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# Pacemaker



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# Pacemakers

- ▣ A pacemaker is a device which provides artificial pacing impulses and delivering them to the heart.
- ▣ It is an electrical pulse generator that delivers the needed pulse at an appropriate time
- ▣ In general, there are two types of Pacemaker.
  - External or Temporary Pacemaker
  - Internal or Permanent Pacemaker

# External Pacemaker

- ▣ External pacemakers are a temporary measure used following open-heart surgery for certain problems experienced by some myocardial infarction patients, and for patients who are to be evaluated for surgical implantation of a permanent mode.
- ▣ External models are usually adjustable from 50 to 150 BPM and produce fixed-duration, short duty cycle pulses (is., 1.5 to 2.0 ms).
- ▣ The peak current amplitude is adjustable from 100  $\mu\text{A}$  to 20 mA.

# Permanent Pacemaker

- ❑ Permanent pacemakers are built into molded epoxy-silicone rubber packages, although some recent models include an outer titanium shield that guards against interference from radio frequency fields.
- ❑ The device is implanted subcutaneously in either the abdomen or a region just below the collarbone.
- ❑ Some implantable pacemaker have a single fixed rate, usually about 70 BPM, while others are dual-rate models.
- ❑ The latter type can be programmed from outside the patient's body using a magnet or induction coil.
- ❑ Still others are programmable from 30 to 150 BPM.

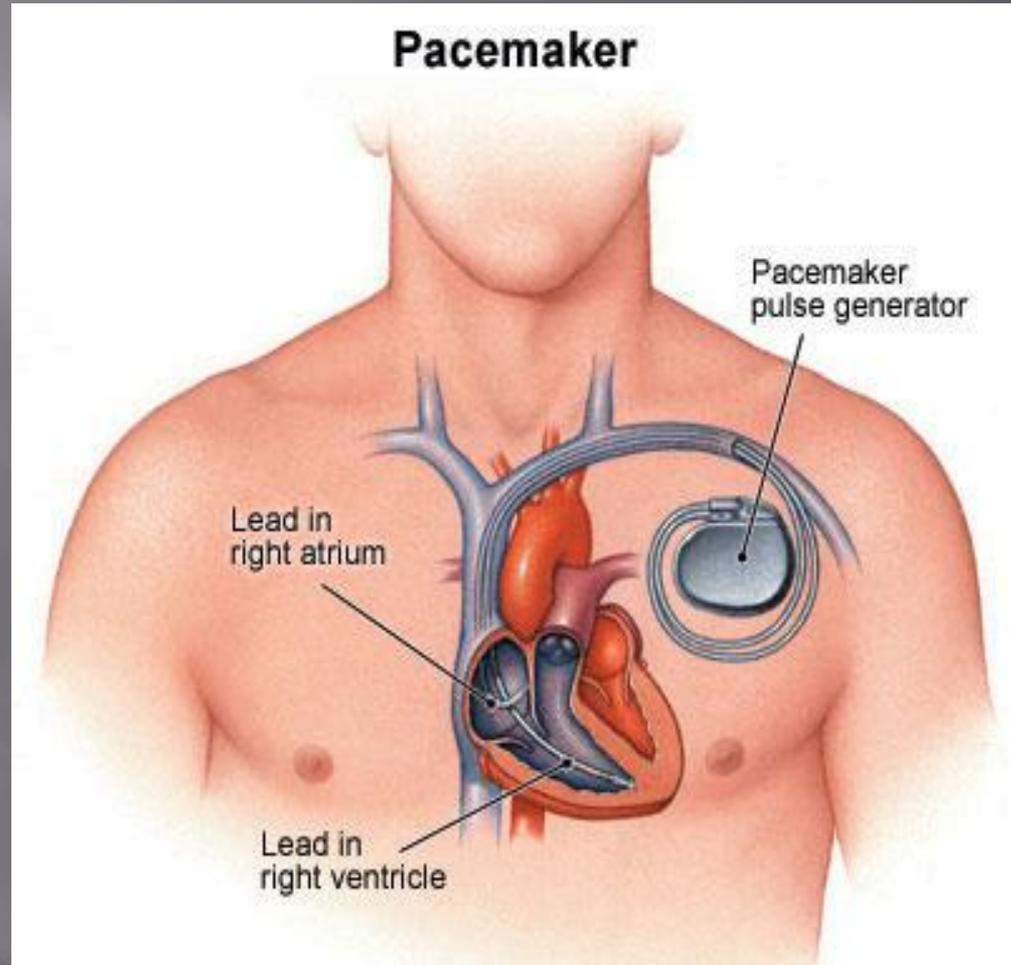
# Cont...

