What is electrophysiology?

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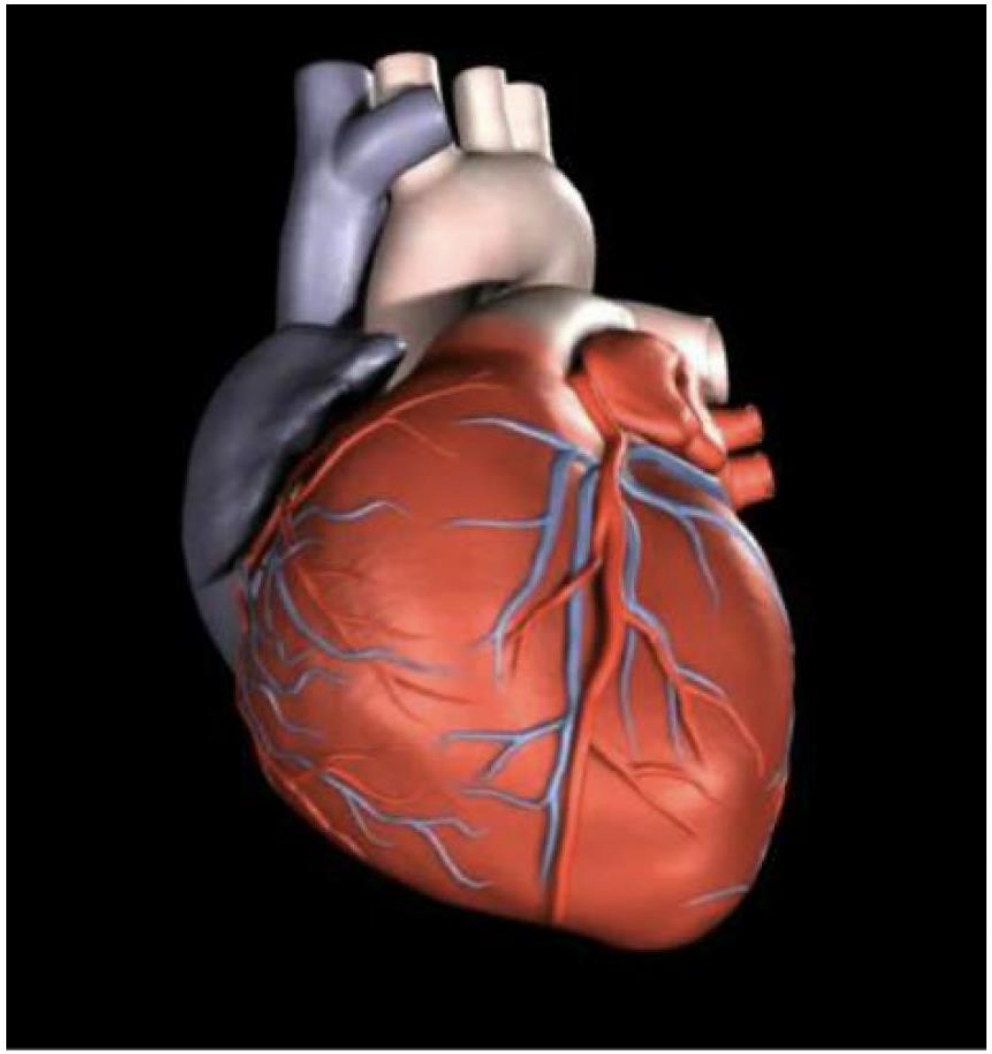
Electrophysiologist: cardiac electricians

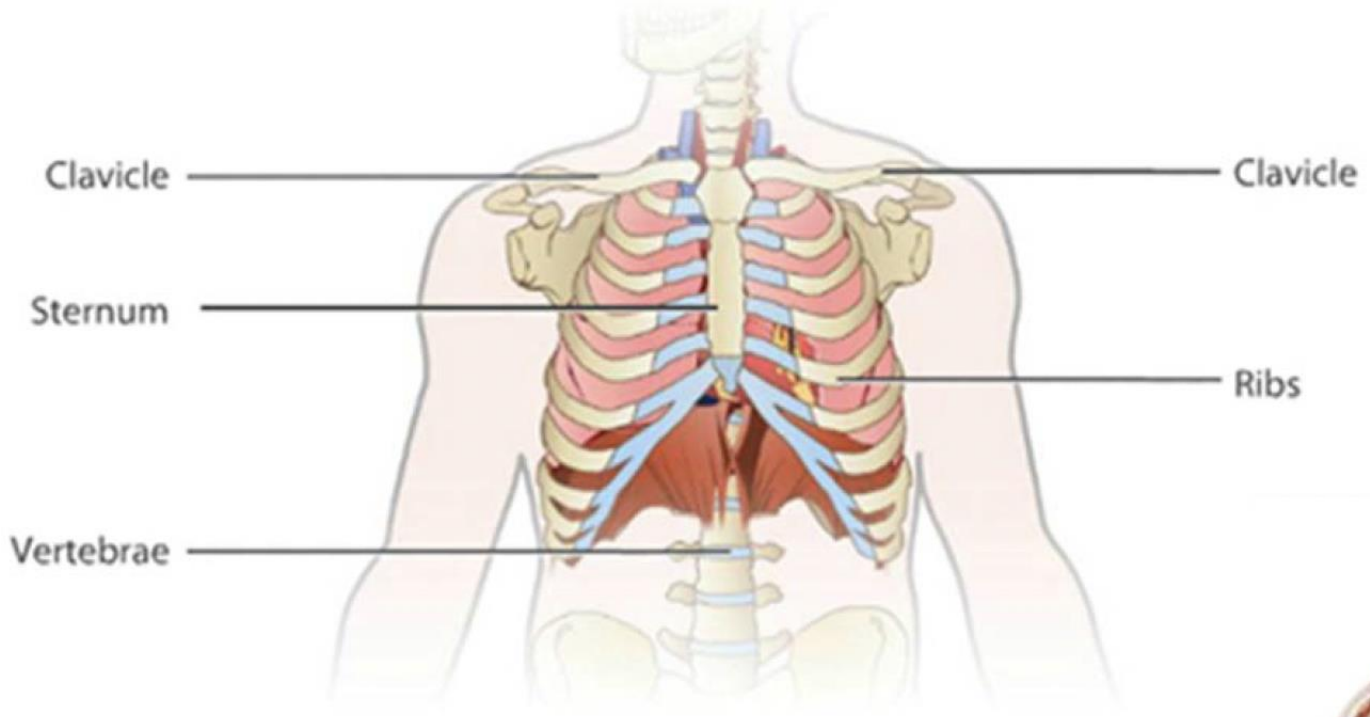
- Slow heart rhythms
  - ? Pacemakers
- Fast heart rhythms
  - From the top part of the heart (atria)
    - Extra electrical pathways
      - Ablation vs medication
    - Irregular heart rhythms
      - ?atrial fibrillation
        - Ablation vs medications
  - From the bottom part of the heart (ventricle)
    - Ventricular tachycardia
      - Ablation vs ICD
    - Ventricular fibrillation
      - ICD
- Sudden death
  - ICD

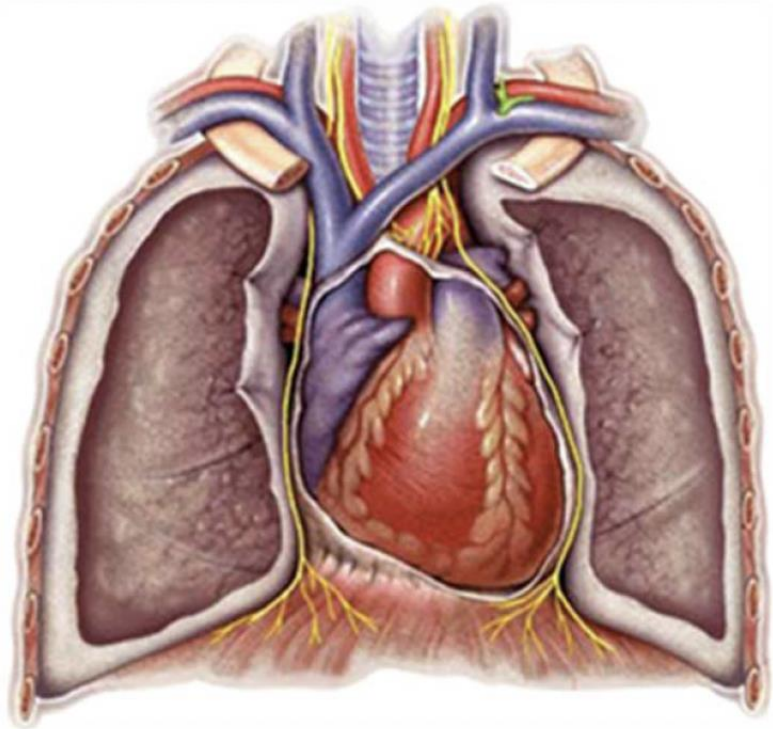
The Heart



- Four-chambered, muscular organ
- Responsible for the vital transport of blood, oxygen, nutrients, and byproducts to and from the tissues.
- Average female heart is 9 ounces
- Average male heart is 10.5 ounces

Thoracic Wall / Cavity





Cardiac Chambers and Structures

Right-Sided Cardiac Chambers

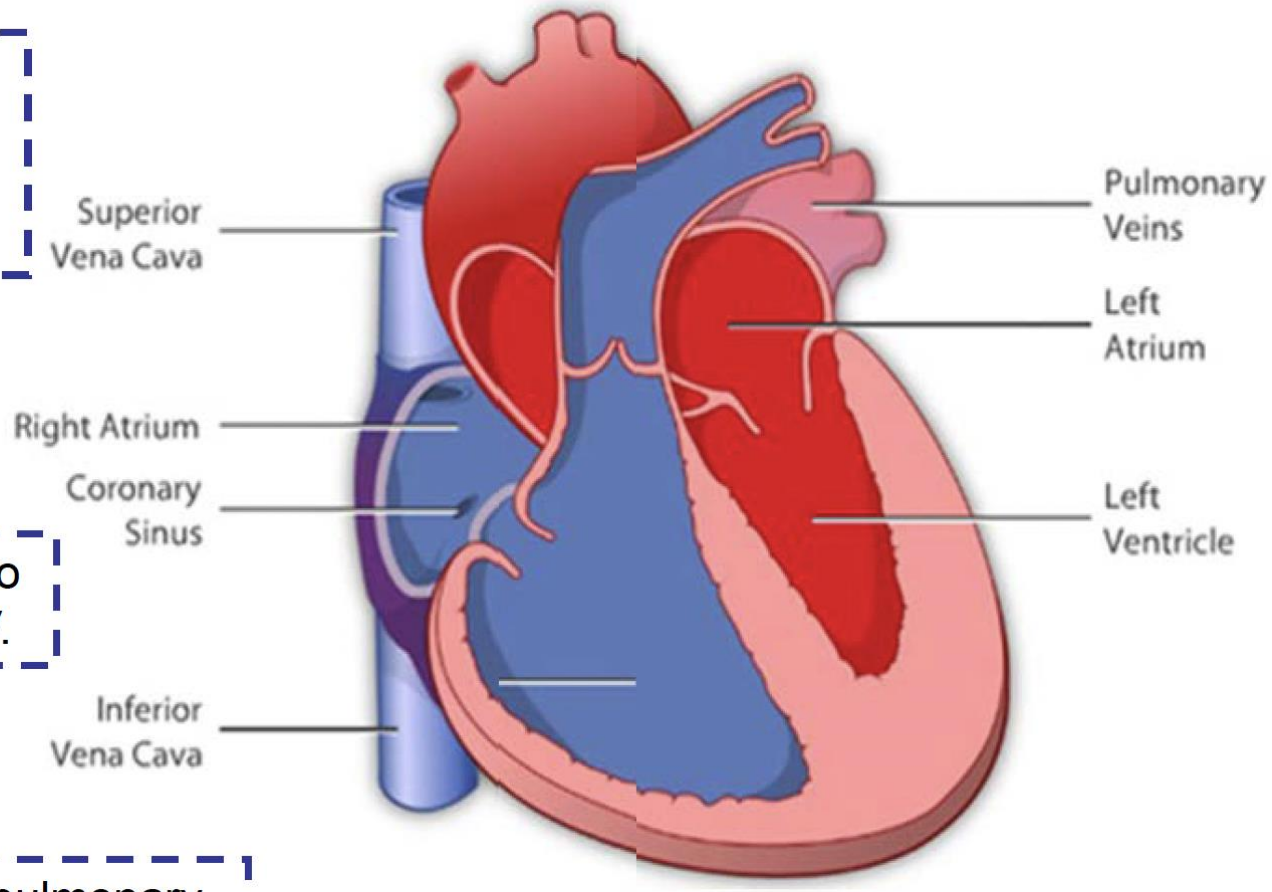
- Receive deoxygenated, or venous, blood.

RA receives blood from 3 veins:

1. Inferior vena cava
2. Superior vena cava
3. Coronary sinus.

Venous blood is then pumped into the pulmonary trunk from the RV.

