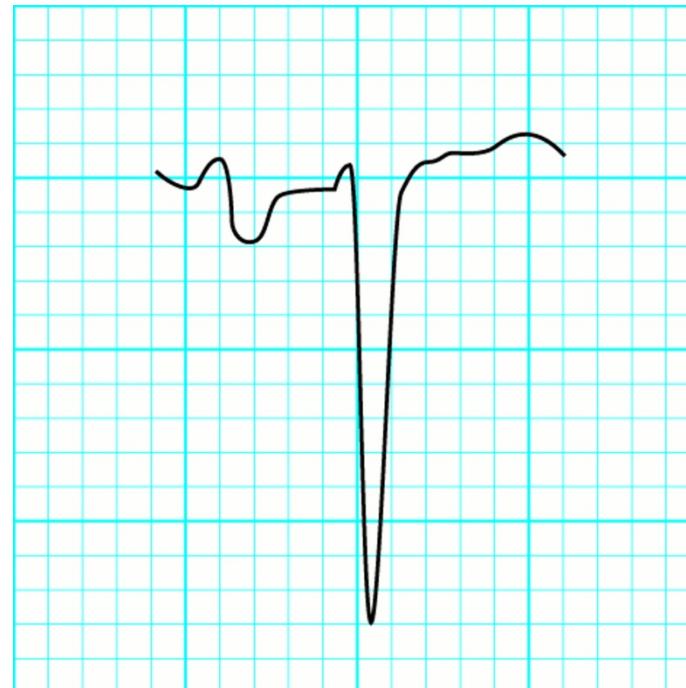


Absent, hidden, buried P waves



Biphasic/Diphasic P Wave

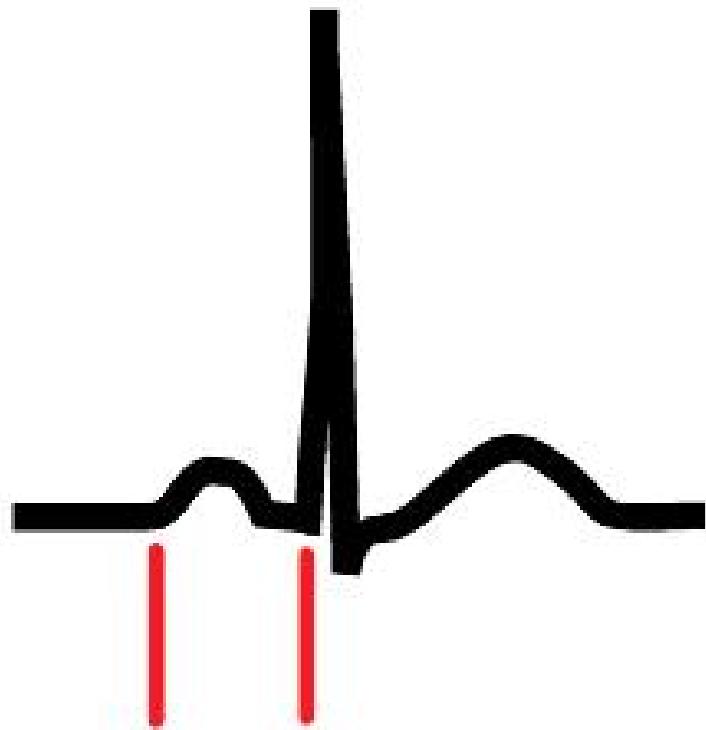
- Biphasic/diphasic P waves may indicate enlargement of both atria



PR Interval

- Represents the time it takes an electrical impulse to be conducted through atria and AV node until impulse begins to cause ventricular depolarization
- Measured from beginning of P wave to beginning of next deflection of baseline
- Normal is 0.12 to 0.20 seconds = 3-5 small squares on graph paper
- Abnormal PRI indicates disturbance in electrical conduction pathway
 - Typically AV node

PR Interval



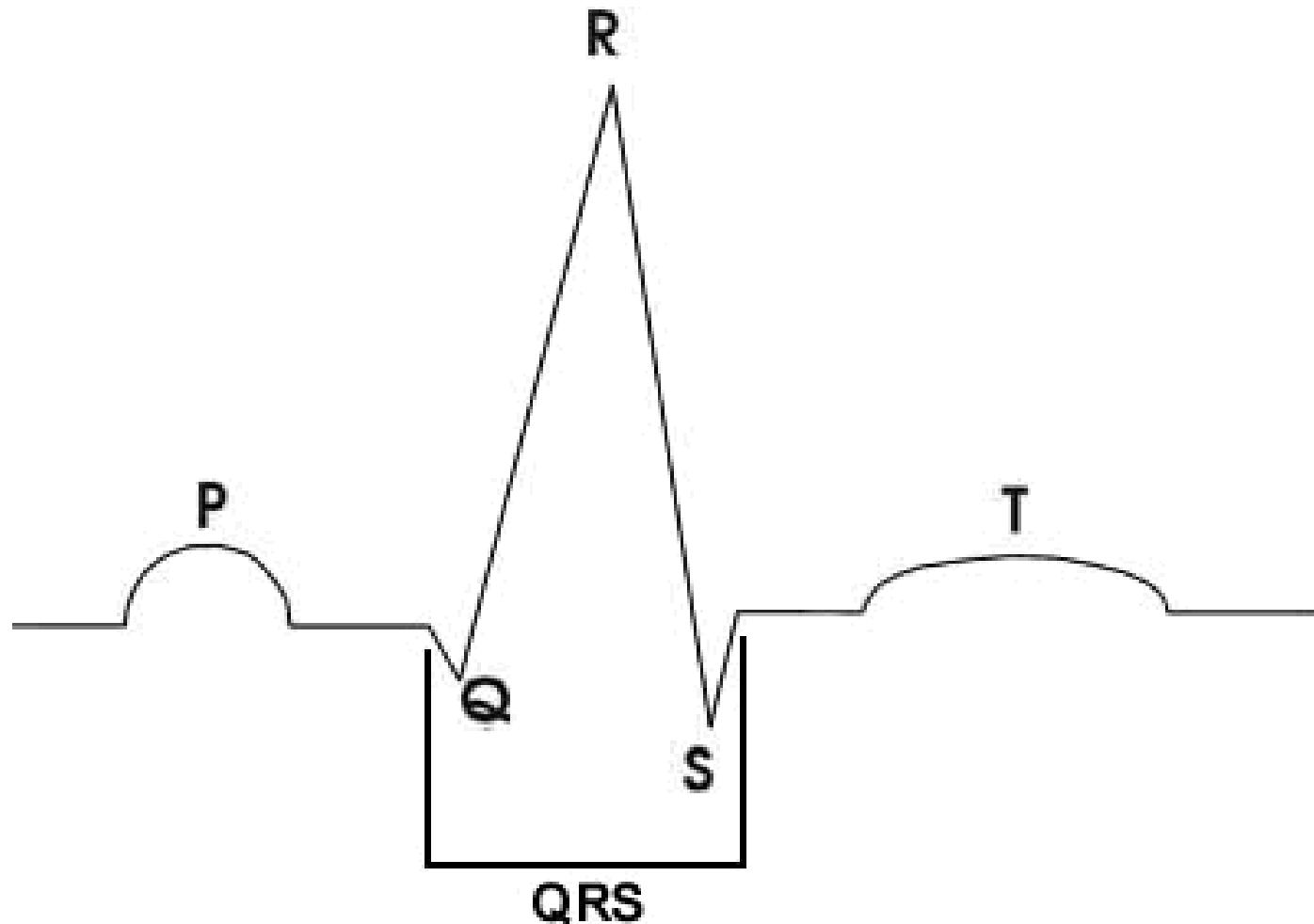
PR Interval



QRS Complex

- Contains 3 waves: Q, R, and S
- Q wave = First negative deflection following P wave
- R wave = First positive deflection after P wave
- S wave = First negative deflection that follows R wave
- Q wave is not always present in all leads

