

Artificial Pacemakers and Anesthesia

Presentors:

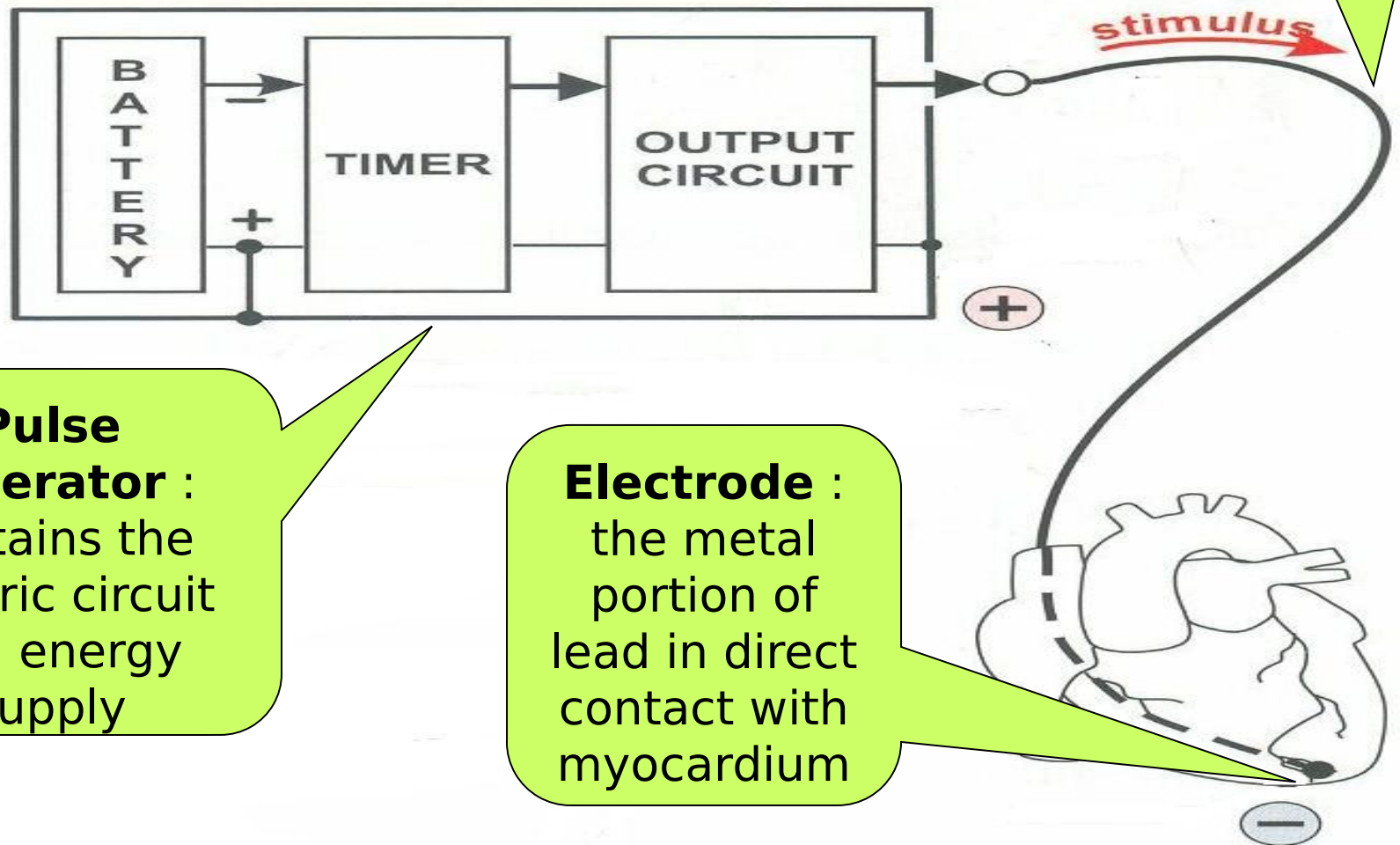
Dr. Abraham Sonny

Dr. Bala Chandran

Moderator:

Dr. Rashmi Ramachandran

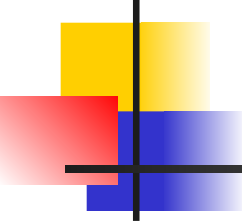
Components



Lead : insulated wire that extends from the generator to the electrode

Pulse generator : contains the electric circuit and energy supply

Electrode : the metal portion of lead in direct contact with myocardium



Lead

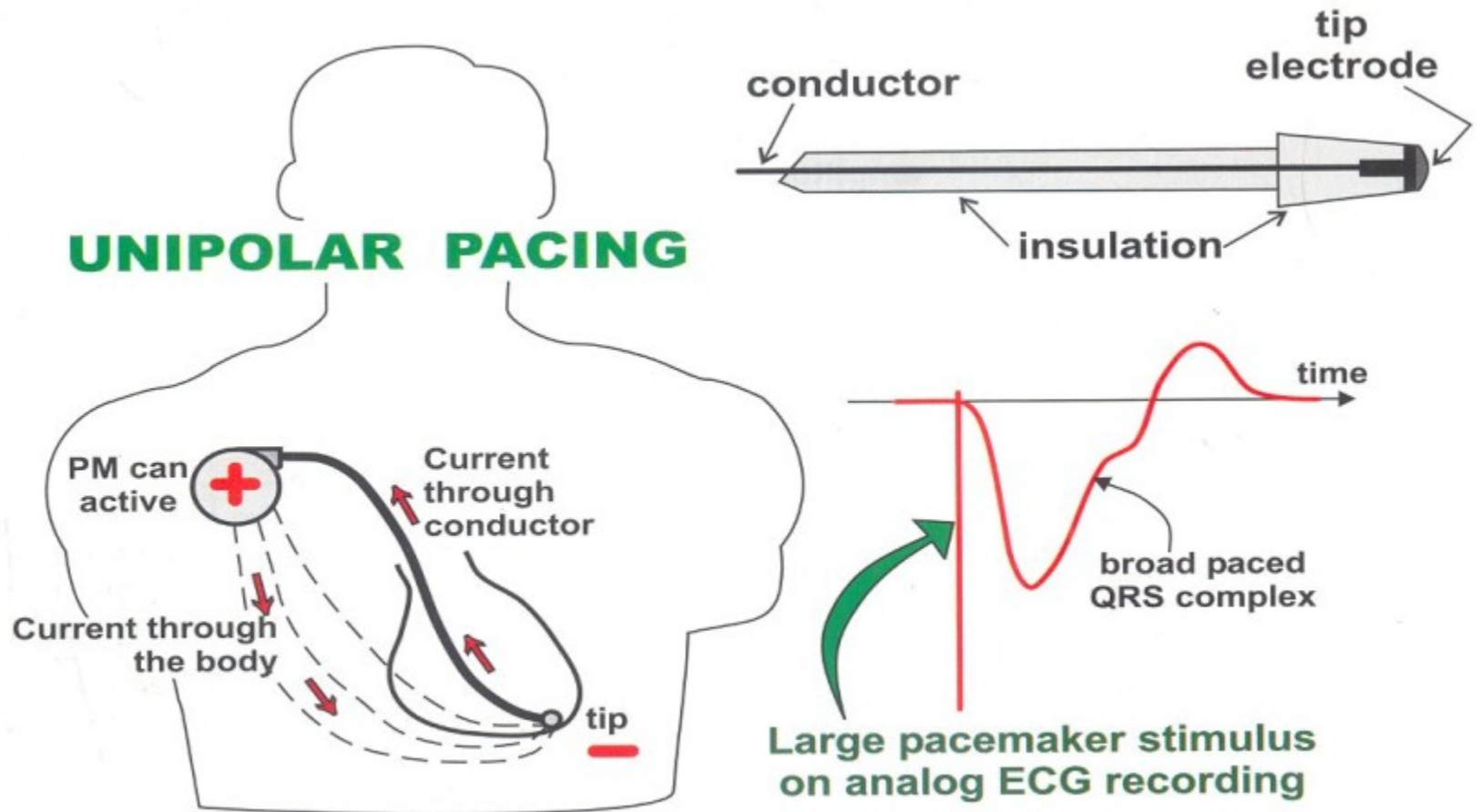
- Unipolar (positive on skin and negative in myocardium)
- Bipolar (both in heart)