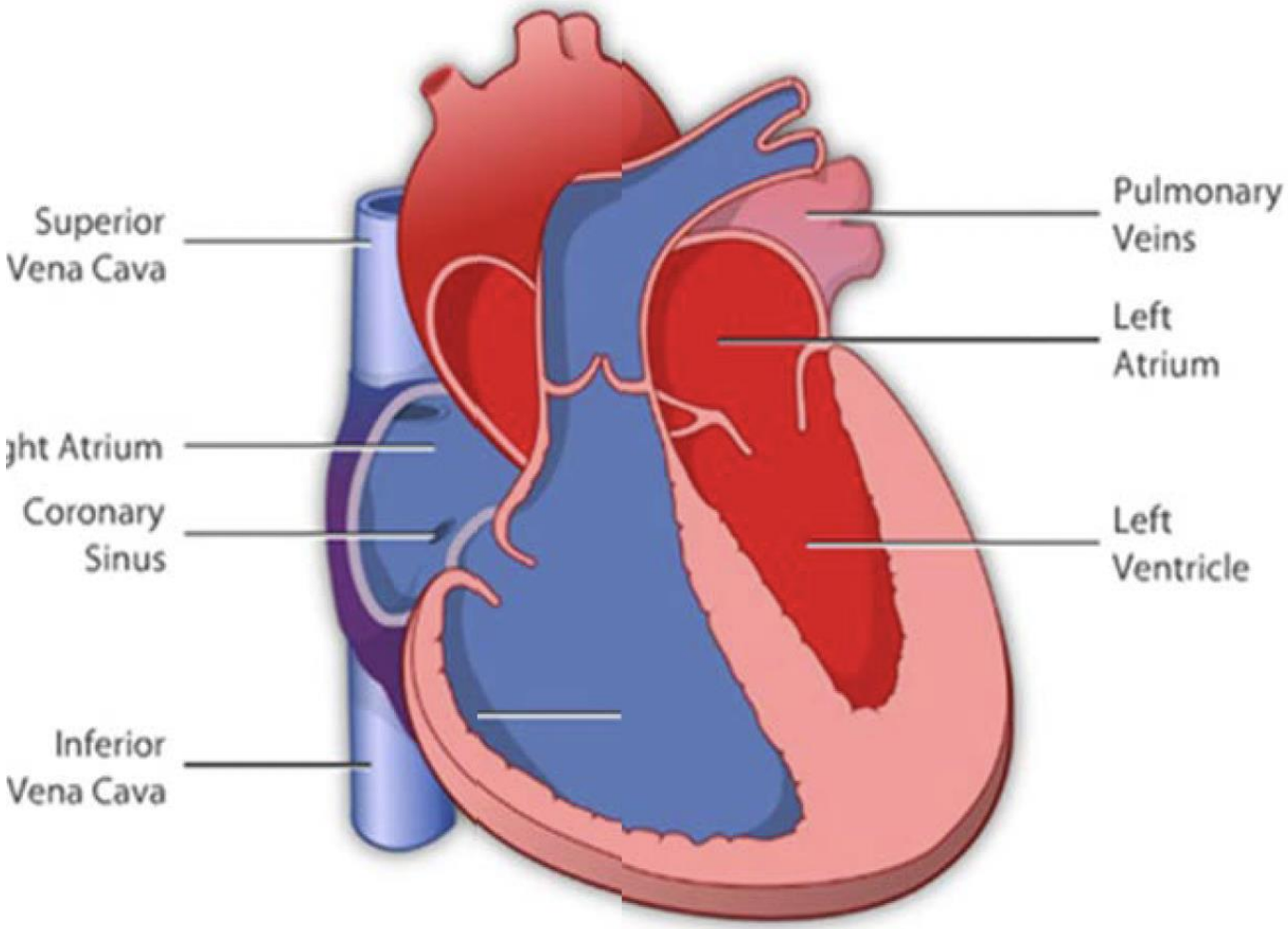
From there, it flows through the pulmonary arteries to the lungs, where it becomes oxygenated and releases carbon dioxide.



Cardiac Chambers and Structures

Left-Sided Cardiac Chambers

- Supply oxygenated (arterial) blood to the body.

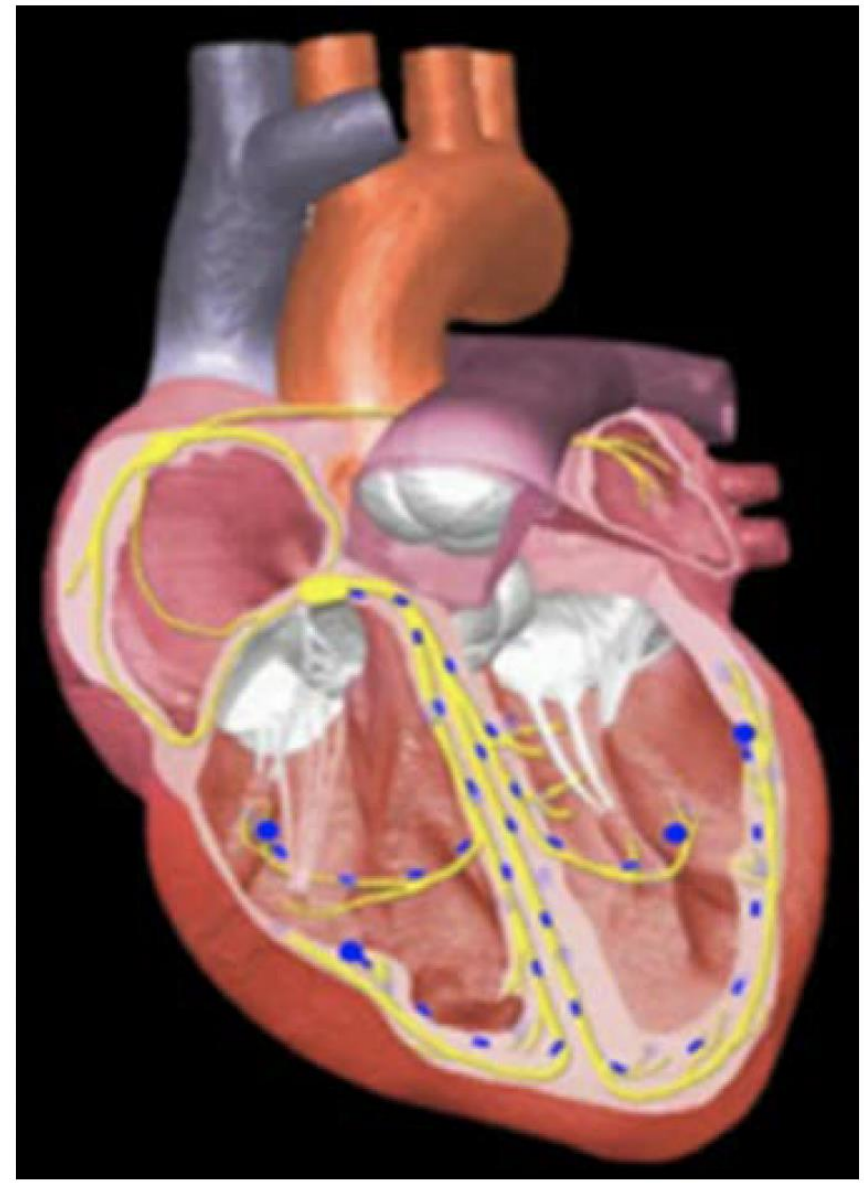


LA receives blood from the lungs via the pulmonary veins.

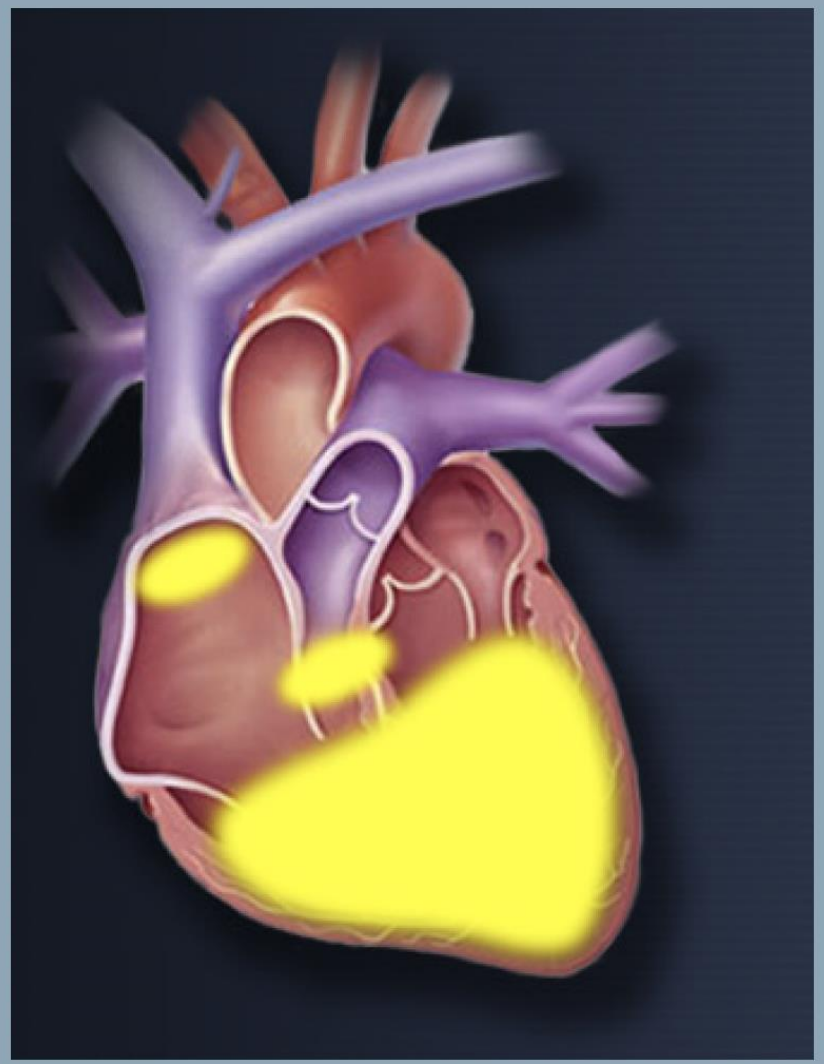
LV pumps oxygenated blood to body tissues via the aorta.

Normal Heart Conduction

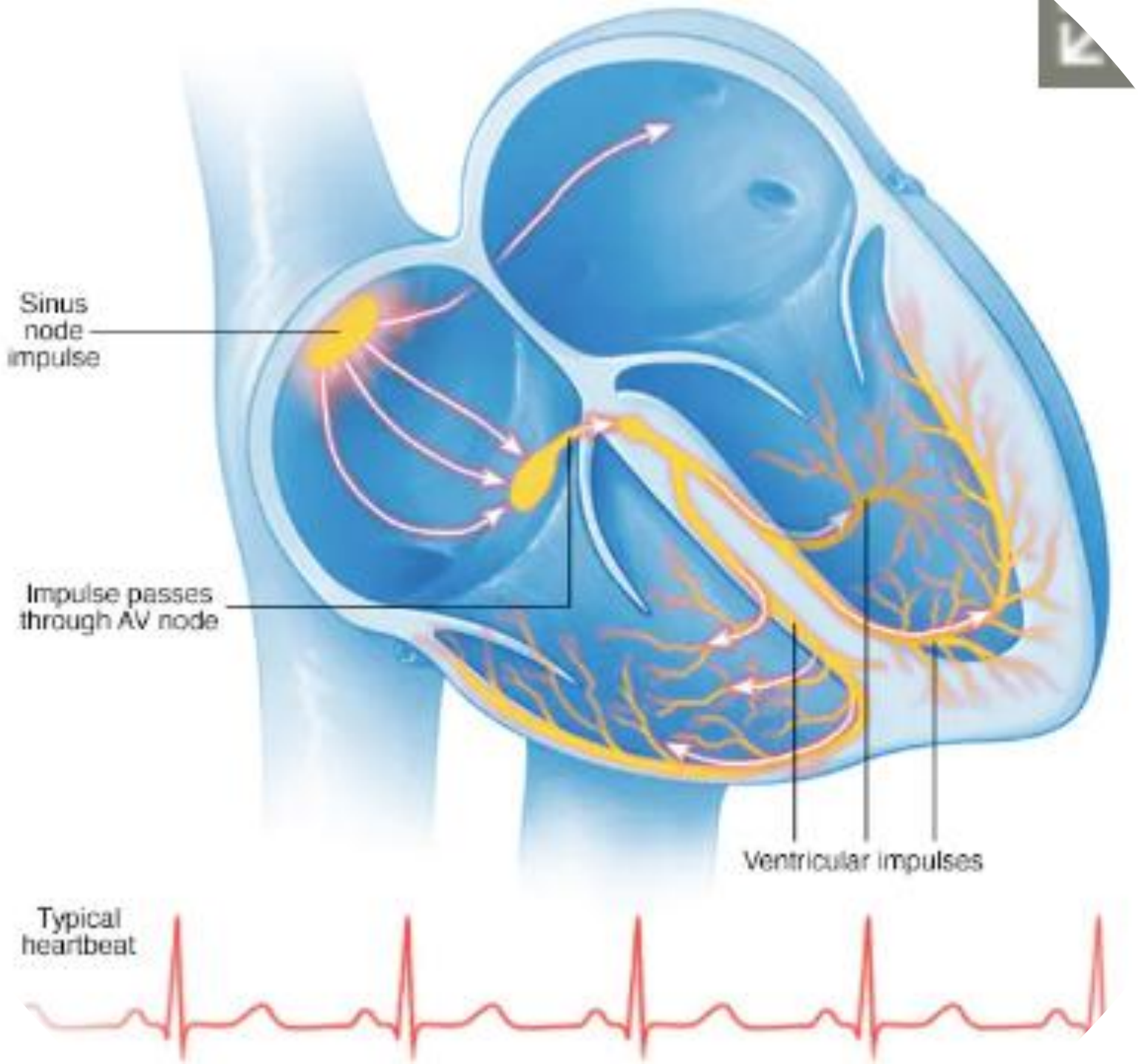
- Electrical activation always precedes mechanical activation, just by milliseconds.
- Heartbeats occur as electrical impulses move through the heart.
- The electrical side of the heart and its contractions are at the core of how the heart operates. This is what constitutes a heartbeat.



