Cardiovascular Pathophysiology 1

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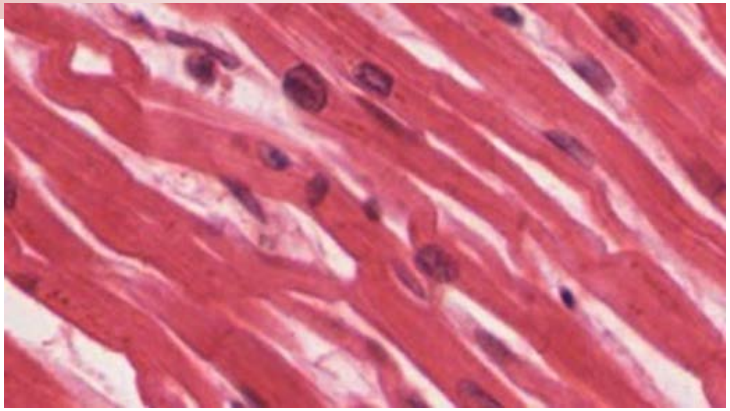
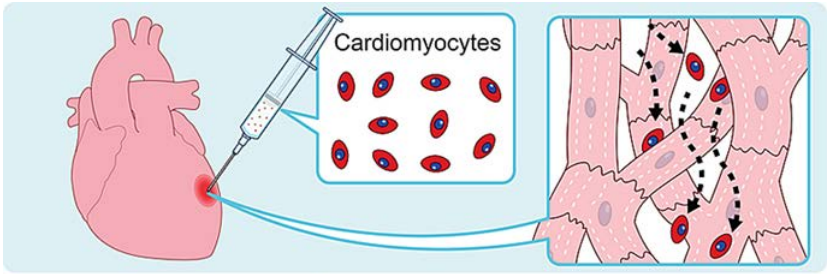
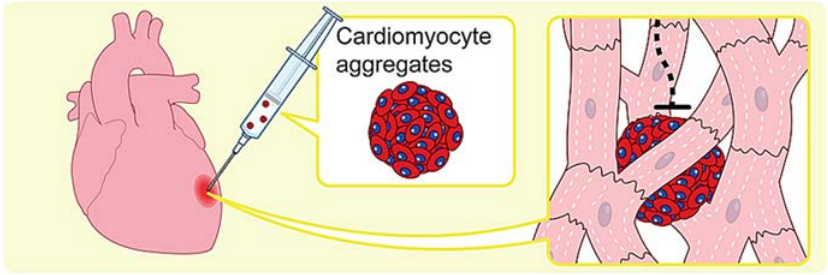
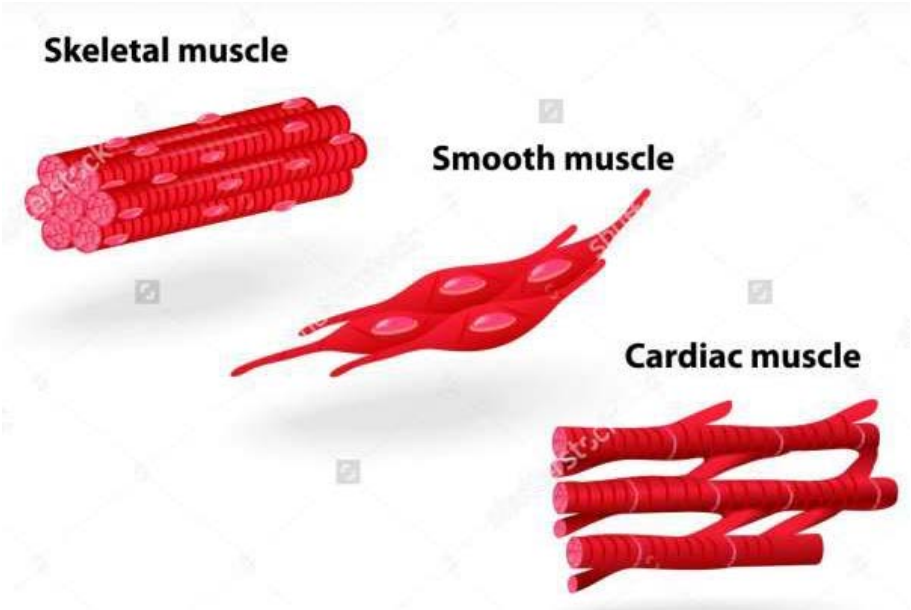
Physiological review

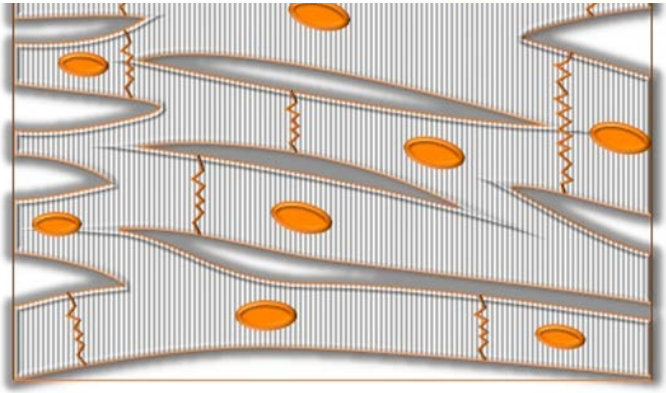
- Heart = complex muscular pump with self organized autogenerating and conducting electrical system
- Cardiomyocyte meshwork = loose reticular organisation of cells (not tighly packed) differing from smooth & skeletal muscles
- Cell to cell trasmission of electric activity (conductivity) against skeletal (nerve synapse) + smooth (hormone)
- Use of elastic recoil forcers after filling + actve contraction
- Oxygen diffusion from the cavity into subemdocardial muscle



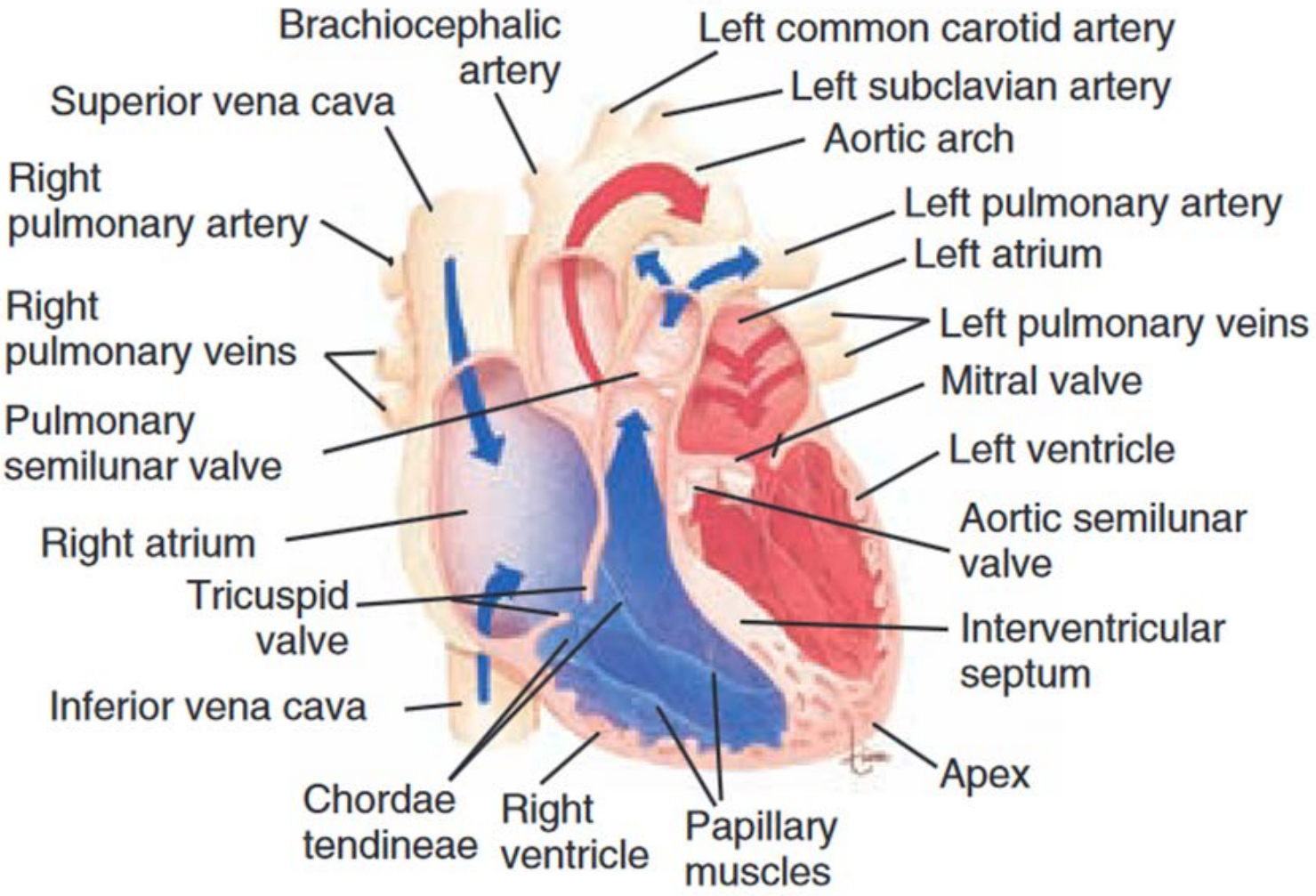


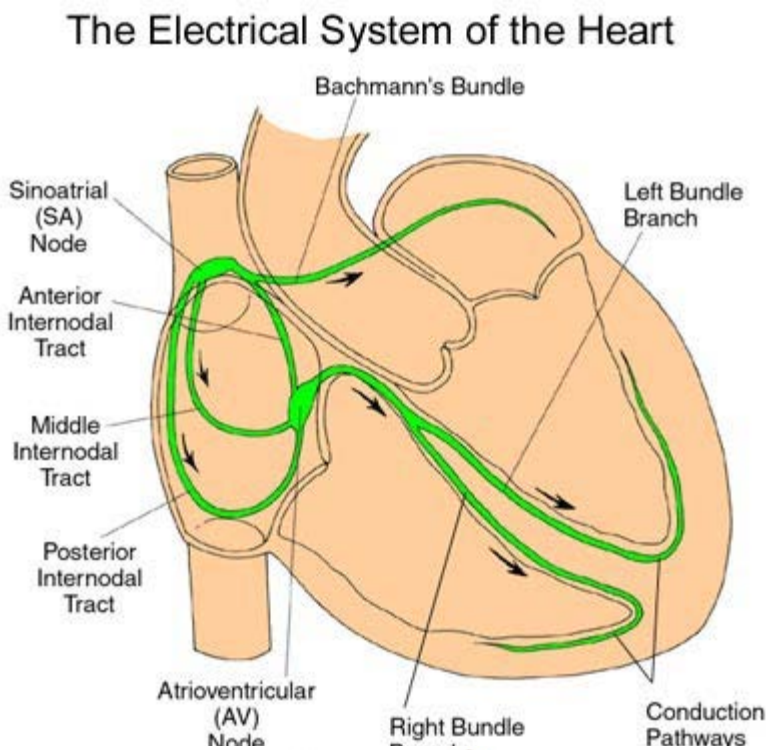




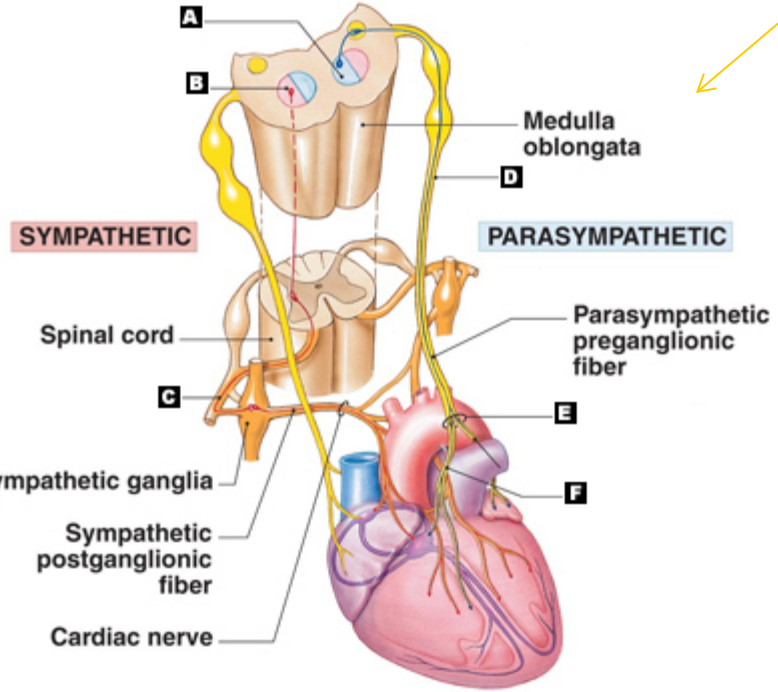


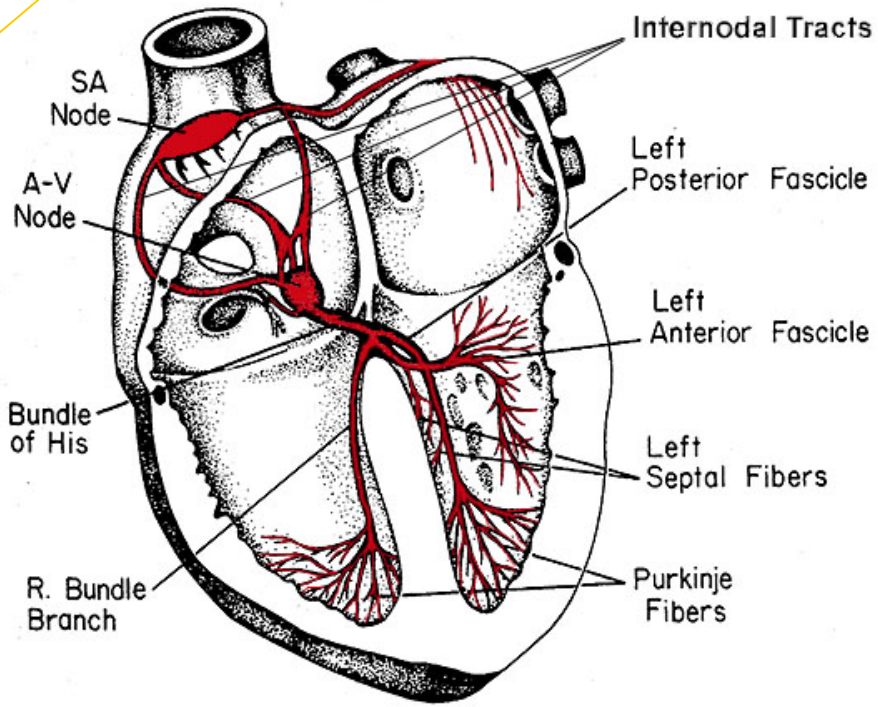
Heart Chambers and Great Vessels



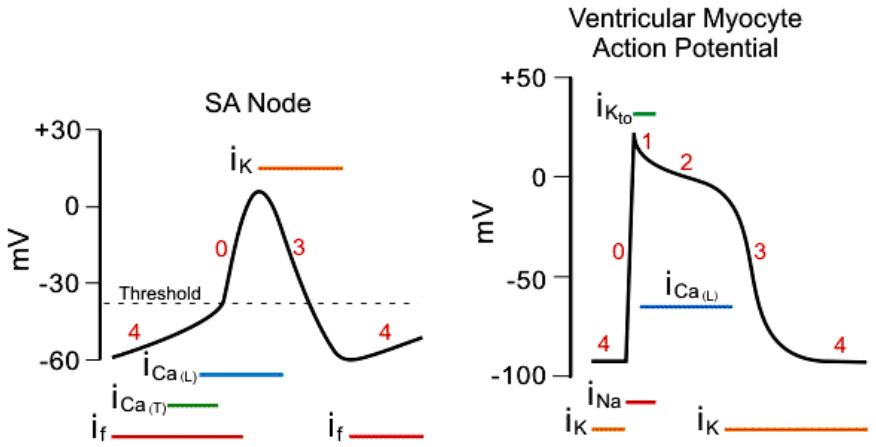


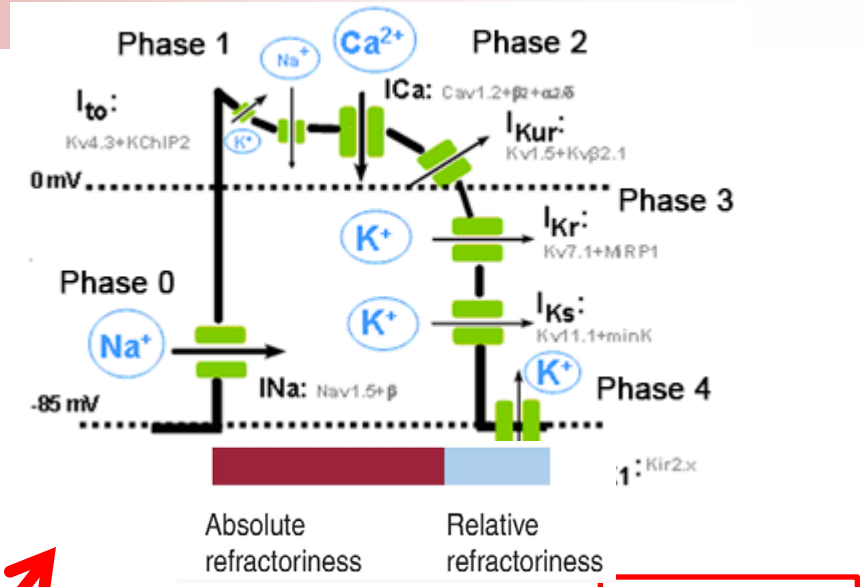
- Cardiomyocytes can conduct electric currents from the cell to cell; intercalated discs elecrtical synapses
- Conductive system = not nerves but preformed muscle cells; specific anatomy to organize (direction, speed) heart exitability = basic rhythm
- Atria and ventricles are electrically isolated; AV gateway control (+ abnormal bypasses)
- Vegetative nerves + homones modulate chromotropy, dromotropic, batmotropic, inotropic action in the heart