Can be either endocardial or epicardial

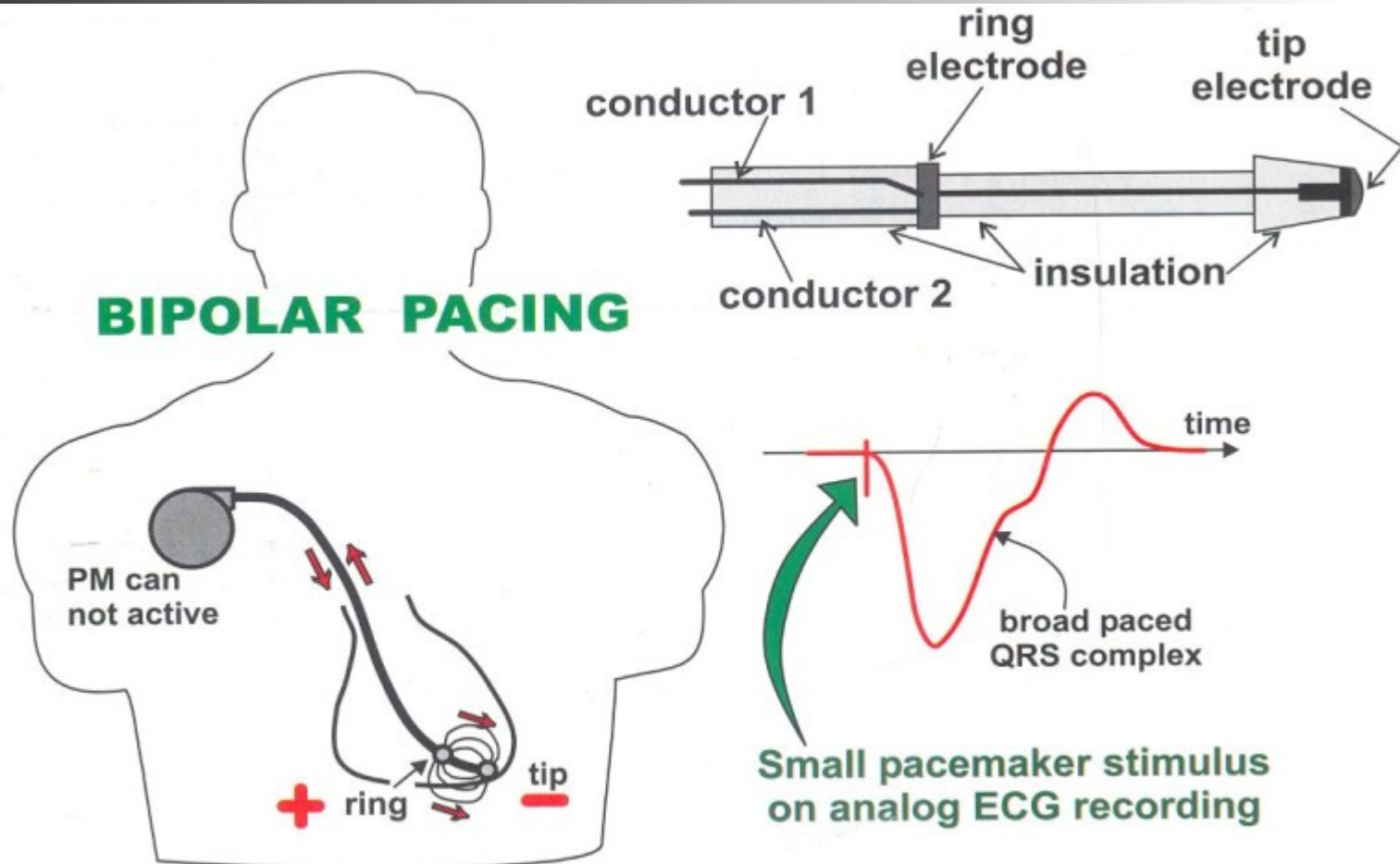
More than 1 lead present in multisite pacing

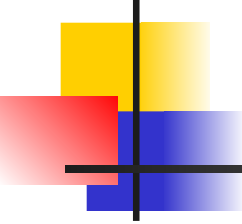
Unipolar

UNIPOLAR PACING



Bipolar

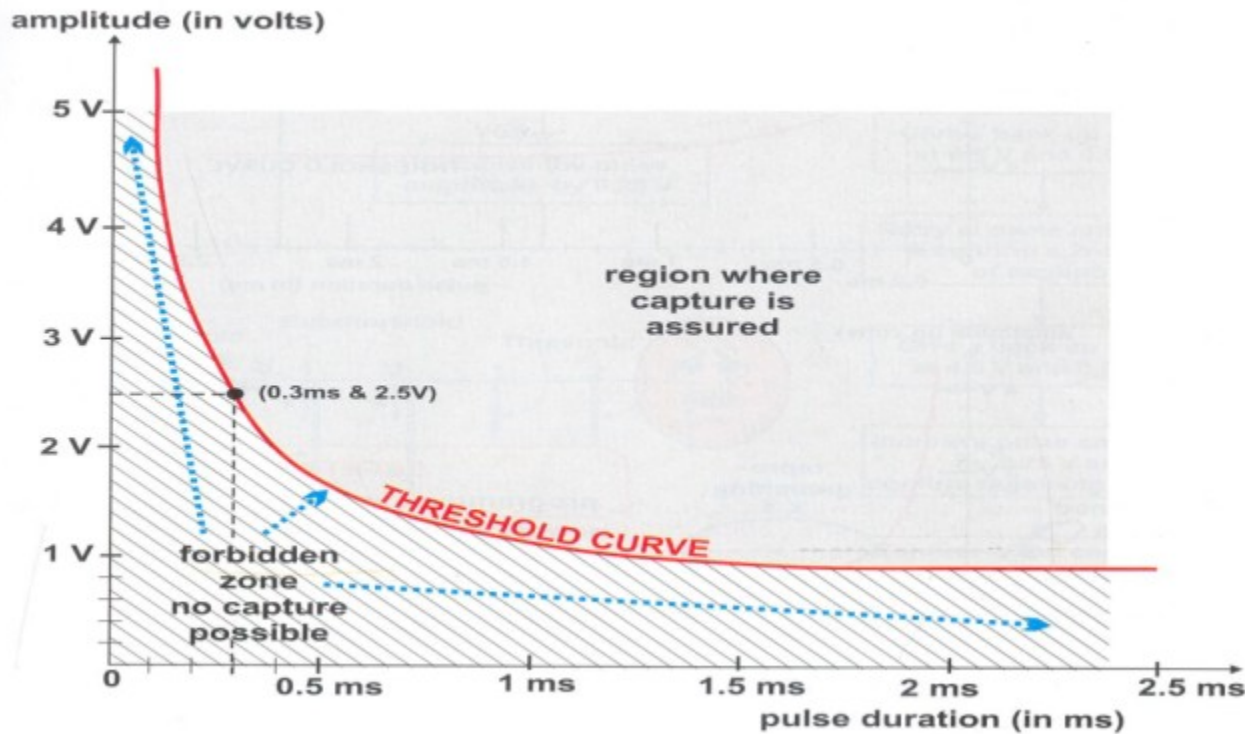




Electrode

- Has both stimulating as well as sensing functions
- Steroid eluting electrode

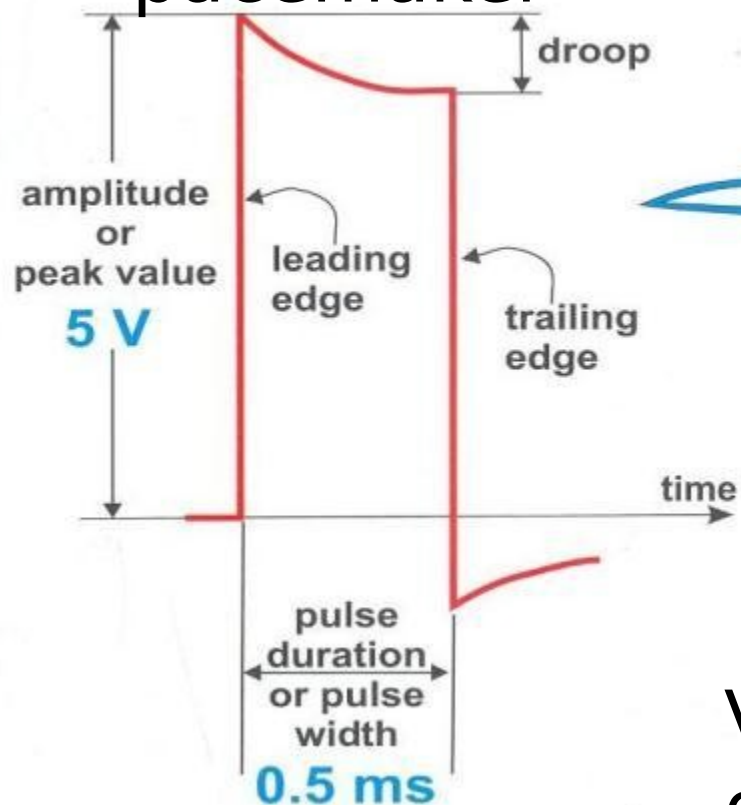
Pacing threshold - strength duration curve



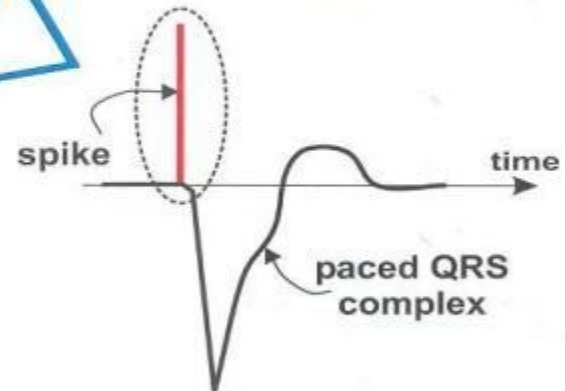
Always expressed in terms of voltage
and pulse duration

Ventricular stimulation (capture)