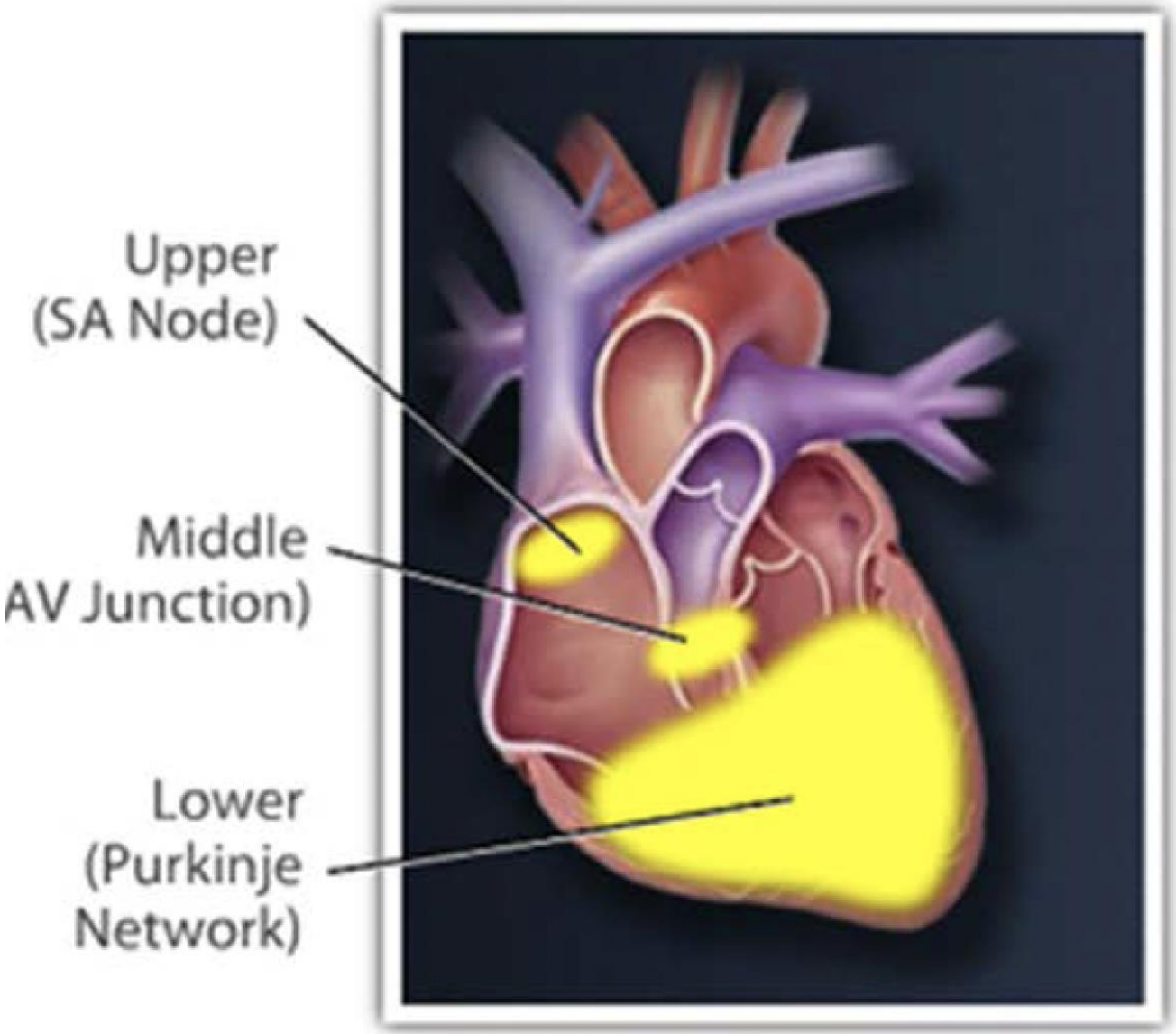
Automaticity



- All cardiac cells have automaticity
- Automaticity is the ability of cardiac cells to contract or depolarize spontaneously *without* external influence.


Sinus node impulse
Impulse passes through AV node
Ventricular impulses
Typical heartbeat

Automaticity: Cardiac Cells

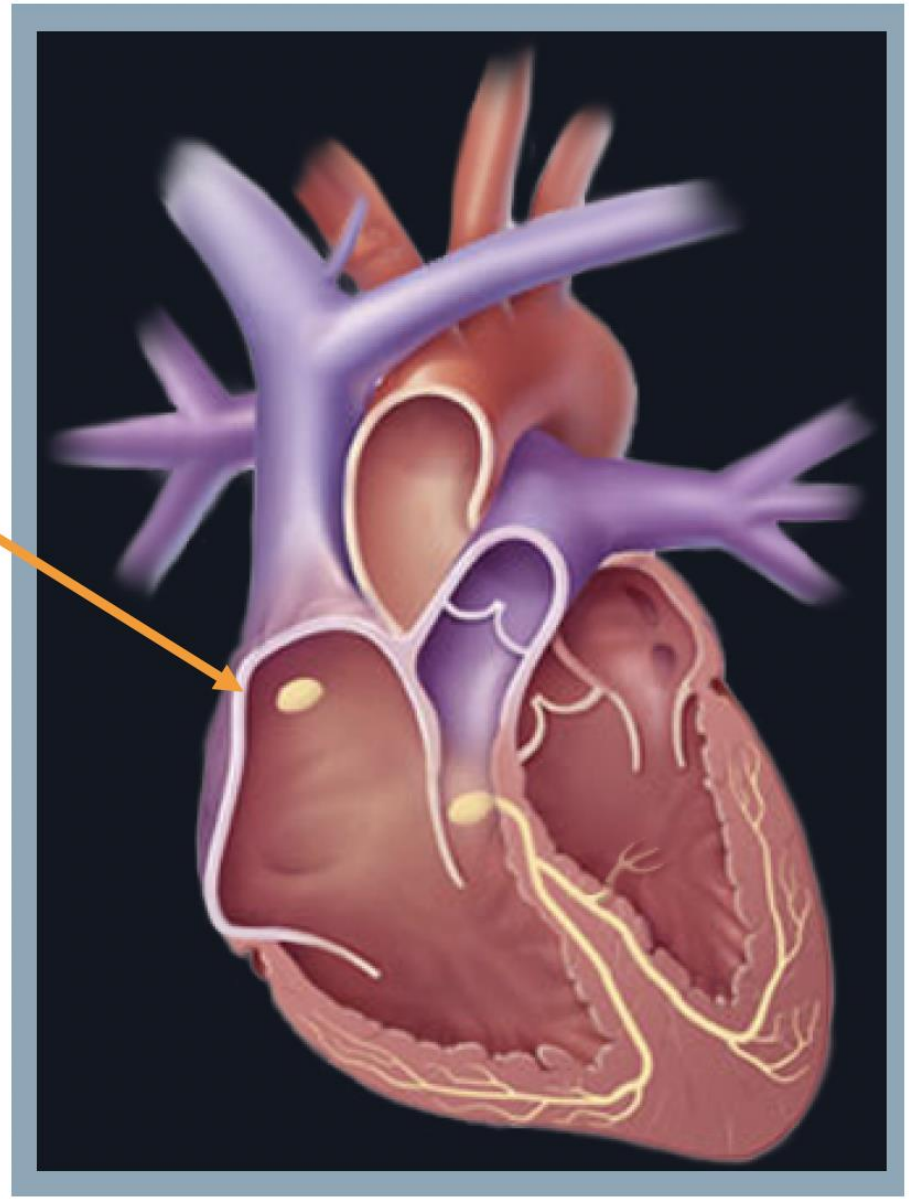


- Cardiac cells that polarize fastest drive heart rate
- Generally present in:
  - Upper (SA Node) 60–100 bpm
  - Middle (AV Junction) 40–60 bpm
  - Lower (Purkinje Network) 20–40 bpm

The Heart's Conduction System

Sinus Node

Sinus Node (SA Node)

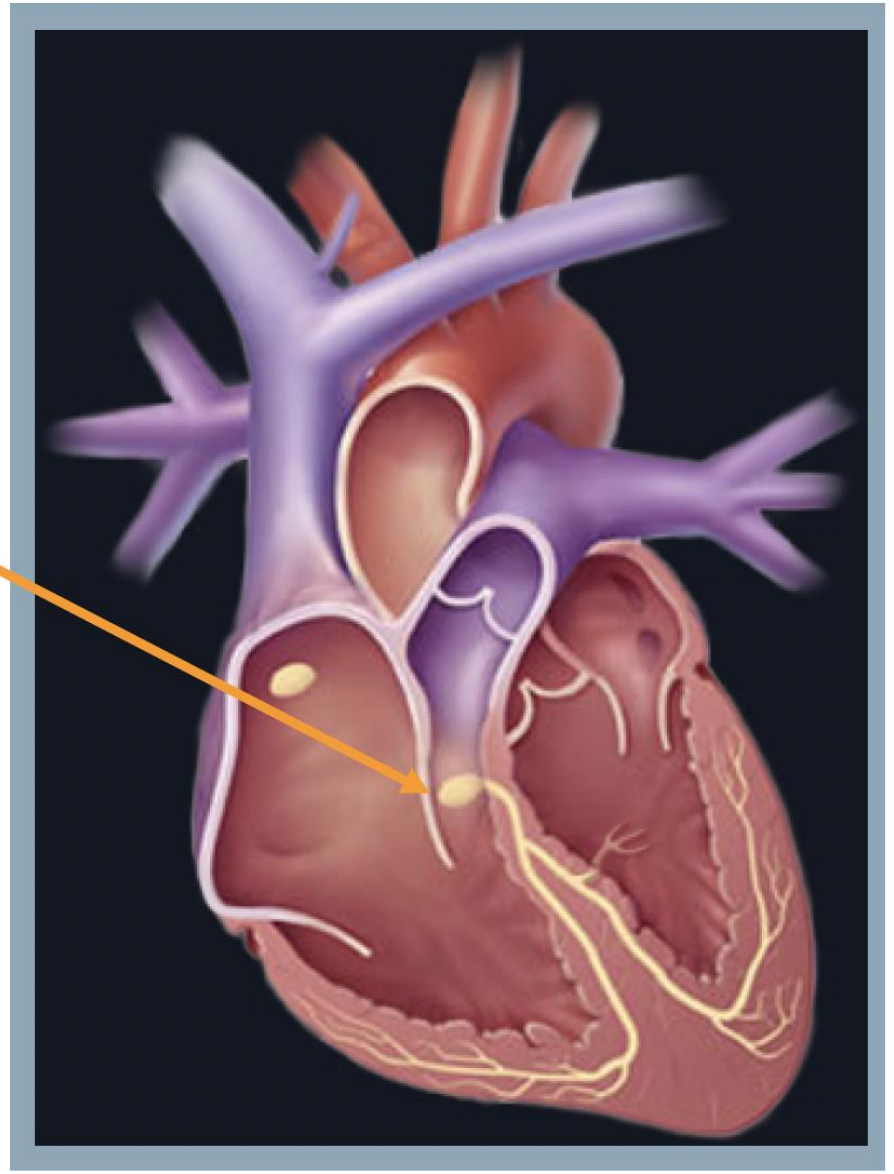


- The Heart's 'Natural Pacemaker'
  - Rate of 60-100 bpm at rest

The Heart's Conduction System

AV Node

Atrioventricular Node (AV Node)

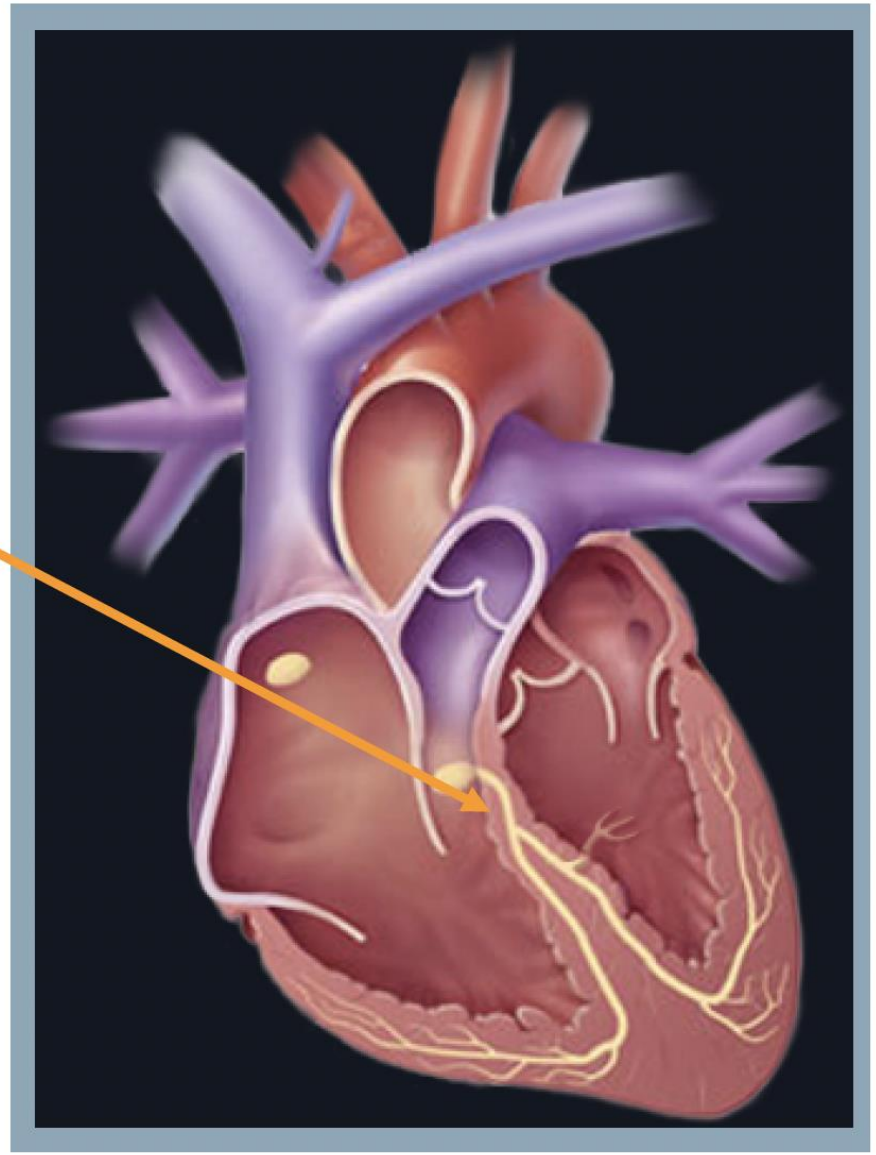


- Receives impulses from SA node
- Delivers impulses to the His-Purkinje System
- Delivers rates between 40-60 bpm if SA node fails to deliver impulses