QRS Complex



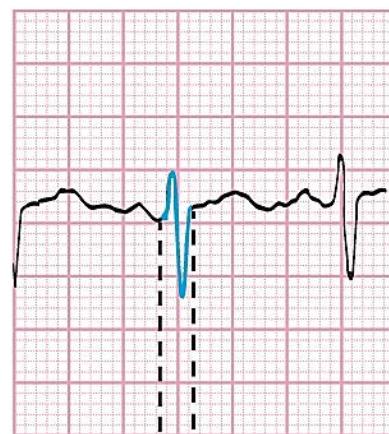
QRS Complex



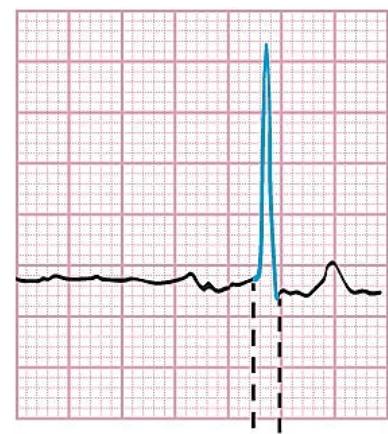
QRS



QRS



QRS



QRS

QRS Complex



QRS Complex

- **Represents ventricular depolarization**
 - Conduction of electrical impulse from bundle of His through ventricular muscle
- **Measurement starts at beginning of Q wave (or R wave if Q absent) and ends where S wave meets baseline**
- **Usually measures 0.04 to 0.12 second (< 3 small squares on graph)**
- **> 0.12 indicates disturbance in electrical conduction pathway**

Abnormal QRS Complex

- **Represents abnormal depolarization of ventricles**
- **Causes:**
 - **Intraventricular conduction disturbance**
 - **Aberrant ventricular conduction**
 - **Ventricular preexcitation**
 - **Electrical impulse originating in ventricular ectopic or escape pacemaker**
 - **Ventricular pacing by a cardiac pacemaker**

ST Segment

- **Portion of line from end of S wave to beginning of T wave**
- **May be normal (flat), elevated (above baseline), or depressed (below baseline)**
- **Changes in ST segment may indicate cardiac problems (ischemia or cardiac disease)**

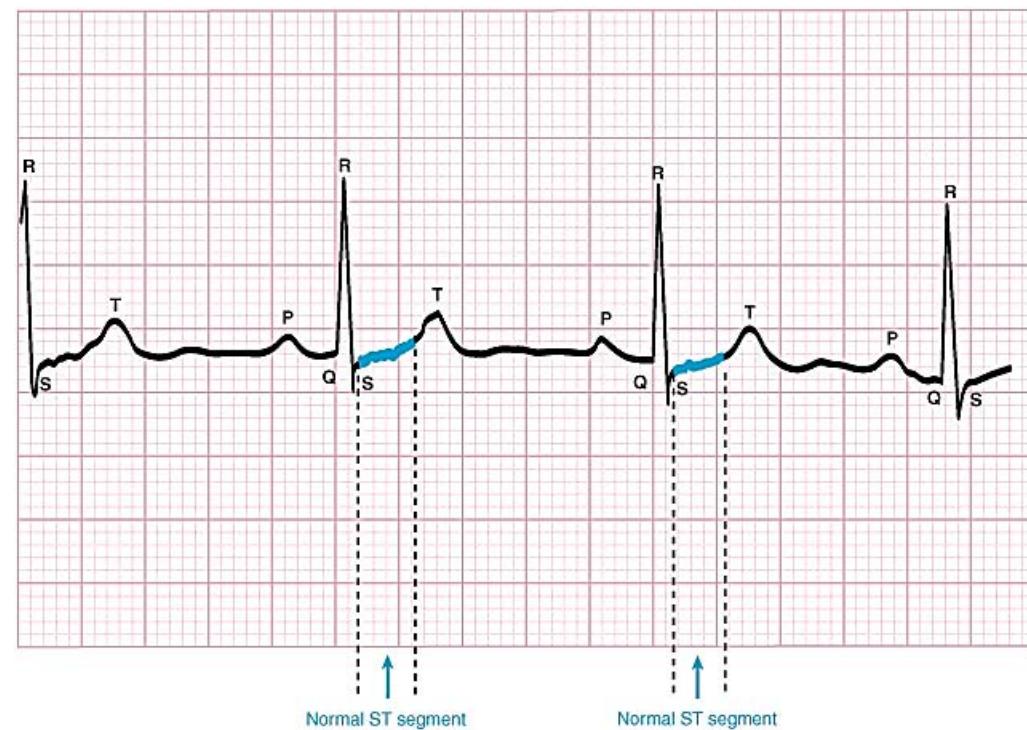
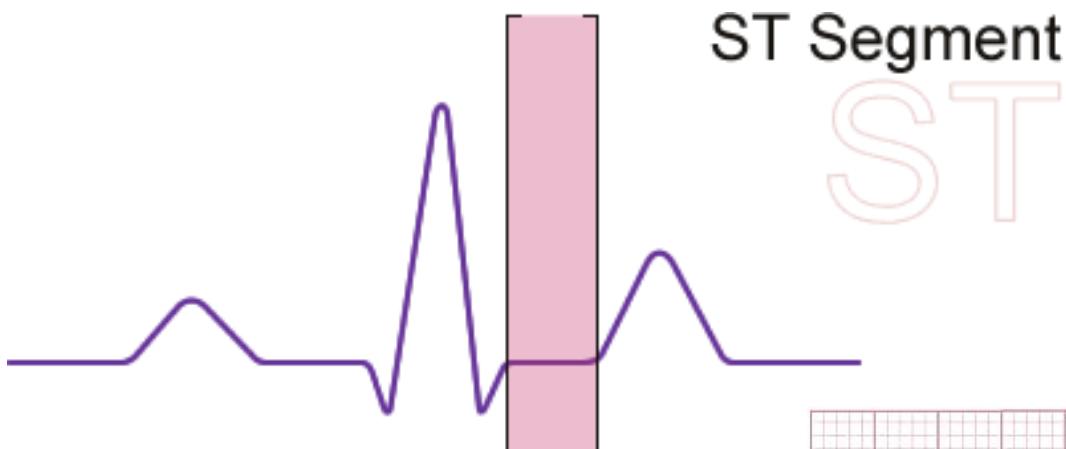
ST Segment

- **Common causes of ST segment elevation are:**
 - Acute MI
 - Myocardial ischemia
 - Prinzmetal angina
 - Ventricular aneurysm
 - Acute pericarditis
 - Early repolarization pattern
 - LV hypertrophy and L bundle branch block
 - Hyperkalemia
 - Hypothermia