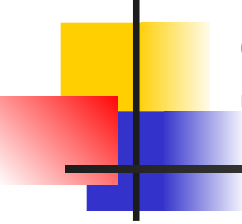
Output pulse of the
pacemaker



the output pulse
corresponds to the
spike on the ECG

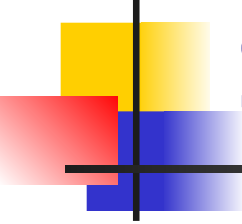


Voltage and pulse
duration



Sensing

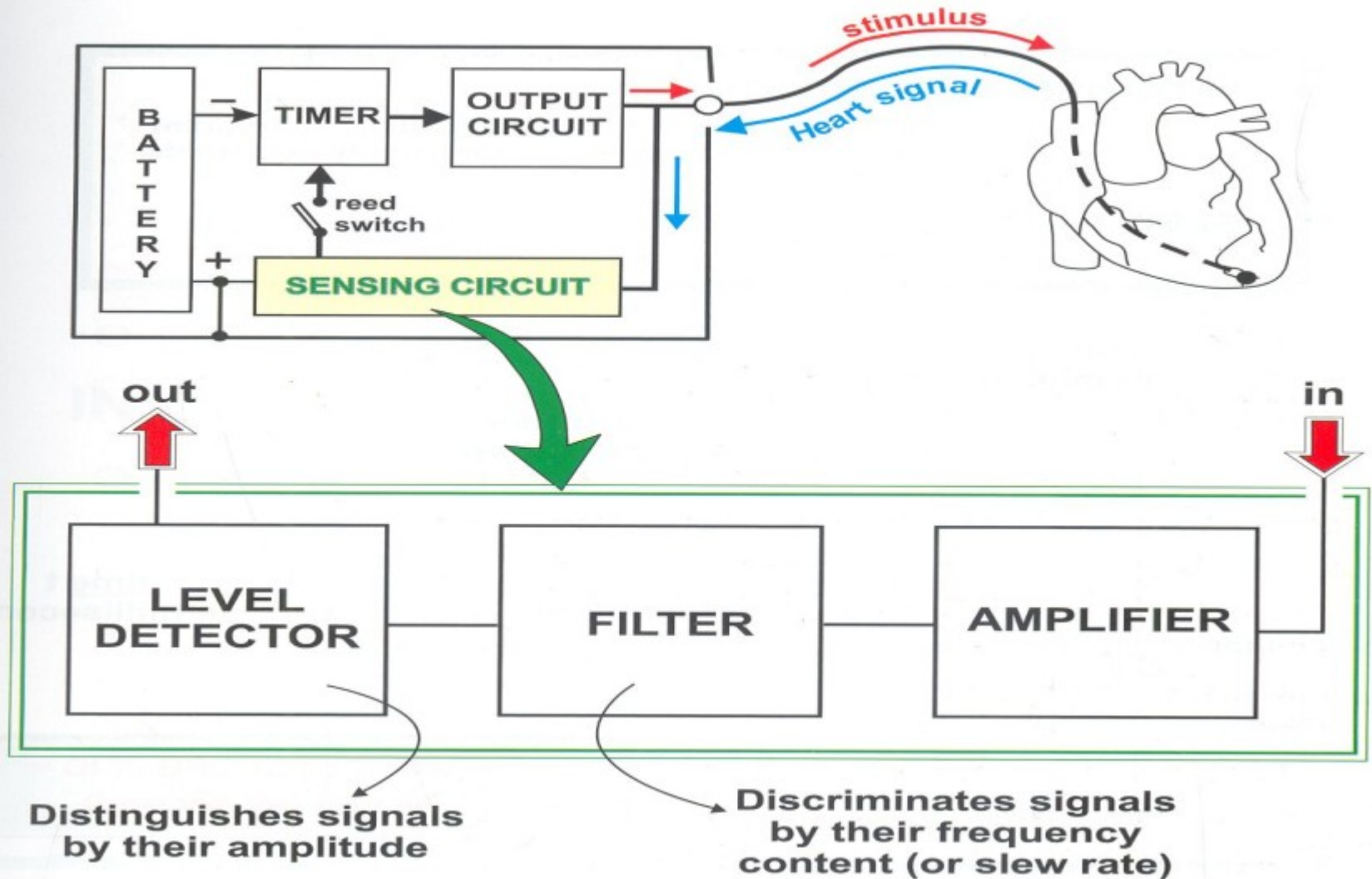
- Function of pacemaker by which it senses the intrinsic electrical activity of the heart
- It identifies this electrical activity by identifying the QRS complex or the R wave in the ECG.

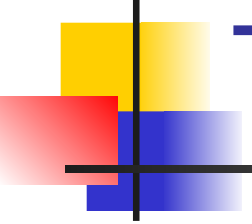


Sensing

- The pacemaker has to correctly recognize the R wave and distinguish it from ambient electrical disturbances as well as from own T wave
- Slew rate: Rate of change in signal amplitude with time

Sensing circuit

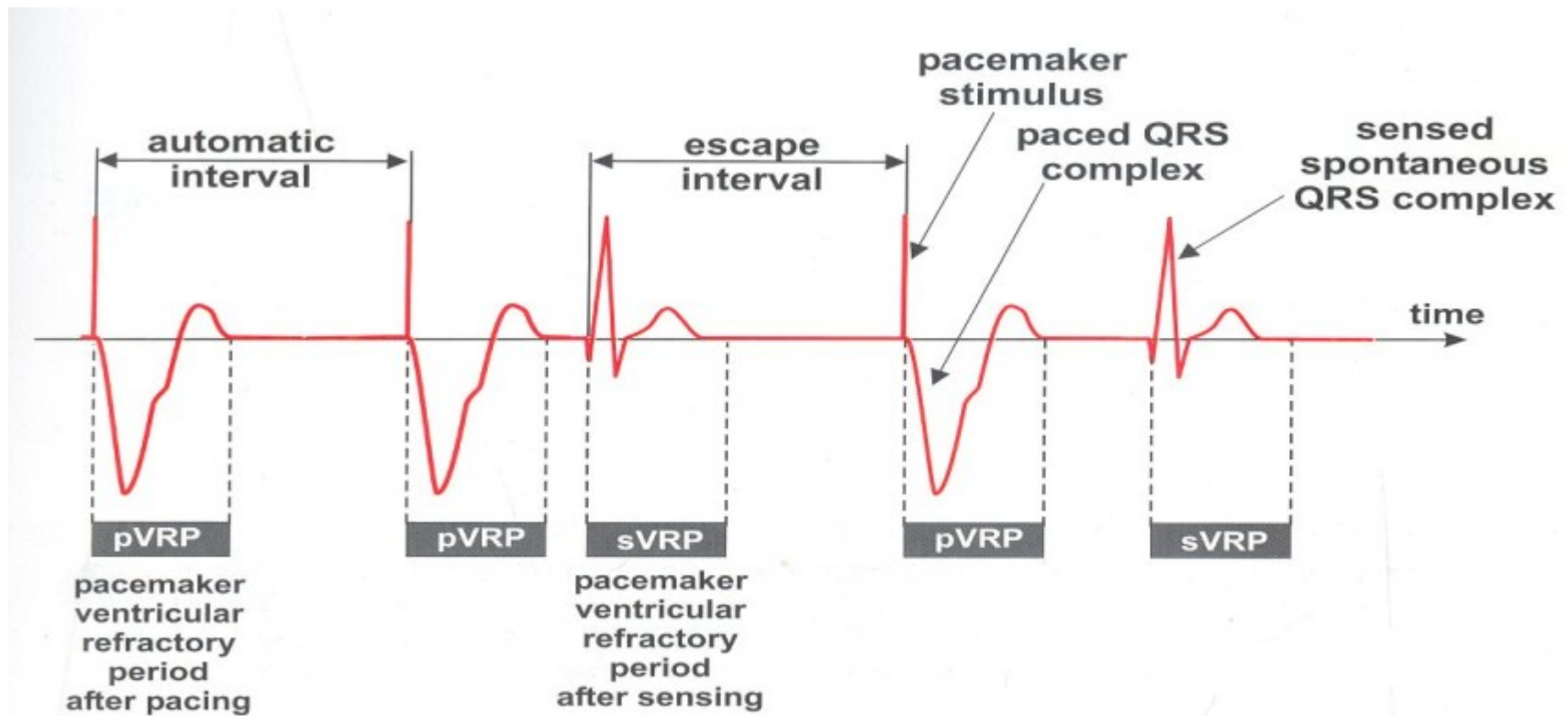




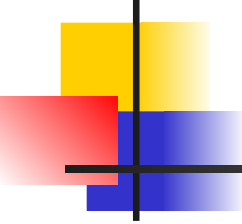
Terminology

- Escape interval: Time the generator takes to emit an impulse in absence of R wave
- Automatic interval : Time (in msec) between successive pacemaker impulses
- Hysteresis : difference between escape and automatic intervals
- Pacemaker ventricular refractory period

What is pacemaker ventricular refractory period ?



occurs after both after paced as well as sensed beat

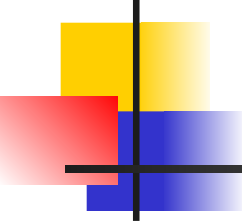


Pacemaker nomenclature

Position II

(~~passing chamber~~)

- O- none
- A- atrium
- V- ventricle
- D- dual (atrium and ventricle)

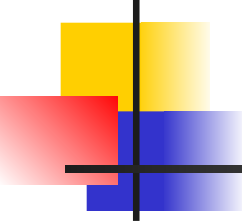


Pacemaker nomenclature

Position IV

(propagability)