The Heart's Conduction System

HIS Bundle

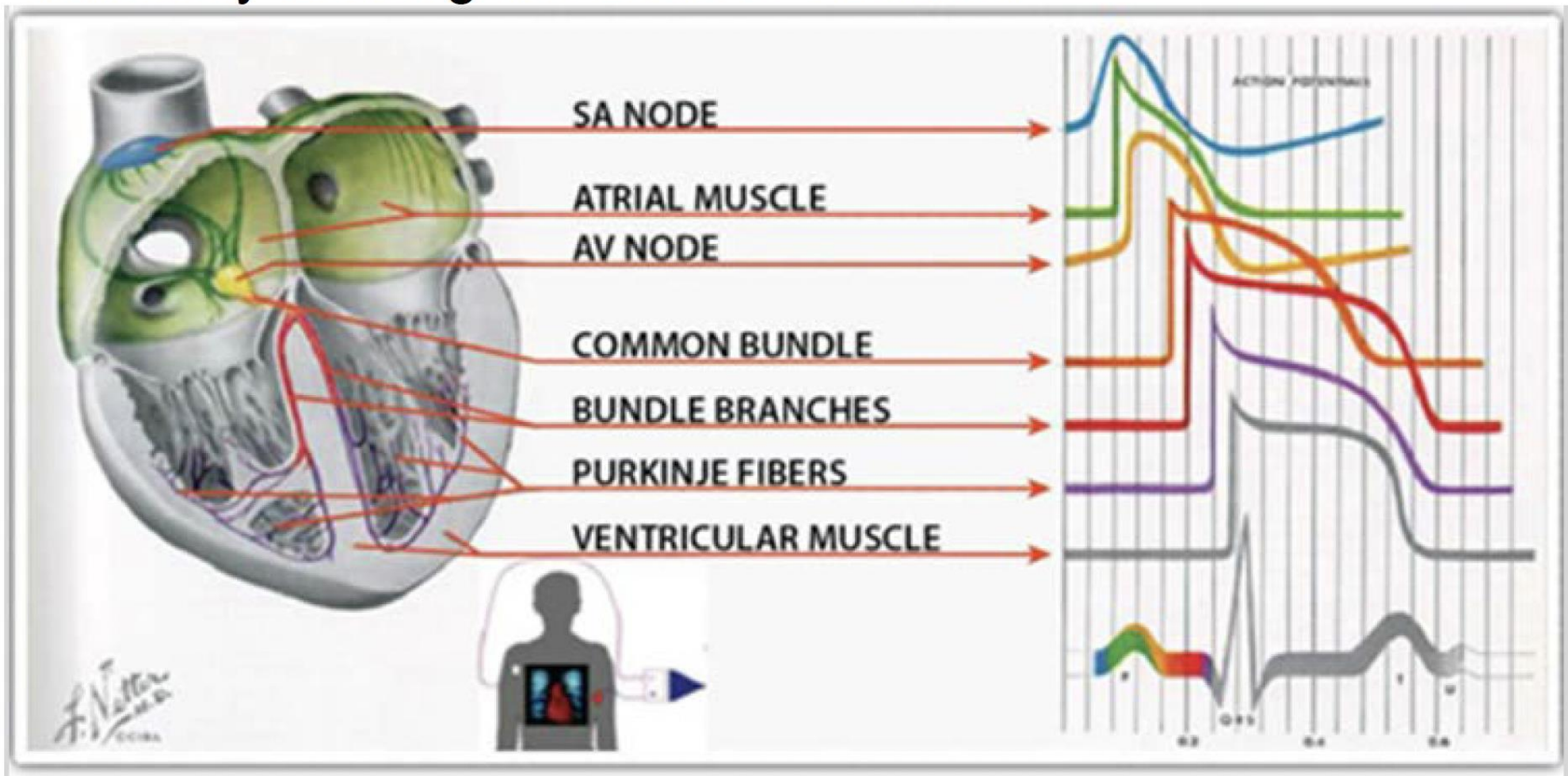
Bundle of His



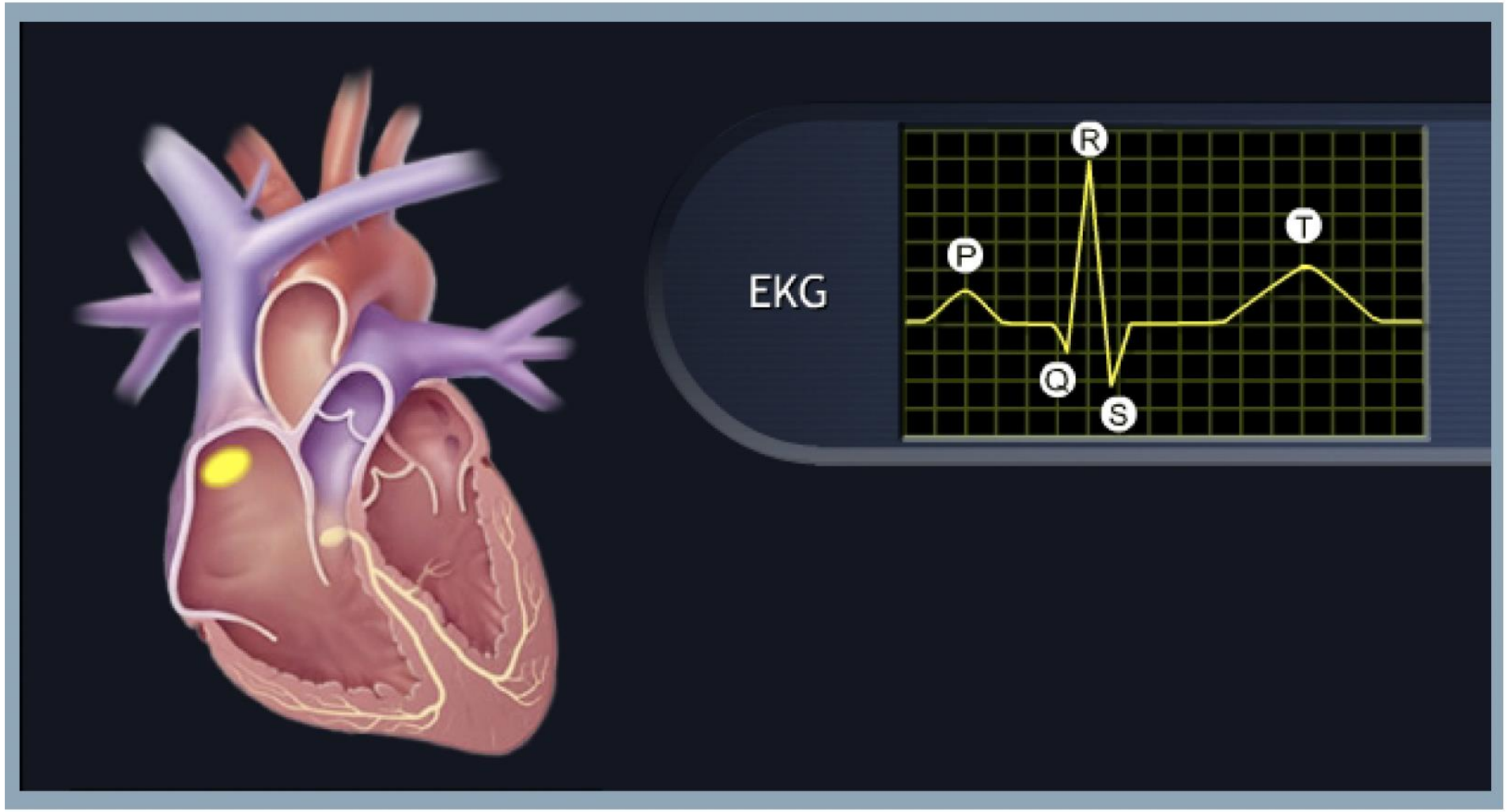
- Begins conduction to the ventricles
- AV Junctional Tissue:
  - Rates between 40-60 bpm

