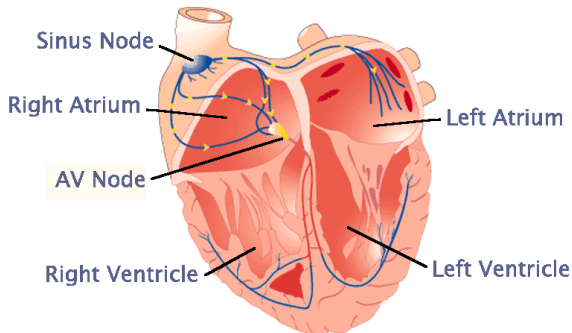


# Introduction to Pacemaker

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# Heart



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Heart is a pump with four chambers:

- Atria - top 2 chambers
- Ventricles - bottom 2 chambers

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<sup>1</sup><http://www.a-fib.com/images/Steve's%20Heart%20Illustration%20Final%20Left-Right-Node%20Corrected.gif>

Cardiac cycle is a sequence of events that happens during single heartbeat. During cardiac cycle blood enters atria and is pumped out of the ventricles.

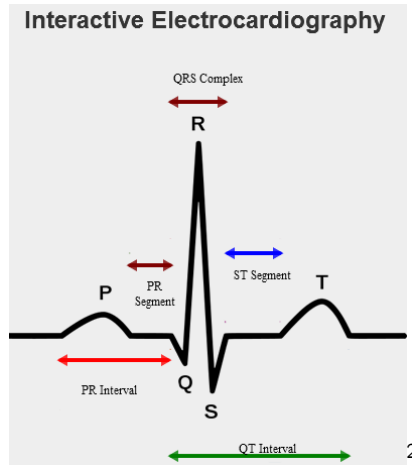
A normal resting heart rate range is 60 - 100 beats per minute (bpm). During extreme exercise it can reach 220 bpm.

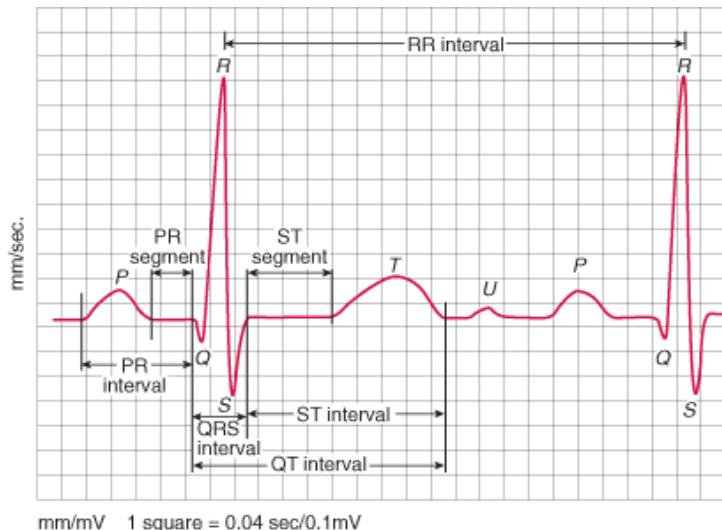
- 1 SA (Sinoatrial) node sends impuls to AV node through atria
- 2 Atria chambers contracts
- 3 AV (Atrioventricular) node sends impuls to ventricles
- 4 Ventricles contract

# Electrocardiography (ECG or EKG)

ECG represents electrical changes during cardiac cycles over time. ECG of a single cardiac cycle is shown on the right.

- P wave denotes current that causes atrial contraction.
- QRS is current that invokes contraction in ventricles.
- T wave represents repolarization of the ventricles. Atrial repolarization is obscured by QRS.





# Durations of ECG waves

If person has 60 bpm, then cardiac cycle is 1 second long.

- P wave - 0.06 to 0.12 seconds
- PR interval - 0.12 to 0.20 sec
- QRS complex - 0.06 to 0.10 sec
- ST segment - 0.08 to 0.12 sec
- T wave - 0.10 to 0.25 sec
- QT interval - depends on heart rate
- U wave recovery of Purkinje fibers in ventricles - usually not present in ECG.