- O--no reentry
- R-inhibited conduction
- T- triggered
- D- dual



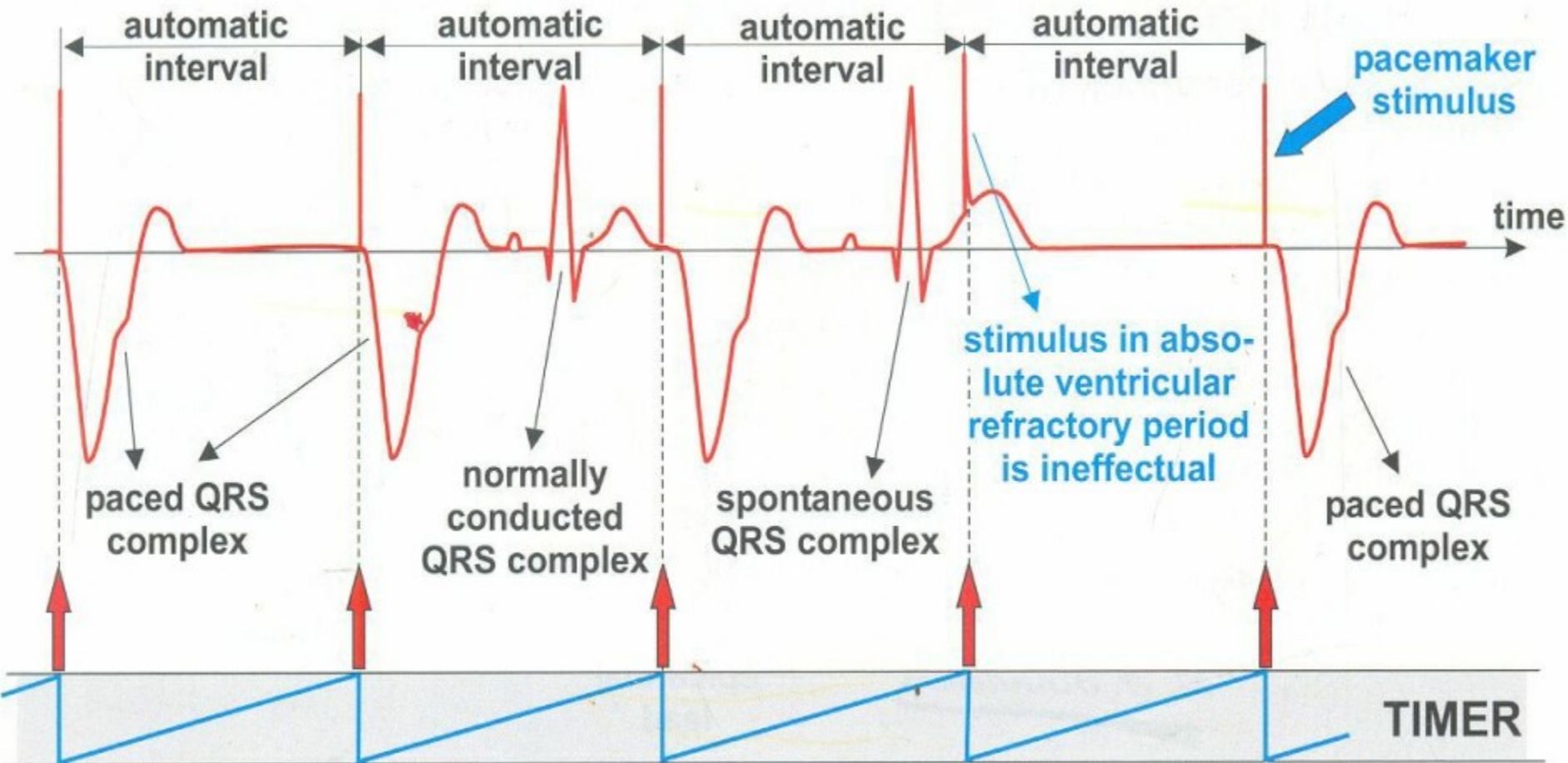
Pacemaker nomenclature

Position V

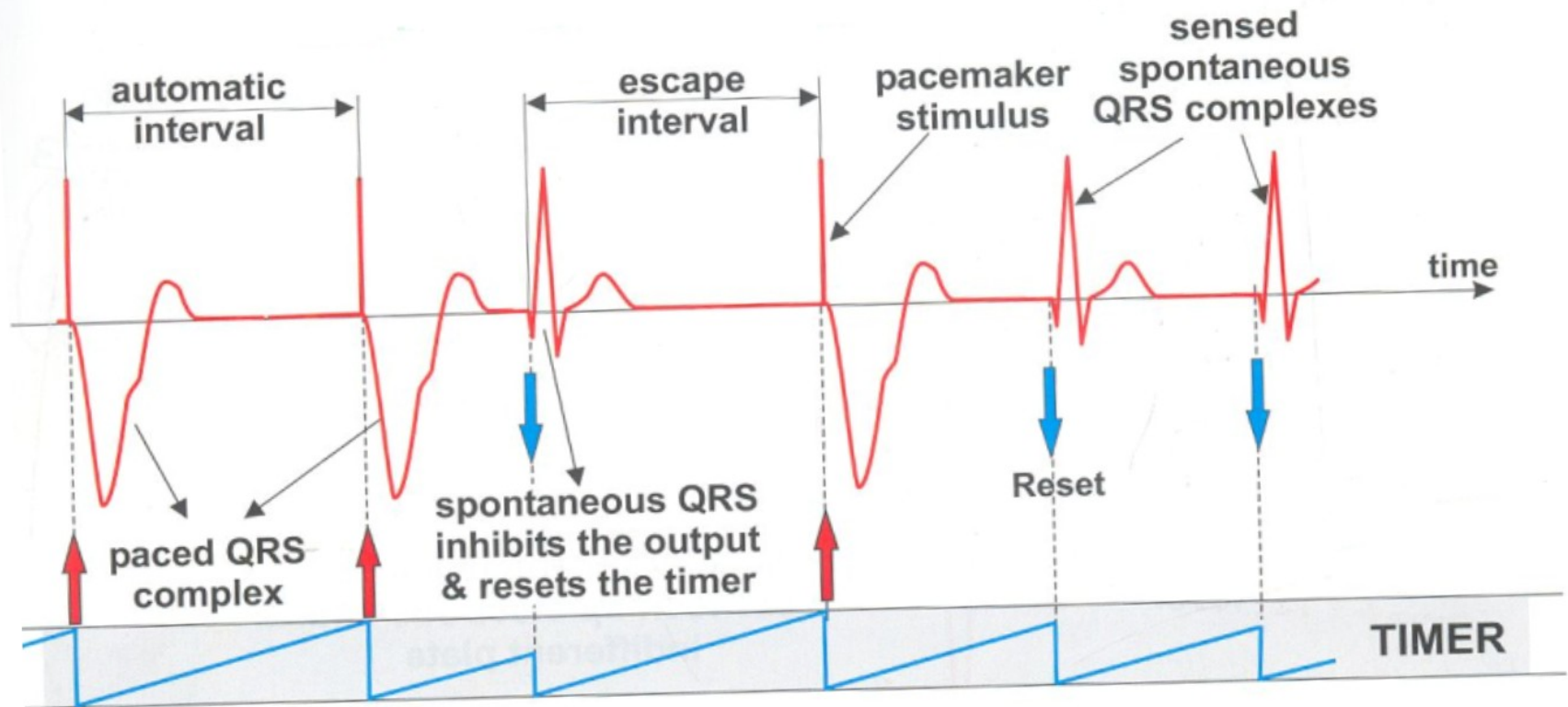
(anti-tachycardia function)

- O- none
- P- pace
- S- shock
- D- dual (pace and shock)

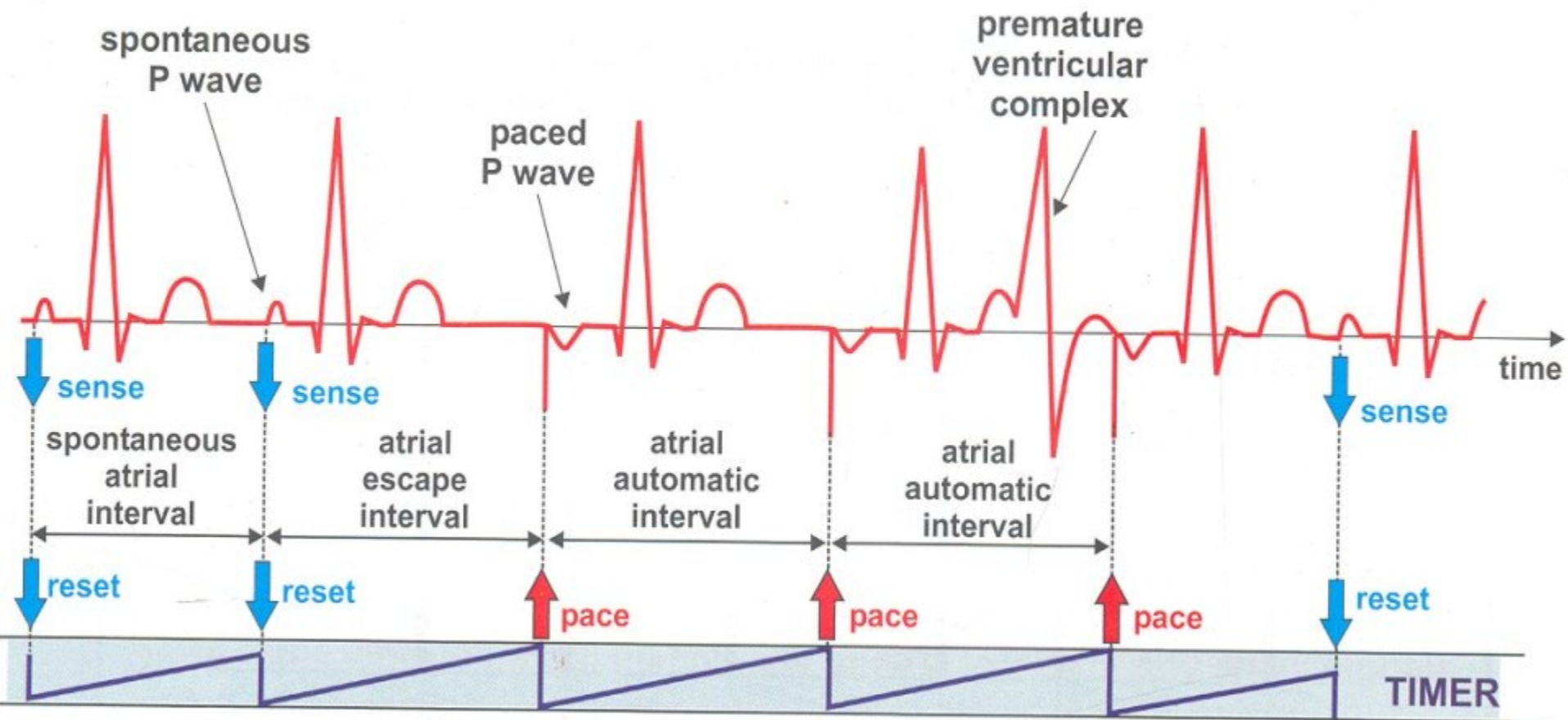
Asynchronous ventricular pacing (VOO)