- ▣ The principal power source for implantable pacemaker is the lithium iodine cell.
- ▣ Mercury pacemaker batteries are able to operate for as long as 4 to 5 years, but its usual to find service periods of 1.5 to 3 years.
- ▣ X-ray examination shorten the battery life.
- ▣ Pulse rate drops with decreased battery voltage.
- ▣ Sometimes the heart rate of patient serve as the early indicator of battery failure.
- ▣ Some work has been done on the nuclear power source for pacemaker.

# Types Of Leads

- ▣ Two types of pacemaker lead wire are used:
  - Endocardial
  - Myocardial
  
- ▣ The **Endocardial** lead is inserted through an opening in a vein and then threaded through the venous system and right atrium and into the right ventricle of the heart.
  
- ▣ The **myocardial** leads are connected directly to the heart muscle.

# Types Of Leads

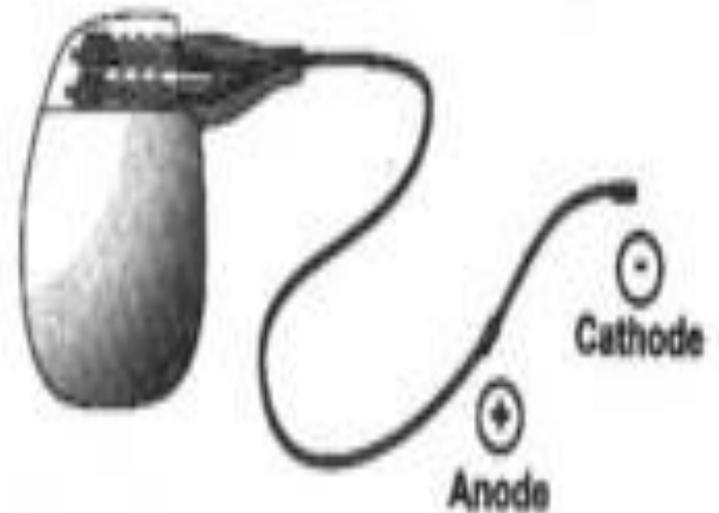


# Types Of Leads

**Unipolar**



**Bipolar**



# Categories

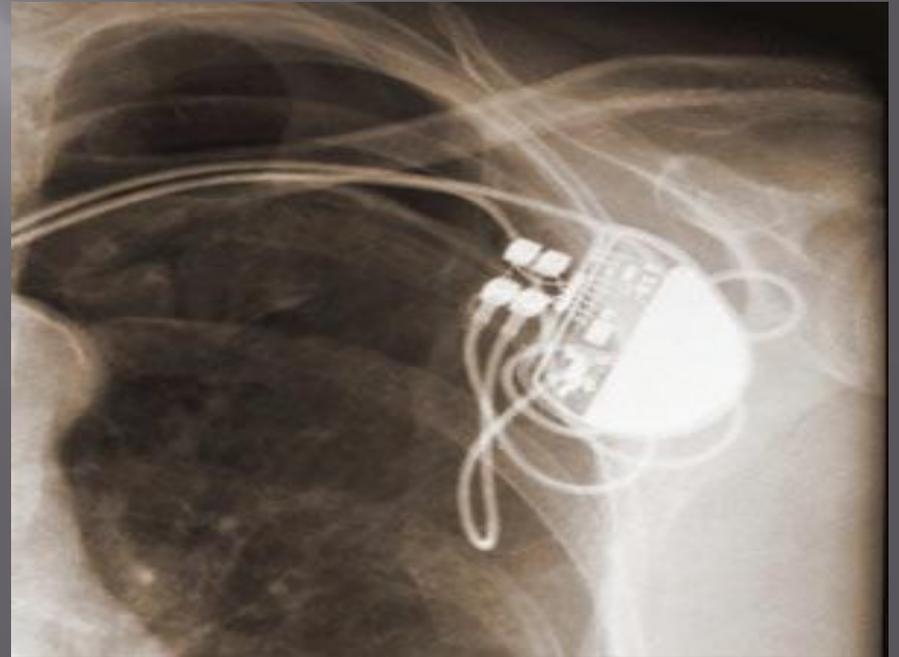
- ▣ There are two categories of Pacemaker
  - Unipolar
  - Bipolar
  