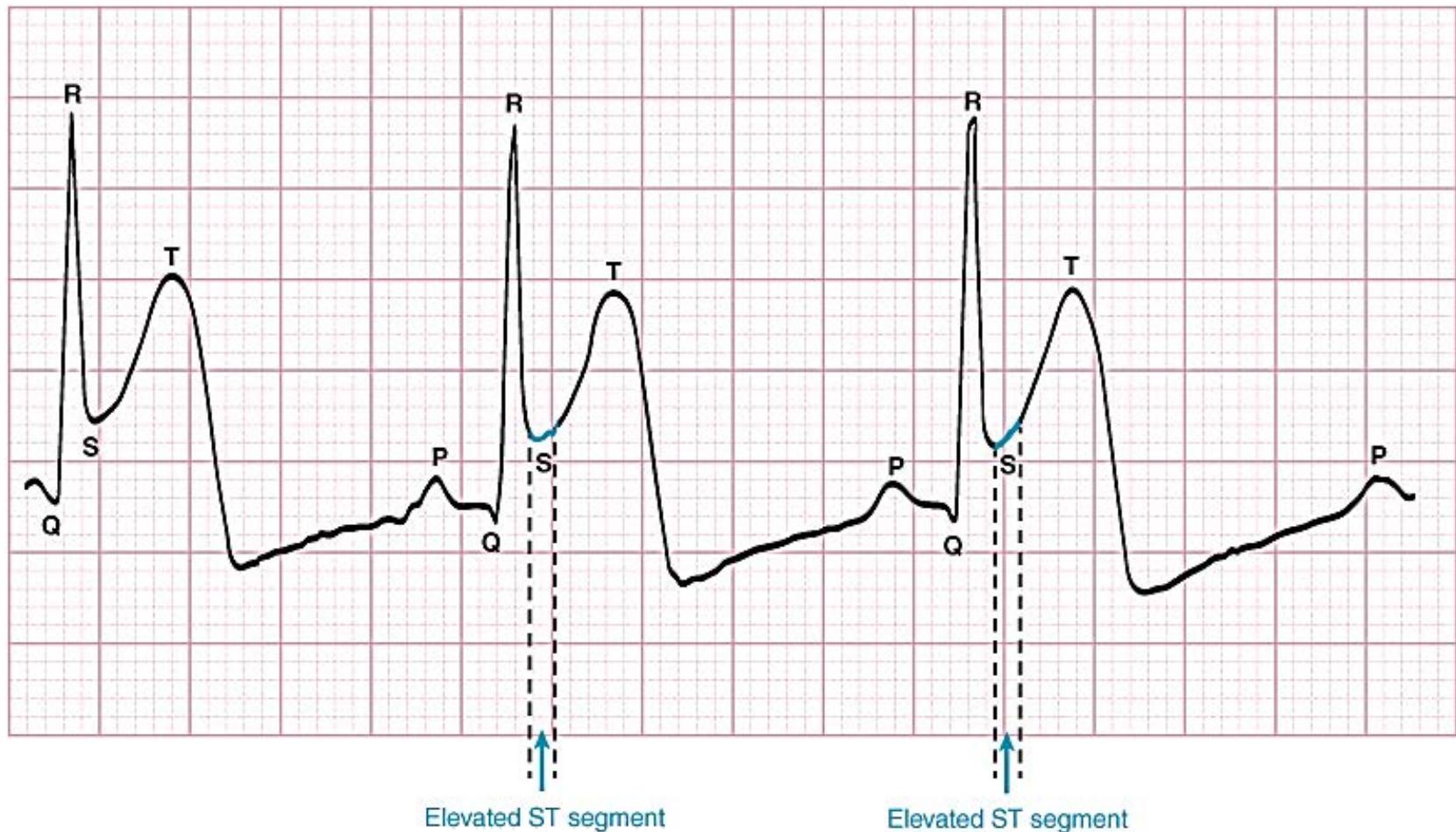
ST Segment

- **Common causes of ST segment depression are:**
 - Subendocardial MI
 - Angina pectoris
 - Reciprocal ECG changes in acute MI
 - R and L ventricular hypertrophy
 - R and L bundle branch block
 - Digitalis effect
 - Hypokalemia