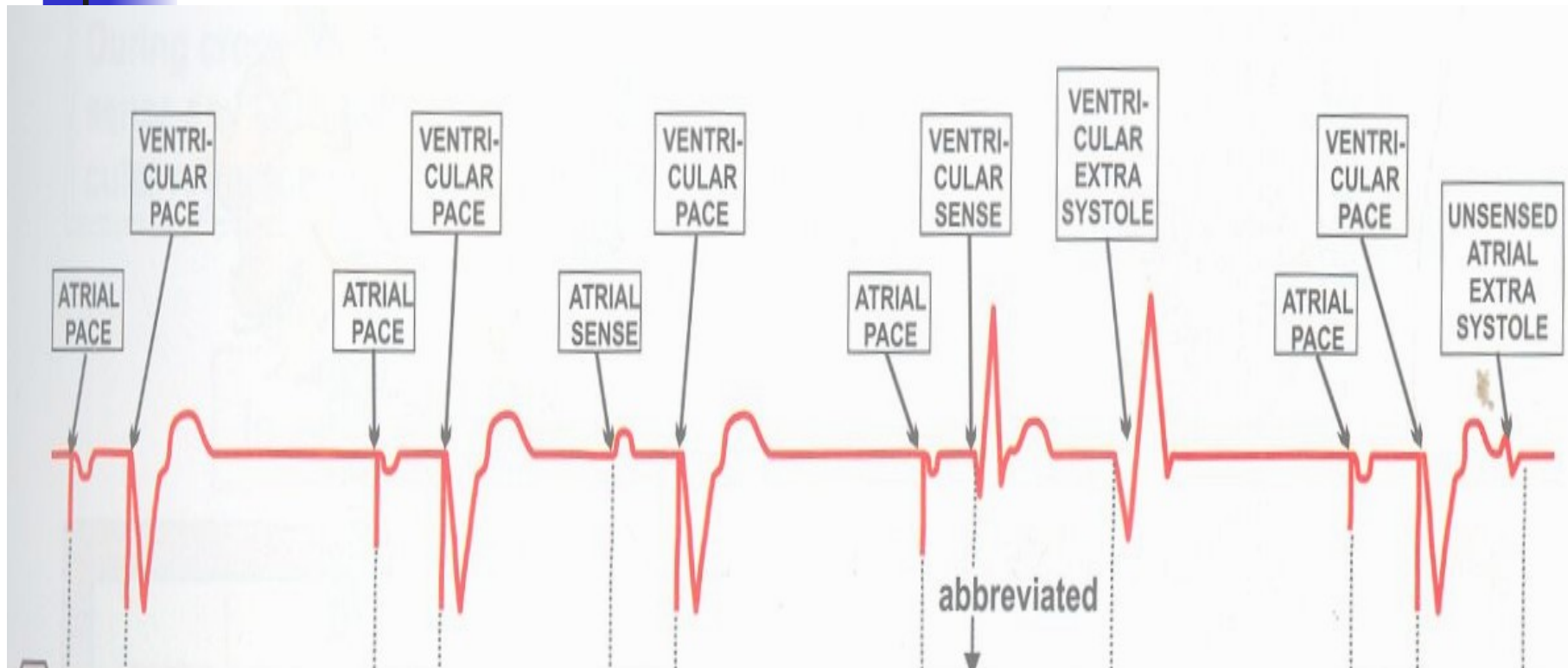
VVI

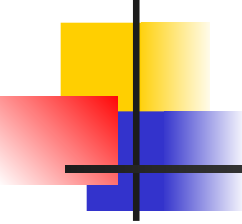


AAI



DDD



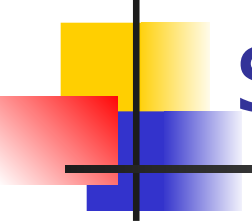


Methods of rate adaptive pacing (primary sensors)

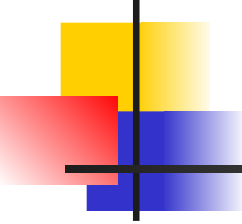
Physiological sensors that detect the
primary determinants of sinoatrial
node function

(circulating catecholamines and ANS
activity)

Methods of rate adaptive pacing (secondary sensors)



- Respiratory rate and minute ventilation (impedance)
- QT interval shortening
- Oxygen saturation
- Central venous temperature rise
- Increase in RV stroke volume
- Decrease in venous blood PH



Methods of rate adaptive pacing (tertiary sensors)

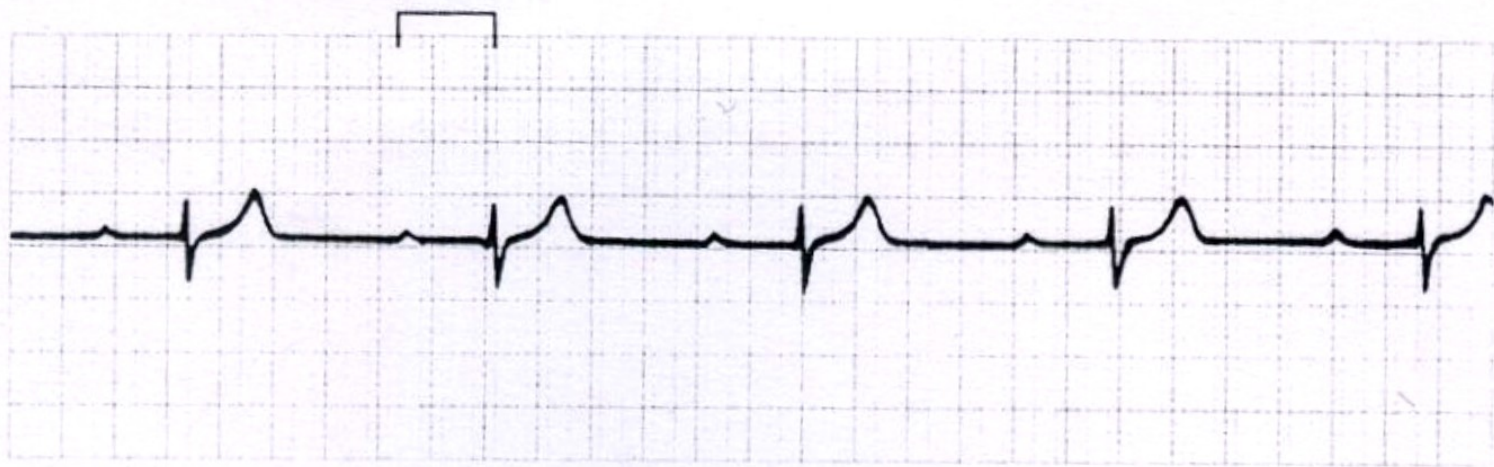
- Body movement (vibration)
- Body movement (acceleration)

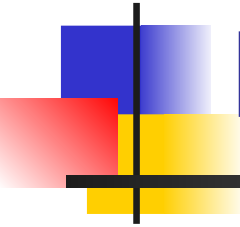


Disorders of conducting system

- SA node dysfunction
- AV conduction disturbances
- Bundle branch block

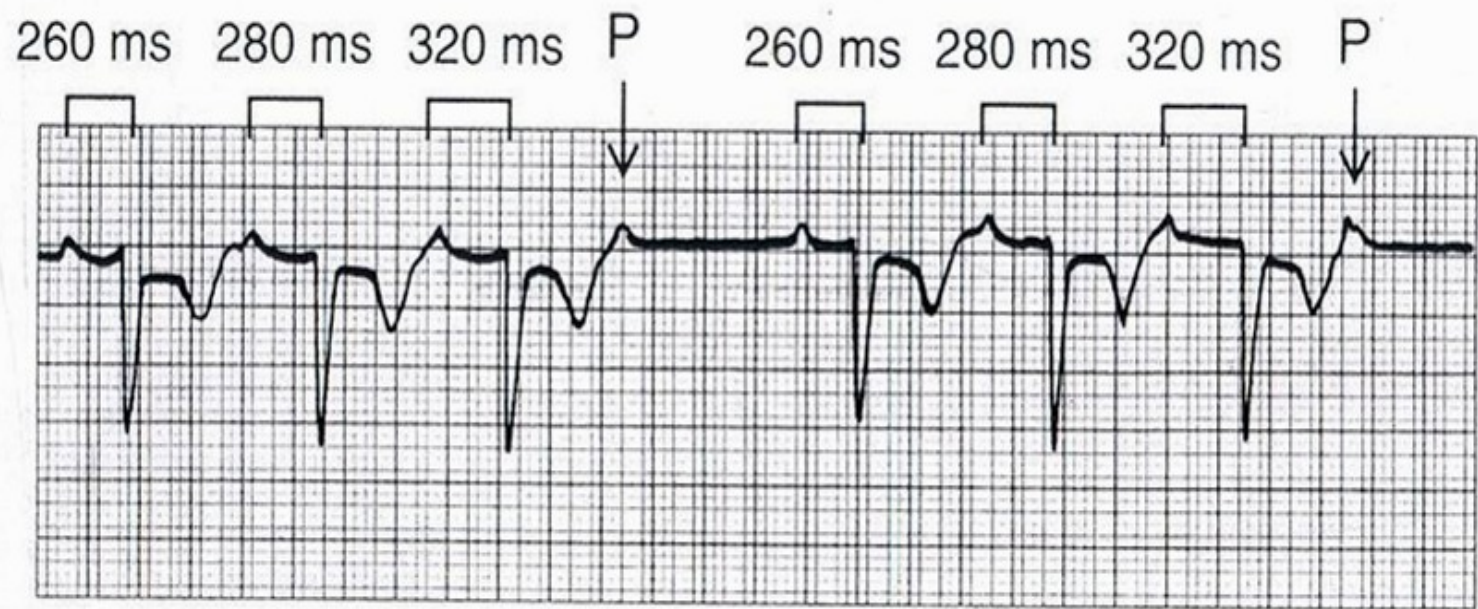
PR
360 ms





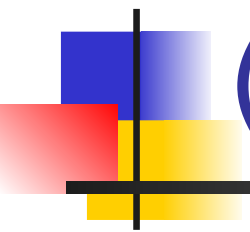
First degree heart block

- PR interval more than 0.2 s.
- Every P wave followed by QRS complex.