- ▣ **Bipolar:** In bipolar, both electrodes are inside a single catheter.
- ▣ The distal tip is one electrode, while the second is located a short distance behind the tip.
- ▣ These electrodes are made of platinum-iridium alloy to prevent interaction with body fluids

# Pacemaker Classifications

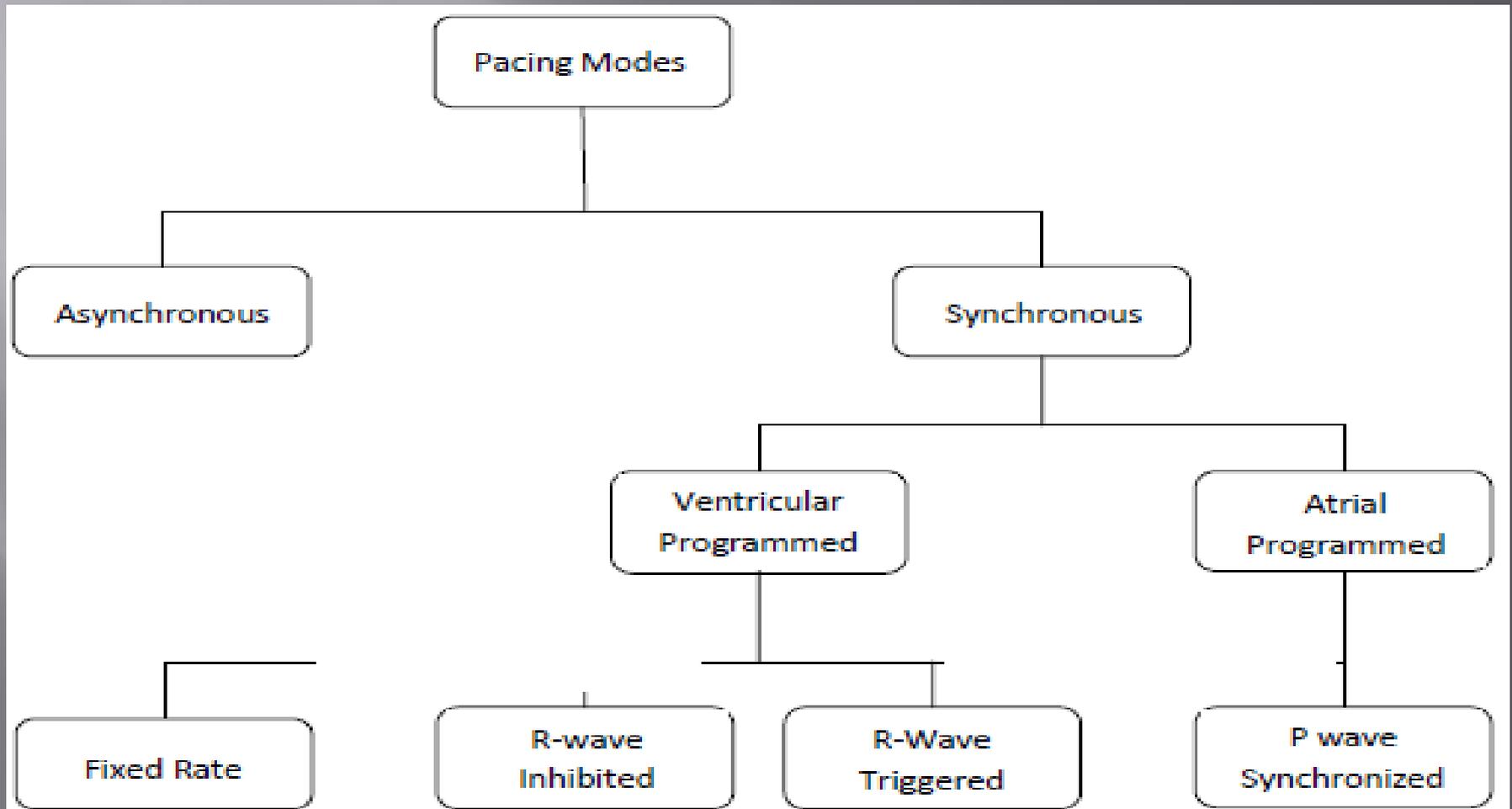
- ▣ There are four general categories of Pacemaker:
  - I. Asynchronous
  - II. Demand
  - III. R-wave inhibited
  - IV. AV synchronized