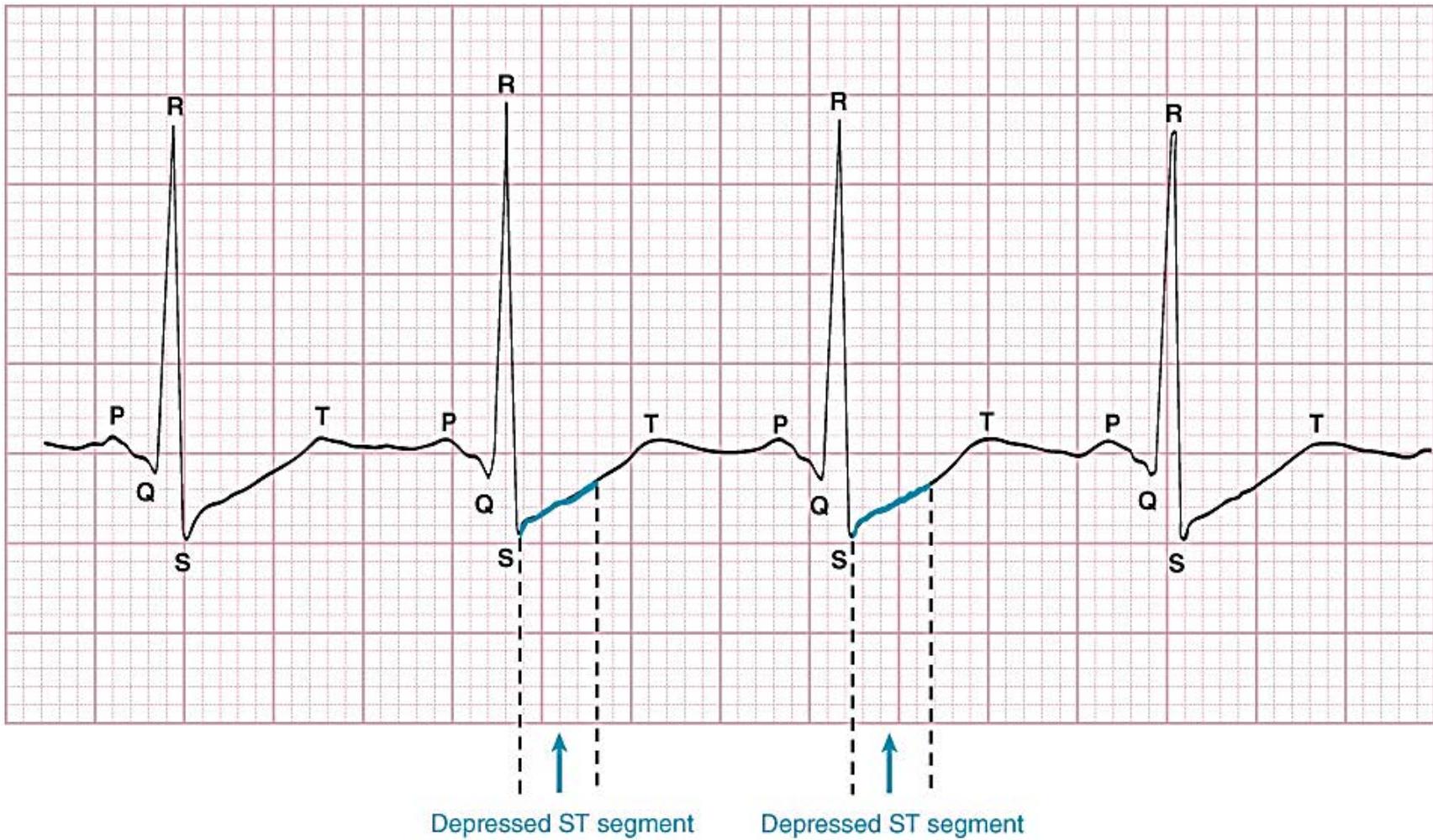
Normal ST Segment



Elevated ST Segment



Depressed ST Segment



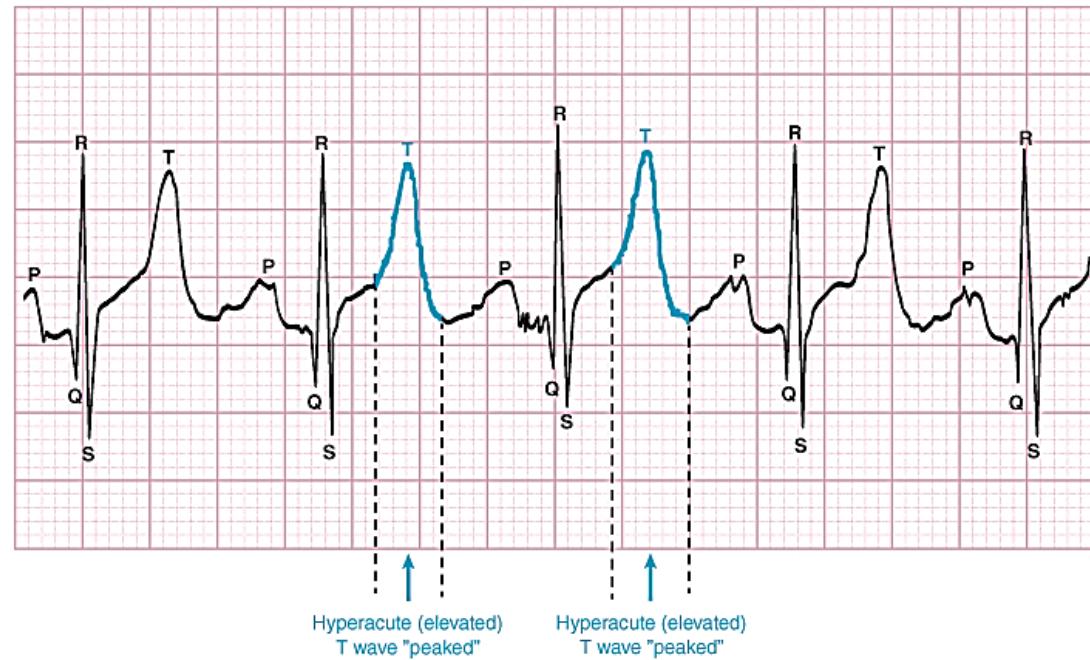
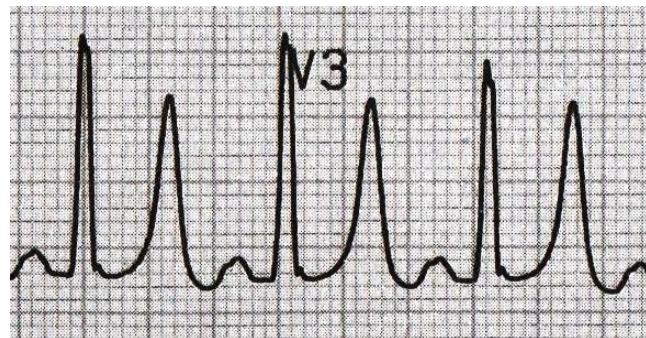
T Wave

- **Follows ST segment**
- **Indicates repolarization of ventricular myocardial cells**
- **May be above or below baseline**