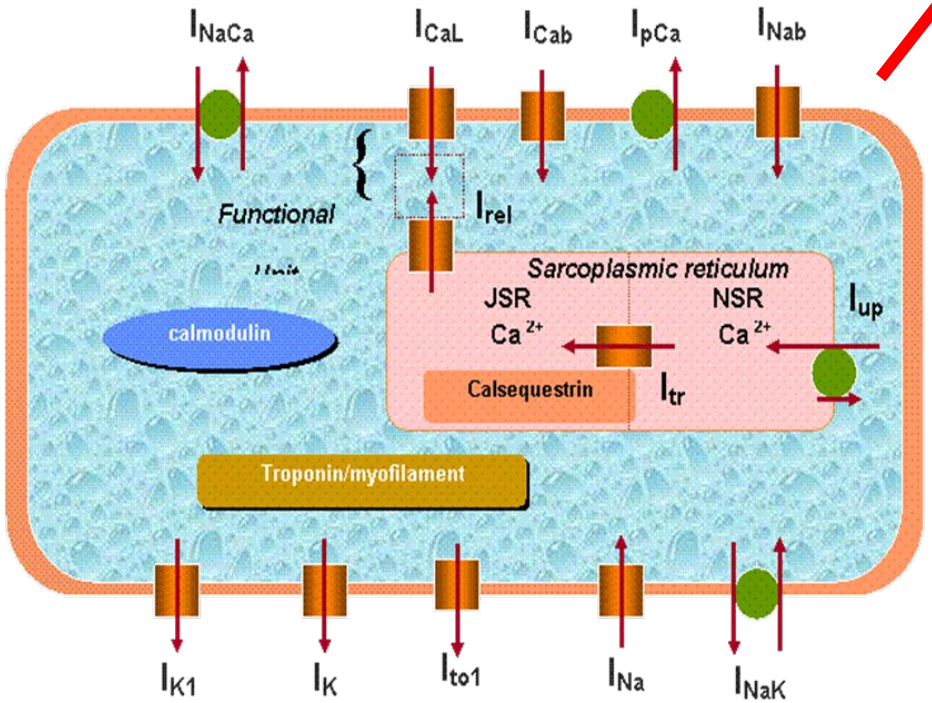


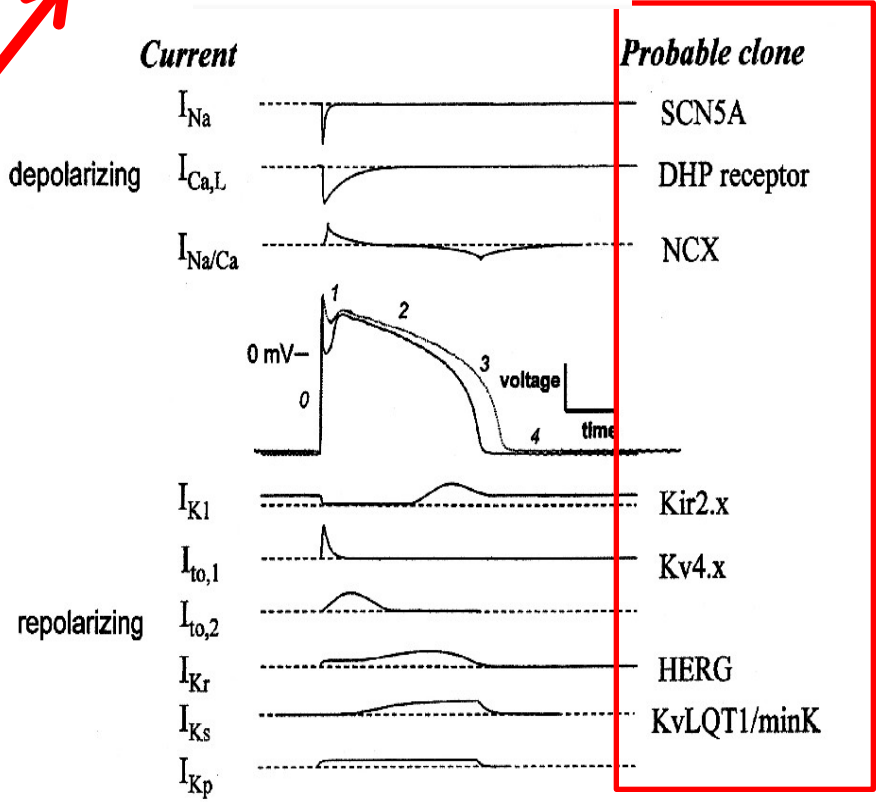


Principal ion channels

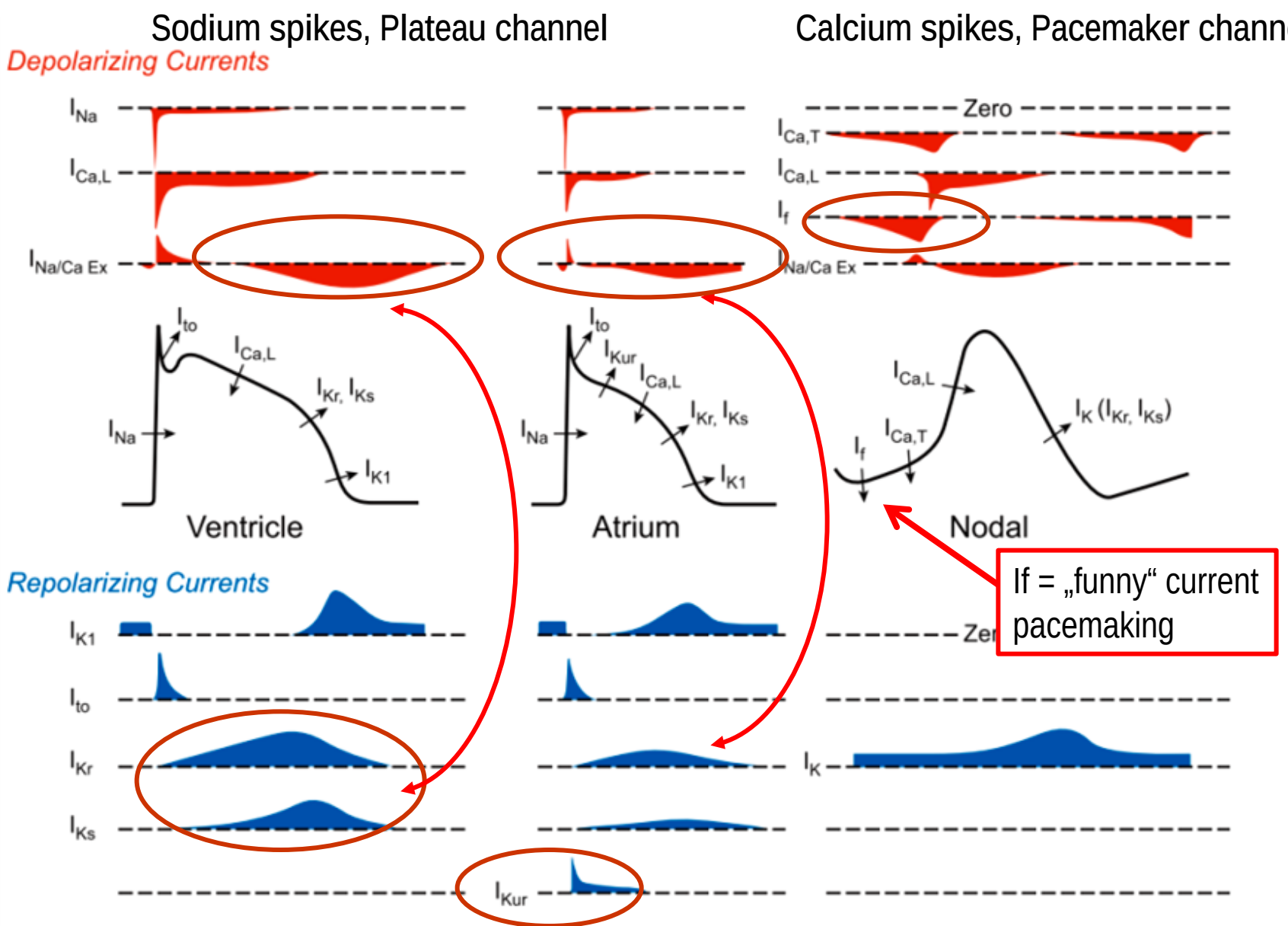








Principal ion currents in the heart cells



Principal ion channels - commentary

Sinoatrial node - primary pacemaker of the heart (resting membrane potential -60mV).

a) If (funny current) initiation of diastolic depolarization - 60 mV

b) ICa (T,L) calcium currents are activated − 40mV,

c) Outward potassium (K+) currents are activated and Ca2+ currents are inactivated

Cardiomyocyte (**resting membrane potential −90mV**).

a) Inflow of positive charge (Ca2+ and Na+) through the gap junction to -65 mV threshold

b) Inward quickly inactivated Na+ current (−65 mV) (phase 0)

c) Outward K+ current initiating repolarization (+ 30 mV) (phase 1).

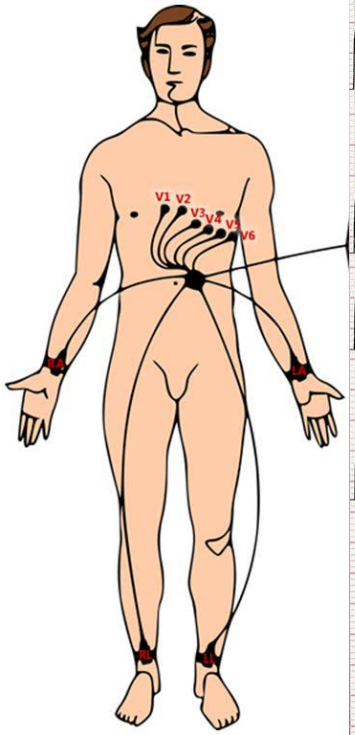
d) Inward Ca2+current (ICa(L)) opposing the K+ current. = AP plateau 0 mV; (phase 2), (main route for Ca2+ influx and triggers Ca2+ release from the sarcoplasmic reticulum, initiating contraction of the myocyte)

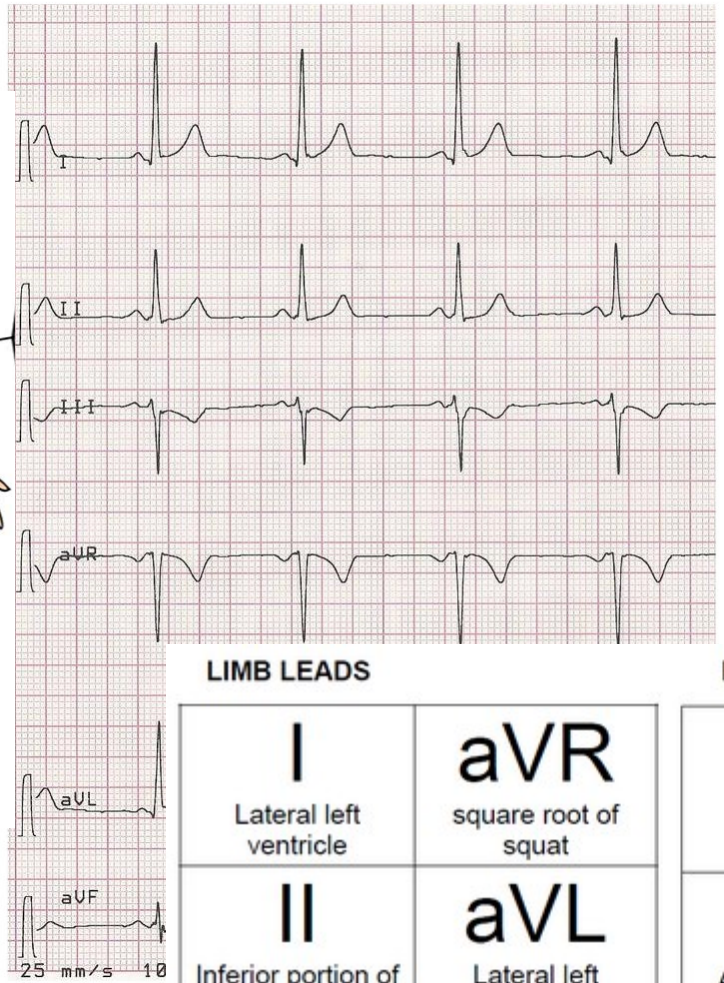
e) Outward delayed rectifier K+ current (IKDR) = repolarization (phase 3)

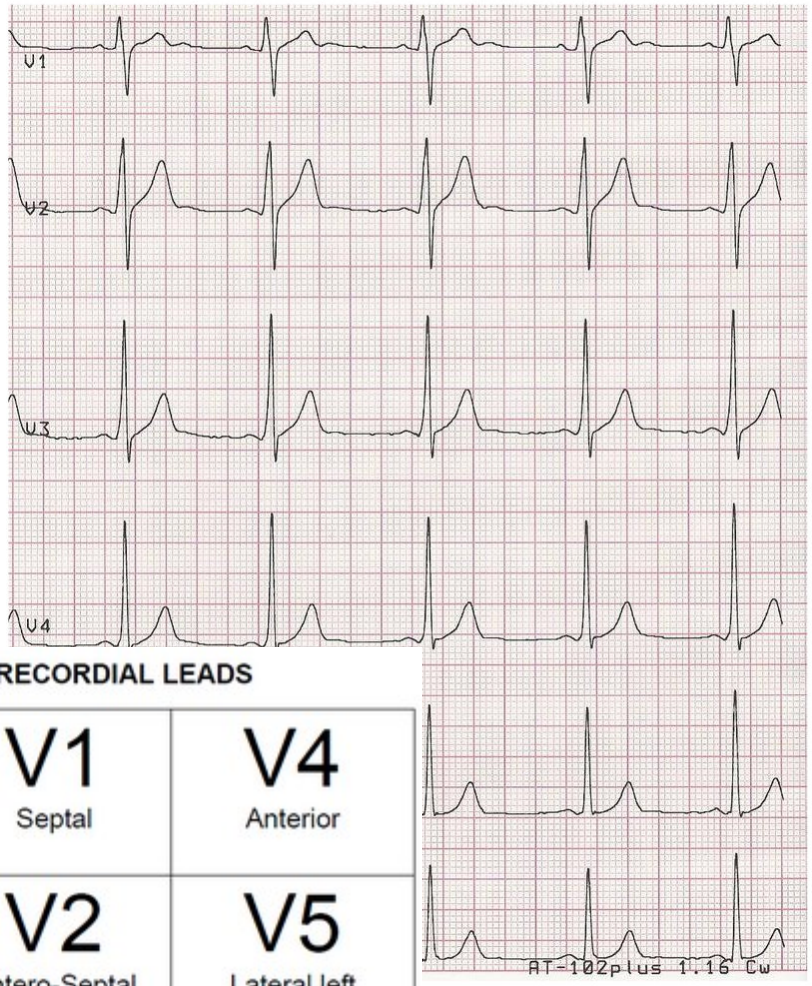
f) Outward K+ channels mediate the final repolarization (phase 4).

Principles of ECG

Standard 12- lead ECG recording

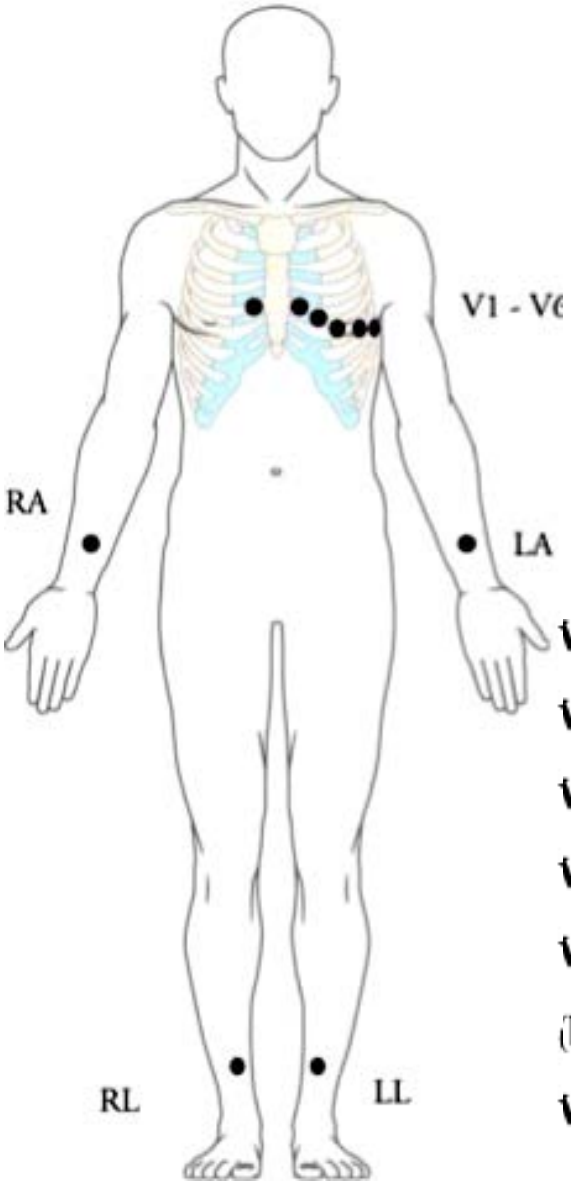


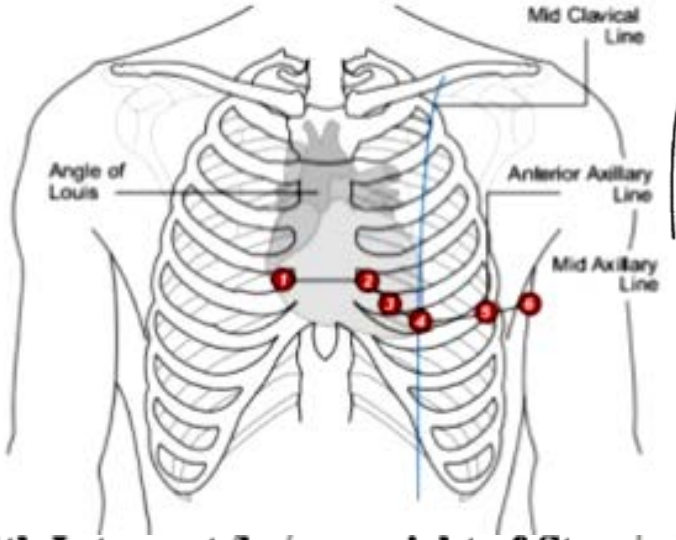


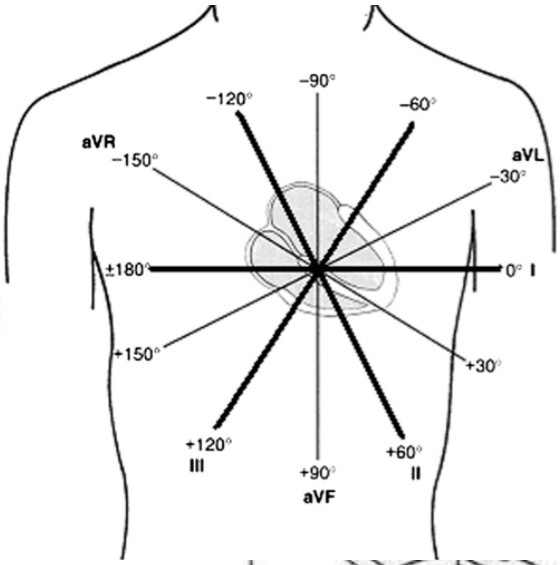


LIMB LEADS		PRECORDIAL LEADS	
I Lateral left ventricle	aVR square root of squat	V1 Septal	V4 Anterior
II Inferior portion of the left ventricle	aVL Lateral left ventricle	V2 Antero-Septal	V5 Lateral left ventricle
III Inferior portion of the left ventricle	aVF Inferior portion of the left ventricle	V3 Anterio-Septal	V6 Lateral left ventricle

Electrode placement







V1 - 4th Intercostal space, right of Sternum

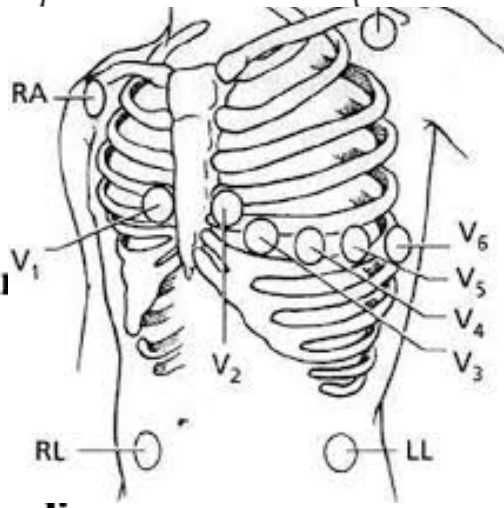
V2 - 4th Intercostal space, left of sternum

V3 - Midway between V2 and V4

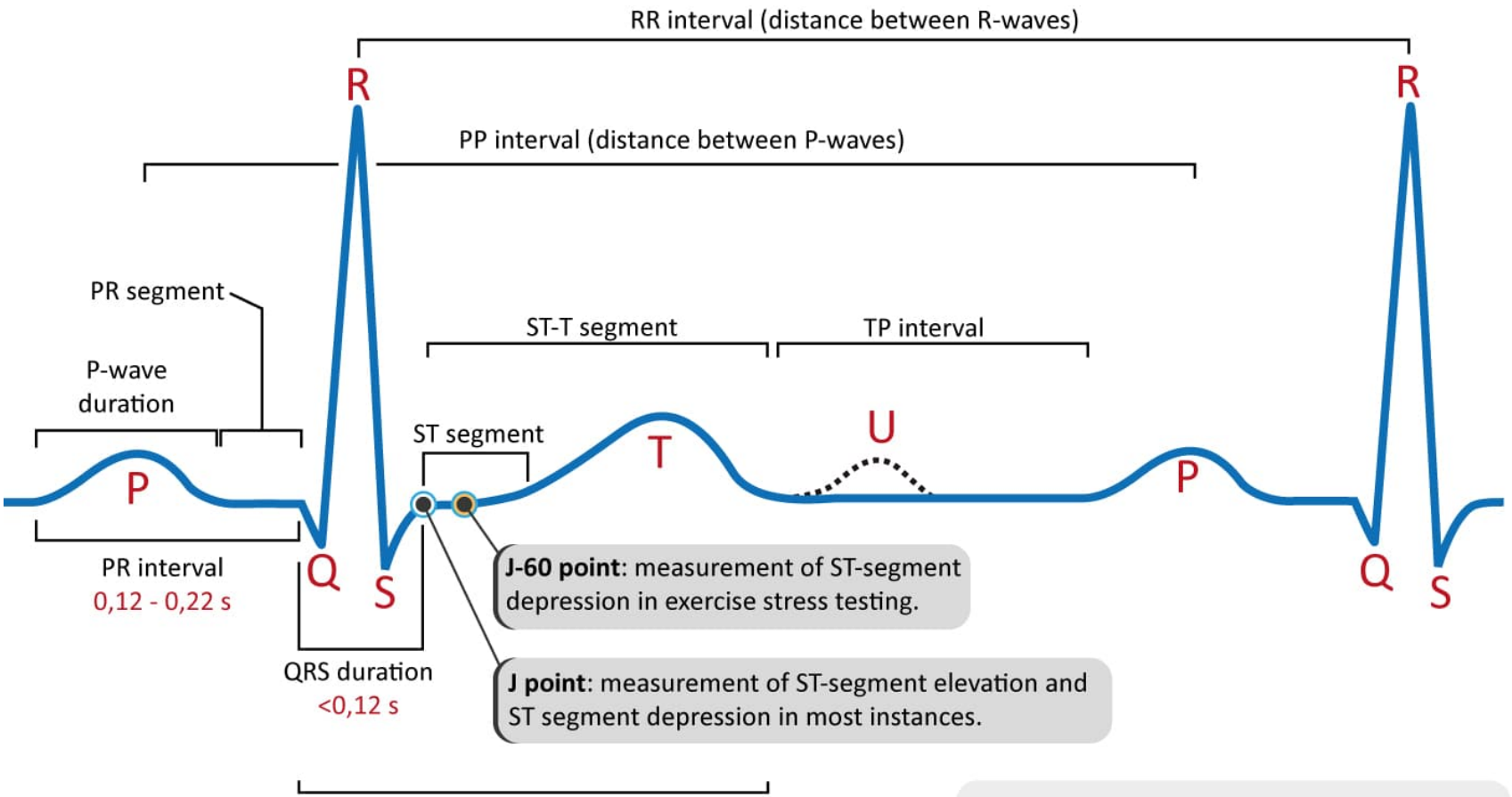
V4 - 5th Intercostal space, in the Midclavicular