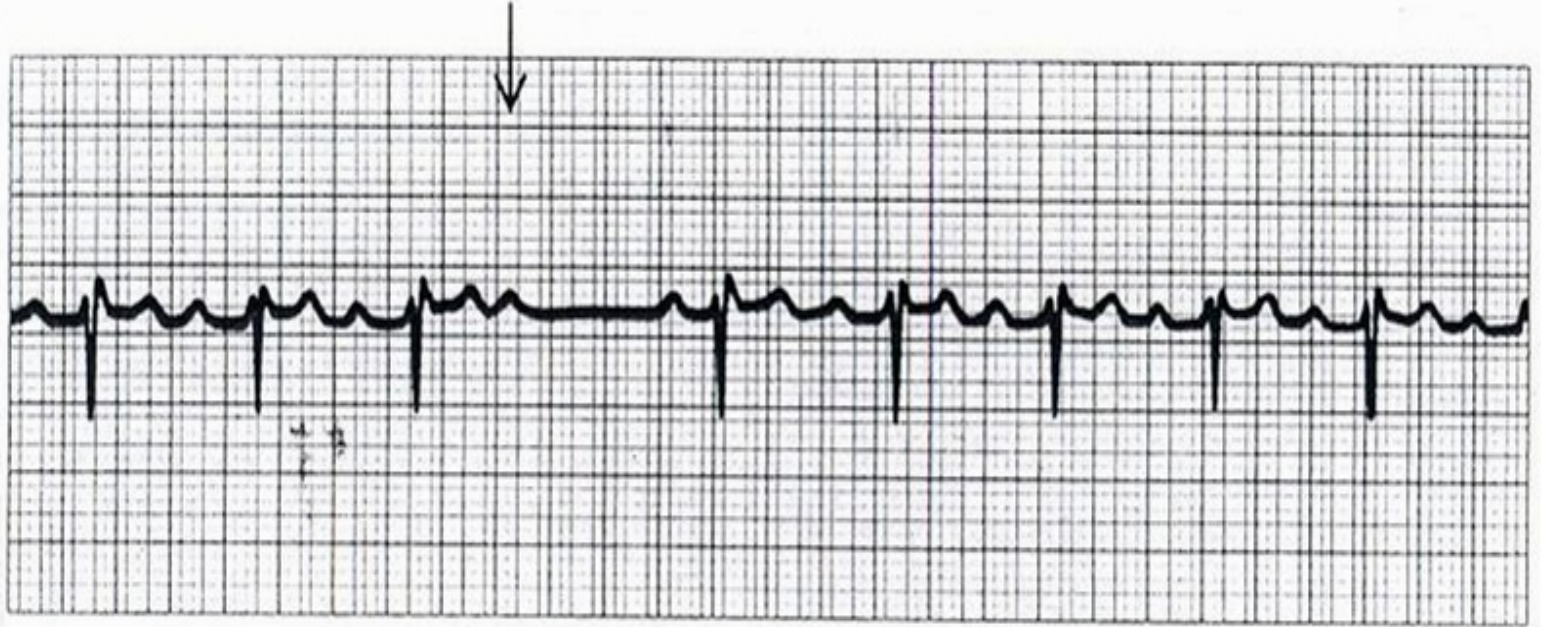
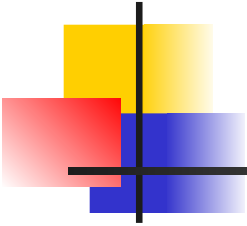


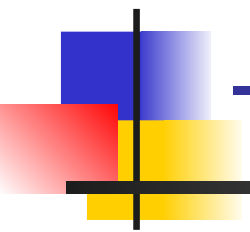
Second degree heartblock

– Mobitz type I (Wenckebach)



- Progressive lengthening of PR interval
- Followed by one non conducted beat
- Next conducted beat has a shorter PR than preceding beat.

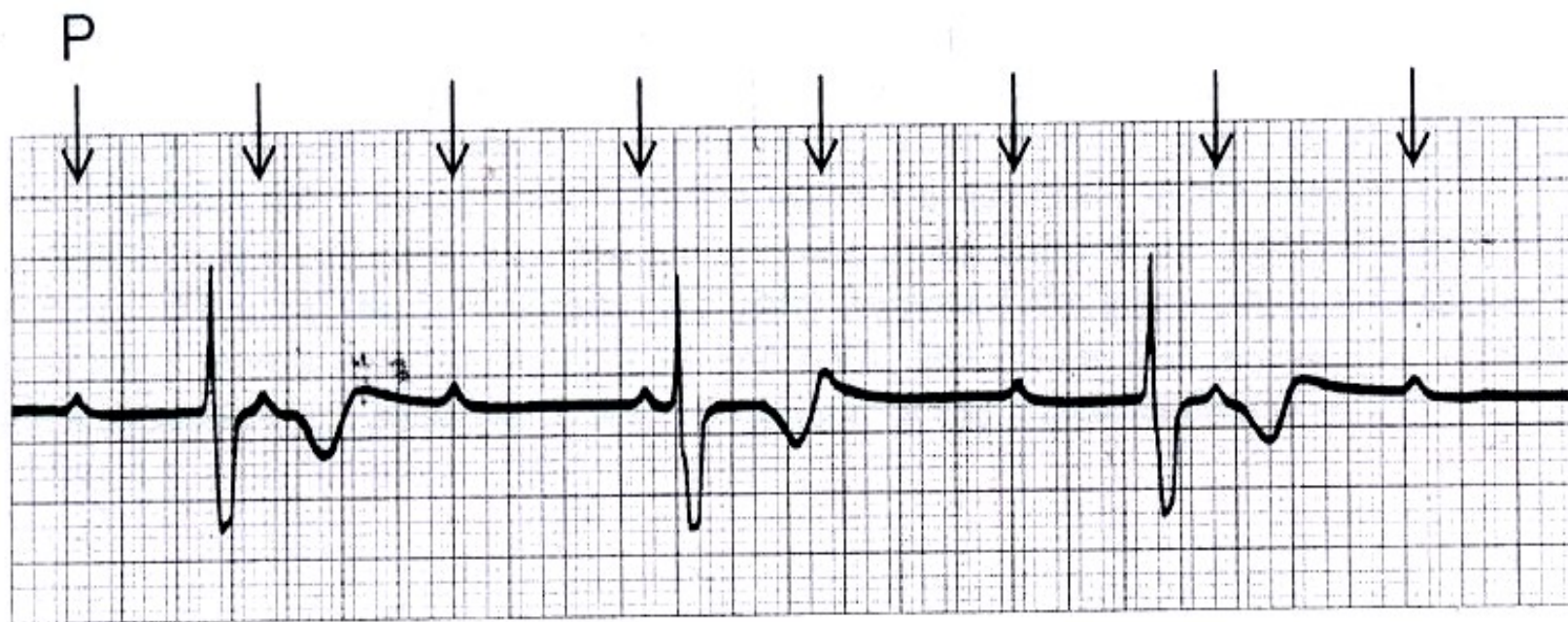


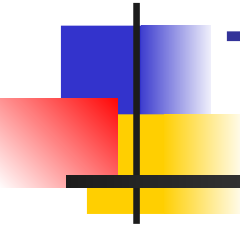


Second degree heartblock

– Mobitz type II

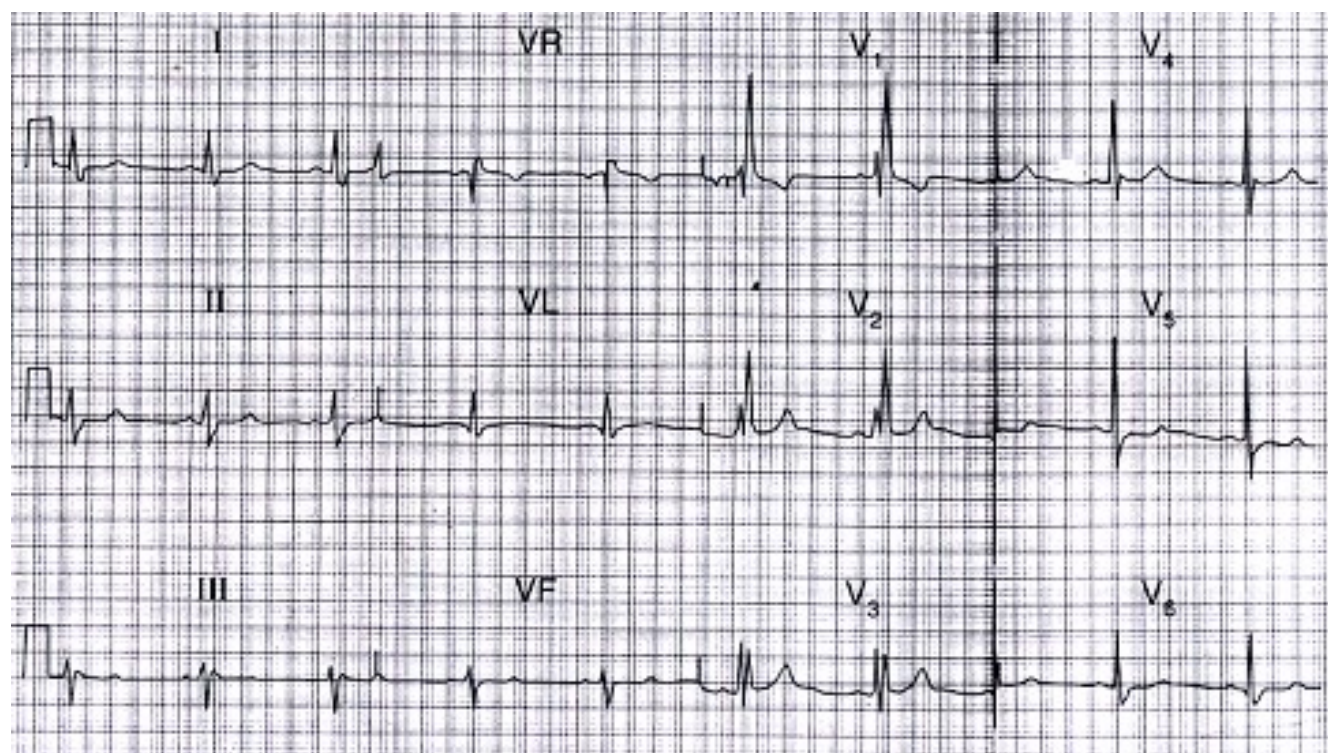
- PR interval of conducted beat is constant
- One P wave is not followed by a QRS complex