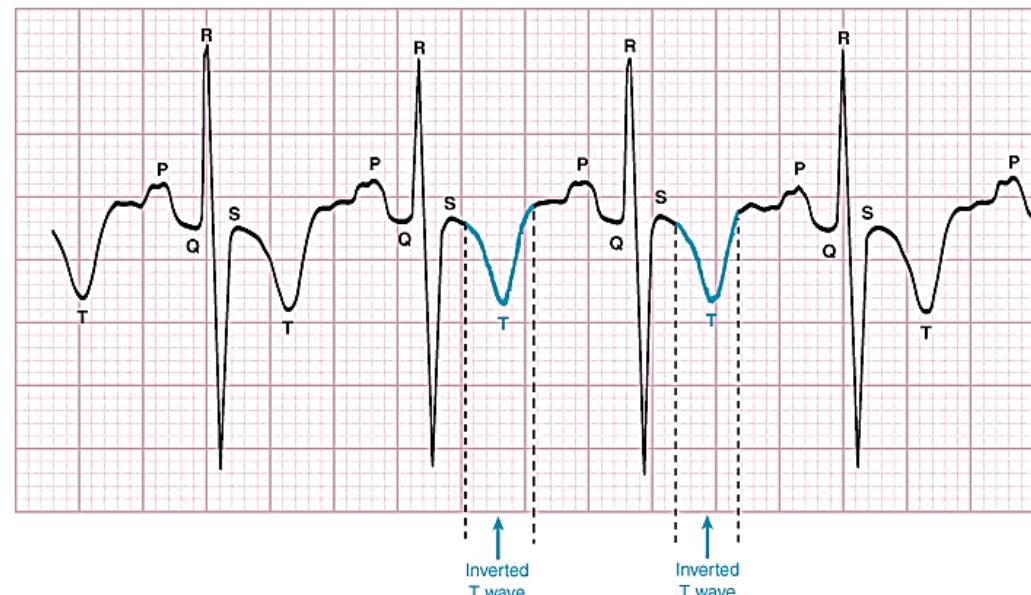
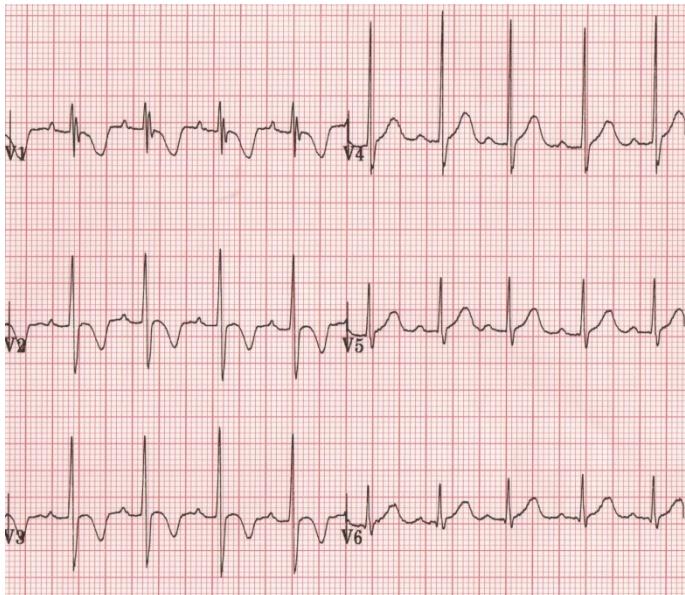
Elevated T Wave

- Elevated = Greater than $\frac{1}{2}$ height of QRS
 - May indicate ischemia of cardiac muscle



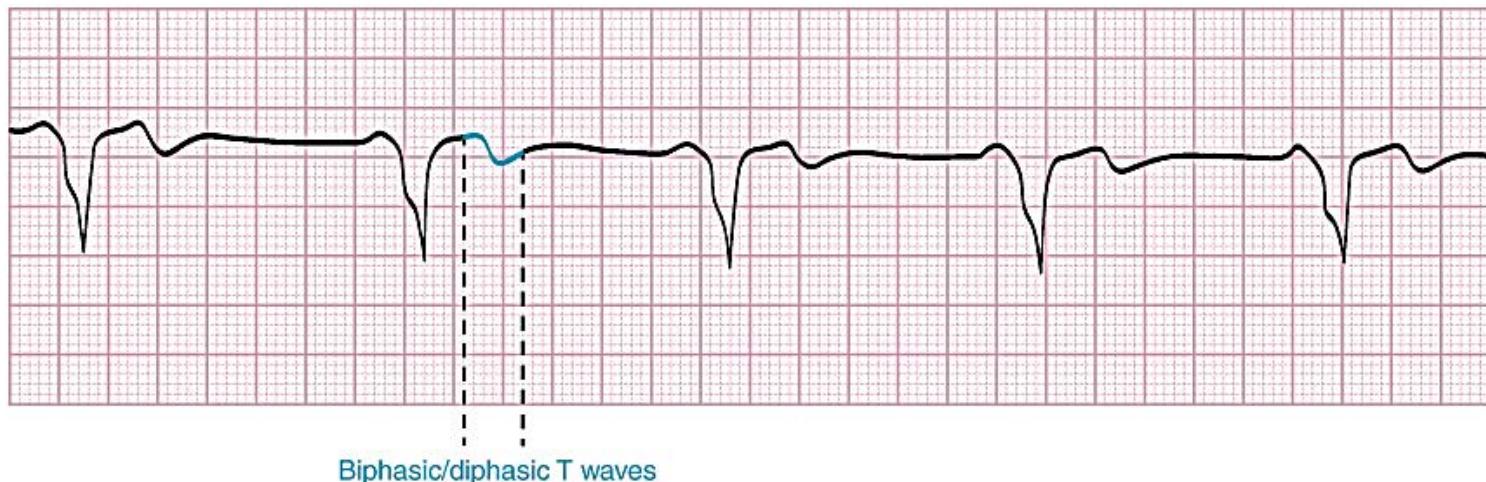
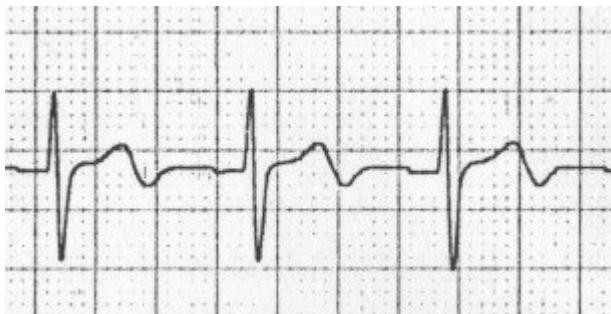
Depressed T Wave