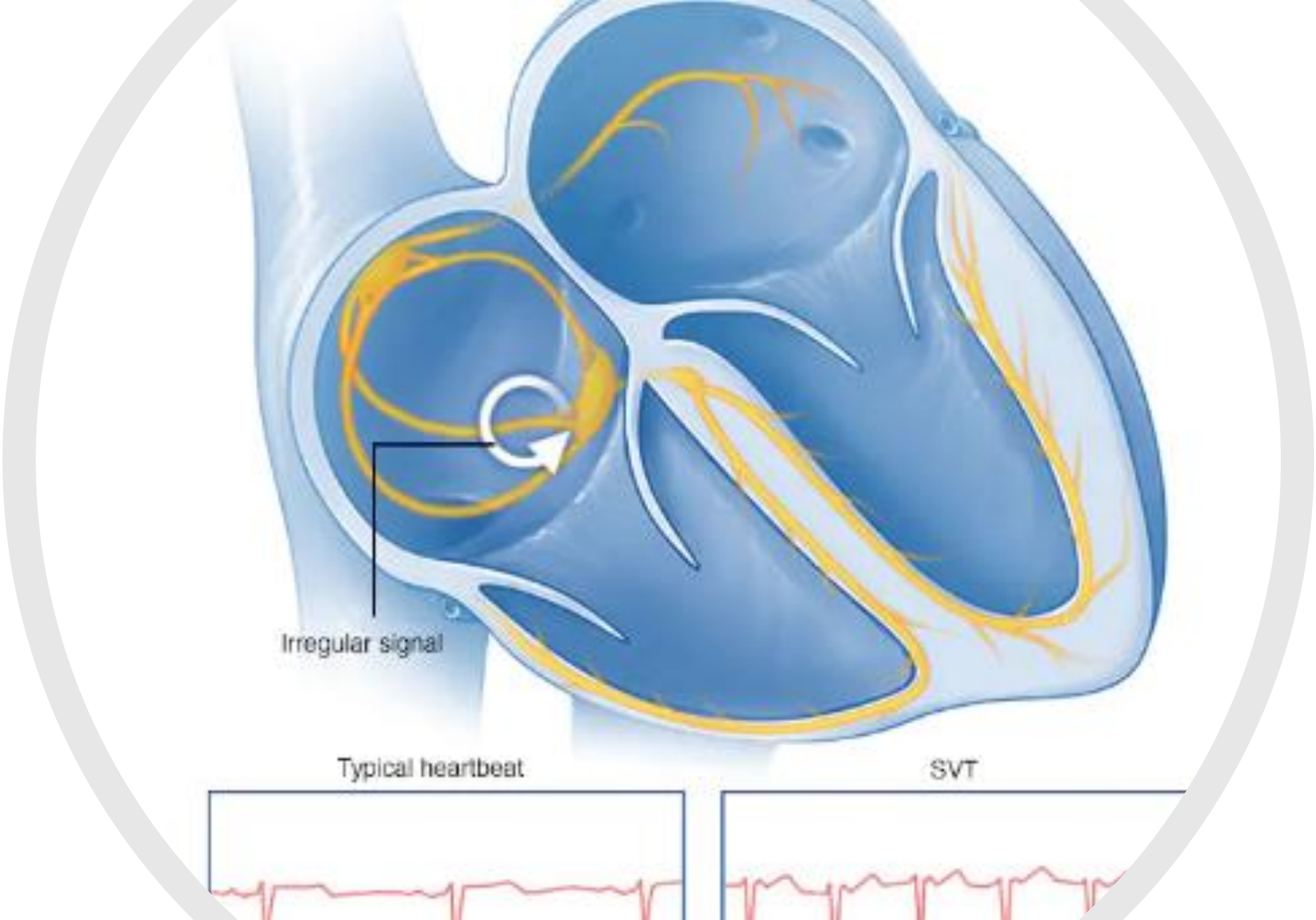
Action Potential of a Cardiac Cell

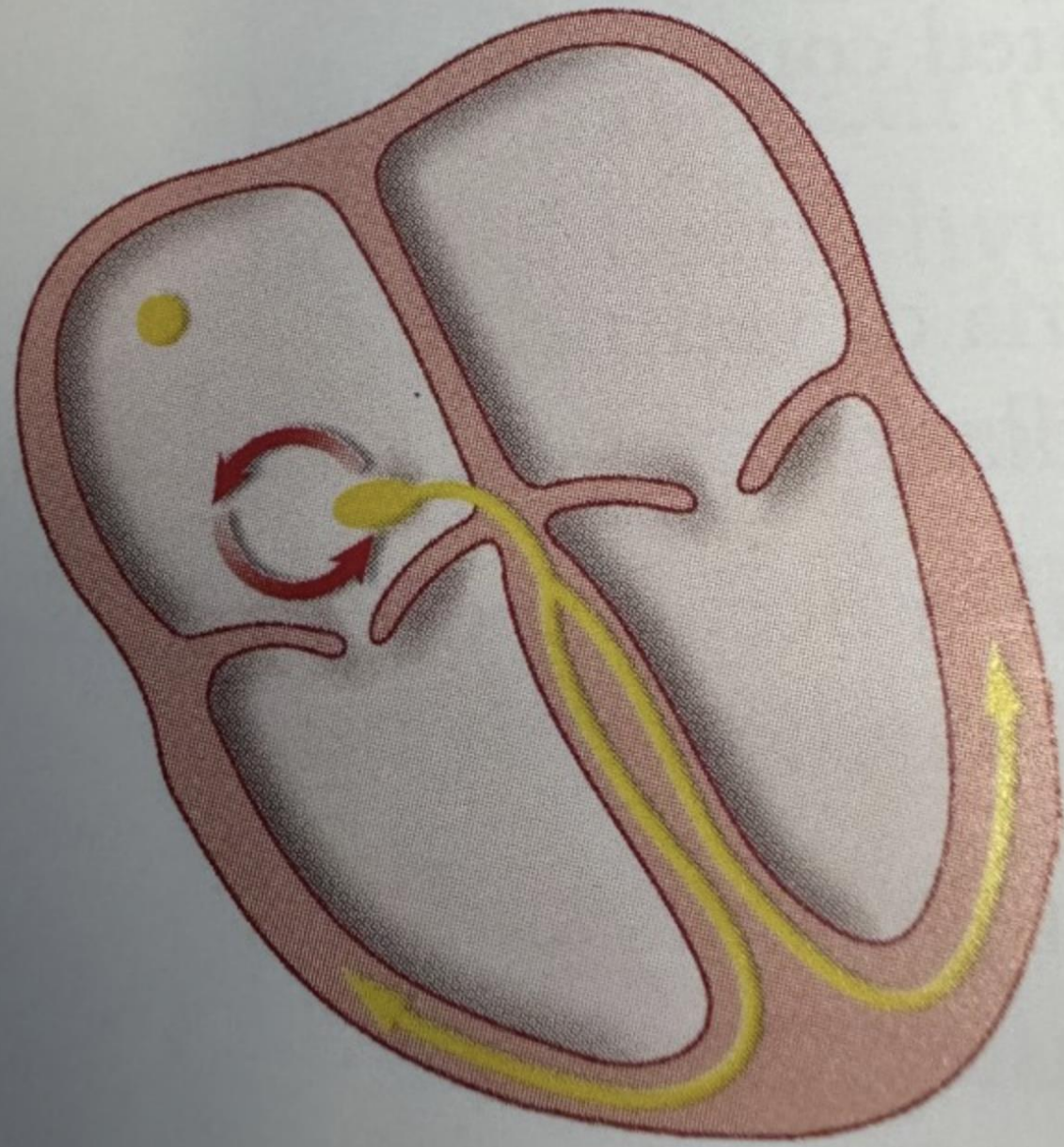
Action potential is the term used to describe specifically *how* the energy within each cell is generated and used, ultimately causing the heart to contract.



Impulse Formation in SA Node




Irregular signal
Typical heartbeat
SVT



AV node

An elect

pathwa

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ECG

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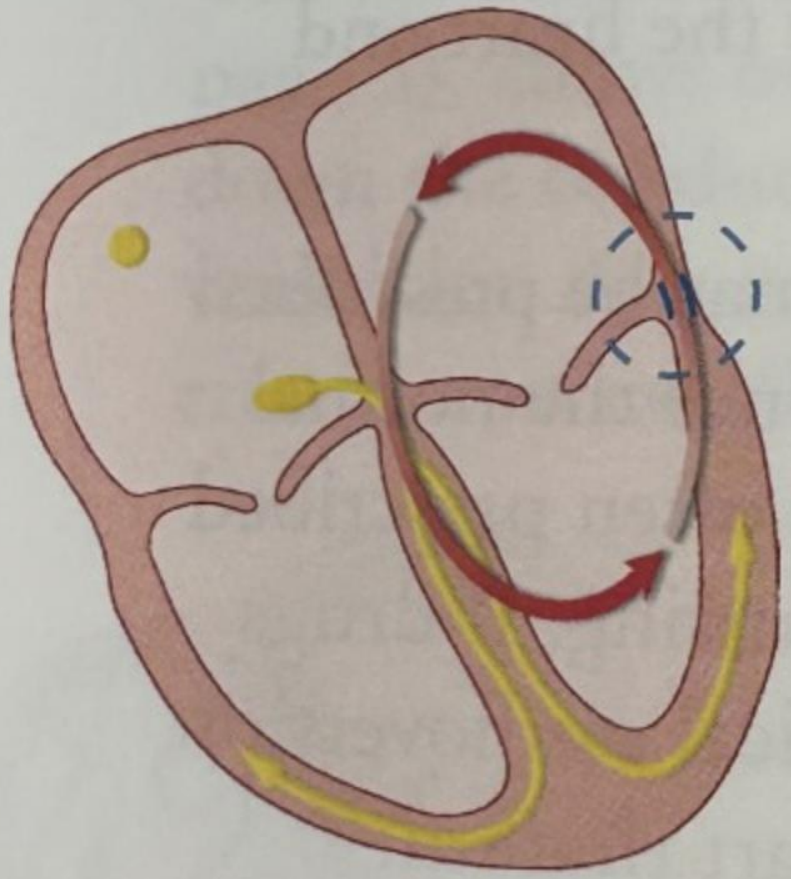
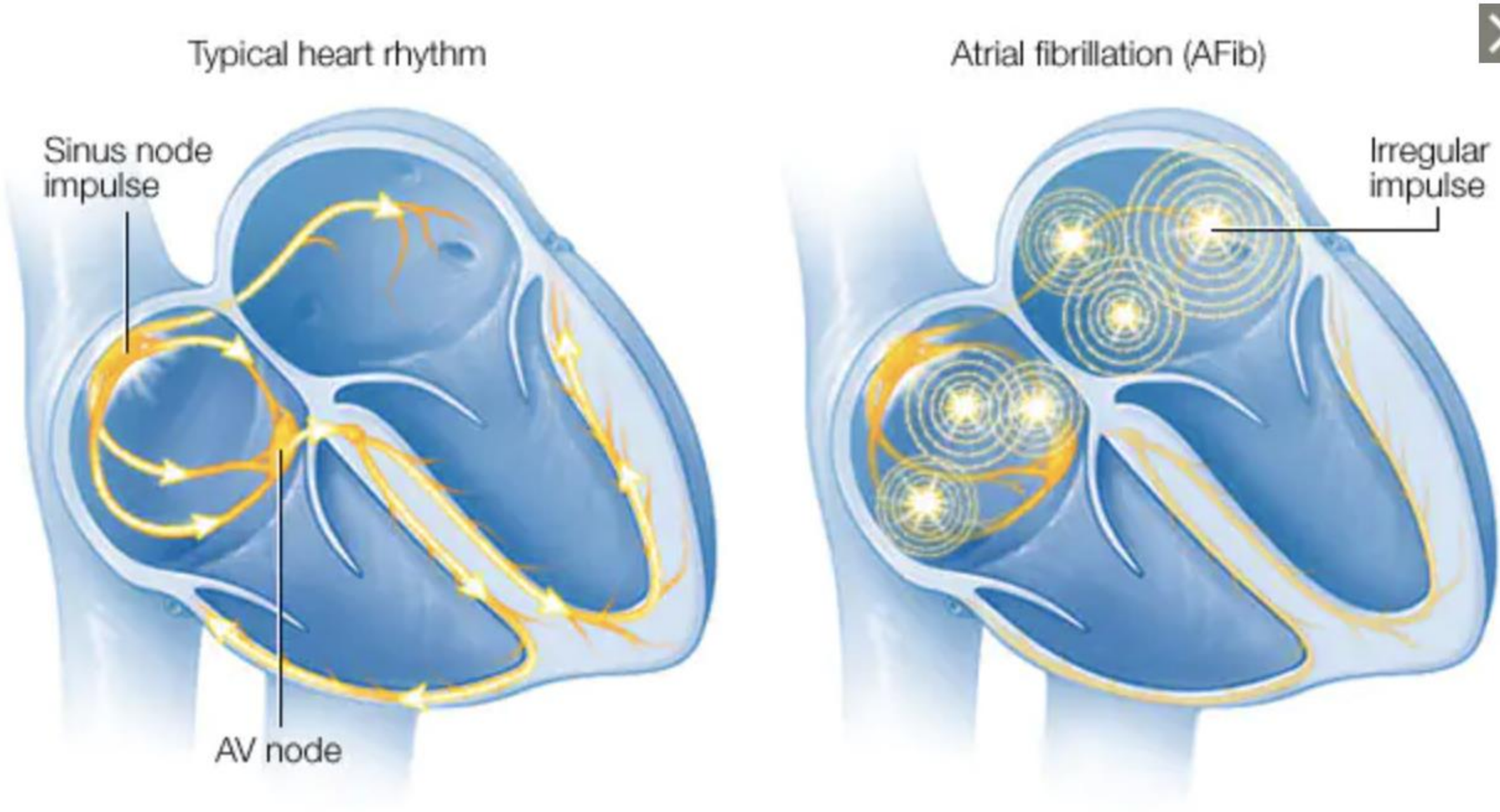
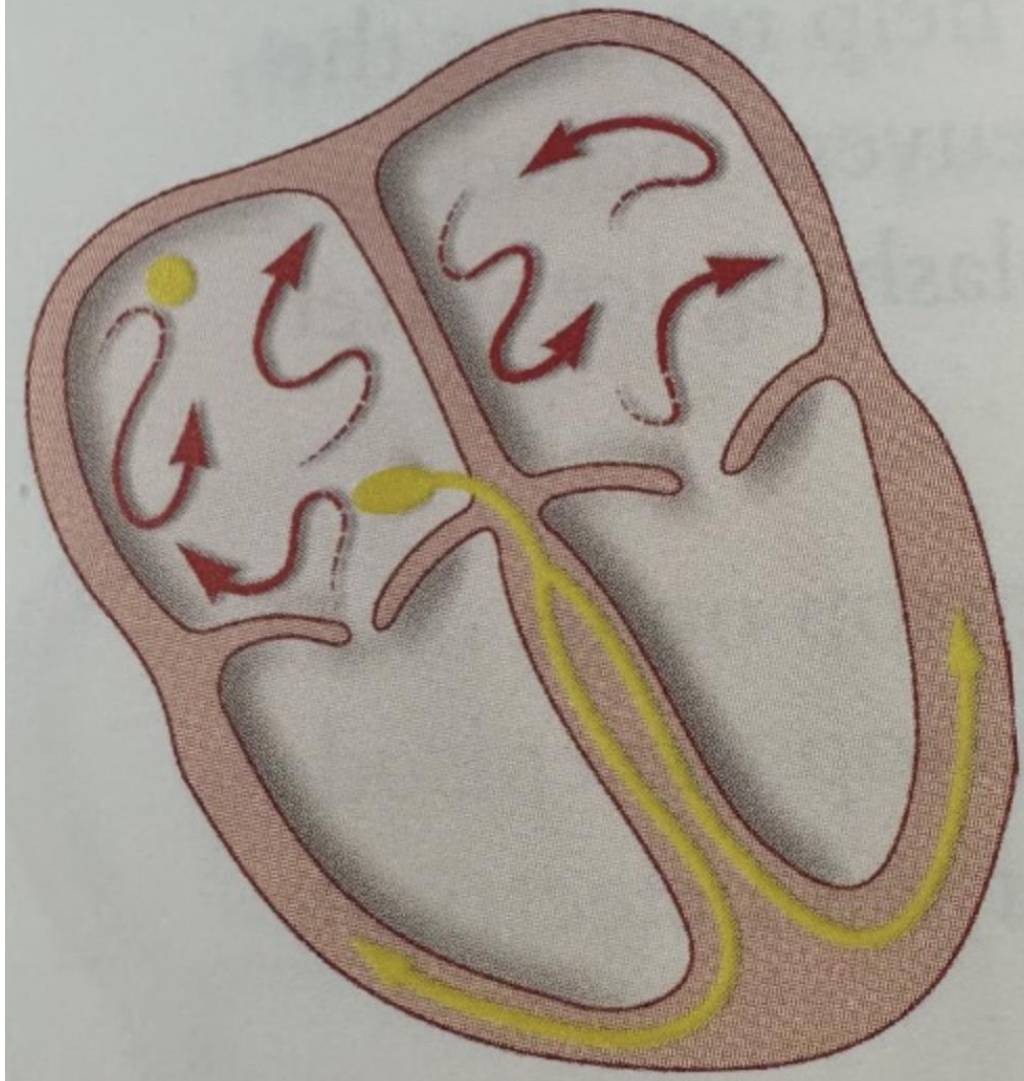


Accessory pathway tachycardia

An impulse has traveled down the AV node to the ventricles, and then up through the accessory pathway to the atria. If the impulse continues to travel in a circle, it may result in an extremely rapid heart rhythm that can be life threatening.

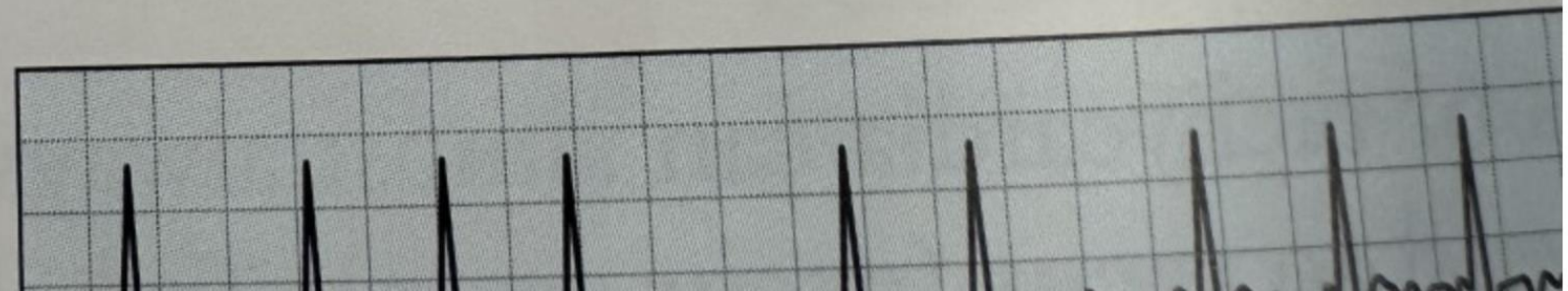
The presence of an accessory pathway *and* episodes of tachycardia is known as the Wolf-Parkinson-White Syndrome, or simply **WPW**.