V5 - same level as V4, at anterior Axillary line (between V4 and V6)

V6 - in 5th Intercostal space, in the Mid axillary line

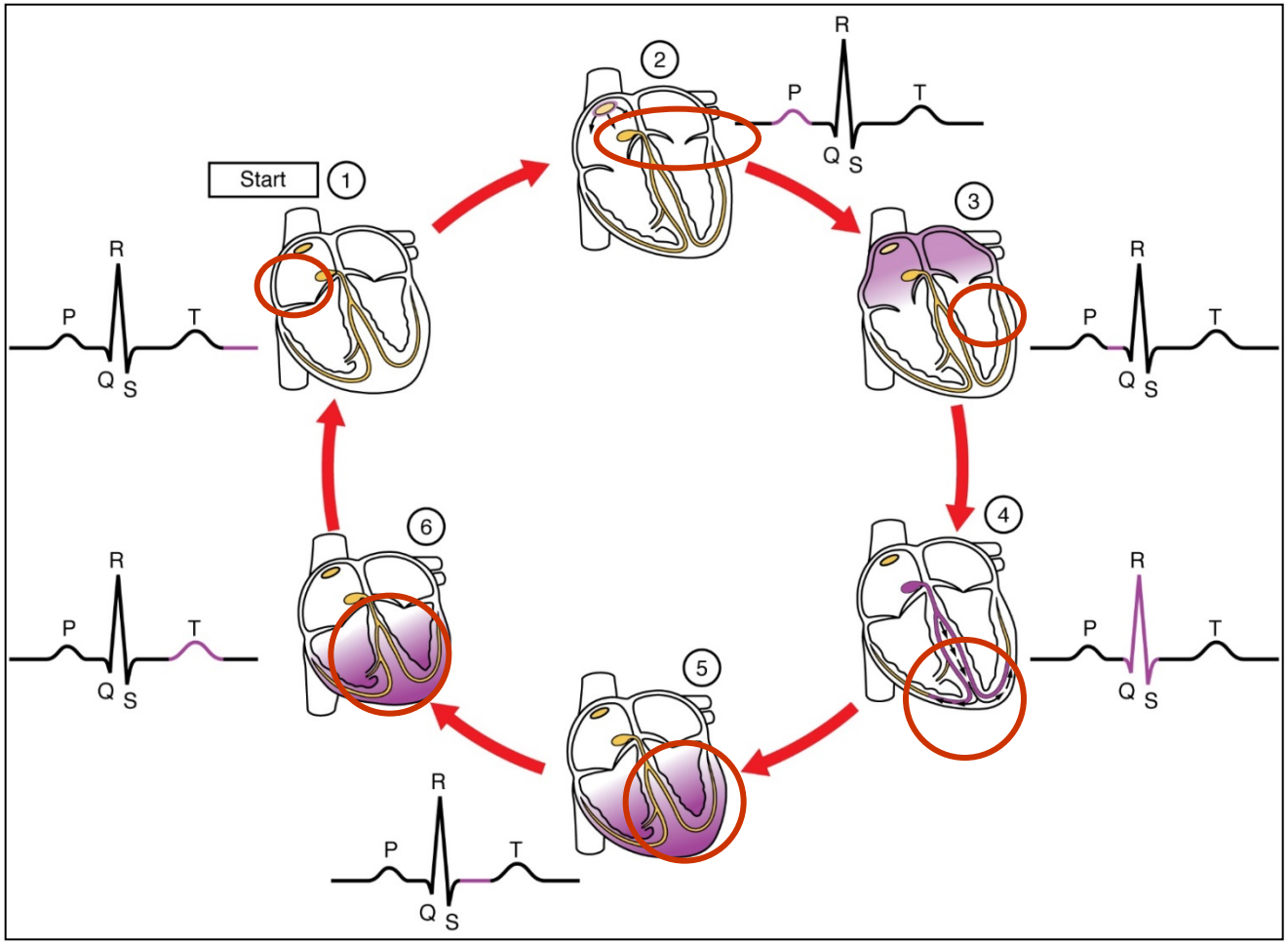


ECG waves and intervals



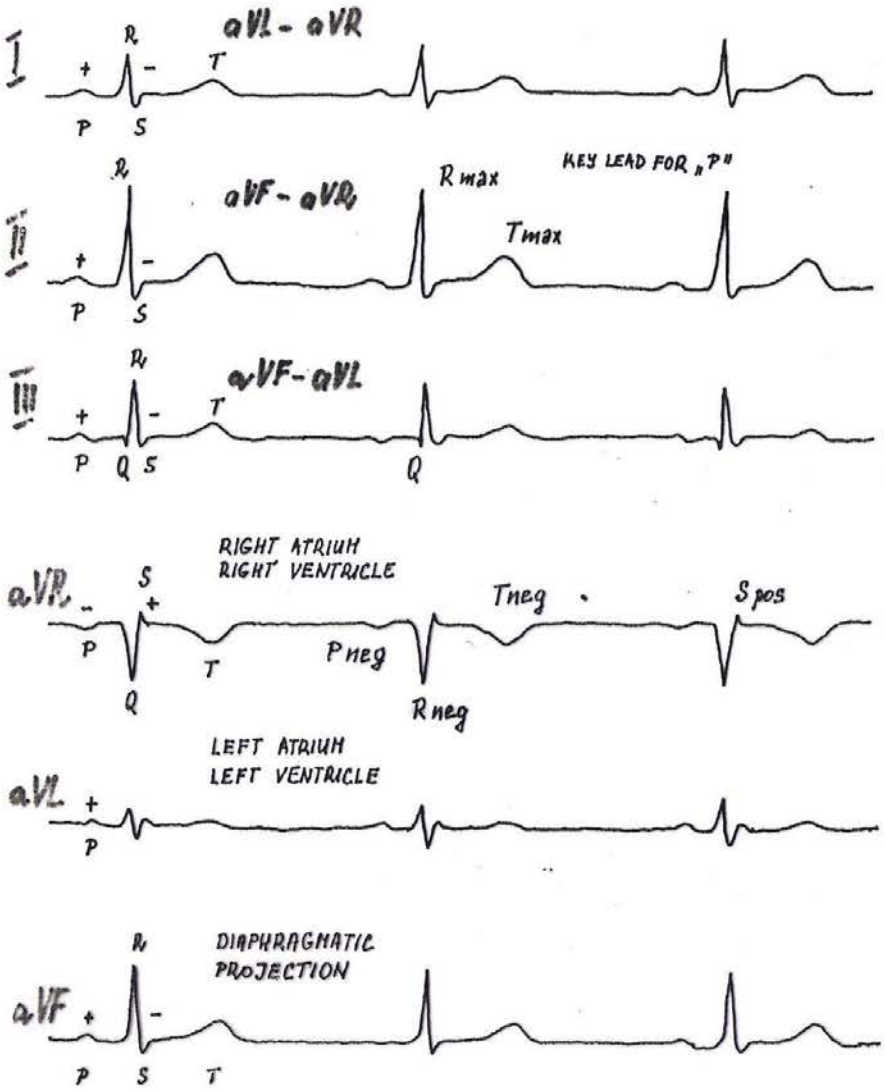
The reference level for measuring ST-segment deviation (depression or elevation) is not the TP interval. The correct reference level is the **PR segment**. This level is also called **baseline** level or **isoelectric level**.

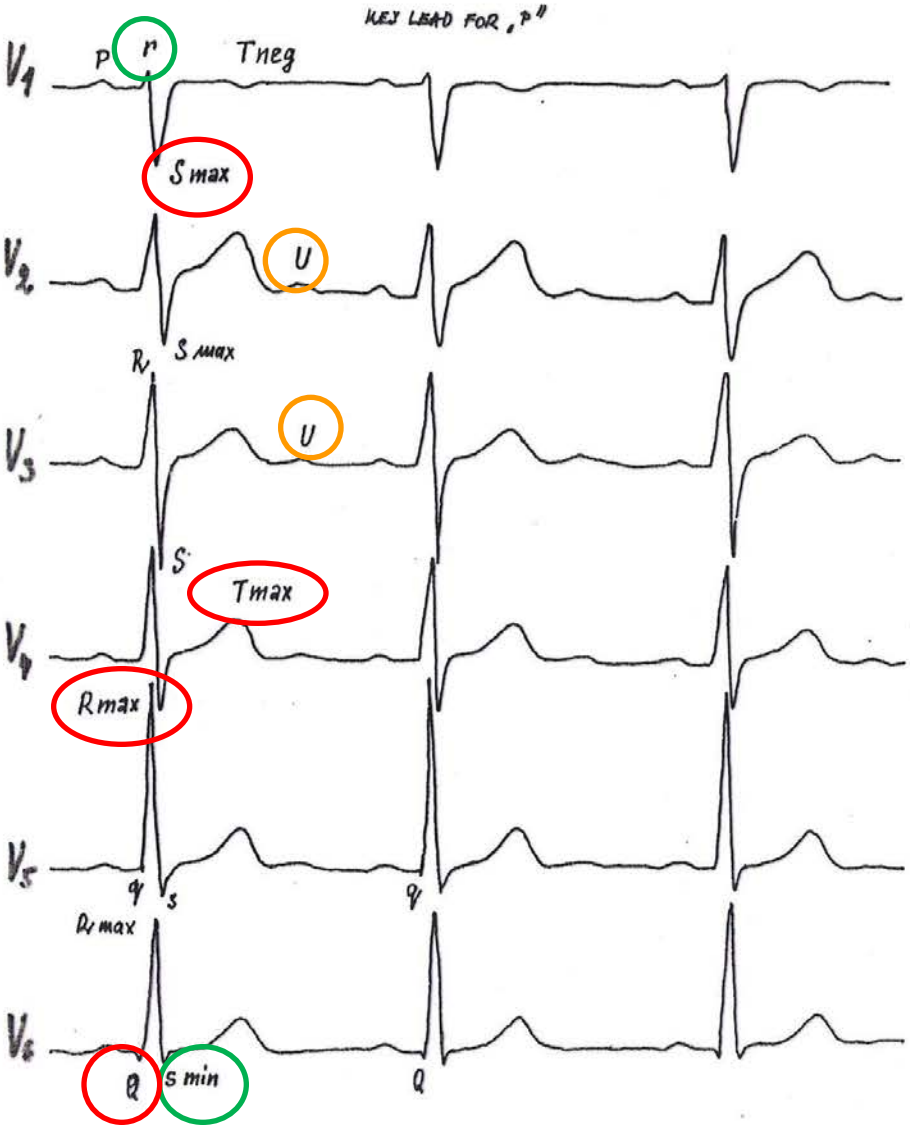
Generation of ECG waveforms



Movement of summary vector of electrical heart activity: P wave = depolarization of righ → left atrium + return to right side; PQ interval = passing through AV nodal area to Hiss bundle; Q wave = right septum + right heart start; uprise R = left septum + left apex + anterior wall; downfall R + S wave = rear; diaphragm. left heart; T wave= repolarisatrion of righ + left chmbers; U wave = left chamber wall

Normal 12- lead ECG recording





ECG from student era (1983)

Arrhythmias - basics

Cardiac arrhythmias (dysrrhythmias)

- Definition: Cardiac dysrhythmias = group of disorders of cardiac electrical rhythm autopacing and distribution in which the heartbeat may show irregularities or ECG abnomalities with no change in normal frequency, or too fast or too slow.

- Epidemiology: affect millions of people, occur at any age incl. children; more common among older people; sudden cardiac death is the cause 1/2 of deaths due to cardiovascular disease or about 15% of all deaths globally. About 80% of sudden cardiac death ← ventricular arrhythmias; Atrial fibrillation & atrial flutter → >100,000 deaths (2015).

- Clinical manifestations:
  - Many types of arrhythmia have no symptoms and are not serious.
  - Typical symptoms include - palpitations, feeling a pause between heartbeats, lightheadedness, shortness of breath, chest pain, etc.
  - Serious complications – asystolia, acute/chronic heart failure, cardiac arrest.

Cardiac arrhythmias (cont.)

- Etiology:
  - Specific cardiac and non-specific **chanellopathies (inborn & acuired)**
  - **Congenital/acquired defects** in electrical **conduction system** of the heart (e.g. abnormalities of resting ECG, pre-excitation (short PR interval)
  - **Structural cardiac diseases** = mitral valve dis., LV aneurysm, congenital heart diseases
  - **Ischemic heart disease** = mother of many arrhythmias (conductive system & myocard); angina, recent myocardial infarction
  - **Internal milieu disturbances** = ↓ or ↑ K+ hyper-/hypokalemia; ↓ or ↑ Ca2+ hypo/hypercalcemia; ↓ Mg2+, acidosis/alkalosis; hypoxia, hypercarbemia ↓ PaO2, ↑ PaCO
  - **Miscellaneous** = Febrile illness, Emotional stress, Smoking, Fatigue
  - **Hormonal dysbalances** (thyroid hormones = hyperthyroidism, growth hormone (gigantism), estrogenes, testosterone
  - **Vegetative dystonias** = sympathetic hyper-reractors (tachycardic arrhythmias); vagal hyperresponsivenes (bradycardia); Pheochromocytoma (catecholaminerg. tumor)
  - **Drugs** = Anti-arrhythmics, Para/ sympathomimetics (β2 agonists, cocaine), antidepressants, caffeine, alcohol

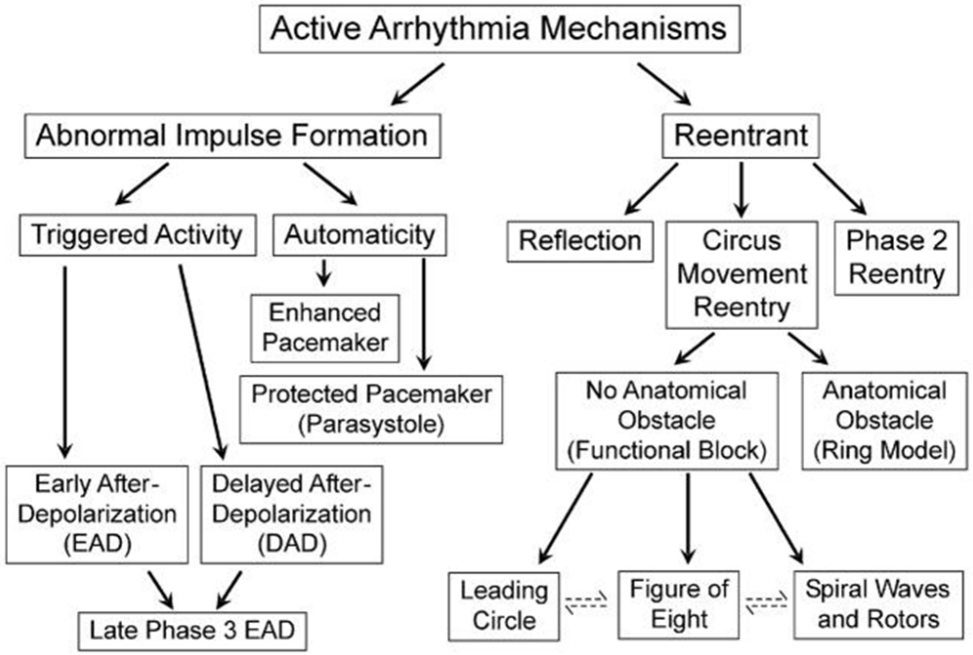
Cardiac arrhythmias (dysrhythmias)

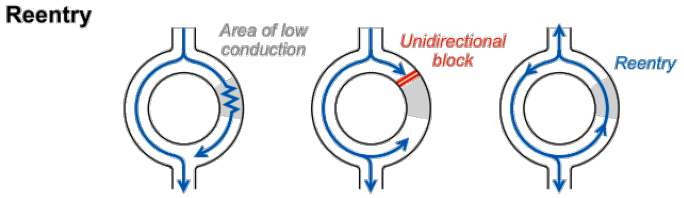
- Classification:
  - According to the origin: a) **Nomotopic** (sinus rhythm) = generated in sinoatrial node ; b) **Ectopic** = released from locations elsewhere
  - According to ectopic location: a) **Supraventricular arrhythmias** (incl. **Atrial arrhythmias** + **Nodal** arrhythmias= atrioventricular node area) b) **Ventricular dysrrhythmia** (generated in conductive system (Hiss bundle, Tawara bundles + myocardium of ventricles)
  - According to stability of pacing : a) **Rhythms** (= paroxysms/ or longer periods (minutes) with out of normal rhythmicity, ECG wave composition, etc.) b) **Extrabeats (captured beats**, short periods, several or individual QRST complexes) **Extra beats** include premature **atrial**, **ventricular** contractions and/or **junctional** contractions.
  - According to the regularity: a) **Regular** (equal RR intervals), (e.g. sinus bradycardia, tachycadia), b) **Irregular** (non-equal RR int.; e.g. sinus arrhythmia, extrasystoles)
  - According to contraction frequency: a) **Normocardic rhythms** 60 - 100 b/ min in adults; b) **Tachycardic rhythms** >100 b/ min (hypoxia, ischemia to the heart !!) c) **Bradycardic rhythms** < 60 b/ min in adults.

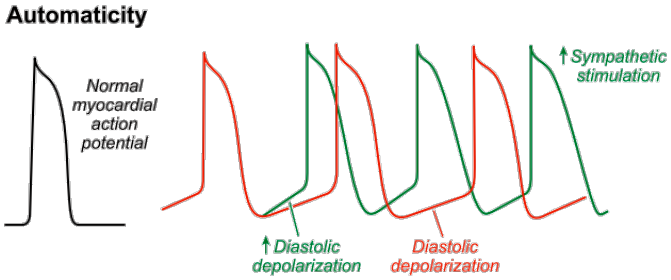
Cardiac arrhythmias (cont.)

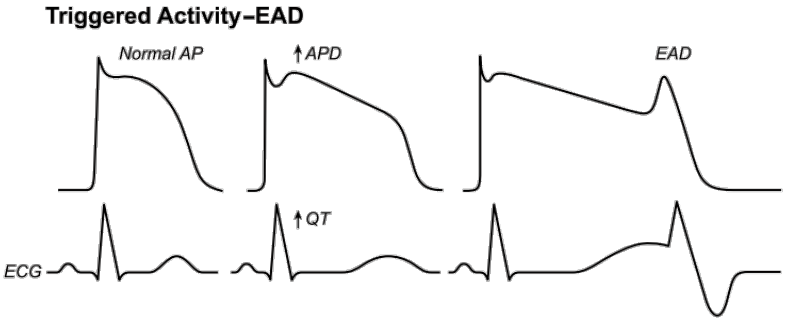
Mechanisms:

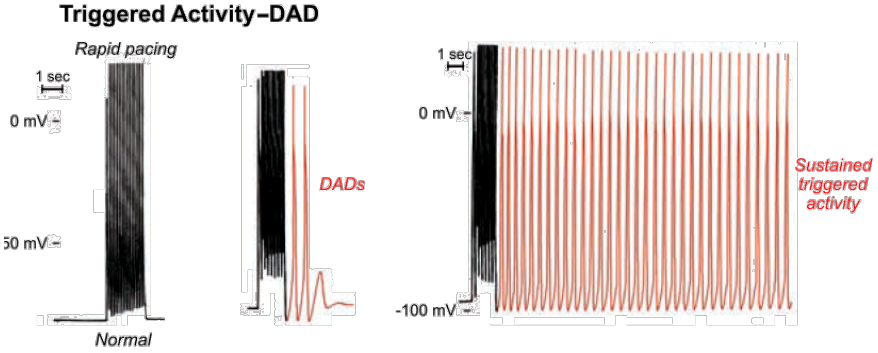
- Abnomal / hidden , protected pacemakers (revived upon pathologic conditions)
- Abnormal automaticity – enhanced pacing (efects of hormones, nervous drive)
- Triggered activity – EAD, DAD (tetanic activity, refractery phases)
- Reentry circuits – small or long loops,
- Channelopathies – specific disorders