- Depressed (inverted) follows upright QRS and is below baseline
 - Looks upside down
 - Frequently indicator of previous cardiac ischemia



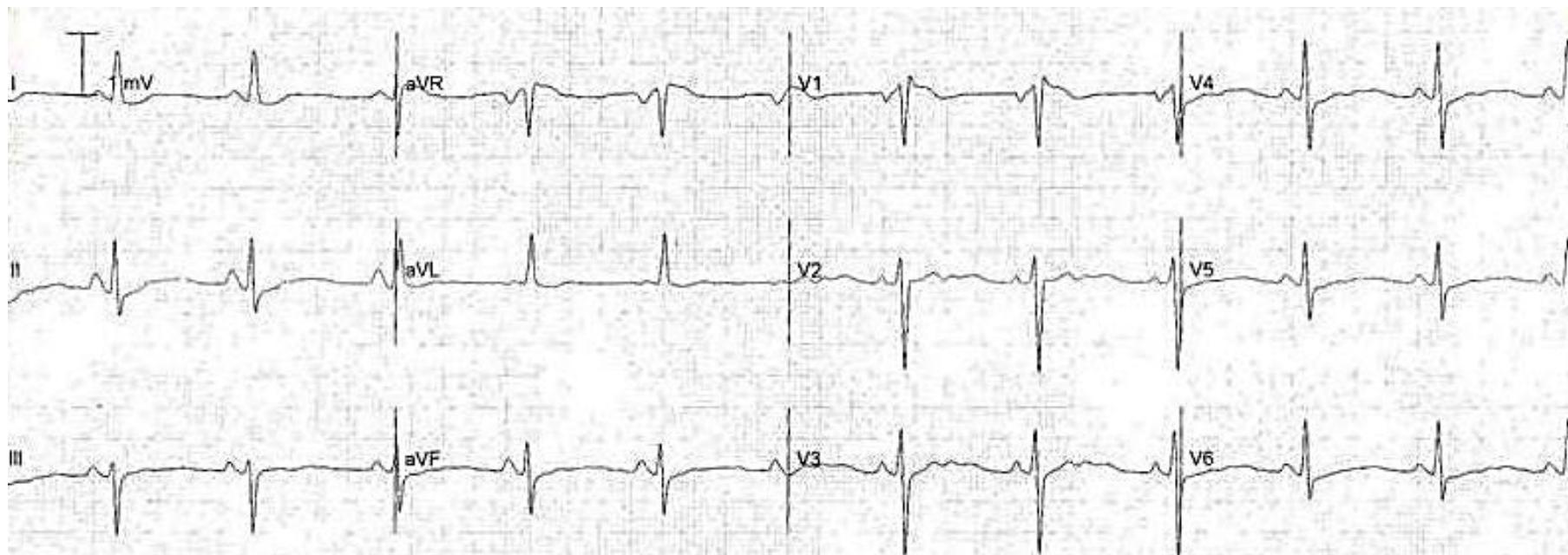
Biphasic/Diphasic T Wave

- Biphasic/diphasic = Both above and below baseline



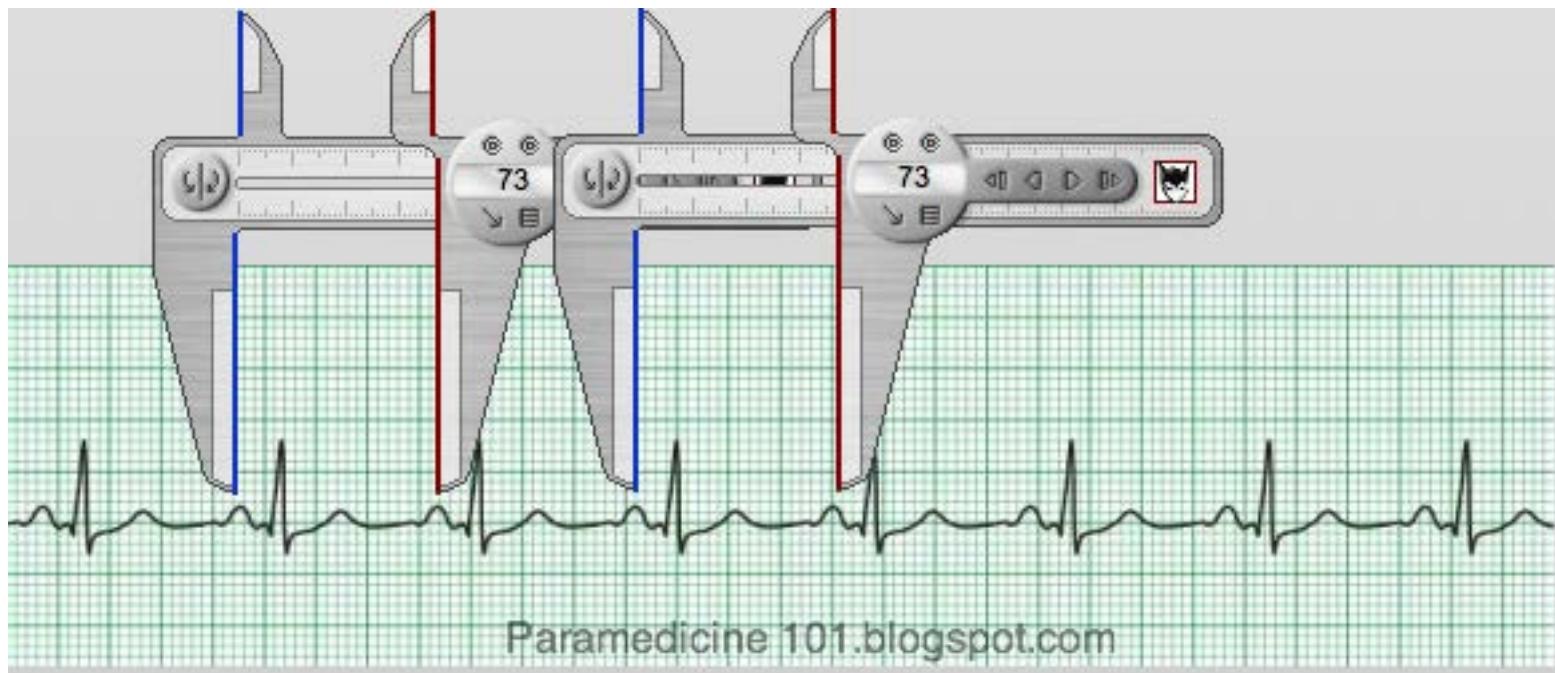
Flat T Wave

- Flat = Absent T wave



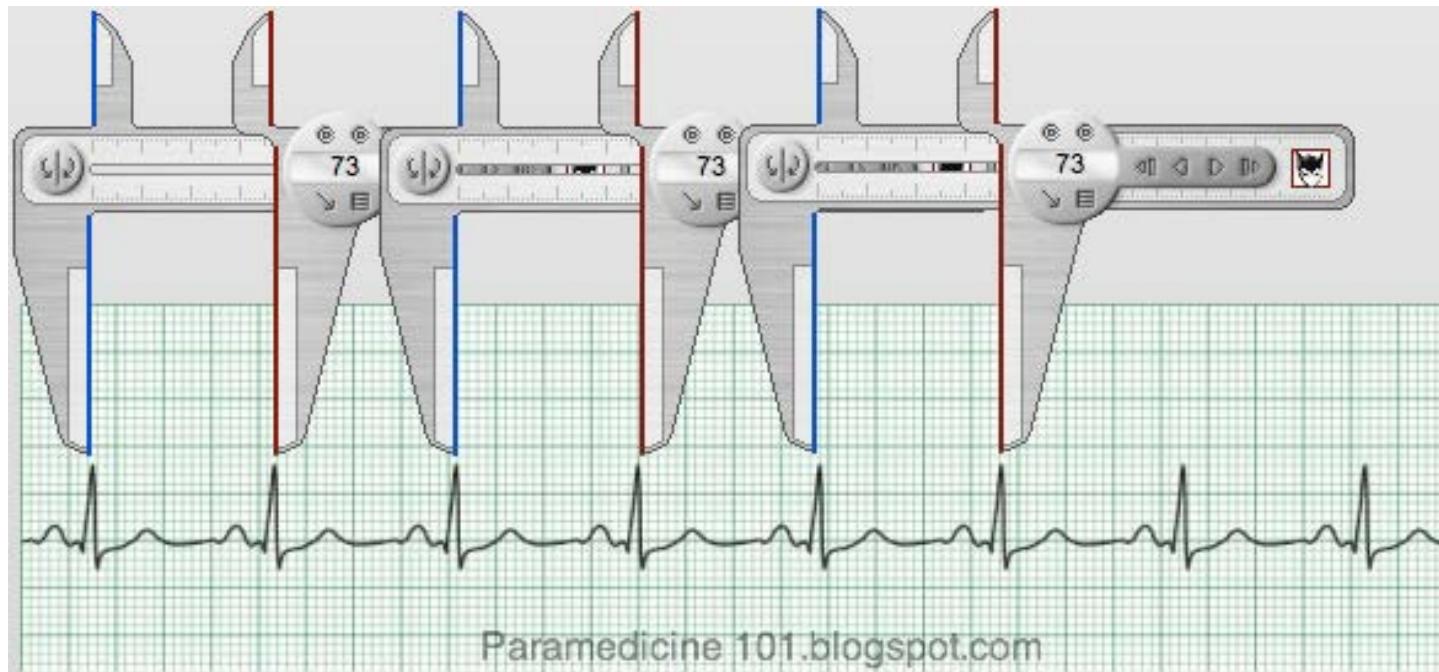
P to P Intervals

- Length of time from one P wave to next P wave



R to R Intervals

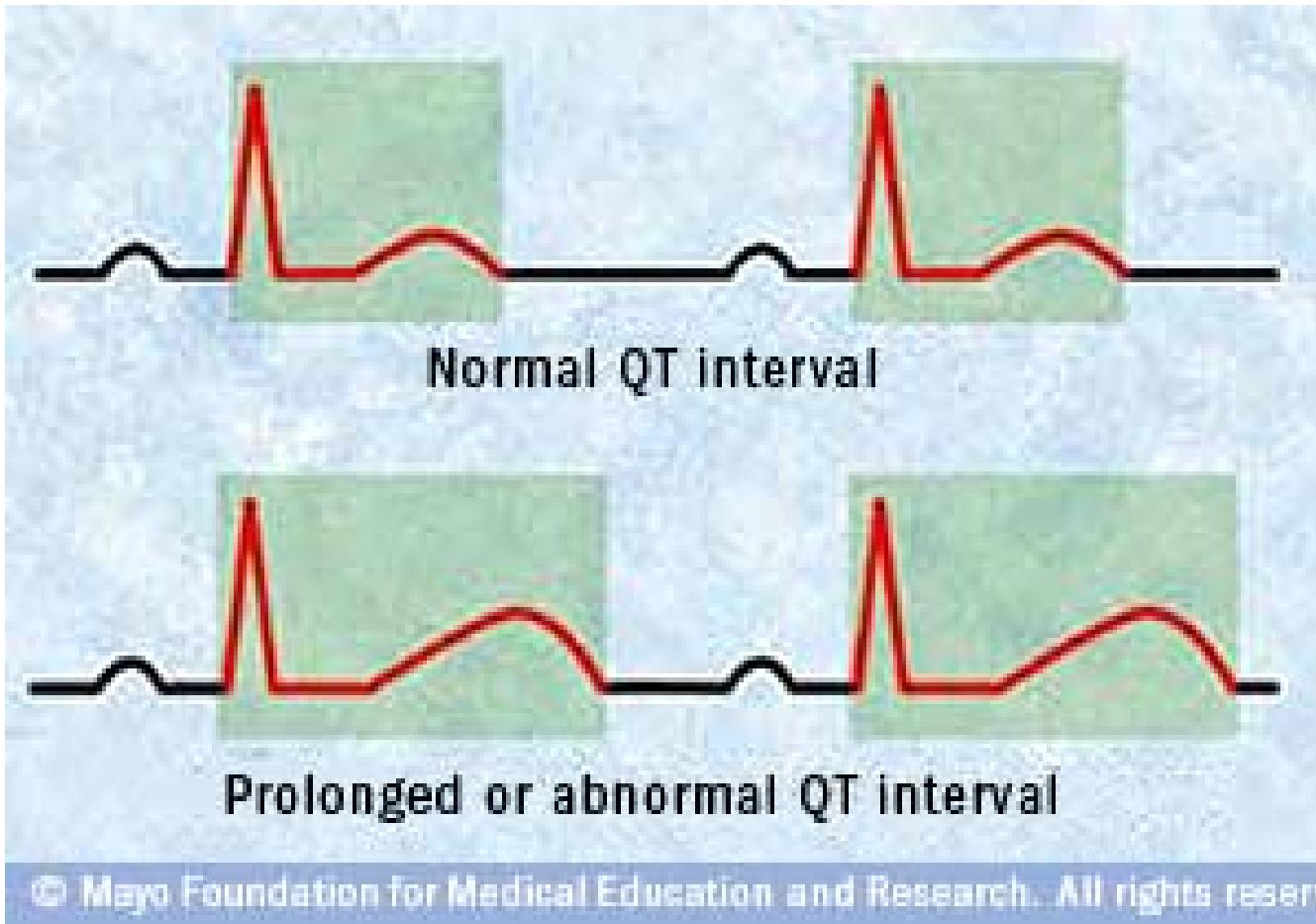
- Length of time from one R wave to next R wave