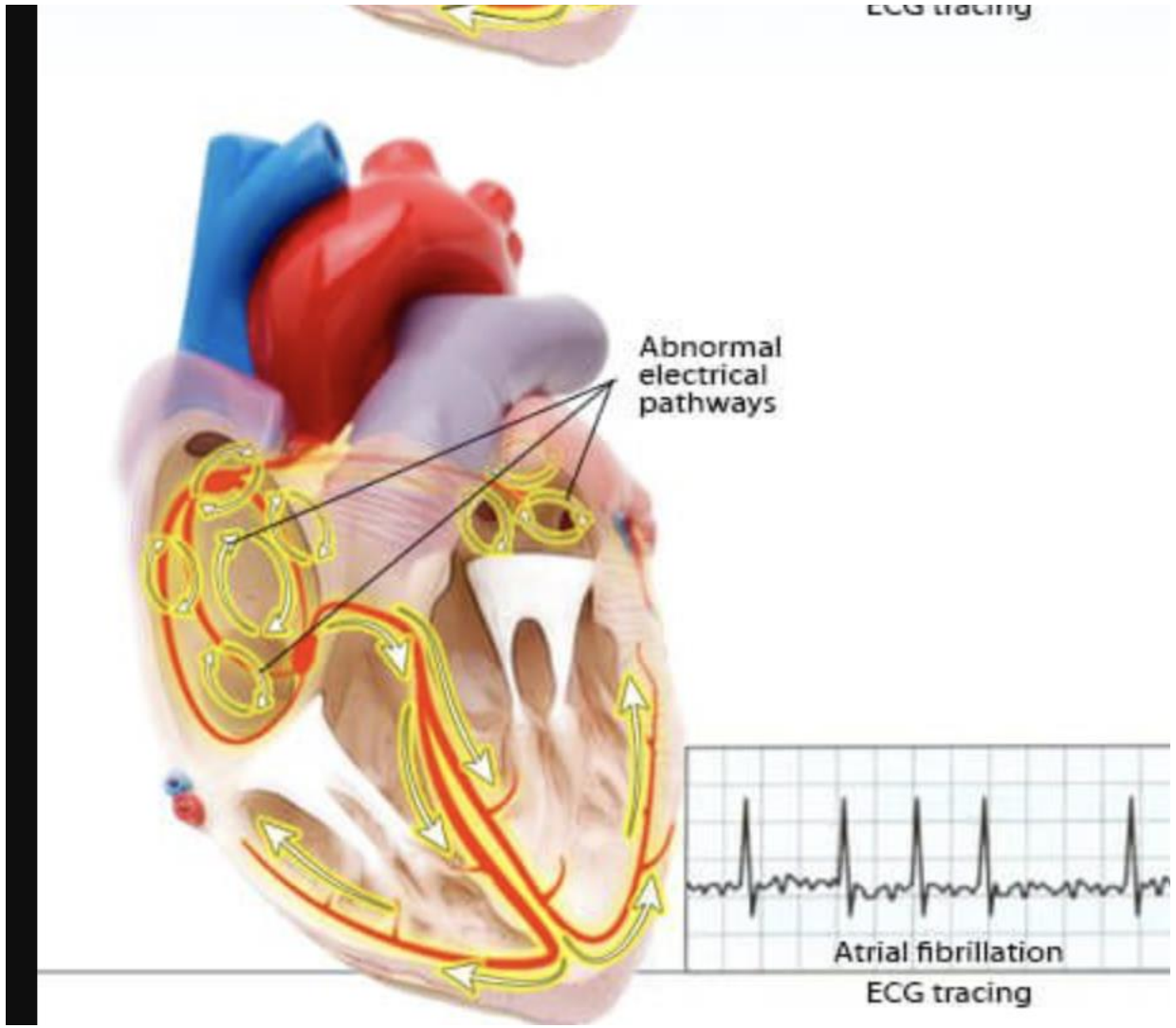

Typical heart rhythm
Sinus node impulse
AV node
Atrial fibrillation (AFib)
Irregular impulse

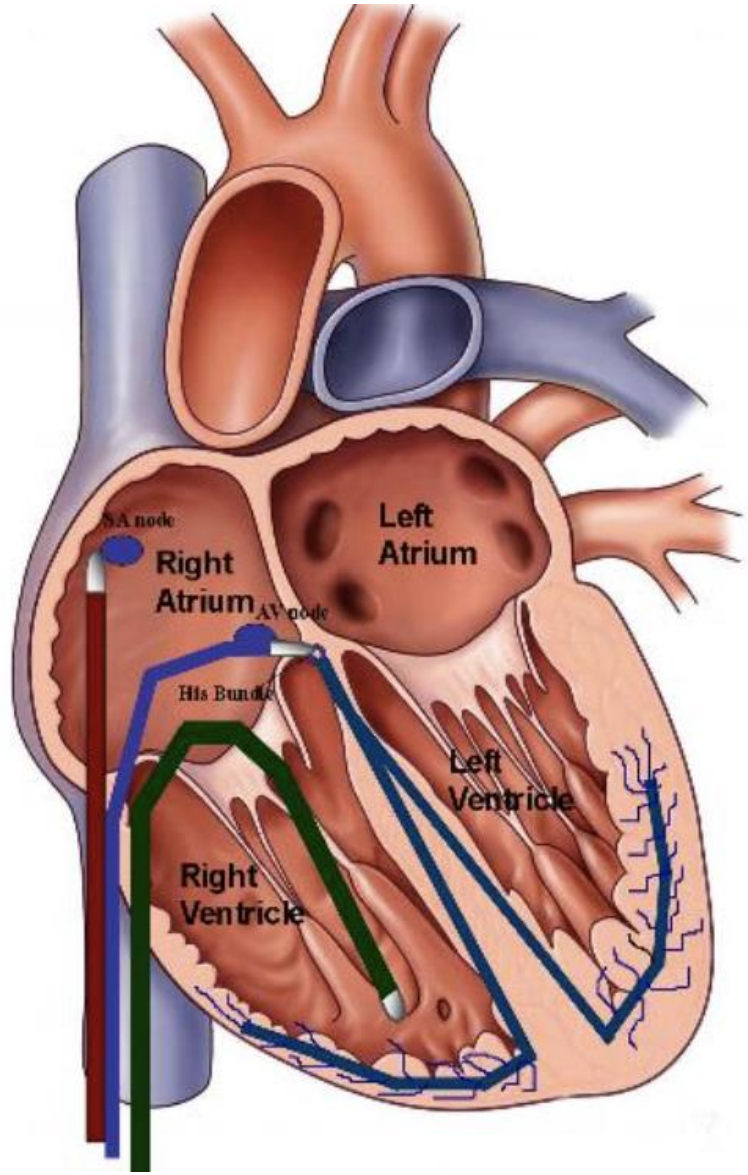


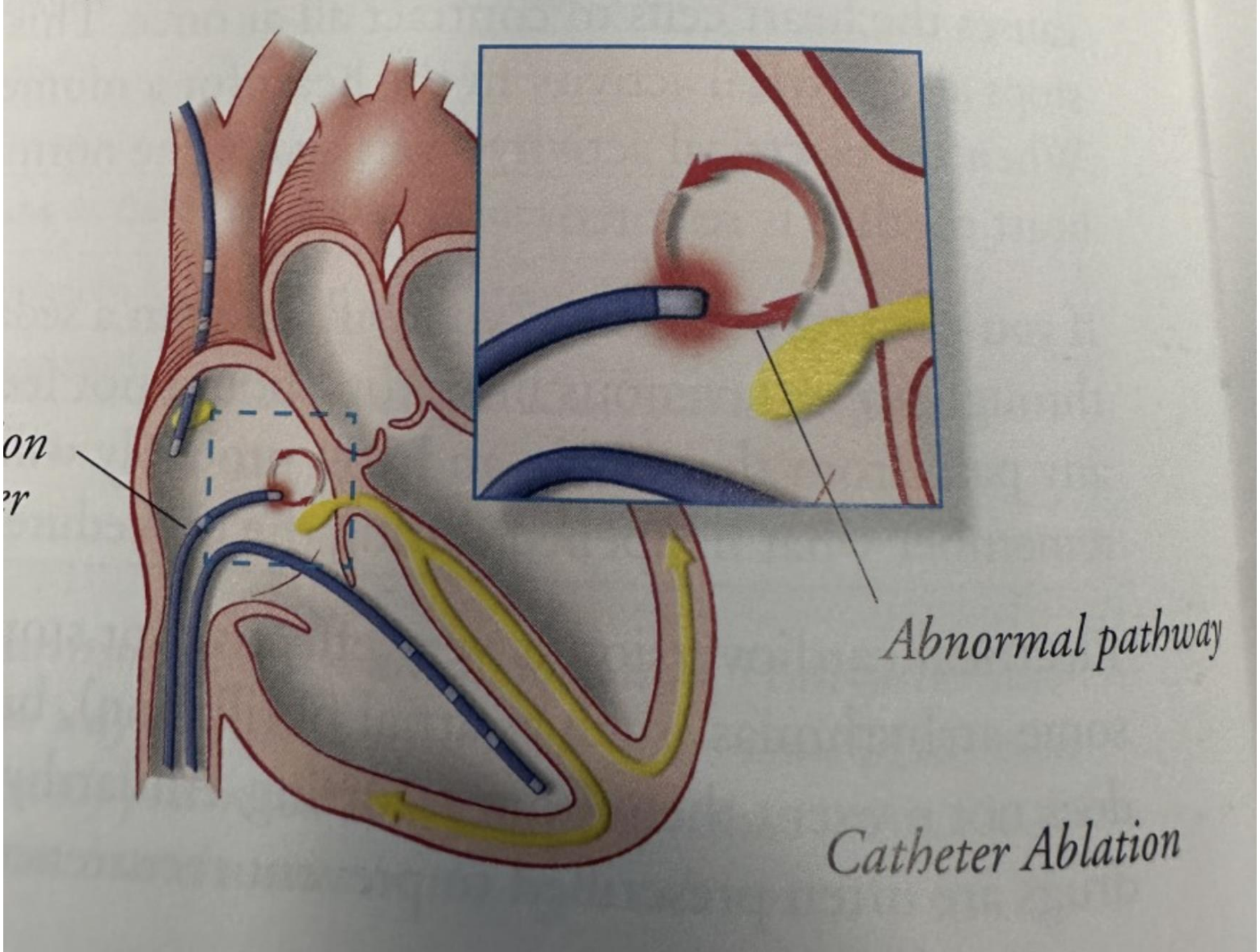
Atrial fibrillation

Multiple wavelets of el
across the atria. The A
some of these wavelet
conduction pathways
ventricles. On the E
is irregular, erratic,