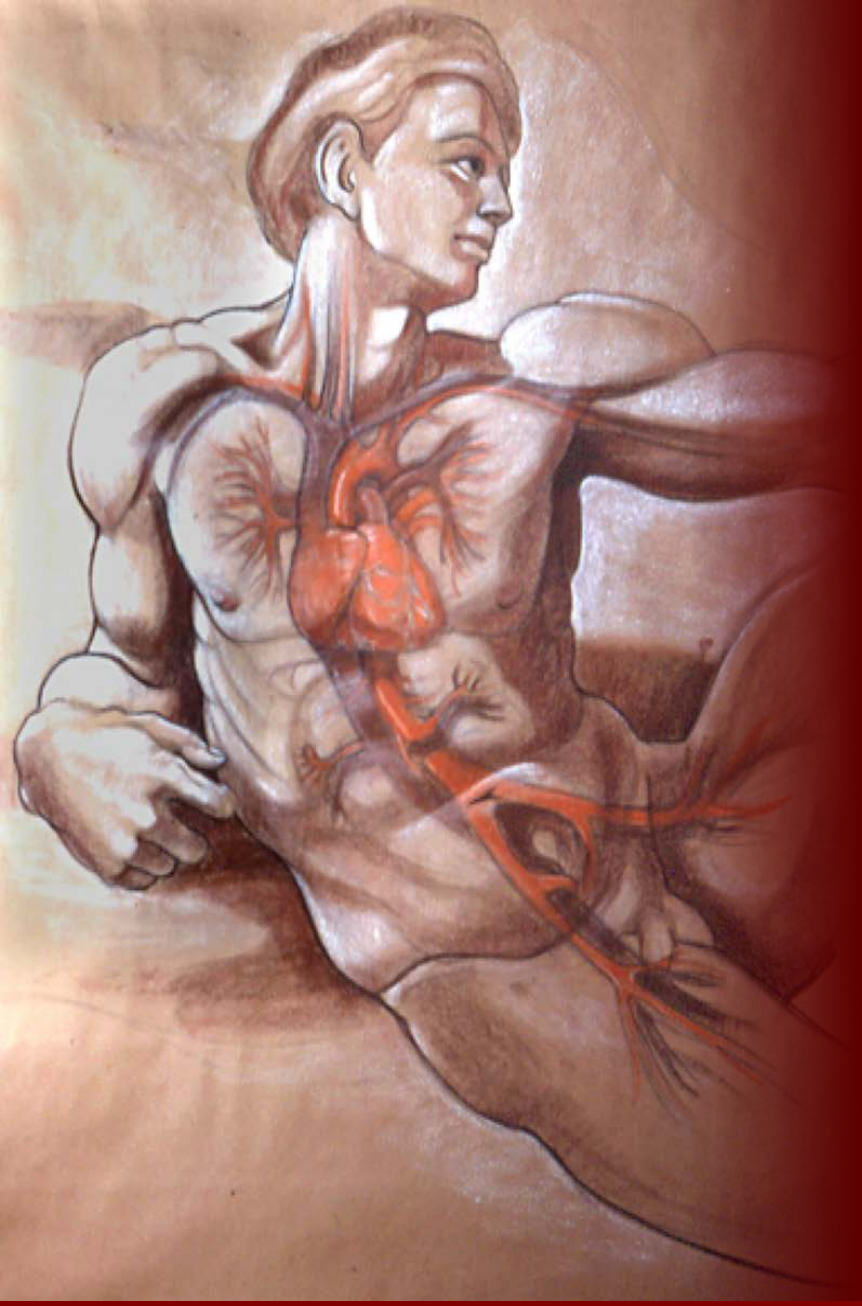












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Sinus Arrhythmias

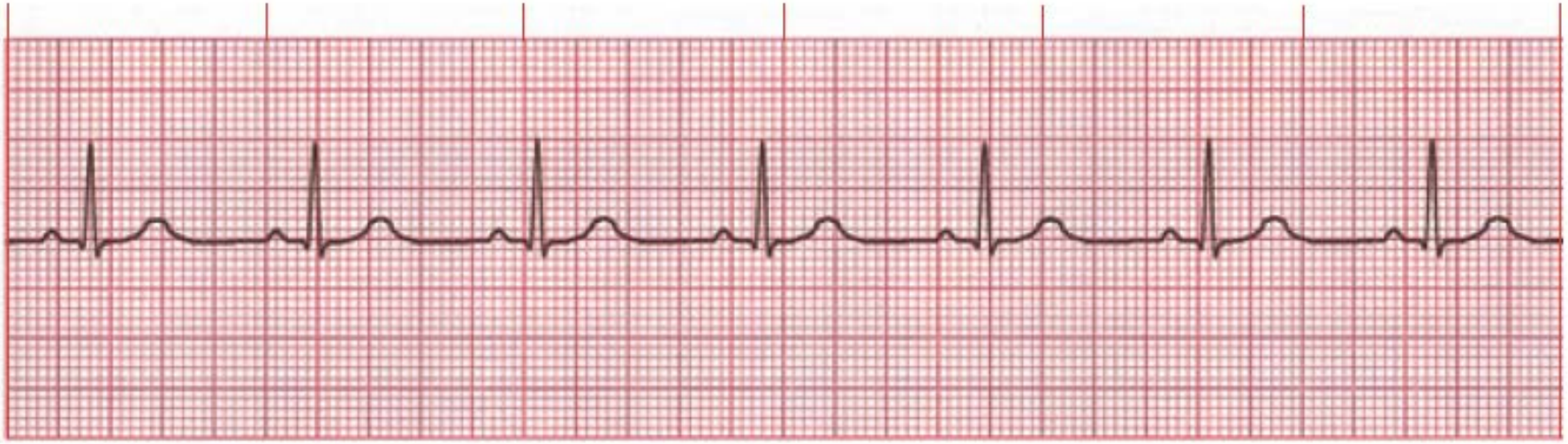
- P wave has normal morphology
- QRS and T wave are of normal morphology

Sinoatrial (SA) Node Arrhythmias

- Upright P waves all look similar.
- PR intervals and QRS complexes are of normal duration.

Note: All ECG strips in this tab were recorded in lead II.

Normal Sinus Rhythm (NSR)



Rate: Normal (60–100 bpm)
Rhythm: Regular
P Waves: Normal (upright and uniform)
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** A normal ECG does not exclude heart disease.

Sinus Bradycardia

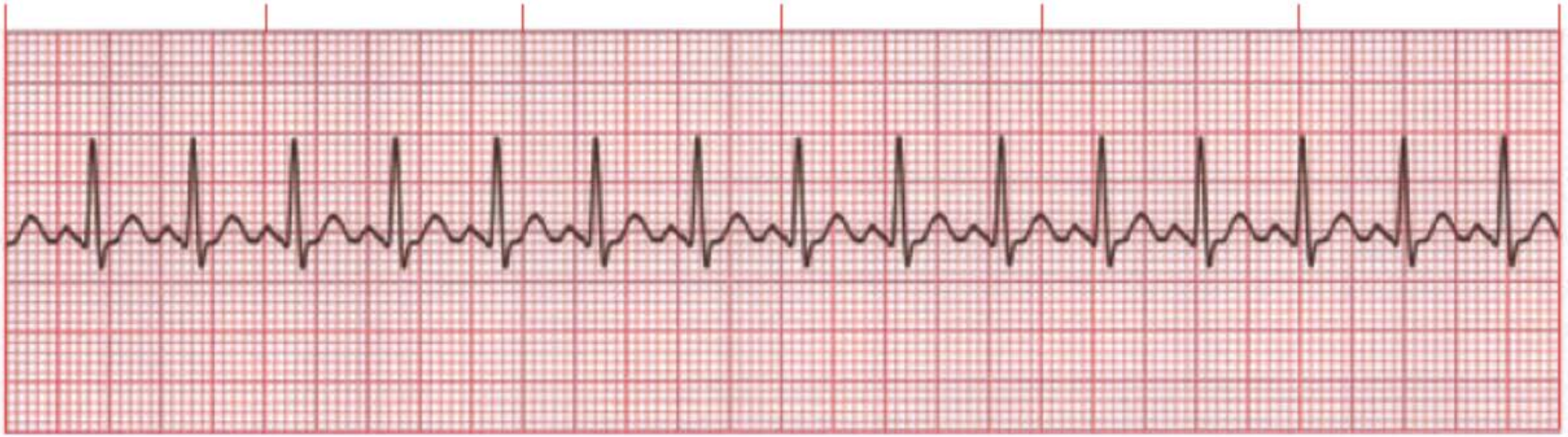
- Results from slowing of the SA node.

Rate: Slow (<60 bpm)
Rhythm: Regular
P Waves: Normal (upright and uniform)
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

Athletes (longs stamina sports)
Normal in sleep
Acute MI (protective, benefitial)
Drugs (beta blockers)

Sinus Tachycardia

- Results from increased SA node discharge.



Rate: Fast (>100 bpm)
Rhythm: Regular
P Waves: Normal (upright and uniform)
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

Any exercise
Stress, Anxiety, Fever,
Hypoxia, hypoxemia
Cardiac failure

Sinus Arrhythmia

- The SA node discharges irregularly.
- The R-R interval is irregular.

Rate: Usually normal (60–100 bpm); frequently increases with inspiration and decreases with expiration
Rhythm: Irregular; varies with respiration
P Waves: Normal (upright and uniform)
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

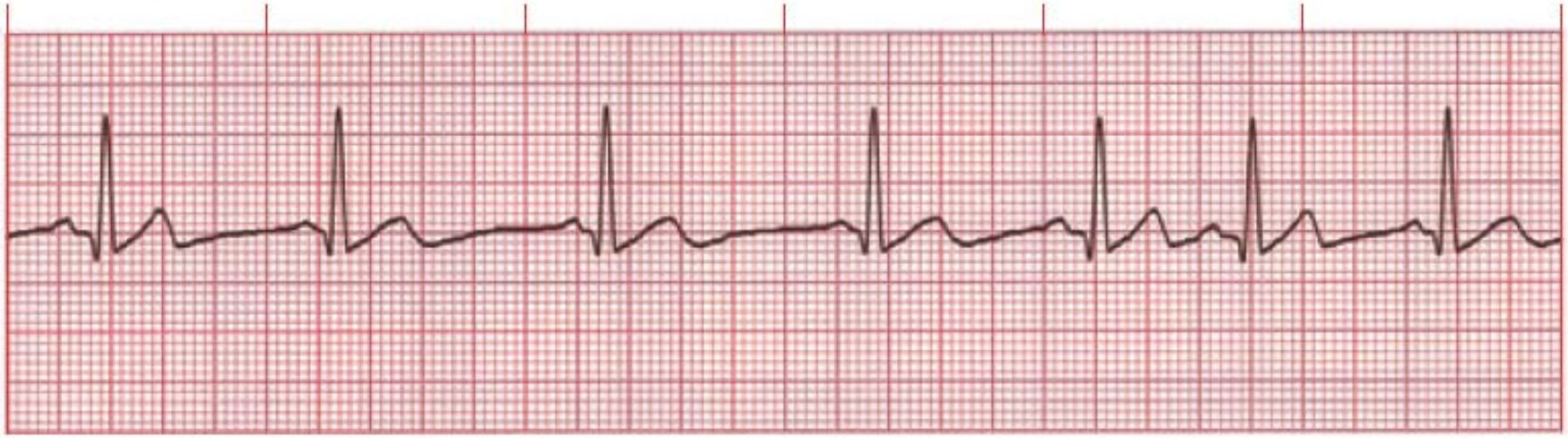
Rate of SA node varies with respiration (respiratory arrhythmia) manily in kids ands elderly = analyzed by HRV

Atrial Arrhythmias

- P wave is different from that generated in SA node
- QRS and T wave are of normal morphology

Wandering Atrial Pacemaker (WAP)

- Pacemaker site transfers from the SA node to other latent pacemaker sites in the atria and the AV junction and then moves back to the SA node.



Rate: Normal (60–100 bpm)
Rhythm: Irregular
P Waves: At least three different forms, determined by the focus in the atria
PR Interval: Variable; determined by focus
QRS: Normal (0.06–0.10 sec)

Multifocal Atrial Tachycardia (MAT)

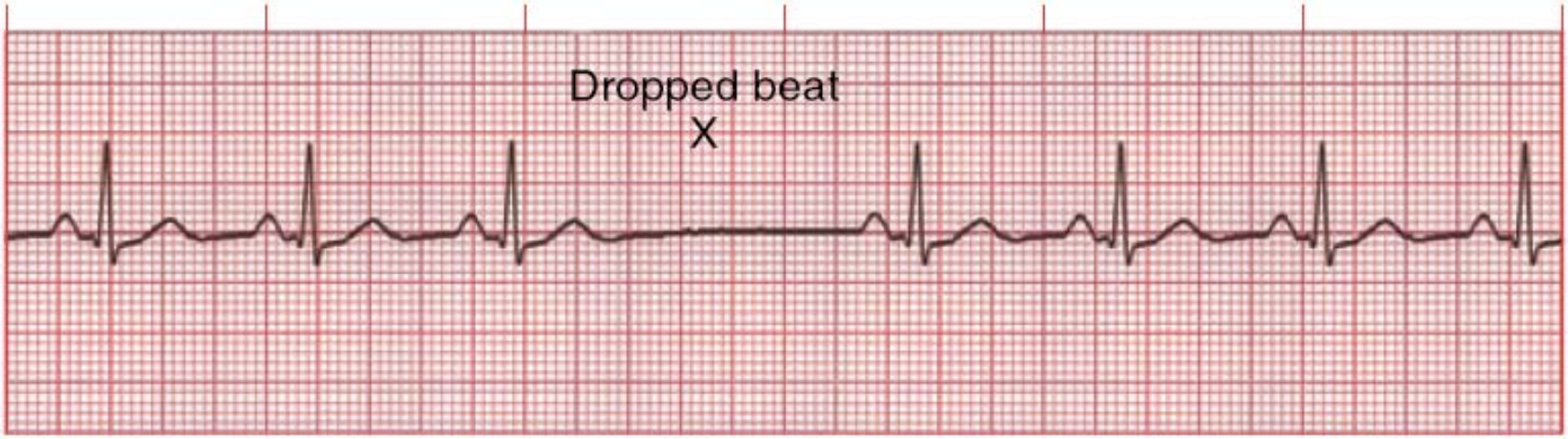
- This form of WAP is associated with a ventricular response of >100 bpm.
- MAT may be confused with atrial fibrillation (A-fib); however, MAT has a visible P wave.

Rate: Fast (>100 bpm)
Rhythm: Irregular
P Wave: At least three different forms, determined by the focus in the atria
PR Interval: Variable; depends on focus
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** MAT is commonly seen in patients with COPD but may also occur in acute MI.

Sinoatrial (SA) Block

- The block occurs in some multiple of the P-P interval.
- After the dropped beat, cycles continue on time.



Rate: Normal to slow; determined by duration and frequency of SA block
Rhythm: Irregular whenever an SA block occurs
P Waves: Normal (upright and uniform) except in areas of dropped beats
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** Cardiac output may decrease, causing syncope or dizziness.

Sinus Pause (Sinus Arrest)

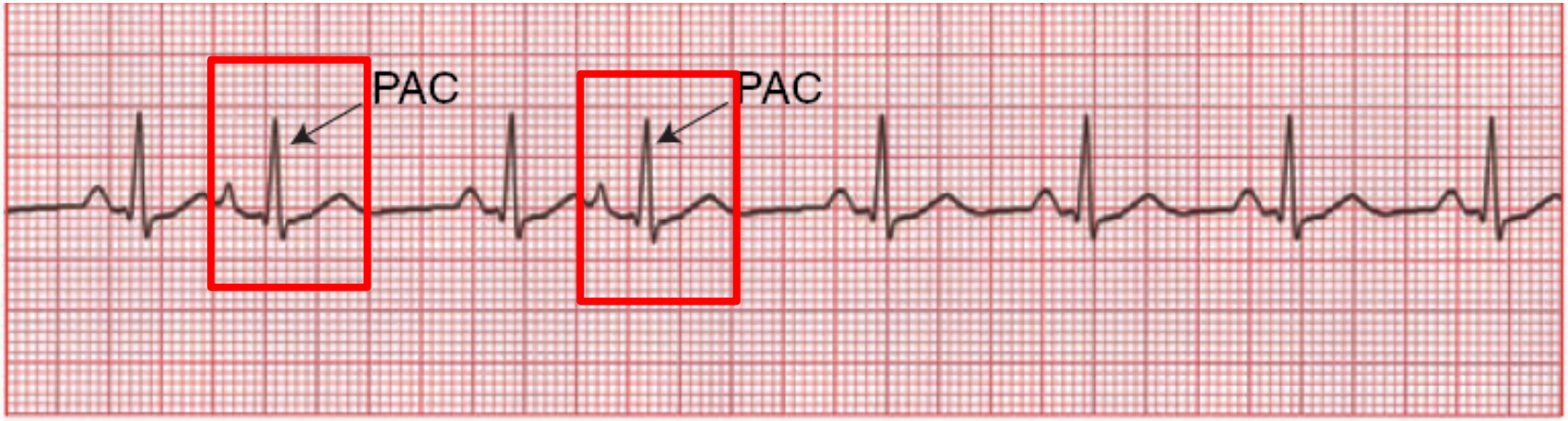
- The SA node fails to discharge and then resumes.
- Electrical activity resumes either when the SA node resets itself or when a lower latent pacemaker begins to discharge.
- The pause (arrest) time interval is not a multiple of the normal P-P interval.

Rate: Normal to slow; determined by duration and frequency of sinus pause (arrest)
Rhythm: Irregular whenever a pause (arrest) occurs
P Waves: Normal (upright and uniform) except in areas of pause (arrest)
PR Interval: Normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** Cardiac output may decrease, causing syncope or dizziness.

Premature Atrial Contractions (PAC)

Extrasystoles with full compensatory phase



Rate: Depends on rate of underlying rhythm
Rhythm: Irregular whenever a PAC occurs
P Waves: Present; in the PAC, may have a different shape
PR Interval: Varies in the PAC; otherwise normal (0.12–0.20 sec)
QRS: Normal (0.06–0.10 sec)

- Extrabeat occurs prior to next expected sinus complex;
- Obviuously, sinus rhythm is resumed after PAC
- PAC may preceede patoxysmal supraventricular tachycardia, Atrial fibrilation or Atrial flutter

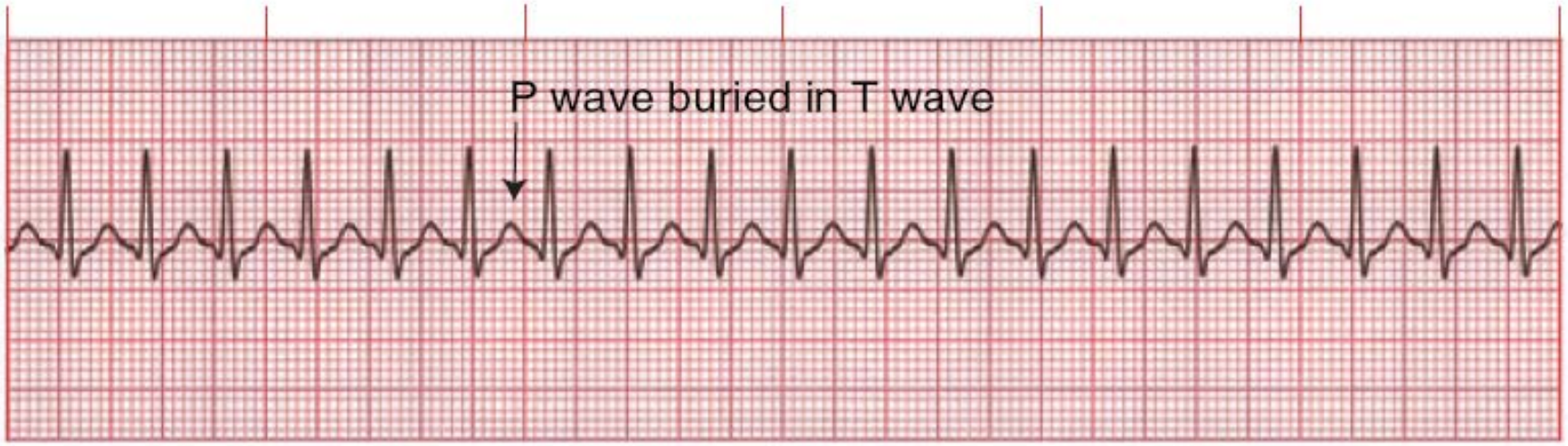
Atrial Tachycardia

- A rapid atrial rate overrides the SA node and becomes the dominant pacemaker.
- Some ST wave and T wave abnormalities may be present.

Rate: 150–250 bpm
Rhythm: Regular
P Waves: Normal (upright and uniform) but differ in shape from sinus P waves
PR Interval: May be short (<0.12 sec) in rapid rates
QRS: Normal (0.06–0.10 sec) but can be aberrant at times

Supraventricular Tachycardia (SVT)

- This arrhythmia has such a fast rate that the P waves may not be seen.

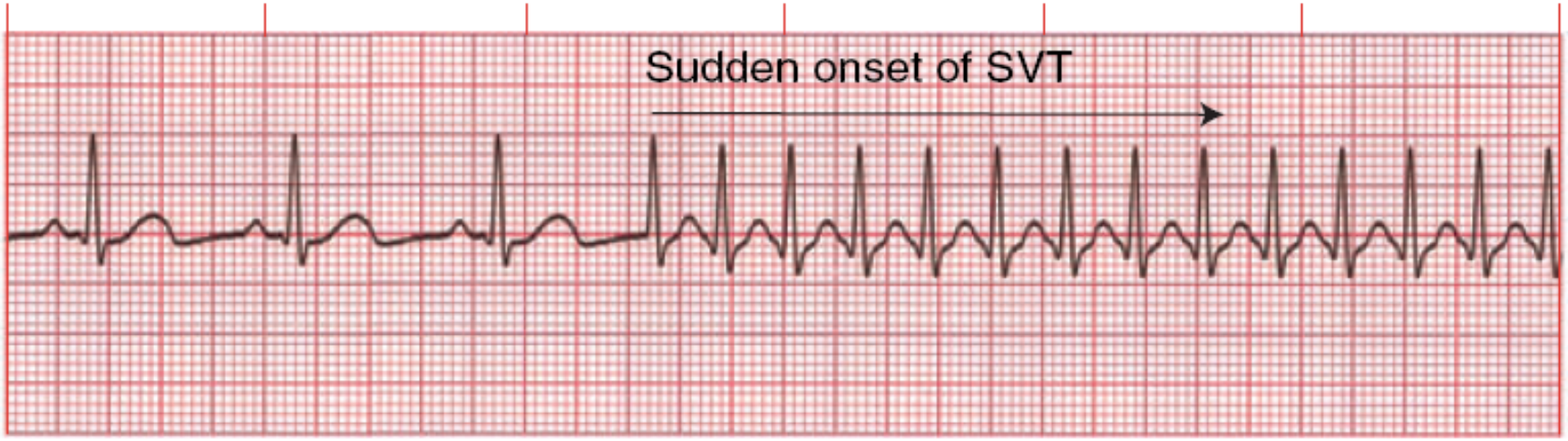


Rate: 150–250 bpm
Rhythm: Regular
P Waves: Frequently buried in preceding T waves and difficult to see
PR Interval: Usually not possible to measure
QRS: Normal (0.06–0.10 sec) but may be wide if abnormally conducted through ventricles

♥ **Clinical Tip:** SVT may be related to caffeine intake, nicotine, stress, or anxiety in healthy adults.