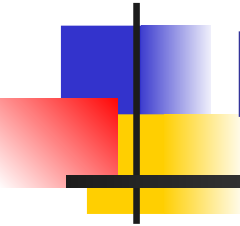




Third degree heart block

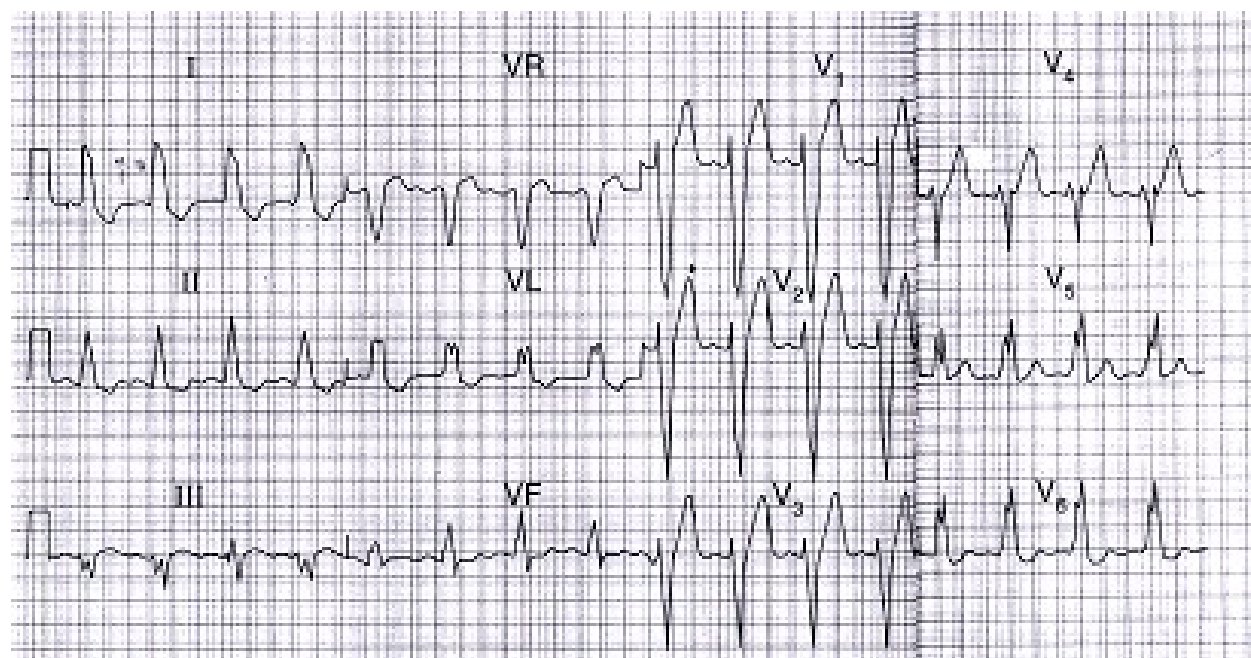
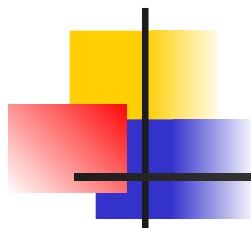
- No temporal relationship between Pwave and QRS complexes
- Broad QRS complexes

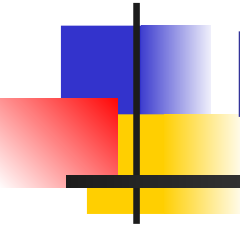




Right bundle branch block

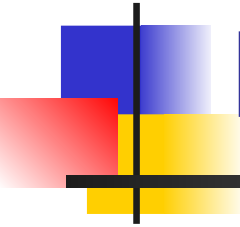
- Normal cardiac axis
- Wide QRS
- RSR1 pattern in V1 and deep wide S wave in V6





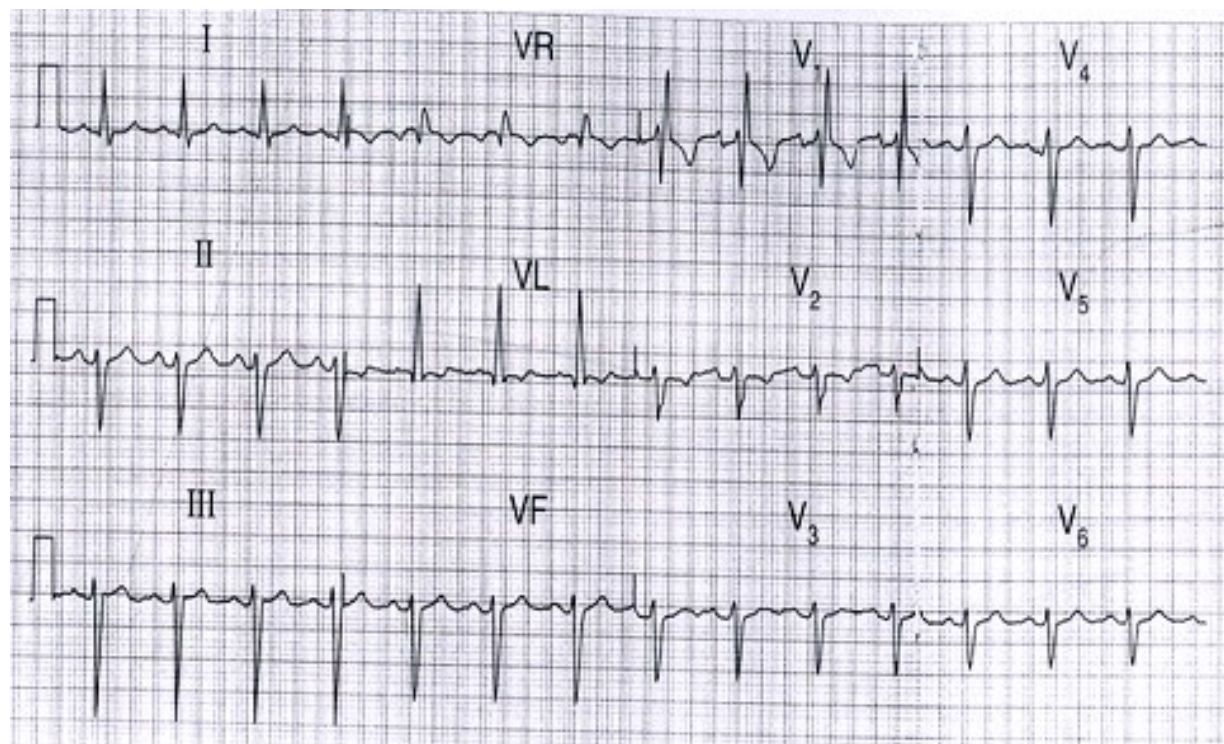
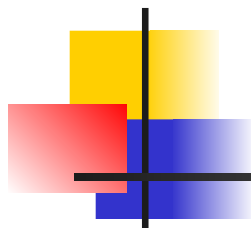
Left bundle branch block

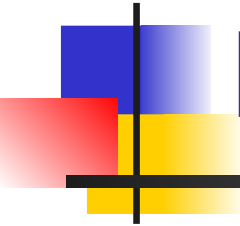
- Normal axis
- Wide QRS
- M pattern in leads I, VL, V5, V6



Left anterior hemiblock

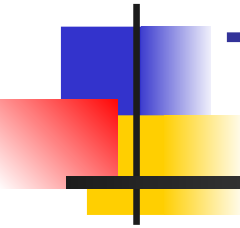
- Wide QRS complex
- Left axis deviation





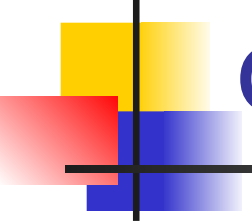
Bifascicular block

Presence of RBBB along with
left hemiblock



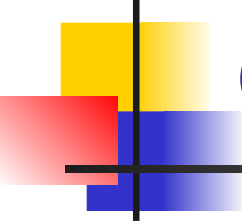
Trifascicular block

RBBB and left anterior and
posterior hemiblock



Indications for artificial cardiac pacing

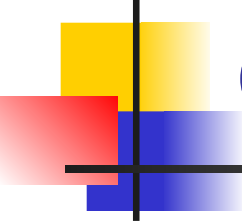
- AV conduction abnormalities
- Sinus node dysfunction
- Neurocardiogenic syncope
- For hemodynamic improvement
- To prevent tachyarrhythmias