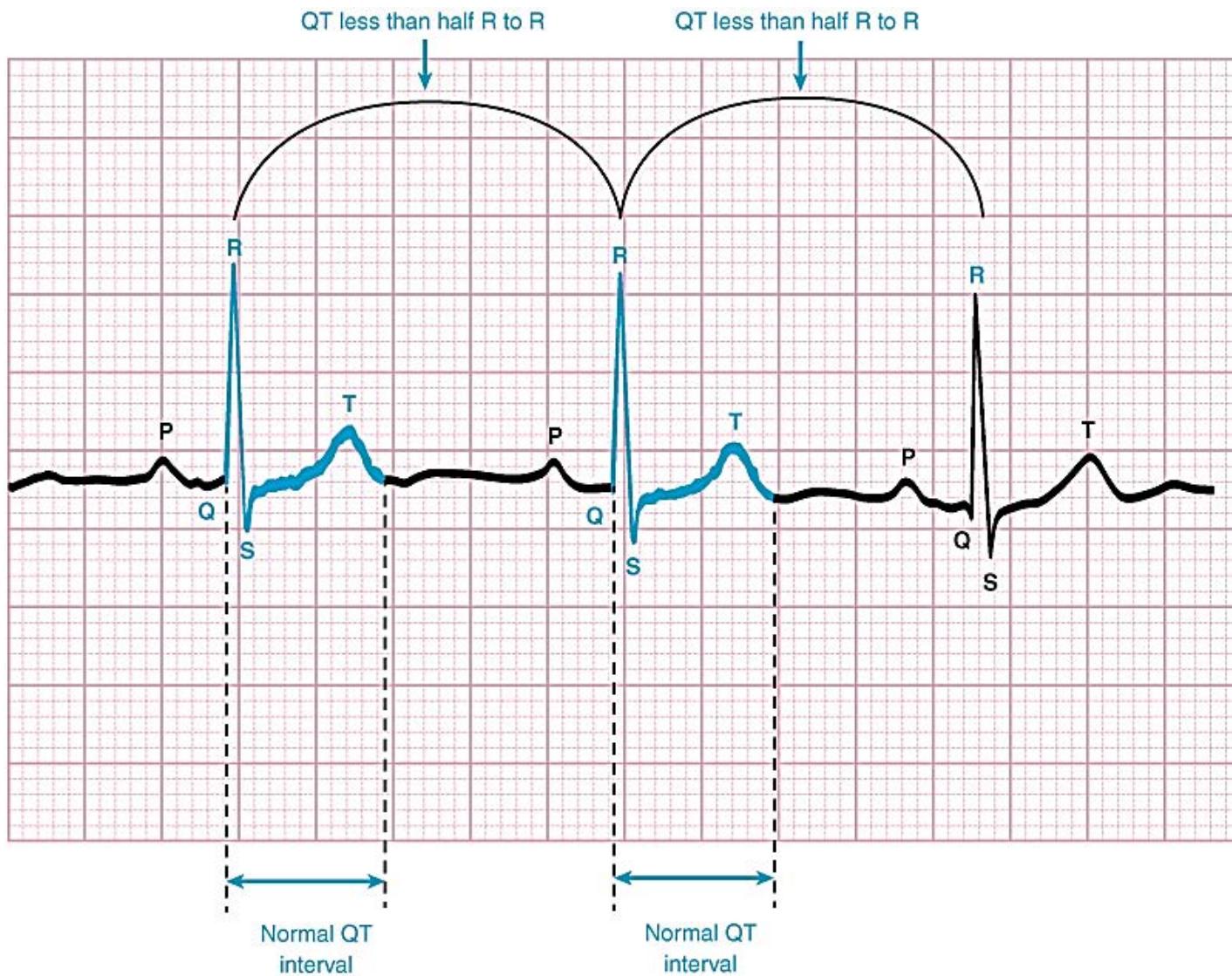
QT Interval

- Shows depolarization and repolarization of ventricles
- Measured from beginning of QRS complex to end of T wave
 - Can also be measured by counting small boxes between beginning of QRS and end of T multiplied by 0.04 second
- Either normal or prolonged
 - Normal = Less than $\frac{1}{2}$ R-R interval of that complex and R wave of following complex; Less than 0.44 second
 - Prolonged = Greater than $\frac{1}{2}$ R-R interval of that complex and R wave of following complex; Greater than 0.44 second; Indicator of problem with electrical conduction pathway of heart

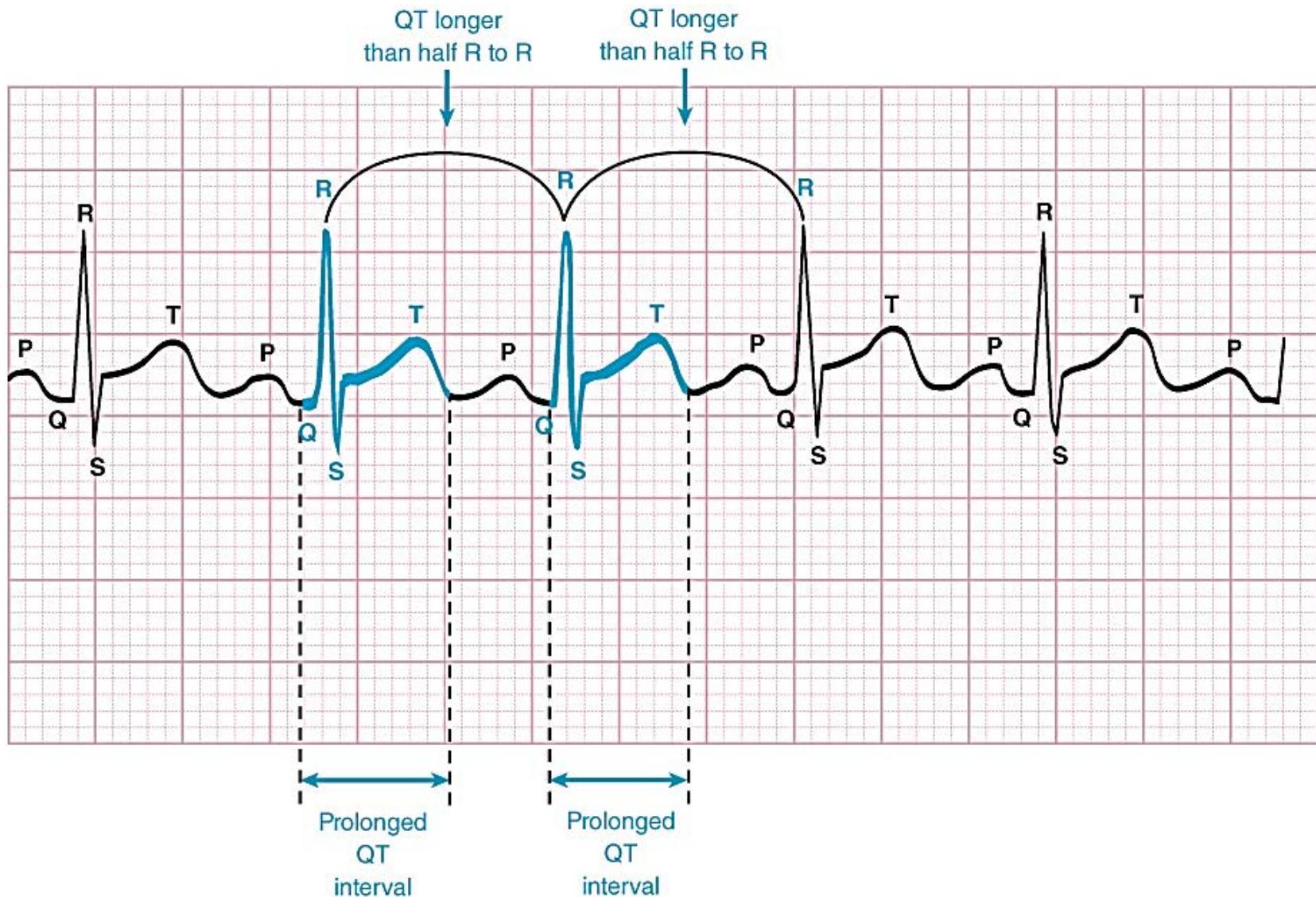
QT Interval



Normal QT Interval



Prolonged QT Interval



QT Interval

- **Abnormally prolonged QT intervals may occur with:**
 - **Pericarditis, acute myocarditis, acute myocardial ischemia and infarction, LV hypertrophy, and hypothermia**
 - **Bradydysrhythmias**
 - **Electrolyte imbalance and liquid protein diets**
 - **Medication effects**
 - **CNS disorders**
 - **Congenital prolonged QT syndrome**

TP Segment

- **Represents time from end of ventricular repolarization to onset of following atrial depolarization, during which electrical activity of heart is absent**