Paroxysmal Supraventricular Tachycardia (PSVT)

- PSVT is a rapid rhythm that starts and stops suddenly.
- For accurate interpretation, the beginning or end of the PSVT must be seen.
- PSVT is sometimes called paroxysmal atrial tachycardia (PAT).

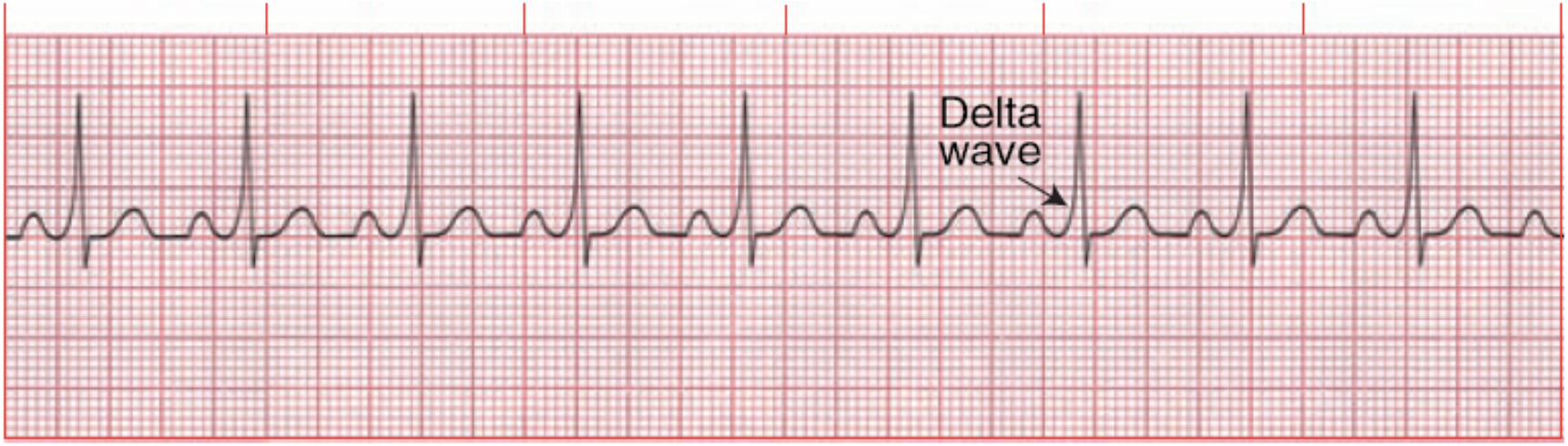


Rate: 150–250 bpm
Rhythm: Regular
P Waves: Frequently buried in preceding T waves and difficult to see
PR Interval: Usually not possible to measure
QRS: Normal (0.06–0.10 sec) but may be wide if abnormally conducted through ventricles

♥ **Clinical Tip:** The patient may feel palpitations, dizziness, lightheadedness, or anxiety.

Wolff-Parkinson-White (WPW) Syndrome

- In WPW an accessory conduction pathway is present between the atria and the ventricles. Electrical impulses are rapidly conducted to the ventricles.
- These rapid impulses create a slurring of the initial portion of the QRS called the delta wave.

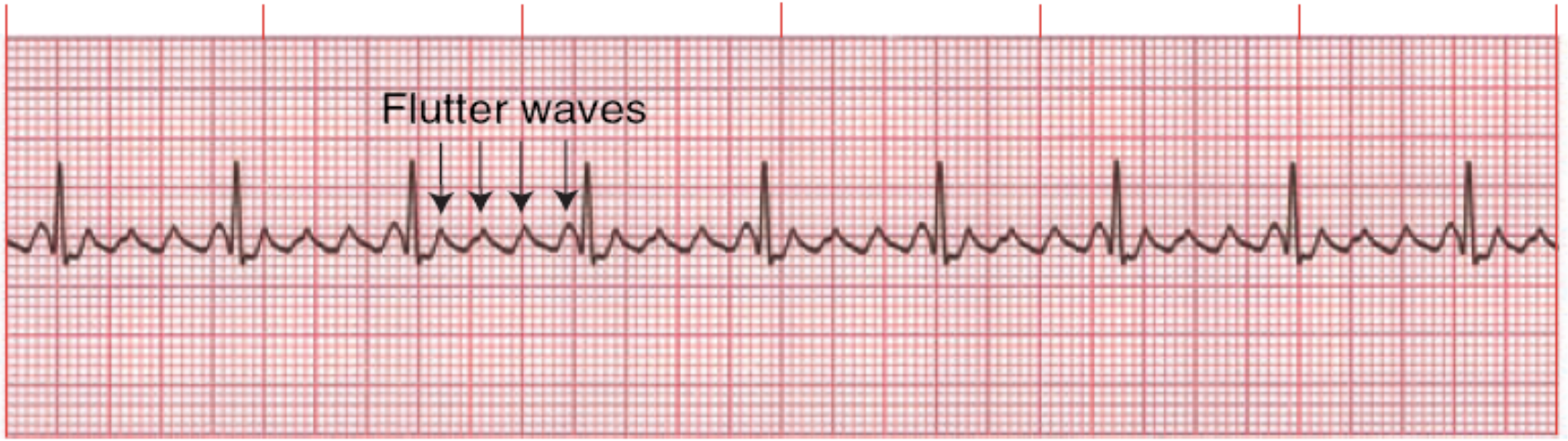


Rate: Depends on rate of underlying rhythm
Rhythm: Regular unless associated with A-fib
P Waves: Normal (upright and uniform) unless A-fib is present
PR Interval: Short (<0.12 sec) if P wave is present
QRS: Wide (>0.10 sec); delta wave present

♥ **Clinical Tip:** WPW is associated with narrow-complex tachycardias, including A-flutter and A-fib.

Atrial Flutter (A-flutter)

- AV node conducts impulses to the ventricles at a 2:1, 3:1, 4:1, or greater ratio (rarely 1:1).
- Degree of AV block may be consistent or variable.



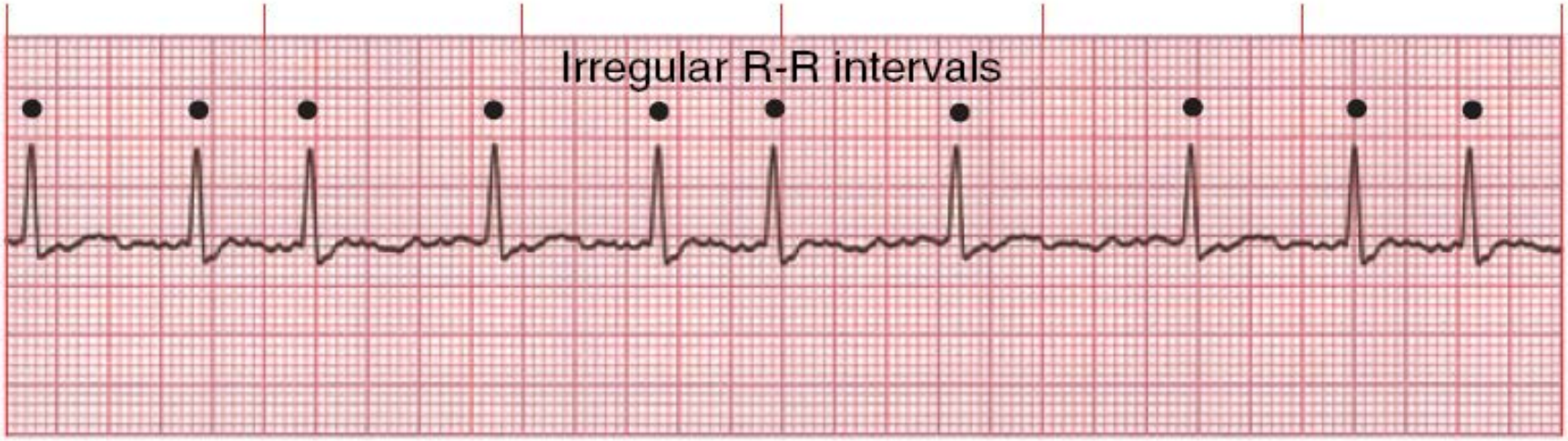
Rate: Atrial: 250–350 bpm; ventricular: slow or fast
Rhythm: Usually regular but may be variable
P Waves: Flutter waves have a saw-toothed appearance
PR Interval: Variable
QRS: Usually normal (0.06–0.10 sec), but may appear widened if flutter waves are buried in QRS

♥ **Clinical Tip:** The presence of A-flutter may be the first indication of cardiac disease.

♥ **Clinical Tip:** Signs and symptoms depend on ventricular response rate.

Atrial Fibrillation (A-fib)

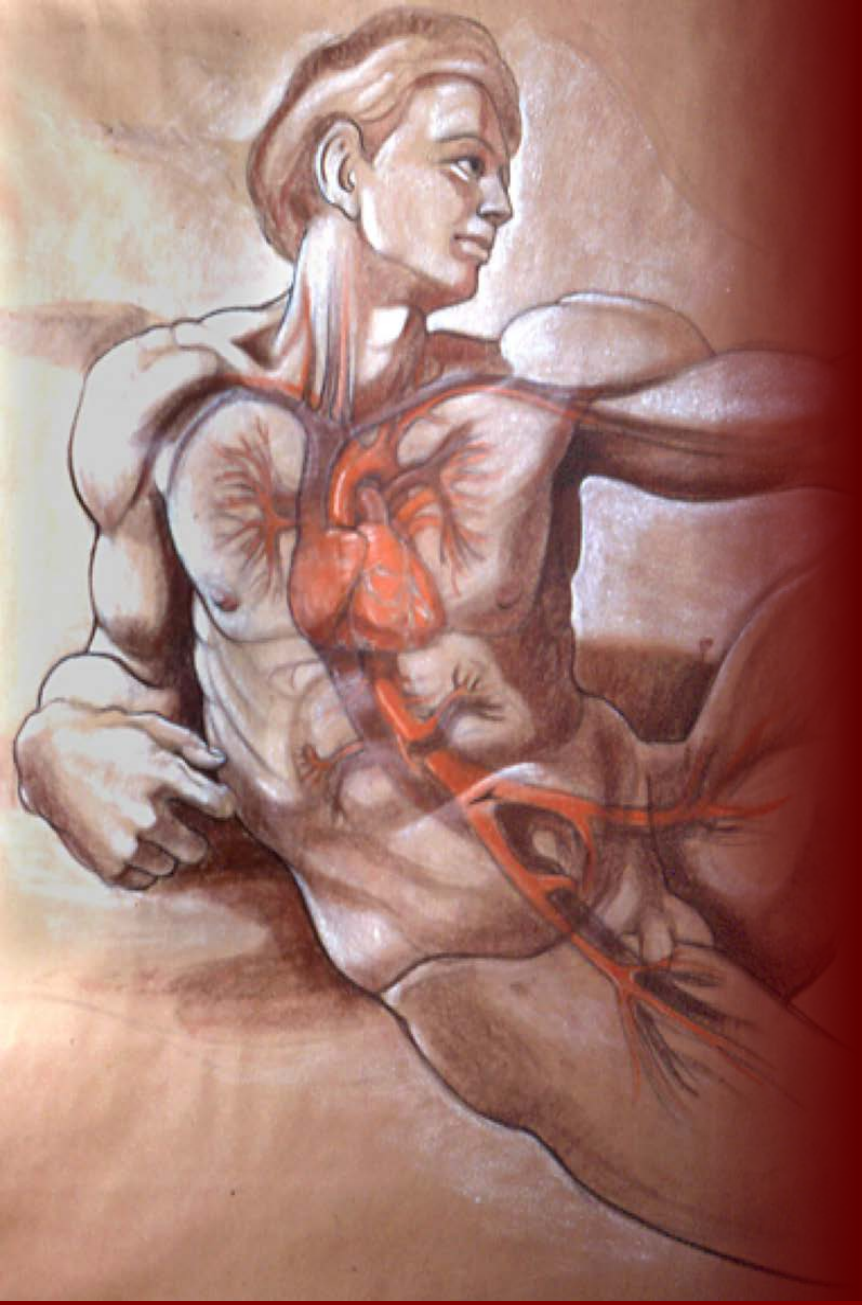
- Rapid, erratic electrical discharge comes from multiple atrial ectopic foci.
- No organized atrial contractions are detectable.



Rate: Atrial: 350 bpm or greater; ventricular: slow or fast
Rhythm: Irregular
P Waves: No true P waves; chaotic atrial activity
PR Interval: None
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** A-fib is usually a chronic arrhythmia associated with underlying heart disease.

♥ **Clinical Tip:** Signs and symptoms depend on ventricular response rate.

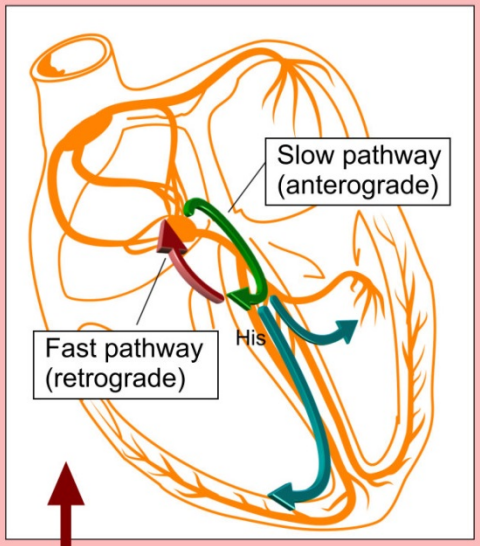


3

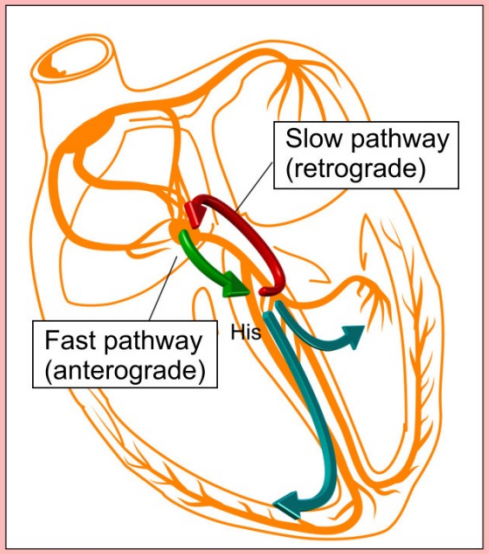
Junctional Arrhythmias

- The atria and SA node loss their pacemaking functions
- A junctional escape rhythm begins

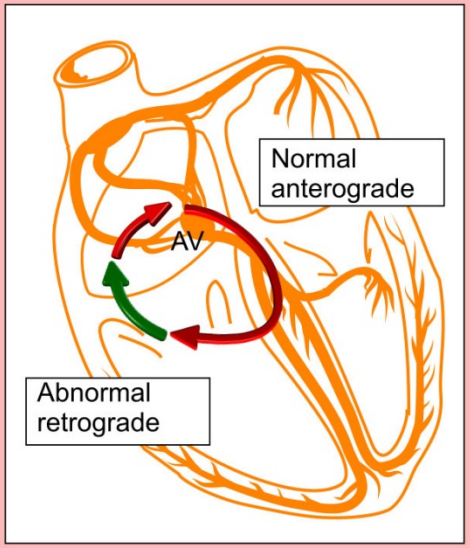
Typical AVNRT (slow-fast)
90-95% cases



Atypical AVNRT (fast-slow)
5-10% cases



Ortodromic AVRT

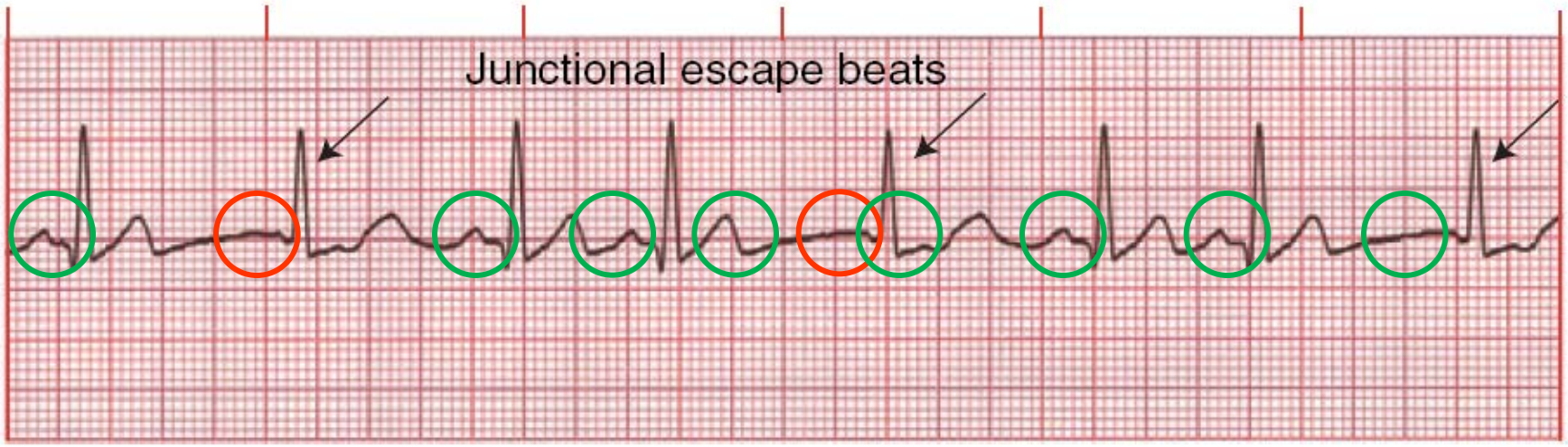


Slow pathway – slow conductance, short refractority, Localized: inferiorily and posteriorily to compact AV- nodal tissue running along the edge of tricuspidal anulus close to the sinus coronarius
Fast pathway – fast conductance, long refractority, Localized: close to the apex of Koch triangle

antegrade limb - impulse propagates in the usual fashion ;
retrograde limb - an abnormal accessory pathway reexiting atrium

Junctional Escape Beats (Extrasystoles)

- An escape complex comes later than the next expected sinus complex.



Rate: Depends on rate of underlying rhythm
Rhythm: Irregular whenever an escape beat occurs
P Waves: None, inverted, buried, or retrograde in the escape beat
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

Premature Junctional Contractions (PJC)

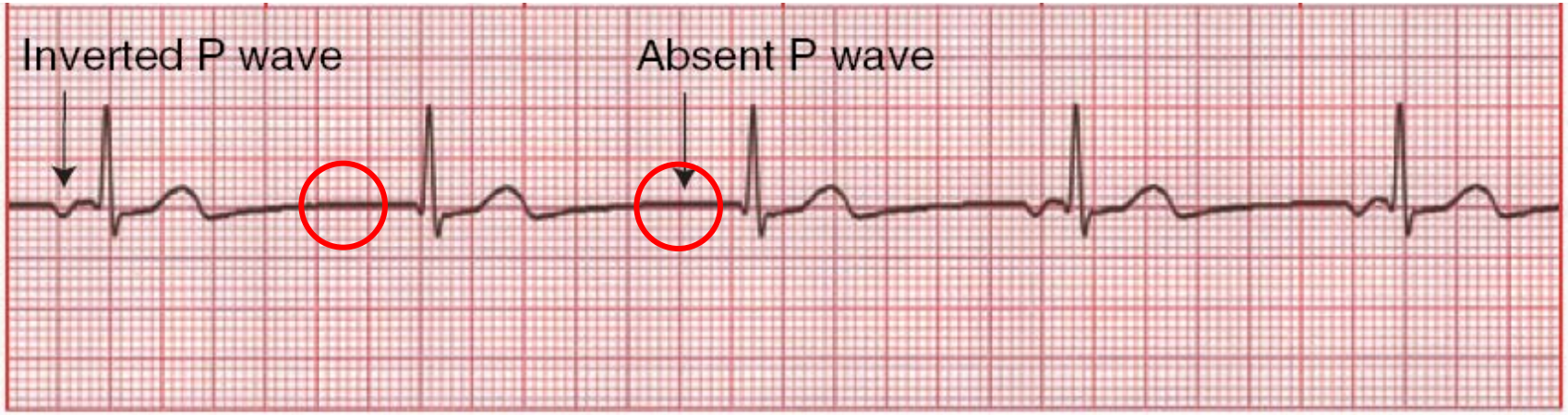
Extrasystoles with full compensatory phase

- Enhanced automaticity in the AV junction produces PJCs.