Indications for artificial cardiac pacing in AV block

Pacemaker necessary

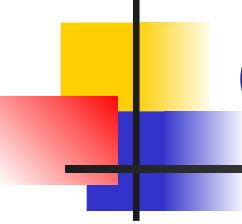
- Symptomatic or asymptomatic acquired CHB
- Symptomatic congenital CHB
- Atrial fibrillation with CHB
- Symptomatic second degree Mobitz type I or type II block



Indications for artificial cardiac pacing in AV block

Pacemaker probably necessary:

- Asymptomatic Mobitz type II block
- Asymptomatic Mobitz type I block at intra His or infra His level
- Hemodynamically symptomatic first degree block (due to loss of AV synchrony)



Indications for artificial cardiac pacing in AV block

Pacemaker not necessary :

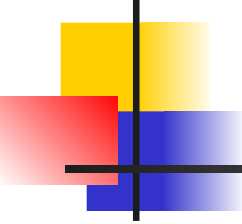
- Asymptomatic Mobitz type I at supra His level
- Asymptomatic first degree block

red - Pacemaker necessary

blue- Pacemaker probably necessary

green- Pacemaker not necessary

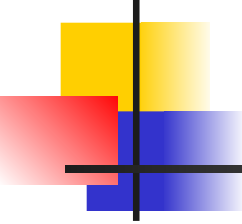
- Symptomatic third degree
- Asymptomatic third degree
- Symptomatic 2nd degree type 2
- Symptomatic 2nd degree type 1
- Asymptomatic 2nd degree type 2
- Asymptomatic 2nd deg type 1(infra His)
- Asymptomatic 2nd deg type 1(supra His)
- Symptomatic 1st deg
- Asymptomatic 1st deg



Fascicular block

Pacemaker necessary:

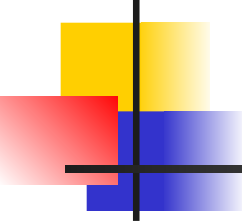
- Bi- or tri- fascicular block associated with CHB (symptomatic or not)
- Associated with intermittent Mobitz type II block



Fascicular block

Pacemaker probably necessary:

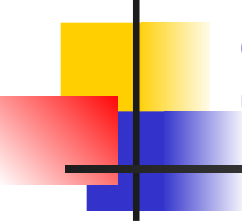
- Bi or tri fascicular block with syncope
- HV interval more than 100 ms



Fascicular block

Pacemaker not necessary :

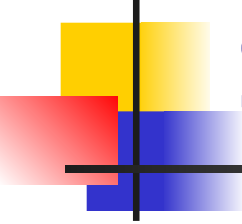
- Fascicular block without AV block without symptoms



Sinus node dysfunction

Pacemaker necessary:

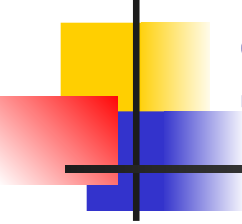
- Symptomatic sinus bradycardia including frequent sinus pauses
- Symptomatic sinus bradycardia due to long term drug therapy of a type and at a dose for which there is no accepted alternative



Sinus node dysfunction

Pacemaker probably necessary:

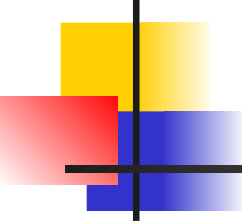
Symptomatic patients with SND with documented rates less than 40 bpm without clear cut association between symptoms and bradycardia



Sinus node dysfunction

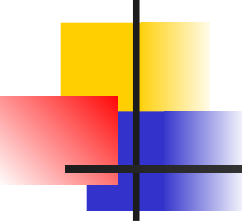
Pacemaker not necessary :

- Asymptomatic SND
- Asymptomatic bradycardia due to drug therapy



Neurocardiogenic syncope

- Due to carotid sinus hypersensitivity and vasovagal syncope
- Recurrent syncope caused by carotid sinus stimulation and minimal pressure induce asystole of more than 3 sec in the absence of any medication that depresses conduction



Pacing for hemodynamic improvement

1. Hypertrophic cardiomyopathy
2. Dilated cardiomyopathy
3. Congestive cardiac failure
4. Atrial fibrillation
5. Sequential pacing to avoid pacemaker syndrome

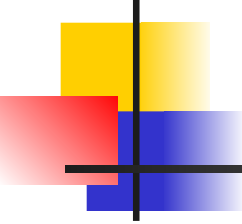


HOCM

- Medically refractory and severely symptomatic HOCM

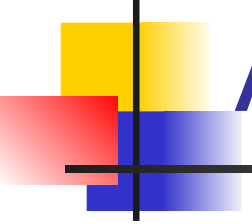
Dual chamber pacing - right atria and right ventricle

- Altered septal activation by right ventricular apical pacing causes less narrowing of LVOT
- Permanent pacing can lead to long term remodelling of LV



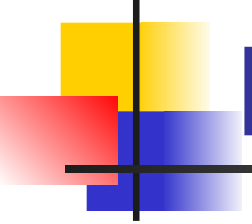
DCM

- AV sequential pacing
- Biventricular pacing



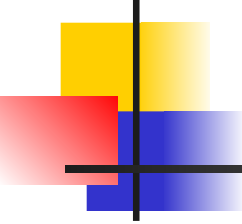
AF

- Dual site atrial pacing has been used to prevent recurrent atrial tachyarrhythmias



Indications for temporary pacing

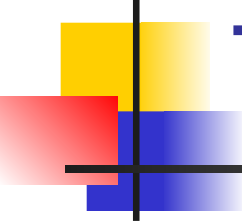
- Sinus bradycardia or lower escape rhythm due to reversible cause with symptoms of hemodynamic compromise
- As standby in patients with increased risk of sudden high degree AV heart block
- Bridge to permanent pacing in 2nd or 3rd degree AVHB
- During AMI: asystole, new bifascicular block, symptomatic bradycardia not responsive to drugs, Mobitz type II
- Bradycardia dependent tachydysrhythmia (TDS with LQTS)



Indications for temporary pacing

During and after heart surgery for :

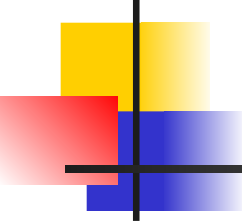
- To overdrive hemodynamically disadvantageous junctional and ventricular rhythm
- Terminate SVT or VT
- Prevent bradycardia dependent tachydysrhythmias



Trans venous pacing

Temporary or permanent

Subclavian or cephalic vein
preferred



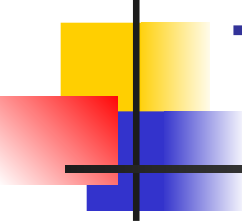
Temporary transvenous pacing – external controls

VVI/VVO

- Output (mA)
- Rate
- R wave sensitivity (mV)

DVI

- Output (mA) ventricular
- Output (mA) atrial
- Rate
- R wave sensitivity (mV)
- AVI



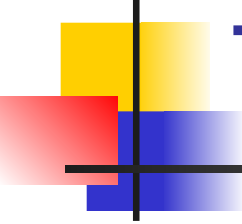
Trans cutaneous pacing

Position of electrodes

1. V3 (negative)
2. Left of spine at the lower aspect of scapula (positive)

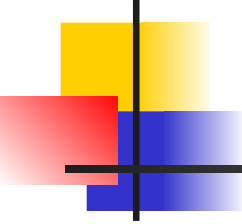
Pulse duration -20- 40 ms

Threshold - 40- 120 mA



Trans esophageal pacing

- Mostly leads to atrial capture
- Electrodes can be placed 1.5 cm from the left atrium
- An intact AV conduction pathway is essential



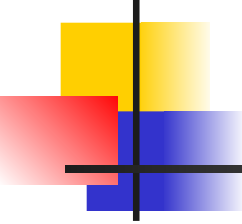
Epicardial placement

Not preferred route

Mostly used after cardiac surgery

Only preferred when no access to right ventricle:

- Associated congenital anomaly
- Prosthetic tricuspid valve
- Intra cardiac right to left shunt

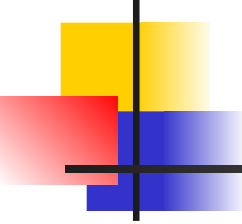


Nomenclature of Implantable Cardioverter Defibrillator (ICD)

Position II

(and tachyarrhythmia pacing chamber)

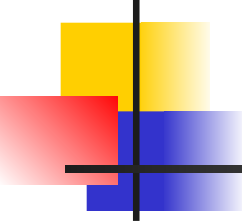
- O- none
- A- atrium
- V- ventricle
- D- dual (atrium and ventricle)



Nomenclature of ICD

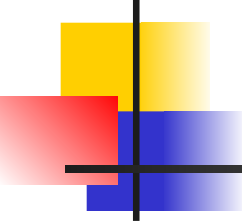
Position of five letter code for
(pacemaker capability of device
(method of detection of
tachyarrhythmia)

- E- intracardiac electrogram
- H- hemodynamic means



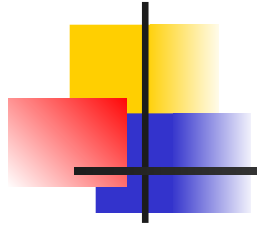
Indications for ICD

- Cardiac arrest due to VF or VT not due to transient or reversible cause
- Spontaneous sustained VT
- Nonsustained VT with CAD, prior MI, LV dysfunction and inducible VF or sustained VT at EPS
- Syncope of undetermined origin with hemodynamically significant VF or VT at EPS.



ICD may be indicated in

- Cardiac arrest presumed due to VF/VT
- Severely symptomatic VT before cardiac transplantation
- LQTS, HCM – high risk of lifethreatening ventricular dysrhythmias



To be continued by Dr. Bala