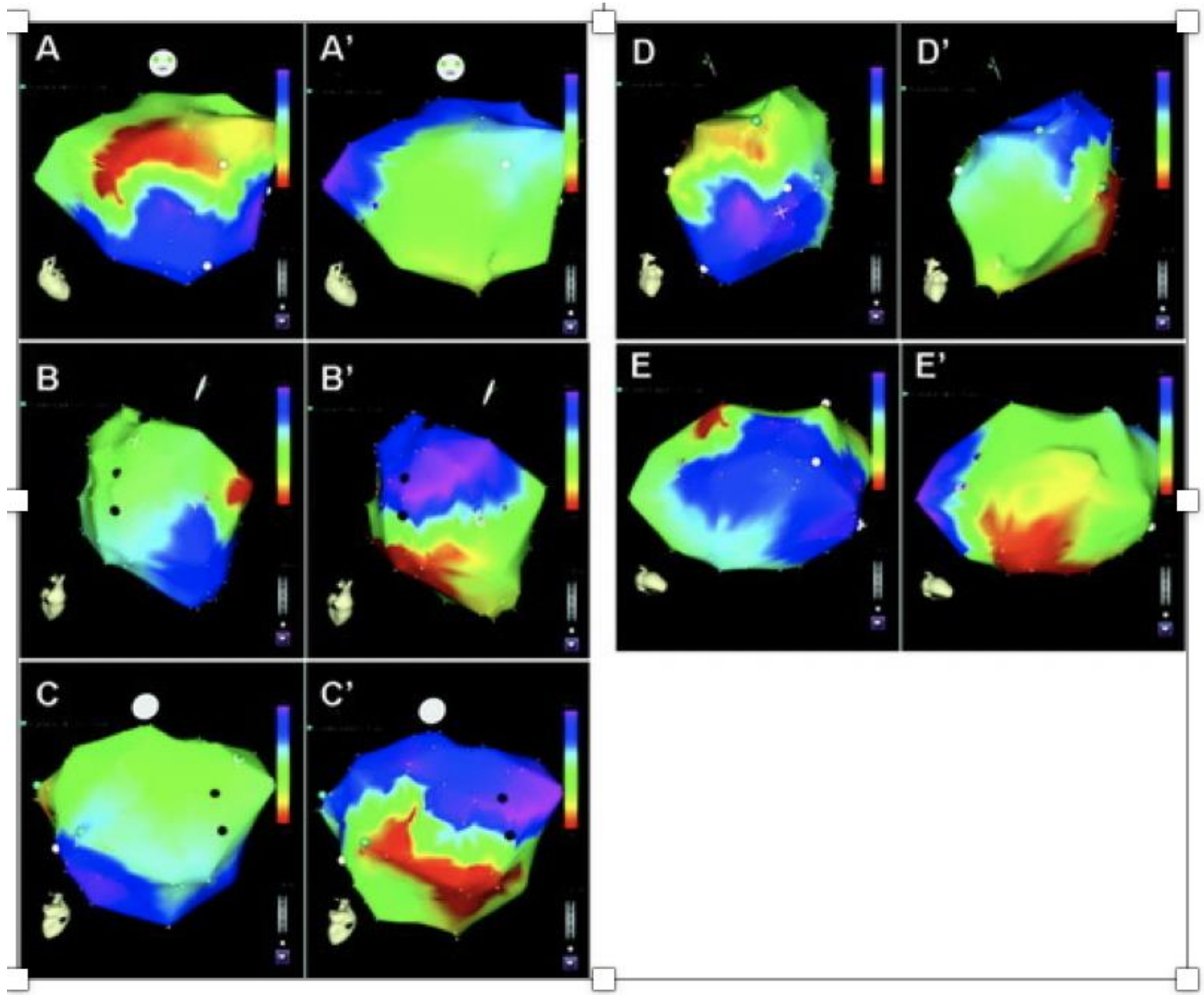


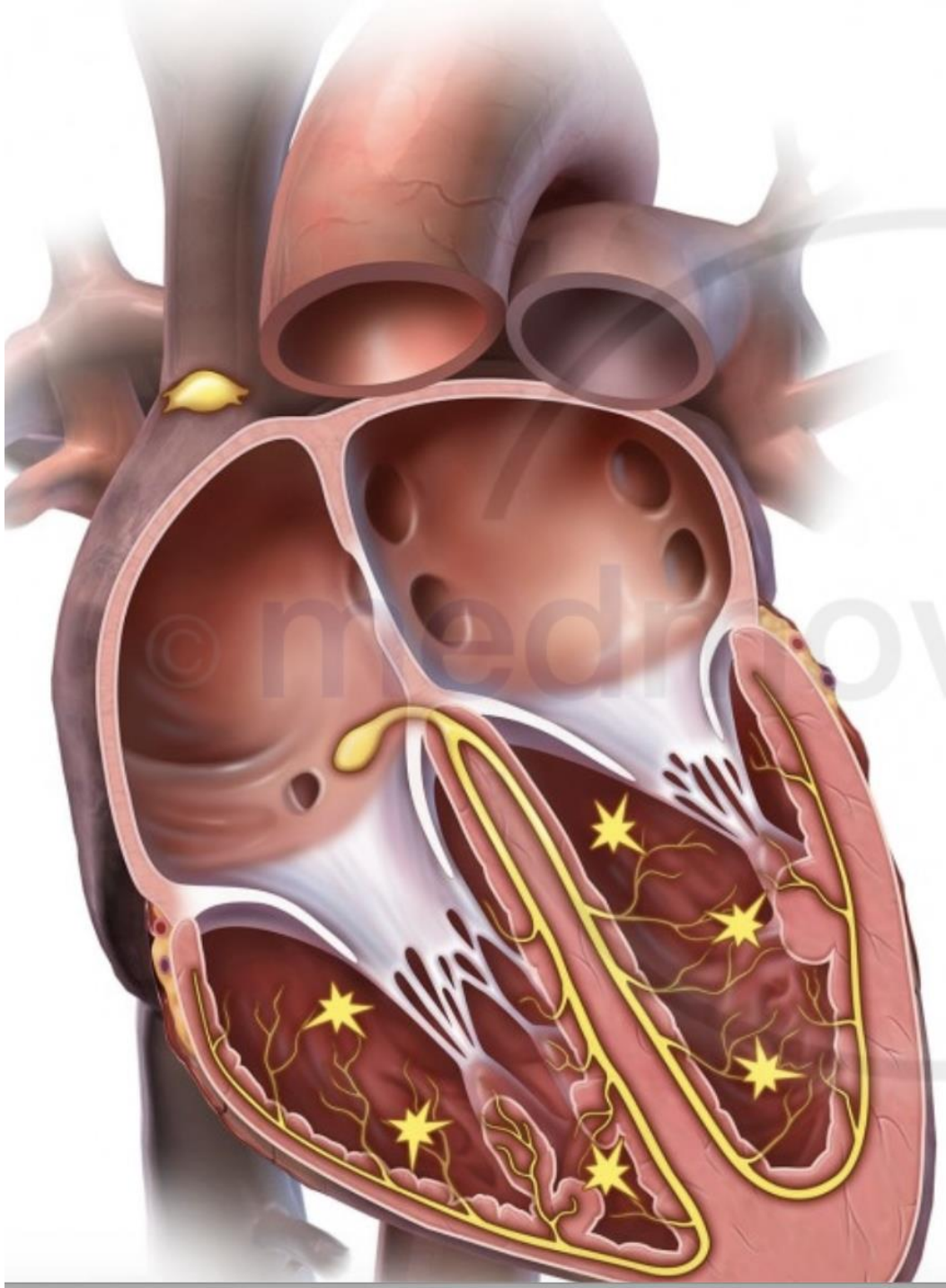

ECG tracing
Abnormal
electrical
pathways
Atrial fibrillation
ECG tracing

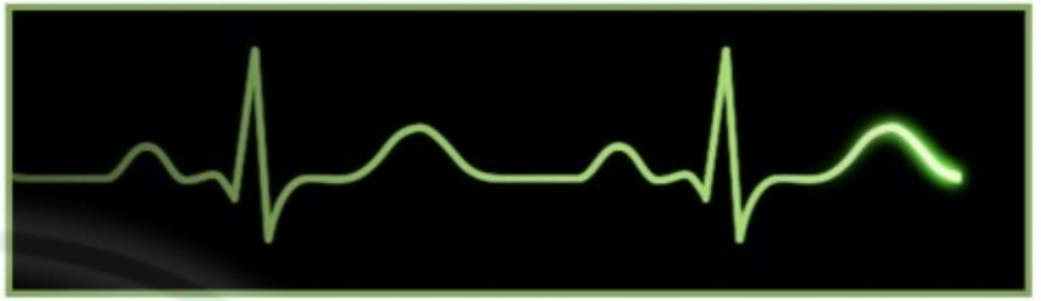

SA node
Right Atrium
AV node
His Bundle
Left Atrium
Left Ventricle
Right Ventricle



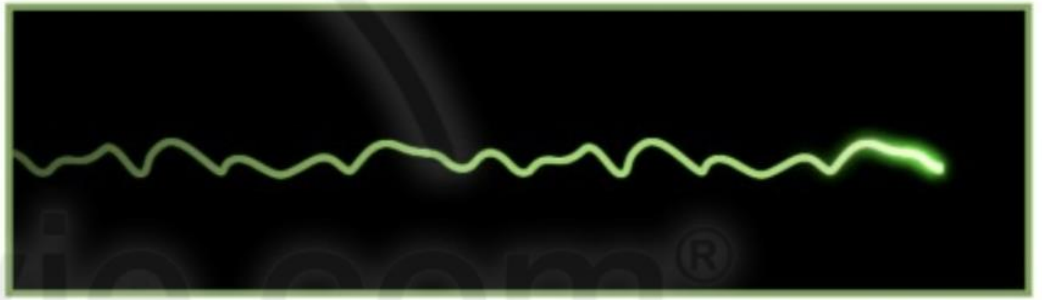
Catheter Ablation


A
A'
D
D'
B
B'
E
E'
C
C'