Rate: Depends on rate of underlying rhythm
Rhythm: Irregular whenever a PJC occurs
P Waves: Absent, inverted, buried, or retrograde in the PJC
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

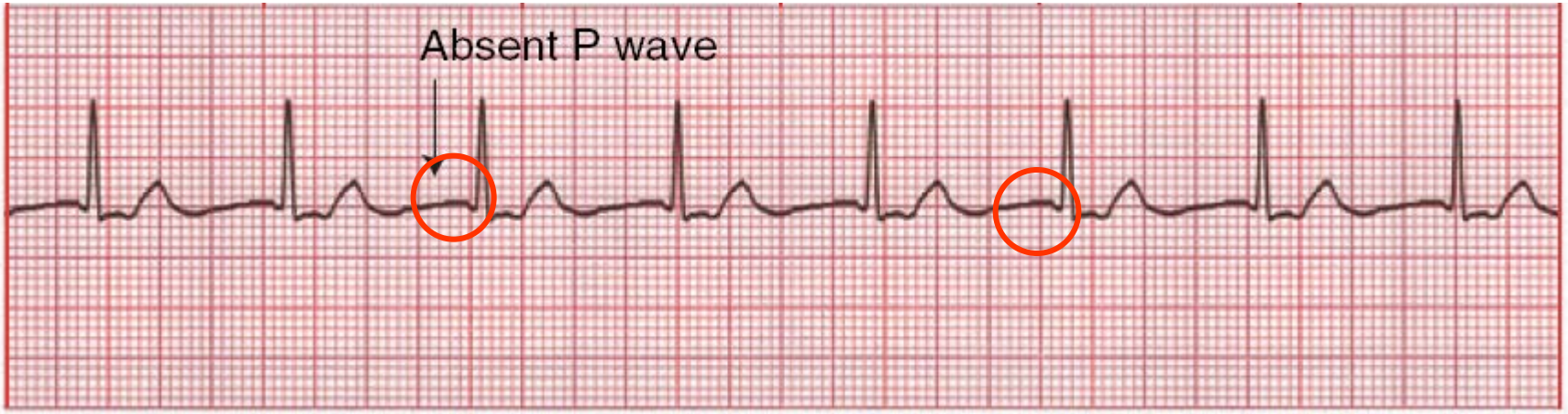
♥ **Clinical Tip:** Before deciding that isolated PJCs may be insignificant, consider the cause.

Junctional Rhythm



Rate: 40–60 bpm
Rhythm: Regular
P Waves: Absent, inverted, buried, or retrograde

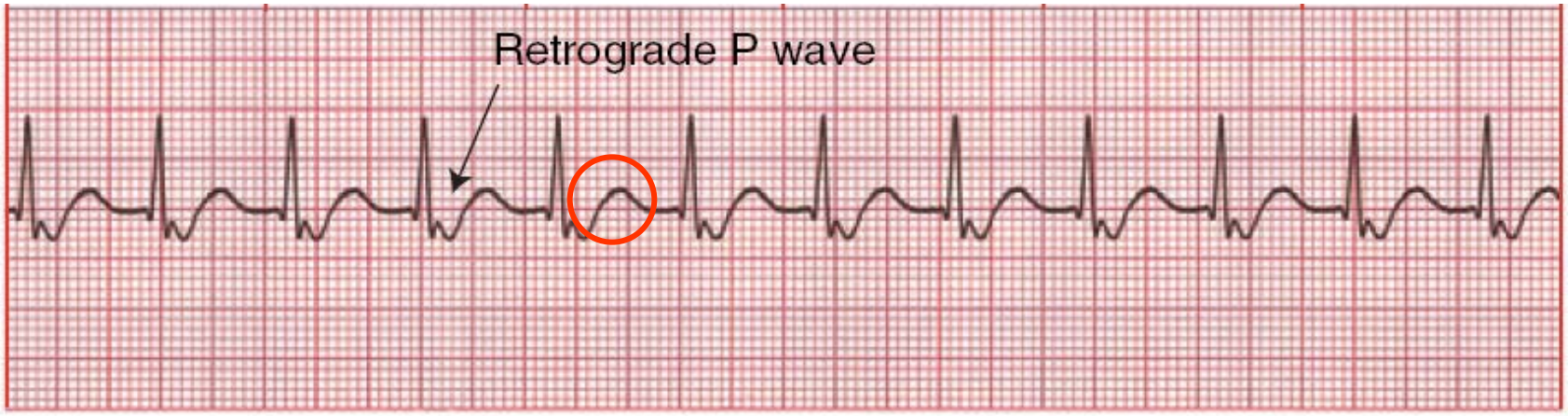
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)



Rate: 61–100 bpm
Rhythm: Regular

P Waves: Absent, inverted, buried, or retrograde
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

Junctional Tachycardia

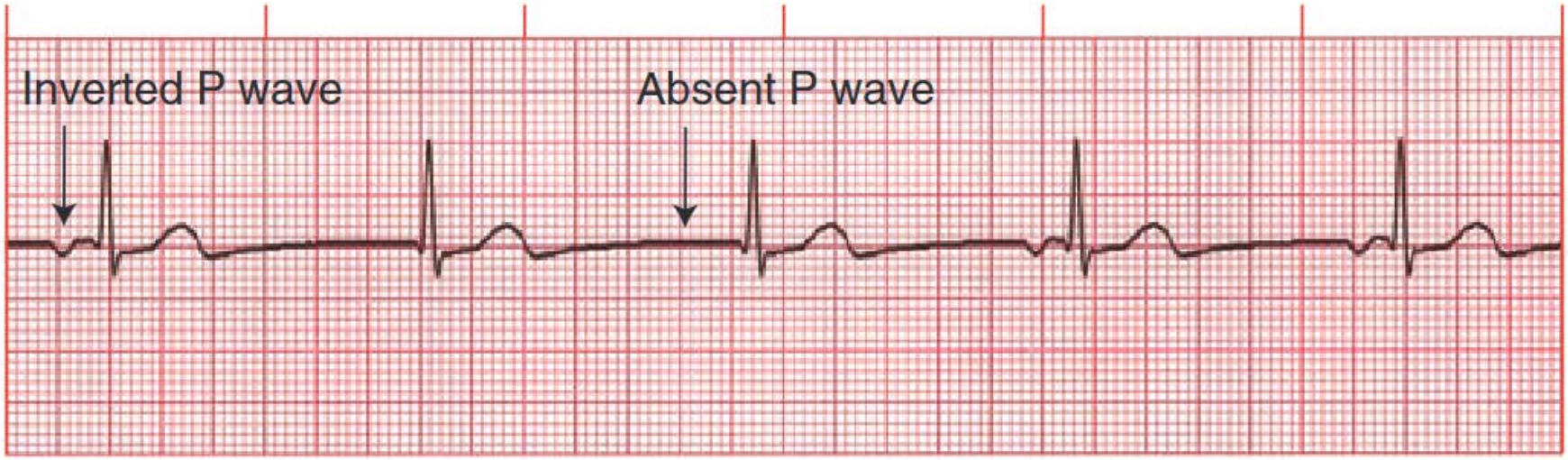


Rate: 101–180 bpm
Rhythm: Regular
P Waves: Absent, inverted, buried, or retrograde
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

Junctional Arrhythmias

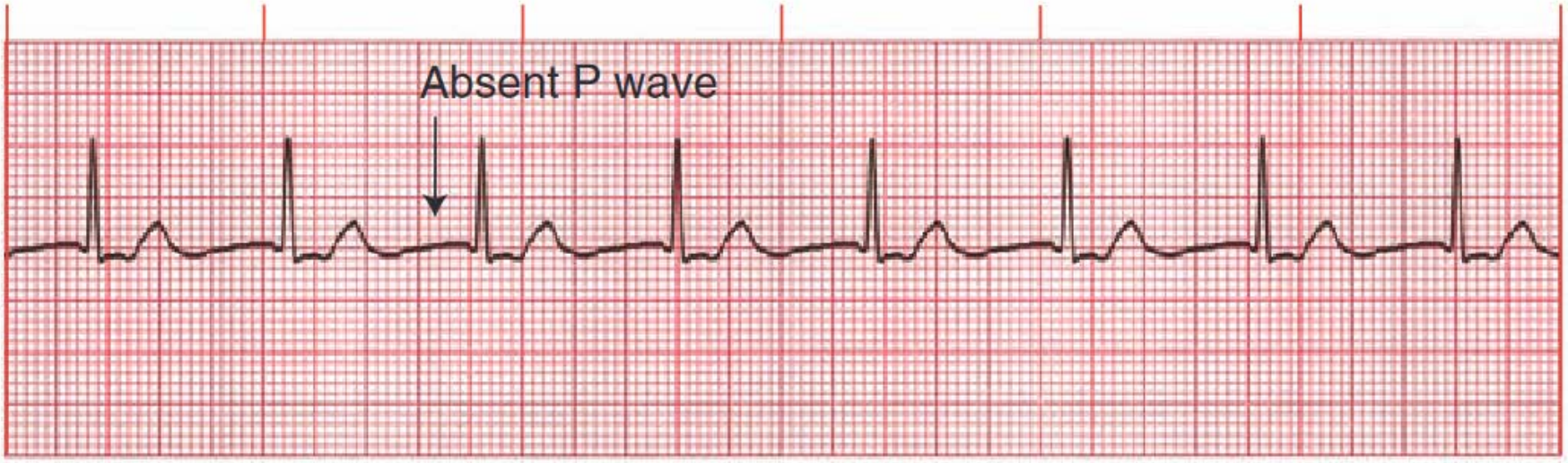
- The atria and SA node do not perform their normal pacemaking functions.
- A junctional escape rhythm begins.

Junctional Rhythm



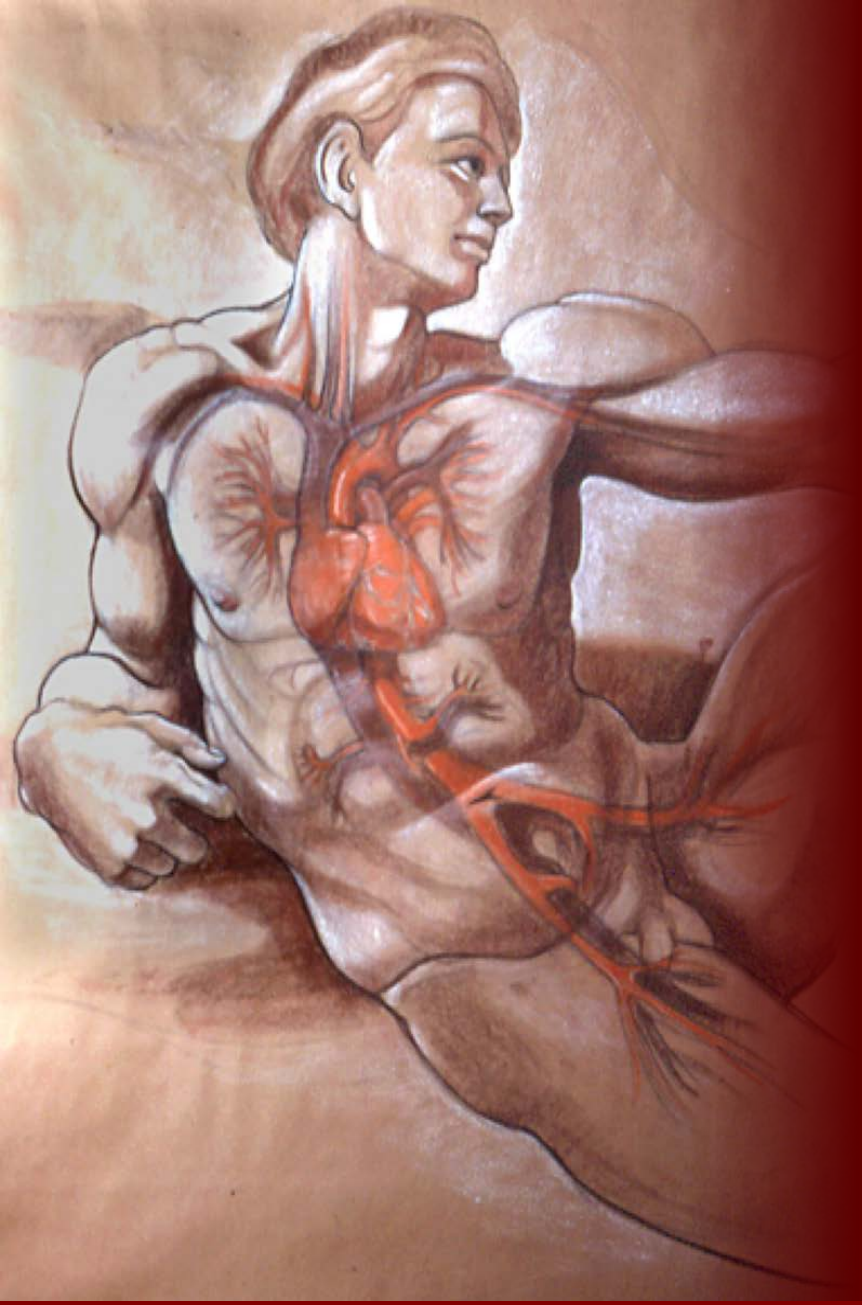
Rate: 40–60 bpm
Rhythm: Regular
P Waves: Absent, inverted, buried, or retrograde
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

Accelerated Junctional Rhythm



Rate: 61–100 bpm
Rhythm: Regular
P Waves: Absent, inverted, buried, or retrograde
PR Interval: None, short, or retrograde
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** Monitor the patient, not just the ECG, for clinical improvement.



Conduction blocks

- The atria and SA node loss their pacemaking functions
- Ventricular loci drive the rhythm

Atrioventricular (AV) Blocks

- AV blocks are divided into three categories: first-, second-, and third-degree.

First-Degree AV Block

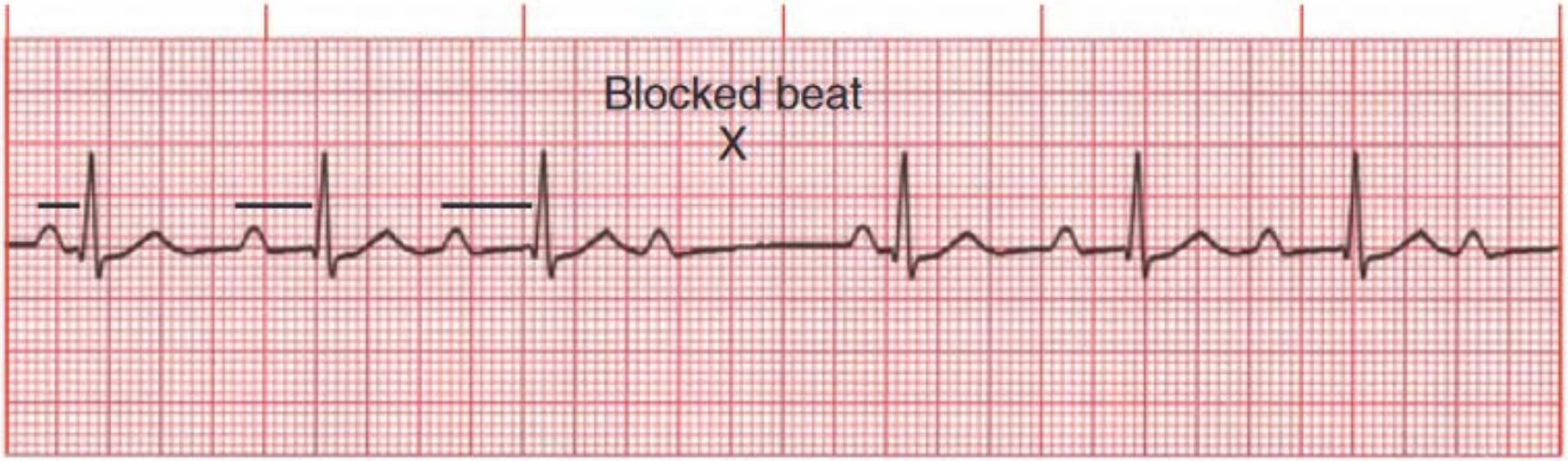
Rate: Depends on rate of underlying rhythm
Rhythm: Regular
P Waves: Normal (upright and uniform)
PR Interval: Prolonged (>0.20 sec)
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** Usually AV block is benign, but if associated with an acute MI, it may lead to further AV defects.

Second-Degree AV Block

Type I (Mobitz I or Wenckebach)

- P-R intervals become progressively longer until one P wave is totally blocked and produces no QRS. After a pause, during which the AV node recovers, this cycle is repeated.



Rate: Depends on rate of underlying rhythm
Rhythm: Irregular
P Waves: Normal (upright and uniform)
PR Interval: Progressively longer until one P wave is blocked and a QRS is dropped
QRS: Normal (0.06–0.10 sec)

♥ **Clinical Tip:** This rhythm may be caused by medication such as beta blockers, digoxin, and calcium channel blockers. Ischemia involving the right coronary artery is another cause.

Second-Degree AV Block

Type II (Mobitz II)

- Conduction ratio (P waves to QRS complexes) is commonly 2:1, 3:1, or 4:1.
- QRS complexes are usually wide because this block usually involves both bundle branches.

Rate: Atrial rate (usually 60–100 bpm); faster than ventricular rate
Rhythm: Atrial regular and ventricular irregular
P Waves: Normal (upright and uniform); more P waves than QRS complexes
PR Interval: Normal or prolonged but constant
QRS: Usually wide (>0.10 sec)

♥ **Clinical Tip:** Resulting bradycardia can compromise cardiac output and lead to complete AV block. This rhythm often occurs with cardiac ischemia or an MI.

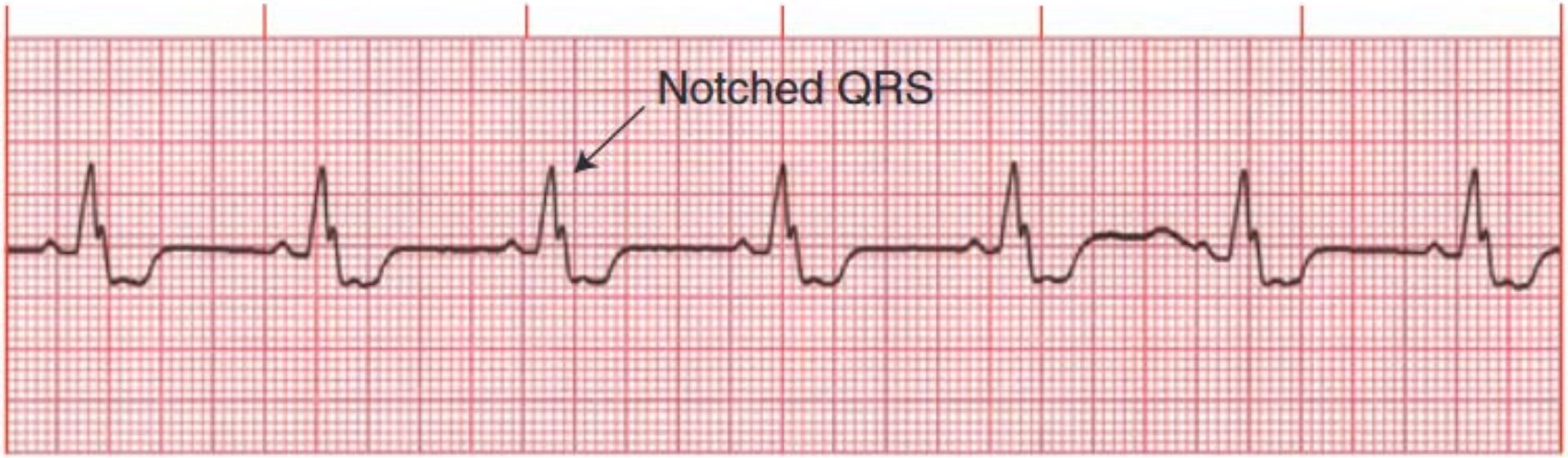
Third-Degree AV Block

- Conduction between atria and ventricles is absent because of electrical block at or below the AV node.
- "Complete heart block" is another name for this rhythm.

Rate: Atrial: 60–100 bpm; ventricular: 40–60 bpm if escape focus is junctional, <40 bpm if escape focus is ventricular
Rhythm: Usually regular, but atria and ventricles act independently
P Waves: Normal (upright and uniform); may be superimposed on QRS complexes or T waves
PR Interval: Varies greatly
QRS: Normal if ventricles are activated by junctional escape focus; wide if escape focus is ventricular

Bundle Branch Block (BBB)

- Either the left or the right ventricle may depolarize late, creating a "notched" QRS complex.



Rate: Depends on rate of underlying rhythm
Rhythm: Regular
P Waves: Normal (upright and uniform)
PR Interval: Normal (0.12–0.20 sec)
QRS: Usually wide (>0.10 sec) with a notched appearance

♥ **Clinical Tip:** Commonly, BBB occurs in coronary artery disease.