Has two main functions:

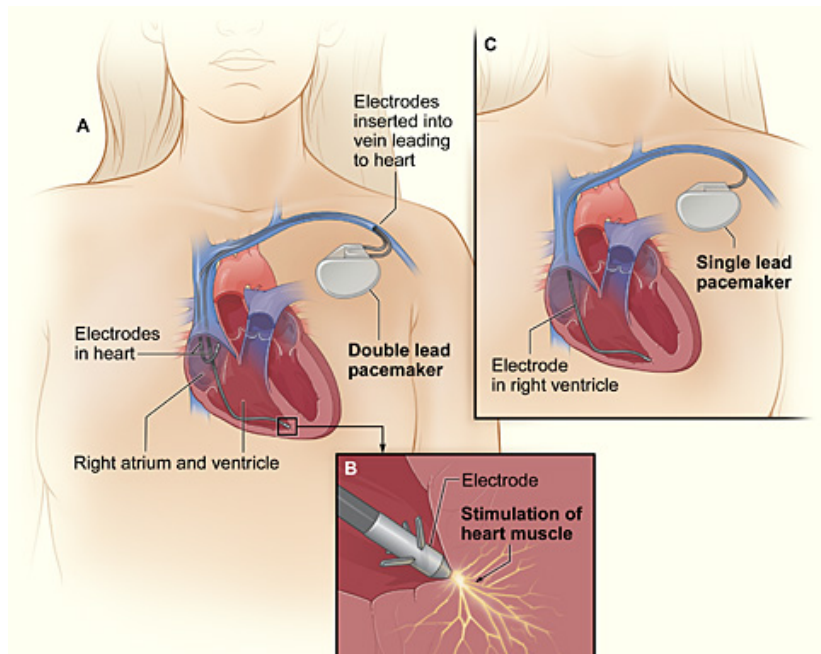
- Sensing
- Pacing of the heart

Pacemaker can only accelerate the heart. It never slows it down. Typically pacemakers have components to detect physical activity (rate sensing).

Pacemaker sends impuls through the lead connected to the heart:

- Single-chamber pacemaker has one lead.
- Double-chamber pacemaker has two leads.

# Pacemaker





# Pacemaker modes

Different heart abnormalities require different pacing modes. Pacing modes are described using classification code. Code can have between 3 to 5 positions.

Chamber(s) Paced	Chamber(s) Sensed	Response To Sensing	Rate Modula- tion
0-None A-Atrium V-Ventricle D-Dual	0-None A-Atrium V-Ventricle D-Dual	0-None T-Triggered I-Inhibited D-Tracked	R-Rate Modulation

Describes the heart chamber that is paced.

- O - No pacing
- A - Pacing occurs in the atria only
- V - Pacing occurs in the ventricles only
- D - Pacing occurs in both atria and ventricles

Describes the heart chamber that is sensed.

- 0 - No sensing
- A - Sensing occurs in the atria only
- V - Sensing occurs in the ventricles only
- D - Sensing occurs in both atria and ventricles

## Third position

Describes what pacemaker does if it senses intrinsic heart electrical activity in the monitored chambers

- 0 - Emits a pulse to selected chamber at a set interval (fixed rate)
- T - Emits a pulse only if sensed event occurred
- I - If intrinsic activity is faster than a set rate (sensed event occurs), it inhibits pacing. Otherwise, it pacing starts.
- D - Will inhibit a pulse if intrinsic event sensed. Will emit pulse in the ventricle if it sensed intrinsic event in atrium, but did not sense a pulse in the ventricle (Requires dual chamber pacemaker)

## Fourth position and DDD explanation

Rate responsive pacemakers can sense patients activity level and adapt to changes.

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In DDD mode, pacemaker:

- 1 Senses atrium and ventricular intrinsic activity
- 2 If after certain interval no intrinsic atrium pulse sensed, pacemaker emits atrium pulse; otherwise inhibit pulse
- 3 If after certain interval no intrinsic ventricle pulse, pacemaker emits ventricular pulse; otherwise inhibit pulse

# Pacemaker cardiac cycle

- Pacemaker uses programmable sensitivity parameters to detect P, R and T waves. Measured in millivolts.
- P and T waves have similar voltages.
- T wave detection: pacemaker paces or senses ventricular event and waits ventricular refractory period.