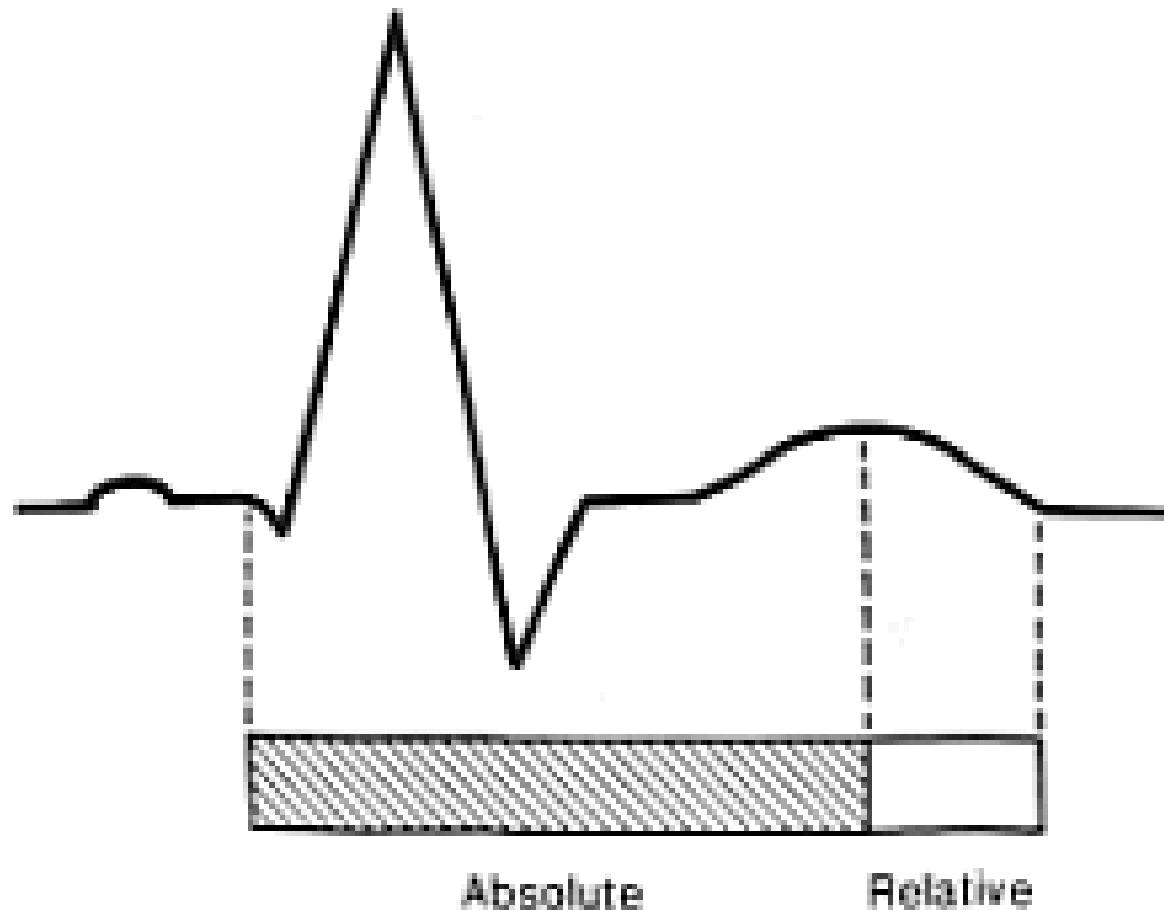
Refractory Periods

- **Time between depolarization and return of cardiac cells to ready or polarized state**
- **During cell recovery, atria and ventricles refilling with blood and preparing to contract**
- **Divided into 2 phases:**
 - **Absolute refractory period**
 - **Cardiac cells not completed repolarization and cannot be stimulated to depolarize**
 - **Period from beginning of QRS to first ½ of T wave**

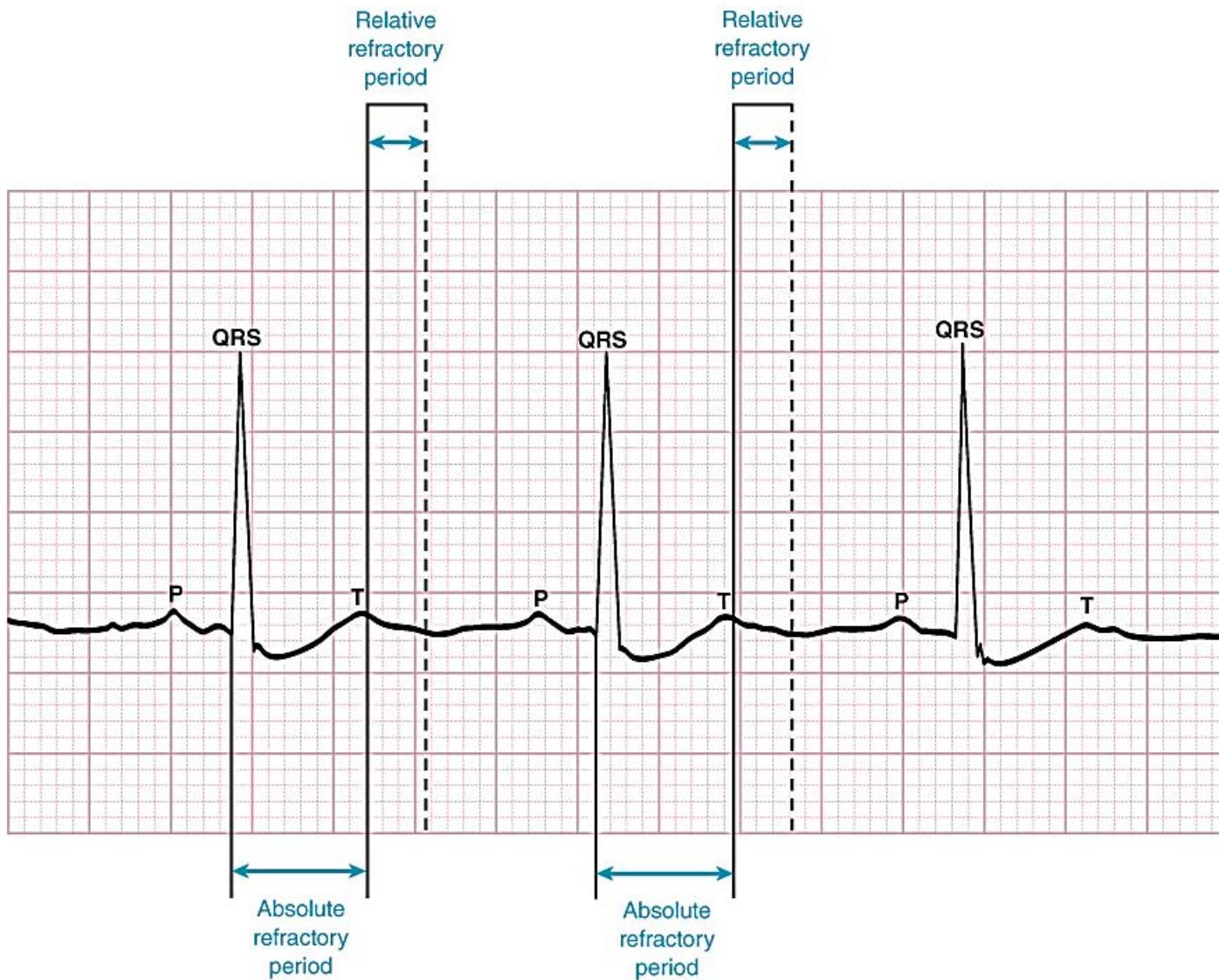
Refractory Periods

- **Relative refractory period**
 - Cardiac cells repolarized to point that some can be stimulated to depolarize with strong enough stimulus
 - Electrical impulse usually slow, abnormal pattern
 - Measured from end of absolute refractory period to end of T wave
 - Also known as vulnerable period of repolarization

Refractory Periods



Refractory Periods



Interpreting a Rhythm Strip

- Must evaluate P waves, PRI, QRS, rhythm (regularity), and rate
- Ask questions like:
 - Are P, PRI, and QRS present in each cardiac cycle?
 - Do they look waves look alike in each cycle?
 - Are they within normal range?
 - Are the intervals equal?
- ST segments, T waves, and QT intervals not required in cardiac rhythm interpretation but abnormal changes in these should be included