Atrioventricular blockade

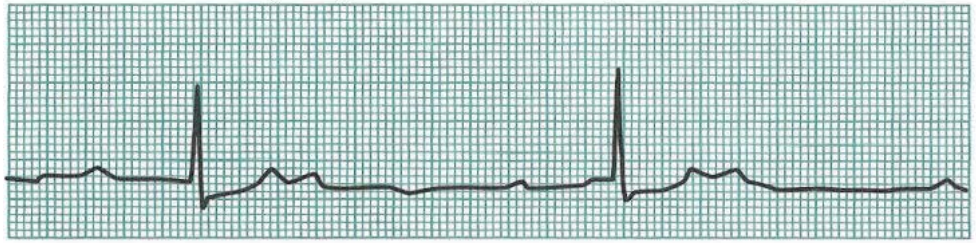
AV block 1rd degree

ECG: lenghtening of PR>0.2 s; HR regular, slower
SY: asymptomatic,
E: physiologic block in tachyarrhythmias

AV block 2nd degree (A. Mobitz type 1, Wenckebach's phenomenom)

ECG: progressive ↔ PR with each beat until one beat is totally blocked
SY: well tolerated, asymptomatic
E: common; block is high in AV-junction; ischemia physiologic block in tachyarrhythmias

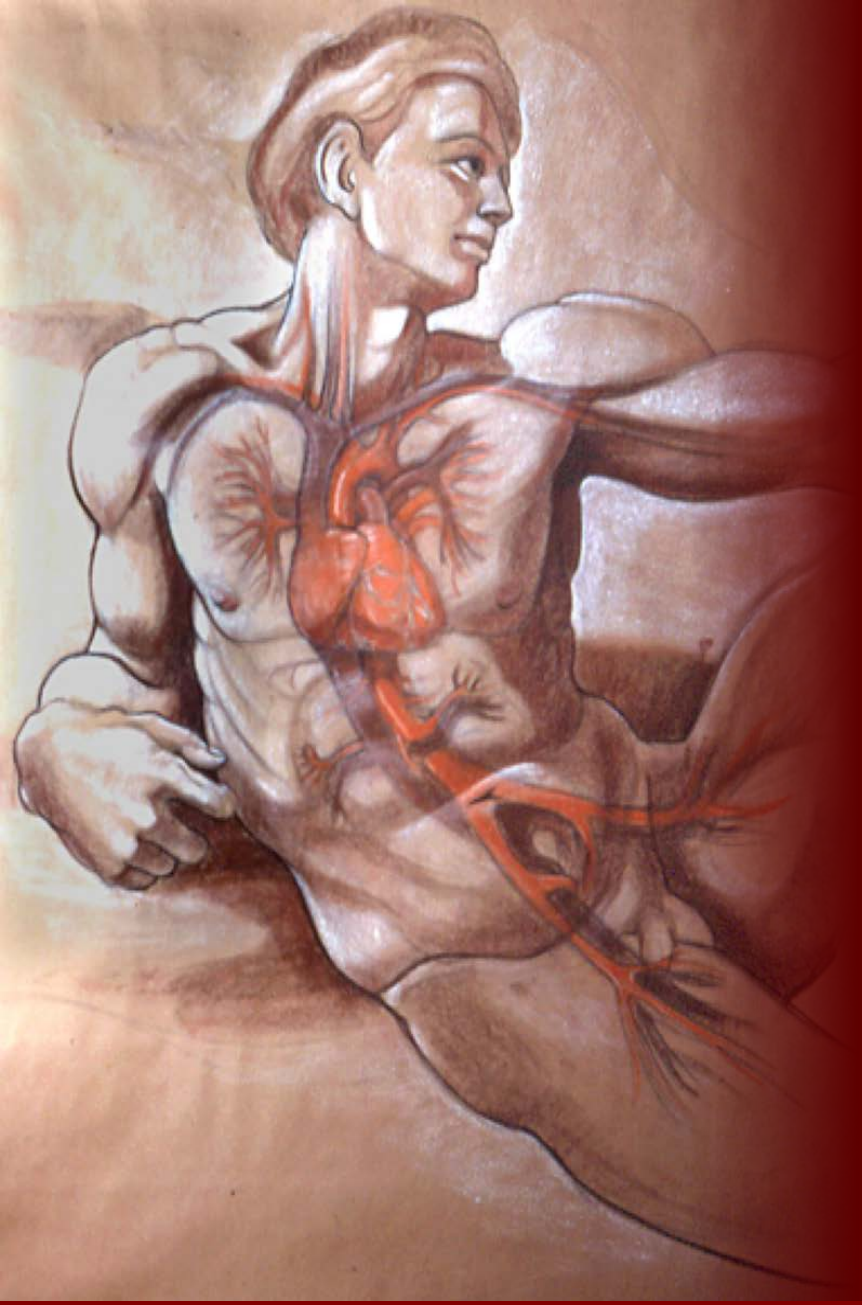
AV block 2nd degree (B. Mobitz type 2) - 1. degree, 2.degree



ECG: no cycle, intermittently dropped beats (uniform ↔ PR); often QRS malfomation due to bundle brach block 2. degreblock of 2-3 consecutive P waves
SY: congestive heart failure if ventricular rhythm is slow in ischemic myocardium,
E: less common; block is low in AV-junction, often in excessive myocardian damage
block of 2-3 consecutive P waves

AV block 3rd degree (AV - dissociation)

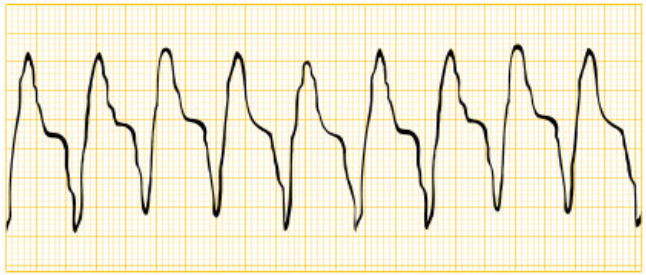
SY:
a) sudden (in MI) - occures unless AV-node or Ven -pacemaker start to pace
b) gradual occurence - most comon - if latent pacemaker is weak



Ventricular Arrhythmias

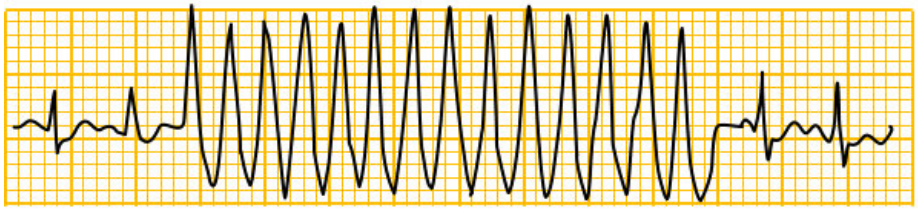
- The atria and SA node loss their pacemaking functions
- Ventricular loci drive the rhythm

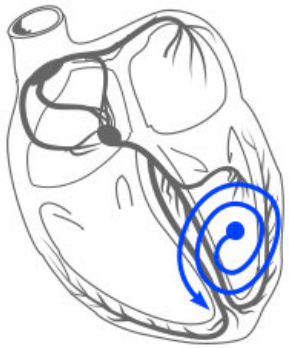
Idioentricular rhythm



Ventricular tachycardia (ectopic beats)

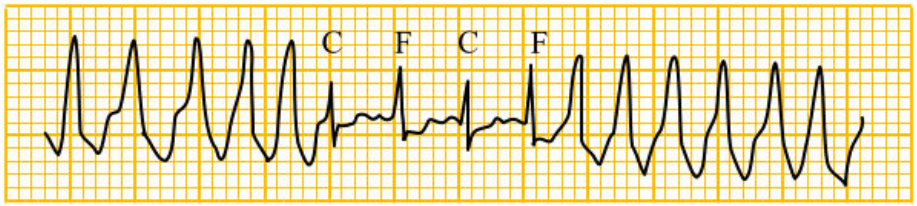
Ventricular tachycardia (paroxysmal)





regular, 100-250/min, wide & bizarre QRS,atria beat independently (AV-dissociation), obten sudden onset and termination

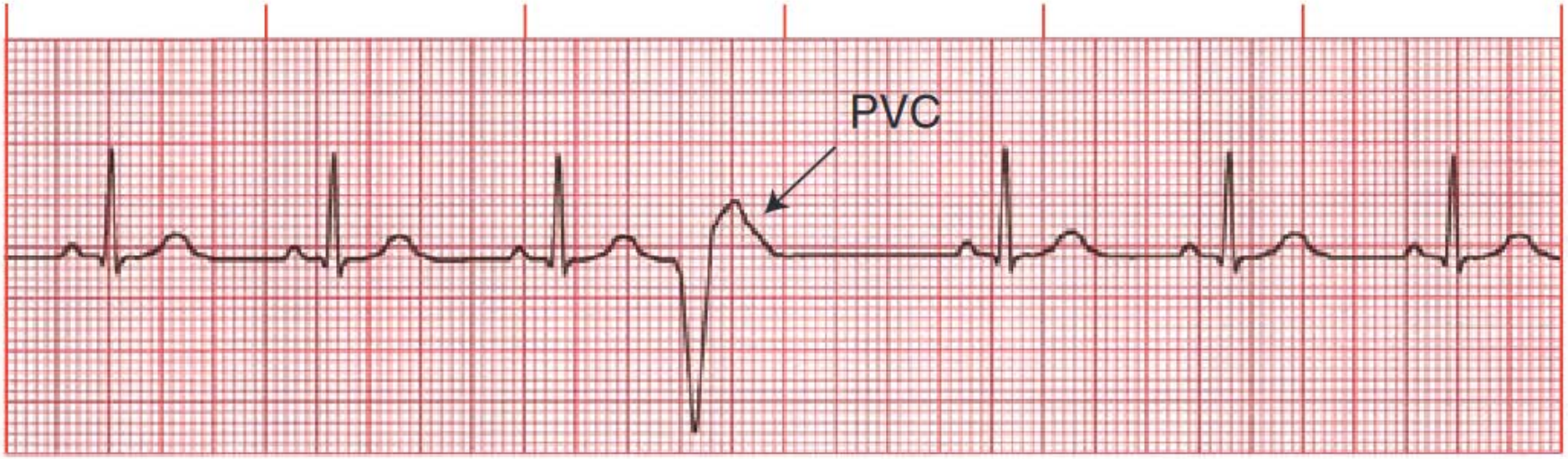
Ventricular tachycardia with capture and fusion beats



slightly irregular, 130/min, wide & bizarre QRS, AV-dissociation), *capture beat* sinus beat between ventricular beats (SA captured by SA node, *fusion beat* - simultaneous activation of ventricles fror

Premature Ventricular Contraction (PVC)

- Usually PVCs result from an irritable ventricular focus.
- PVCs may be uniform (same form) or multiform (different forms).
- The pause following a PVC may be compensatory or noncompensatory.

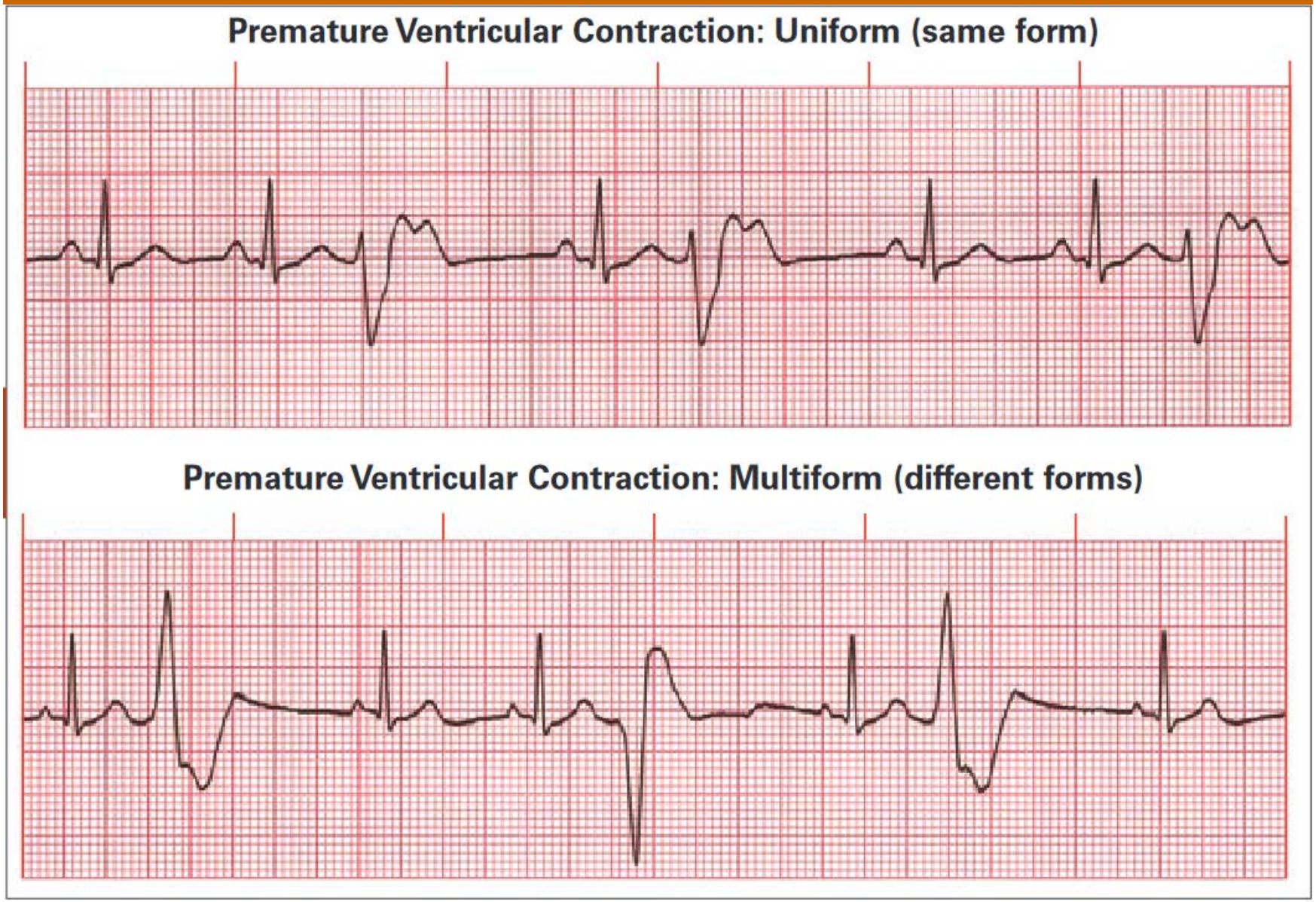


Rate: Depends on rate of underlying rhythm
Rhythm: Irregular whenever a PVC occurs
P Waves: None associated with the PVC
PR Interval: None associated with the PVC
QRS: Wide (>0.10 sec), bizarre appearance

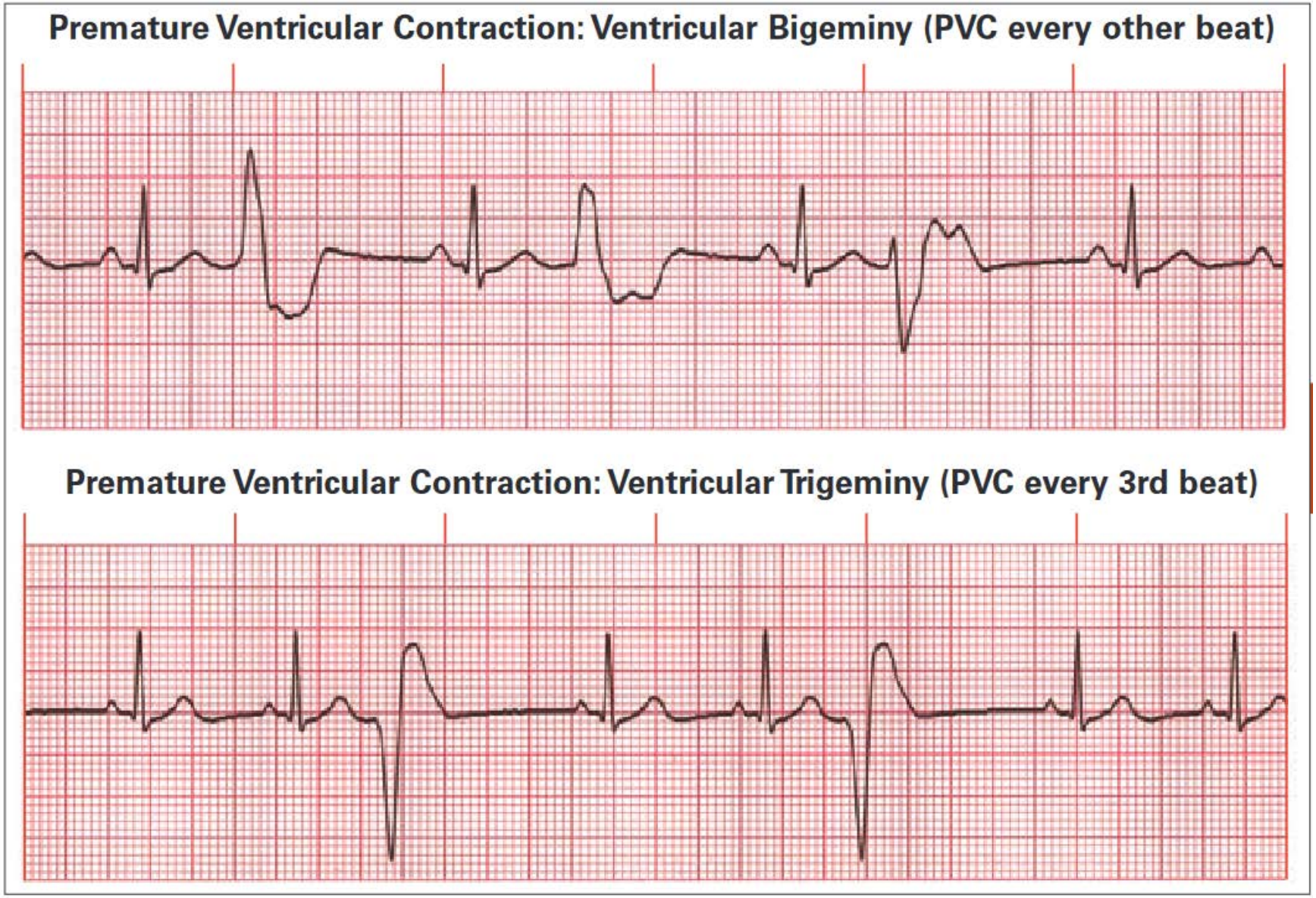
♥ **Clinical Tip:** Patients may sense the occurrence of PVCs as skipped beats. Because the ventricles are only partially filled, the PVC frequently does not generate a pulse.

Ventricular Escape Beats (Extrasystoles)

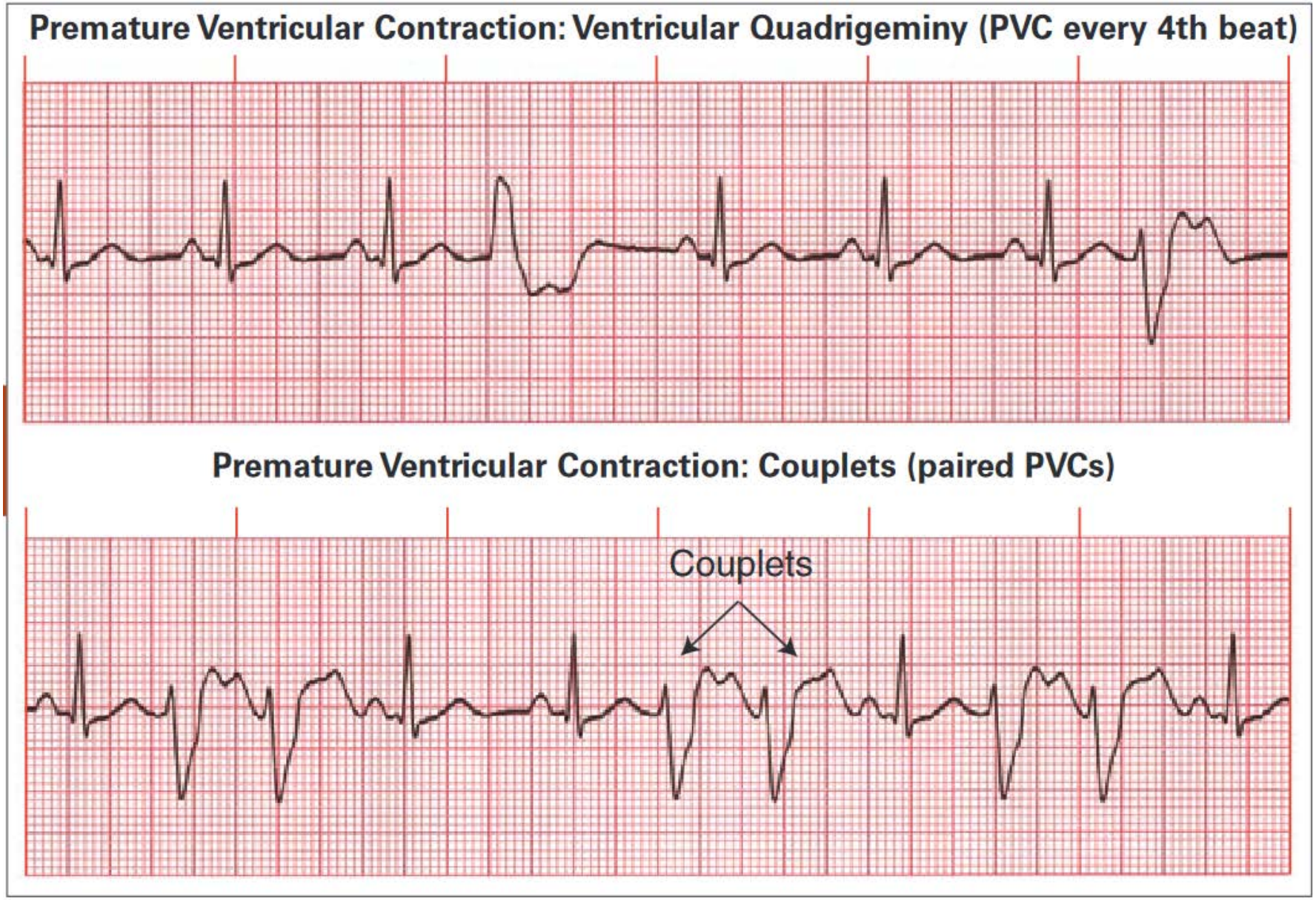
Ventricular Escape Beats (Extrasystoles)