# Pacemaker Classifications

Electrodes are implanted beneath the skin  
o/p leads are connected directly to the heart muscle  
Pulse generator is powered by small batteries



# Pacing Modes



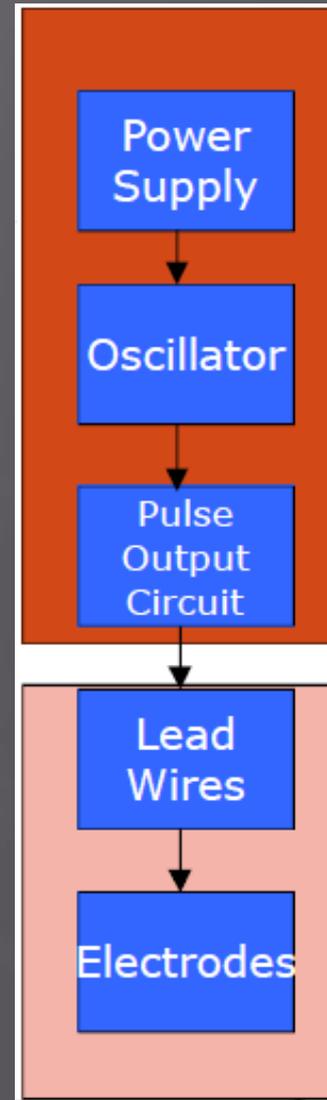
# Asynchronous

- ▣ The simplest form of the pacemaker; not common any longer.
- ▣ The asynchronous pacemaker produces pulses at a fixed rate in the 60 to 80 beats/min range.
- ▣ The standard rate is 70 beats/min, but rates within the specified range are obtainable on special order.
- ▣ Asynchronous (does not synchronize with intrinsic (natural) heart rate (HR)).

# Cont...

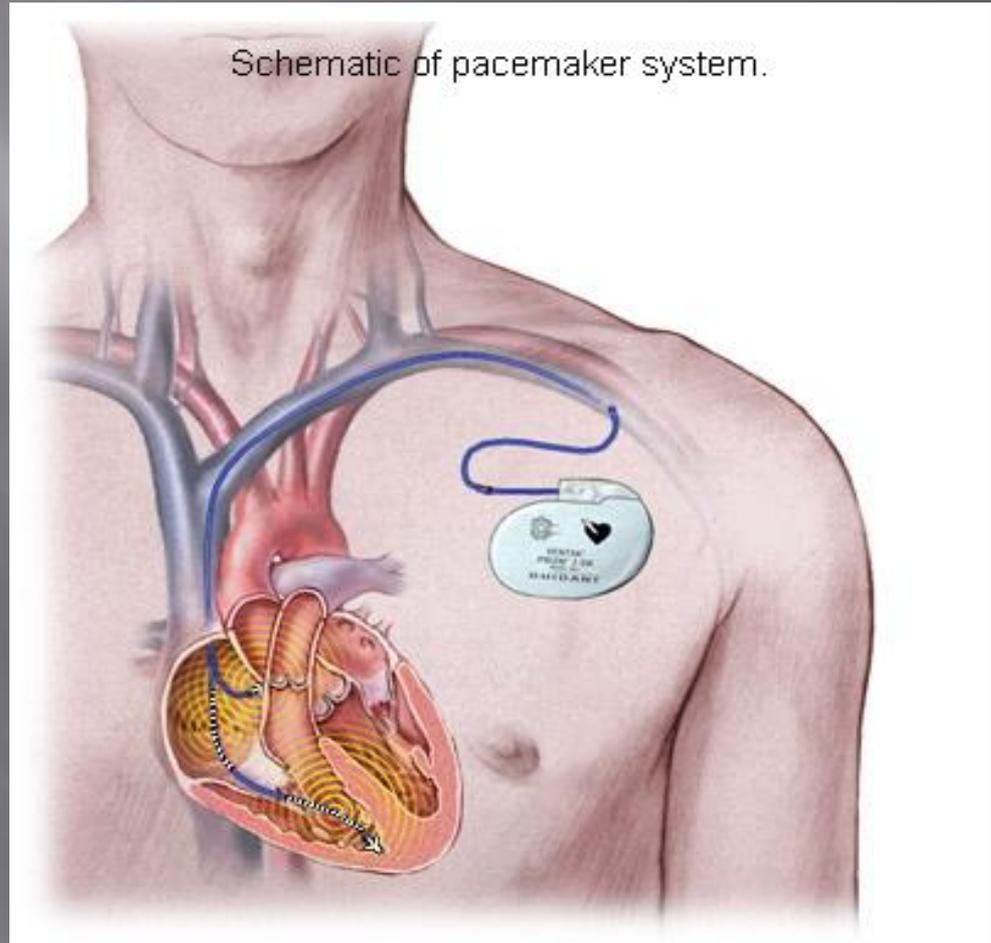
▣ Block diagram shows components of competitive asynchronous pacemaker.

- Power supply – provides energy
- Oscillator – controls pulse rate
- Pulse output – produces stimuli
- Lead wires – conduct stimuli
- Electrodes – transmit stimuli to the tissue



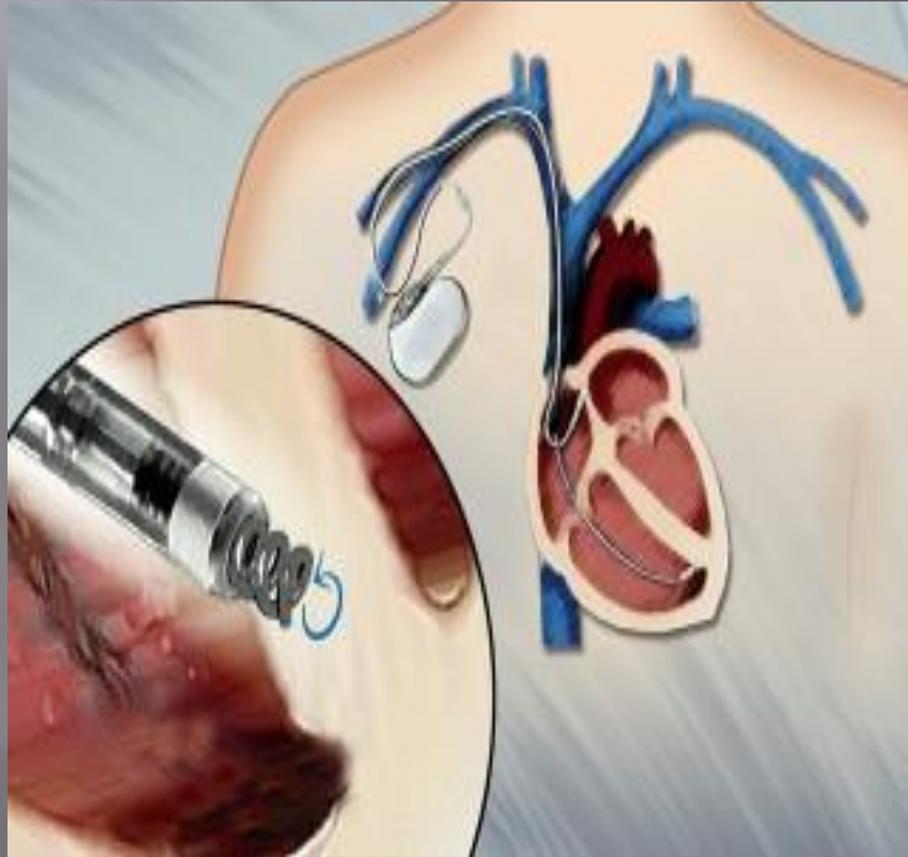
# Cont...

Schematic of pacemaker system.



# Demand Pacemaker

- ▣ The demand pacemaker adjusts its firing rate to the patient's heart rate.
- ▣ It contains circuitry that senses the ECG R wave and measures R to R interval.
- ▣ During the first quarter of this, the pacemaker is dominant to prevent response to the T wave feature of the ECG.
- ▣ If R wave is not sensed within this period, then the pacemaker emits a pulse.
- ▣ Contains two circuits
  - One forms impulses
  - One acts as a sensor



# R-wave Inhibited

- ▣ The R-wave inhibited pacemaker is similar to the demand type, except that it does not emit pulses during normal heart activity.
- ▣ The triggering circuits are inhibited for a period of time after each R-wave.

# AV Synchronized

- ▣ The AV synchronized pacemaker responds to the ECG P wave- the ECG feature created by contraction of heart's atria.
- ▣ The atrial pacer circuitry contains a P Q delay circuit that stimulates the propagation time in the heart's electro conduction.
- ▣ The AV pacer has the advantage that it will follow the changing heart rate demands of the body.

Questions...??