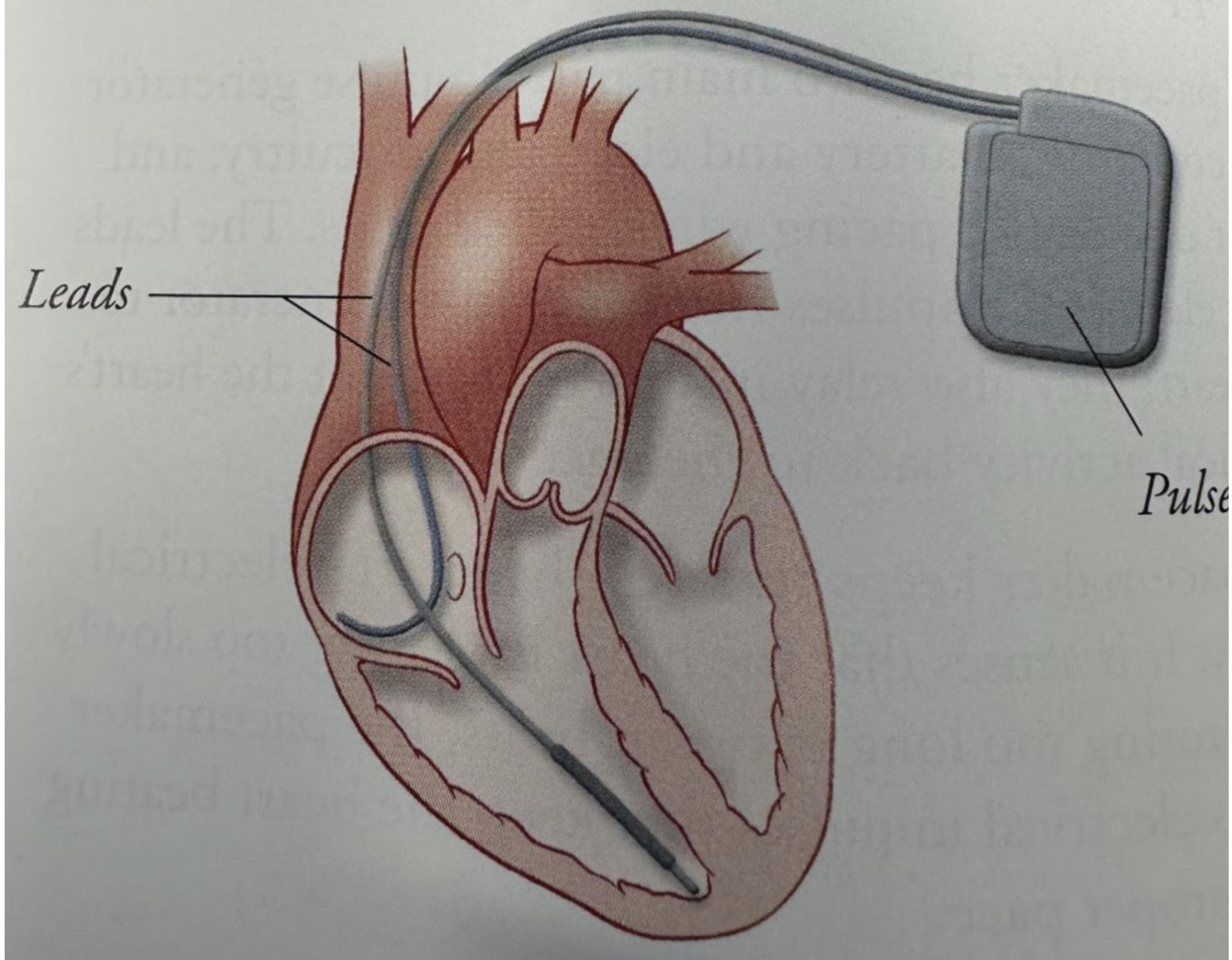
Ventricular Fibrillation ECG

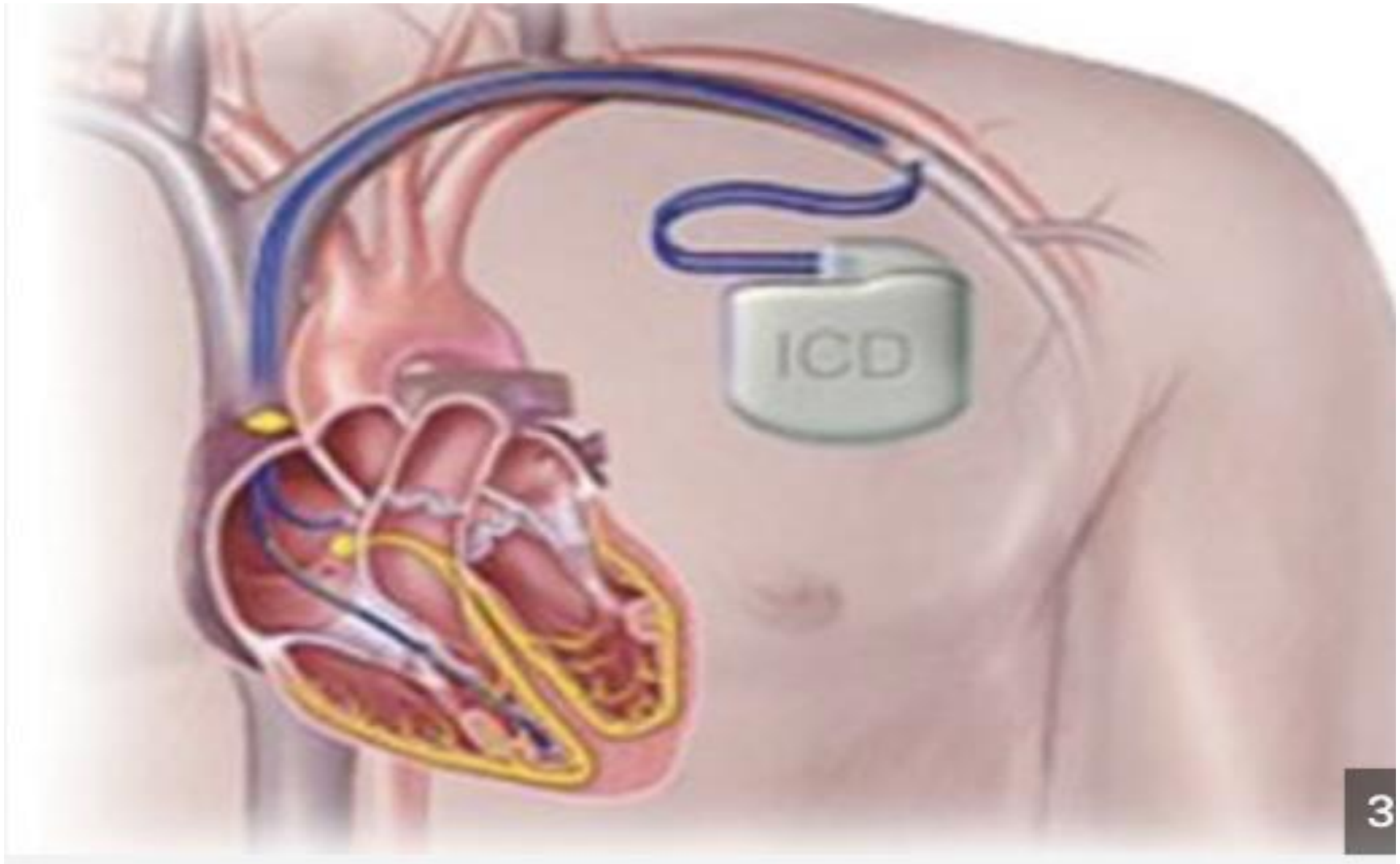


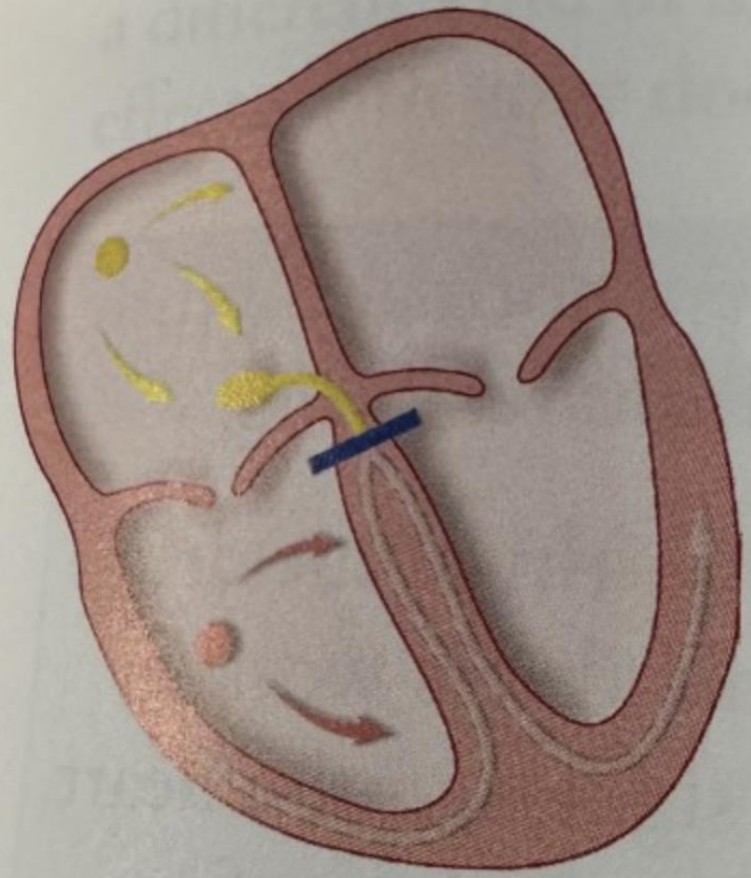
Disorganized electrical pulses cause the lower chambers (ventricles) to quiver instead of pumping blood.

If untreated, this can result in sudden cardiac arrest and death.

Arrhythmia Origin =

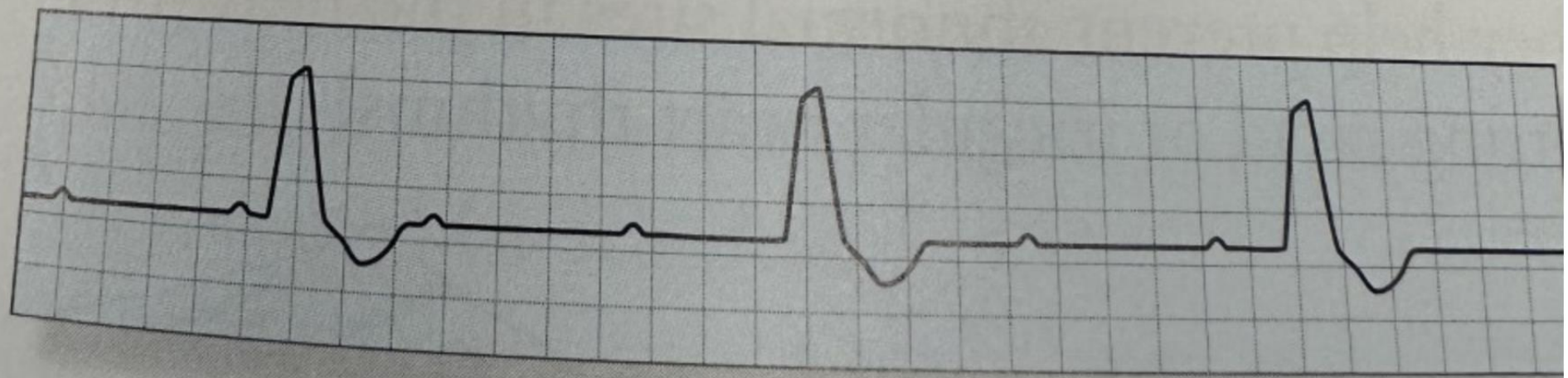

Leads
Pulse

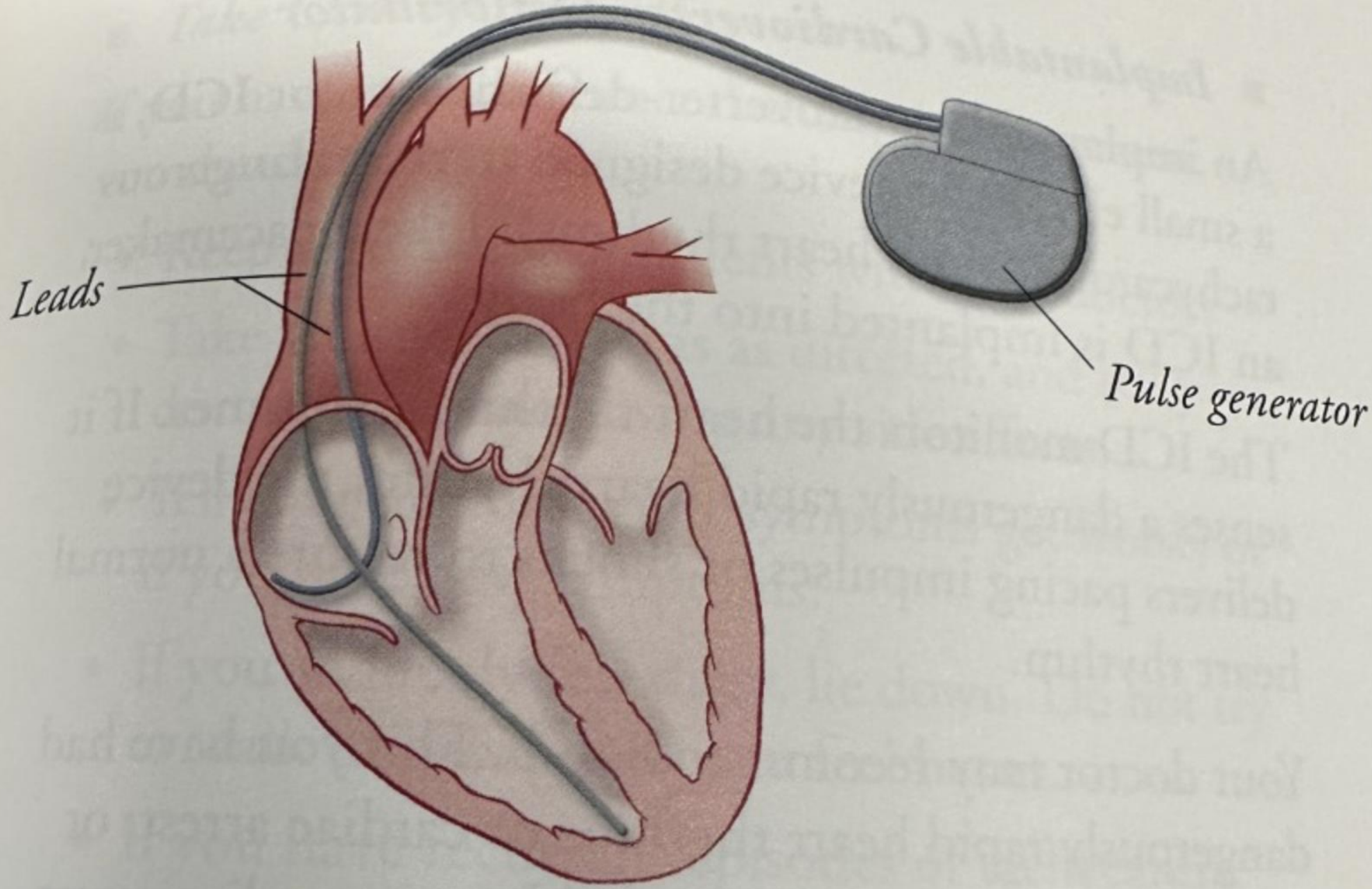

ICD



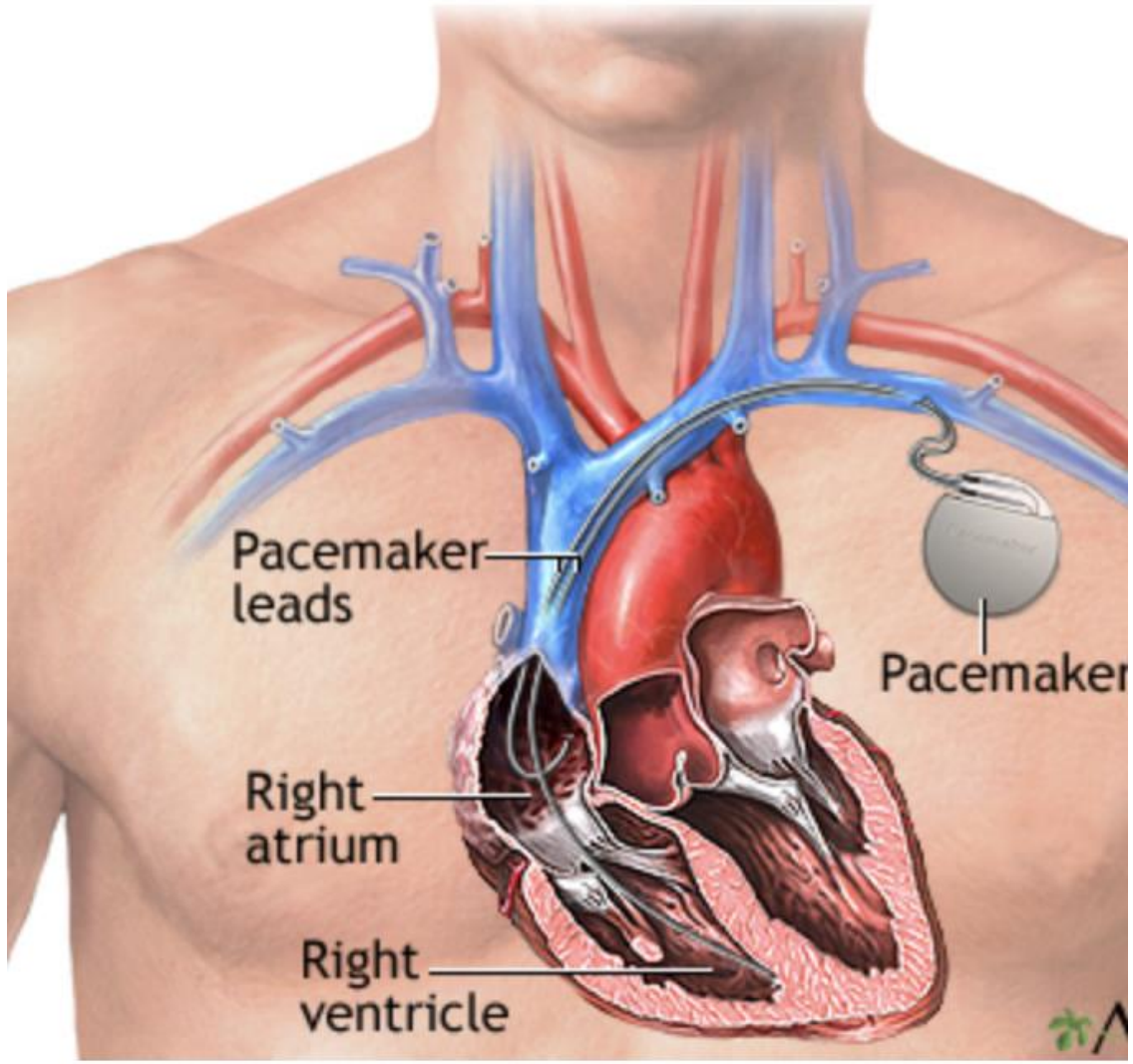
Complete heart block

Impulses coming from the atria are
blocked. The ventricles are stimulat
"backup pacemaker" (a site in the h
that takes the place of the SA node
ECG shows a very slow heart rhyth





Pacemaker


Pacemaker leads
Pacemaker
Right atrium
Right ventricle