Ventricular Escape Beats (Extrasystoles)



Ventricular Escape Beats (Extrasystoles)



Ventricular Arrhythmias

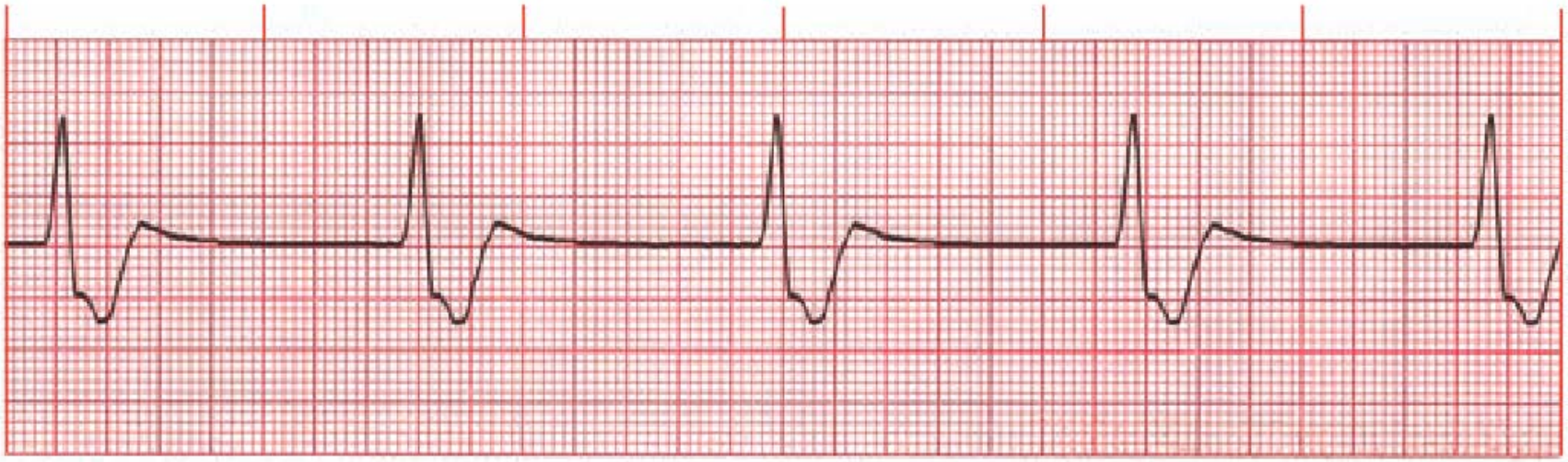
- QRS complex is >0.10 sec. P Waves are absent or, if visible, have no consistent relationship to the QRS complex.

Idioventricular Rhythm

Rate: 20–40 bpm
Rhythm: Regular
P Waves: None
PR Interval: None
QRS: Wide (>0.10 sec), bizarre appearance

♥ **Clinical Tip:** Idioventricular rhythm may also be called agonal rhythm.

Accelerated Idioventricular Rhythm

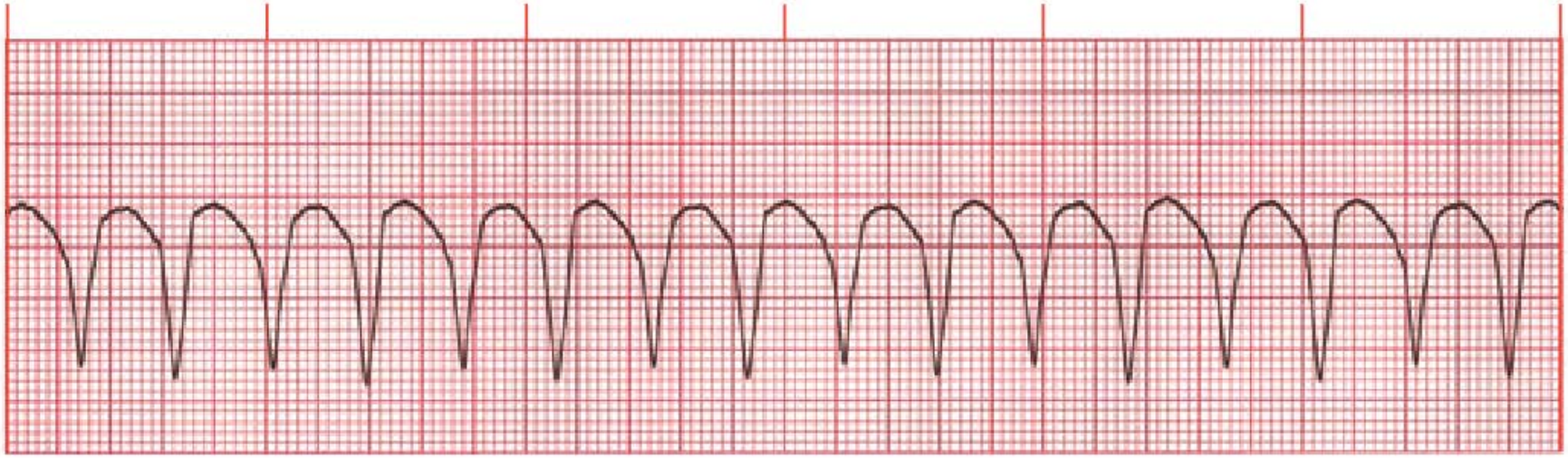


Rate: 41–100 bpm
Rhythm: Regular
P Waves: None
PR Interval: None
QRS: Wide (>0.10 sec), bizarre appearance

♥ **Clinical Tip:** Idioventricular rhythms appear when supraventricular pacing sites are depressed or absent. Diminished cardiac output is expected if the heart rate is slow.

Ventricular Tachycardia (VT): Monomorphic

- QRS complexes in monomorphic VT have the same shape and amplitude.



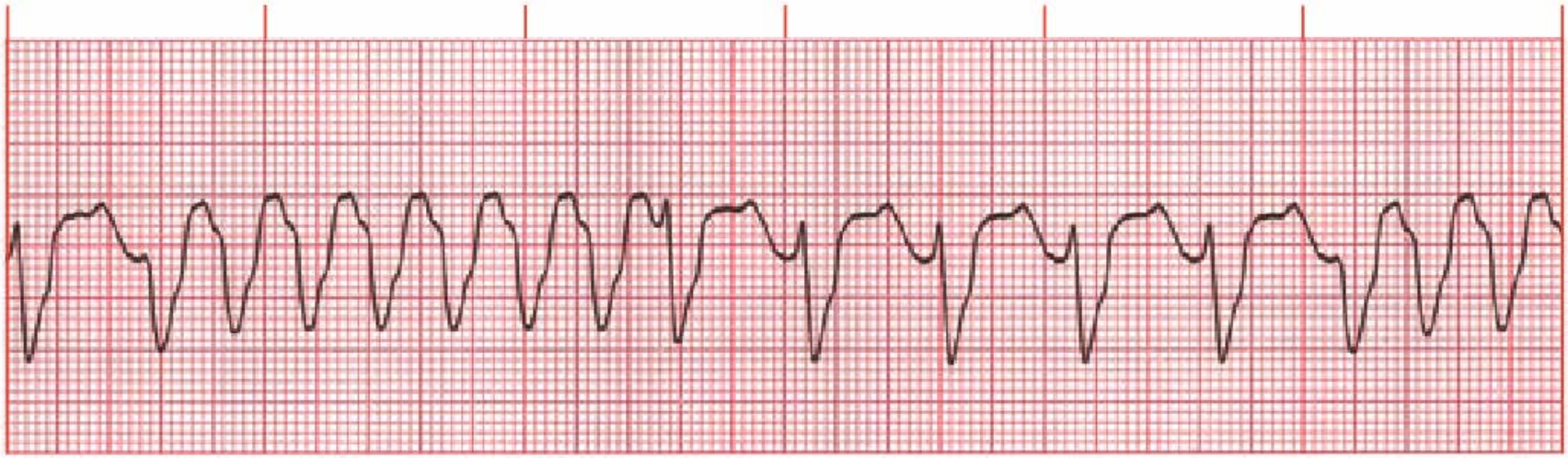
Rate: 100–250 bpm
Rhythm: Regular
P Waves: None or not associated with the QRS
PR Interval: None
QRS: Wide (>0.10 sec), bizarre appearance

♥ **Clinical Tip:** It is important to confirm the presence or absence of pulses because monomorphic VT may be perfusing or nonperfusing.

♥ **Clinical Tip:** Monomorphic VT will probably deteriorate into VF or unstable VT if sustained and not treated.

Ventricular Tachycardia (VT): Polymorphic

- QRS complexes in polymorphic VT vary in shape and amplitude.
- The QT interval is normal or long.

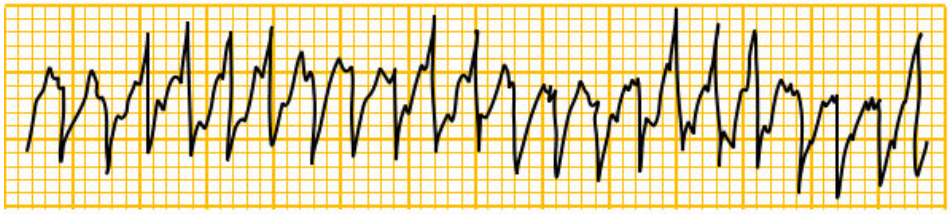


Rate: 100–250 bpm
Rhythm: Regular or irregular
P Waves: None or not associated with the QRS
PR Interval: None
QRS: Wide (>0.10 sec), bizarre appearance

♥ **Clinical Tip:** It is important to confirm the presence or absence of pulses because polymorphic VT may be perfusing or nonperfusing.

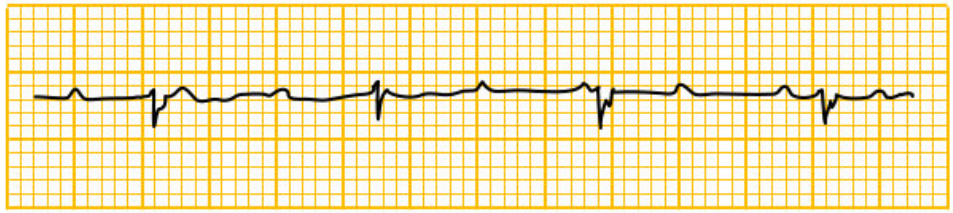
♥ **Clinical Tip:** Consider electrolyte abnormalities as a possible etiology.

Torsade de pointes (polymorphous tachycardia)



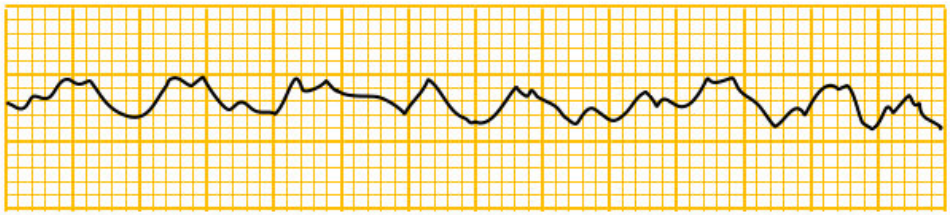
irregular, 200-250 /min, progressive changes in amplitude and polarity of QRS
"twisting around isoelectric line", occrues in patients with impaired ventricular repolarisation

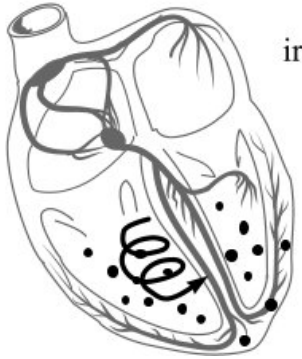
Ventricular escape beats and rhythms



irregular, 35-40 /min, wide bizzare QRS complexes

Ventricular fibrilation

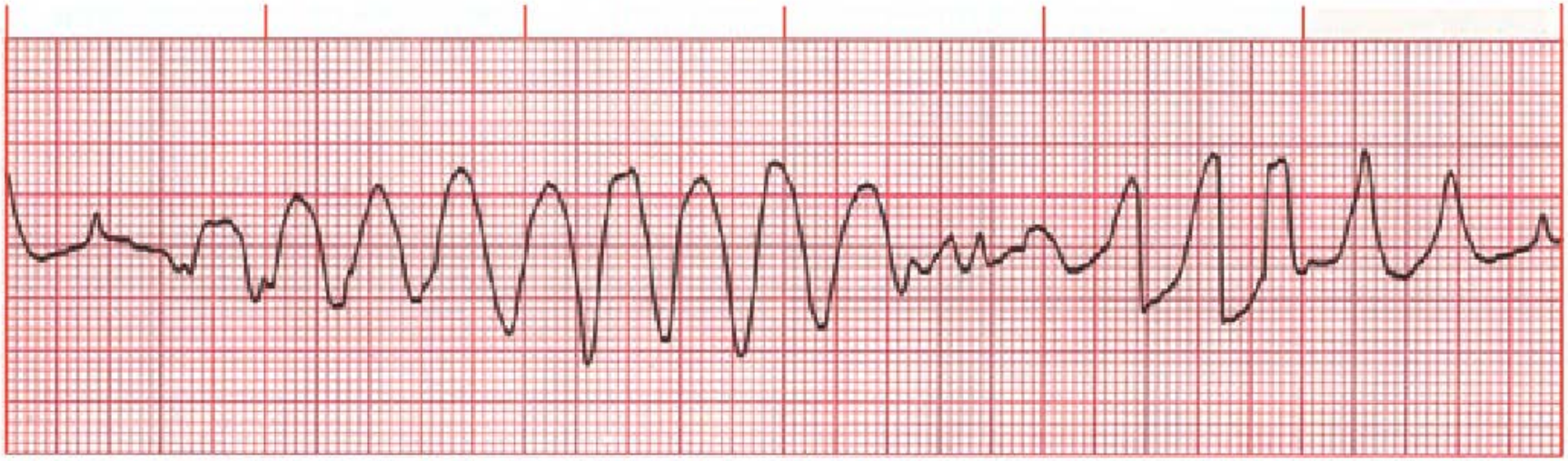




irregular, circulatory failure

Torsade de Pointes

- The QRS reverses polarity and the strip shows a spindle effect.
- This rhythm is an unusual variant of polymorphic VT with normal or long QT intervals.
- In French the term means "twisting of the points."



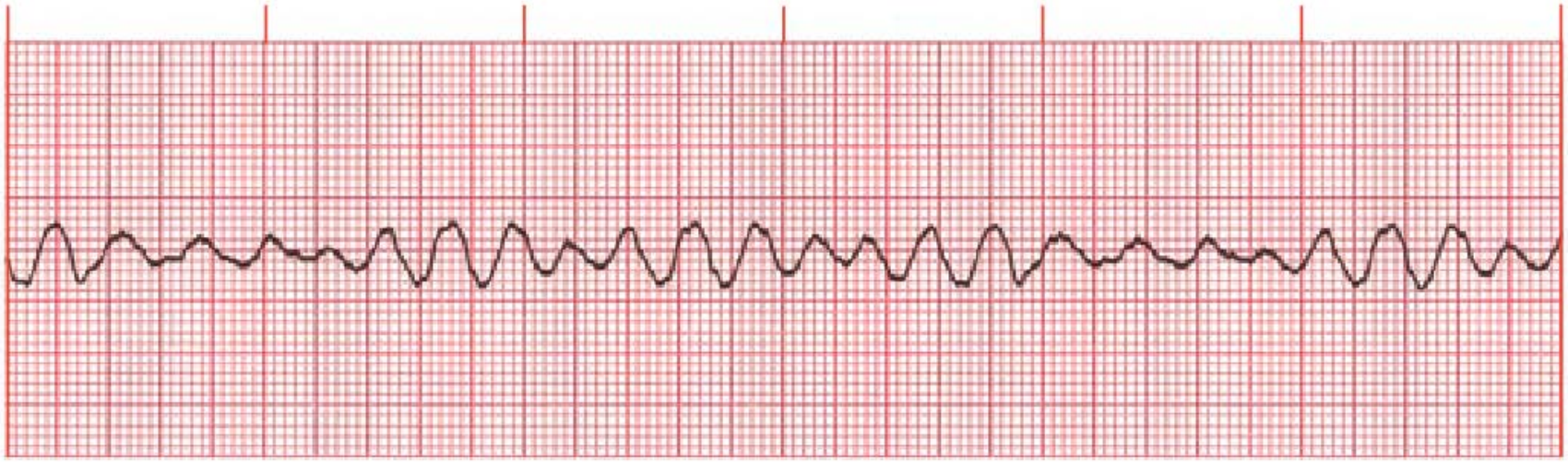
Rate: 200–250 bpm
Rhythm: Irregular
P Waves: None
PR Interval: None
QRS: Wide (>0.10 sec), bizarre appearance

♥ **Clinical Tip:** Torsade de pointes may deteriorate to VF or asystole.

♥ **Clinical Tip:** Frequent causes are drugs that prolong QT interval and electrolyte abnormalities such as hypomagnesemia.

Ventricular Fibrillation (VF)

- Chaotic electrical activity occurs with no ventricular depolarization or contraction.
- The amplitude and frequency of the fibrillatory activity can be used to define the type of fibrillation as coarse, medium, or fine.



Rate: Indeterminate
Rhythm: Chaotic
P Waves: None
PR Interval: None
QRS: None

♥ **Clinical Tip:** There is no pulse or cardiac output. Rapid intervention is critical. The longer the delay, the less the chance of conversion.

Pulseless Electrical Activity (PEA)

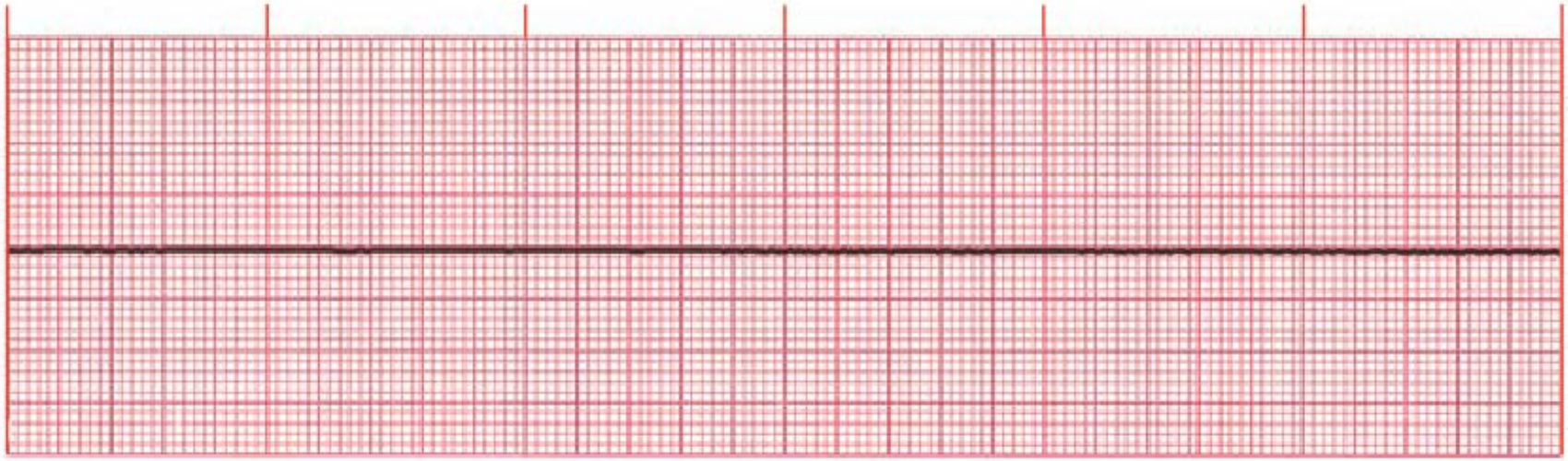
- Monitor shows an identifiable electrical rhythm, but no pulse is detected.
- Rhythm may be sinus, atrial, junctional, or ventricular in origin.
- PEA is also called electromechanical dissociation (EMD).

Rate, rhythm, P waves, P-R interval, and QRS: Reflect underlying rhythm.

♥ **Clinical Tip:** Potential causes of PEA are pulmonary embolism, MI, acidosis, tension pneumothorax, hyper- and hypokalemia, cardiac tamponade, hypovolemia, hypoxia, hypothermia, and drug overdose (i.e., cyclic antidepressants, beta blockers, calcium channel blockers, digoxin).

Asystole

- Electrical activity in the ventricles is completely absent.



Rate: None
Rhythm: None
P Waves: None
PR Interval: None
QRS: None

♥ **Clinical Tip:** Always confirm asystole by checking the ECG in two different leads. Also, search to identify underlying ventricular fibrillation.

♥ **Clinical Tip:** Seek to identify the underlying cause as in PEA.

ECG praxis

Patterns that every medical student has to know: