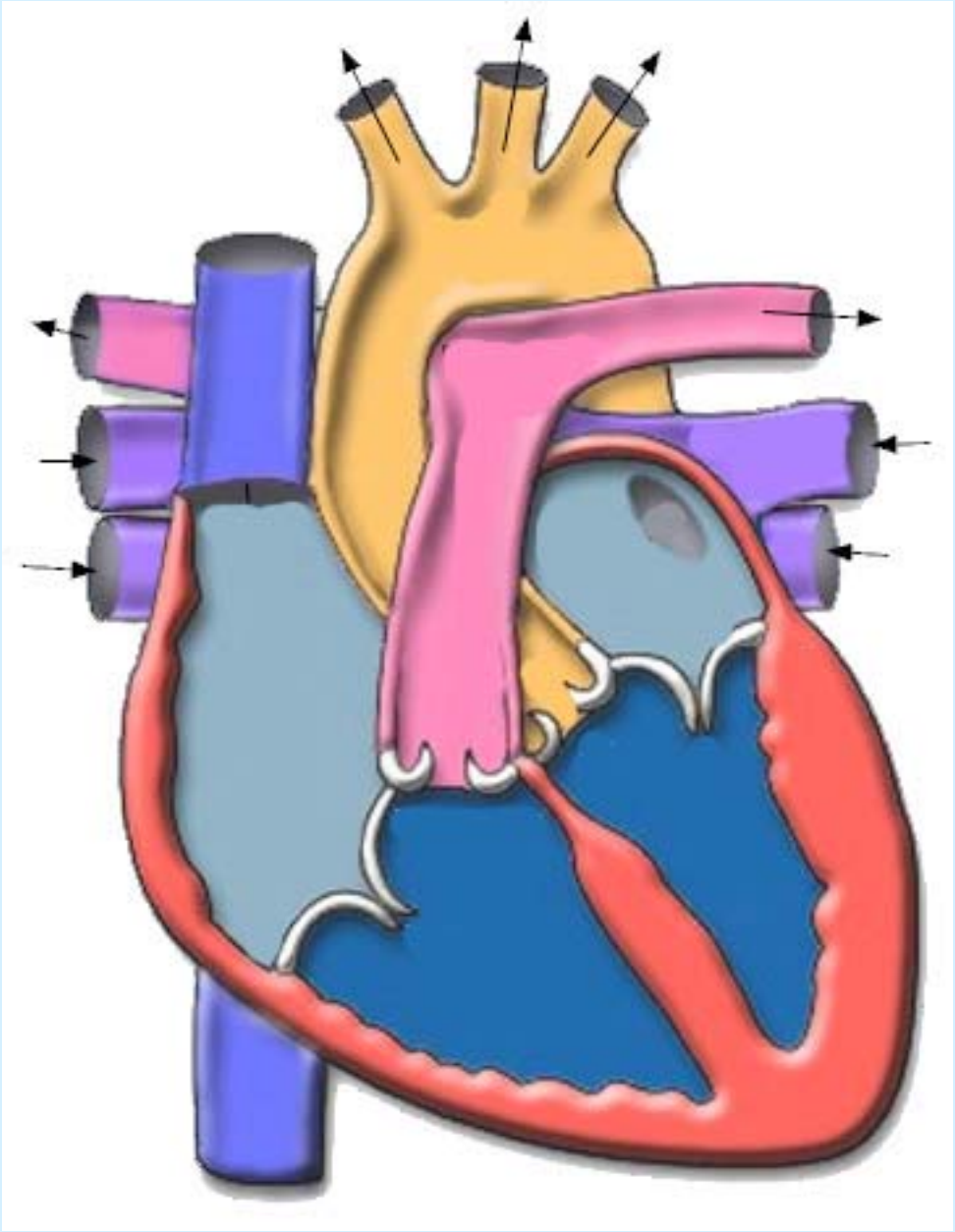
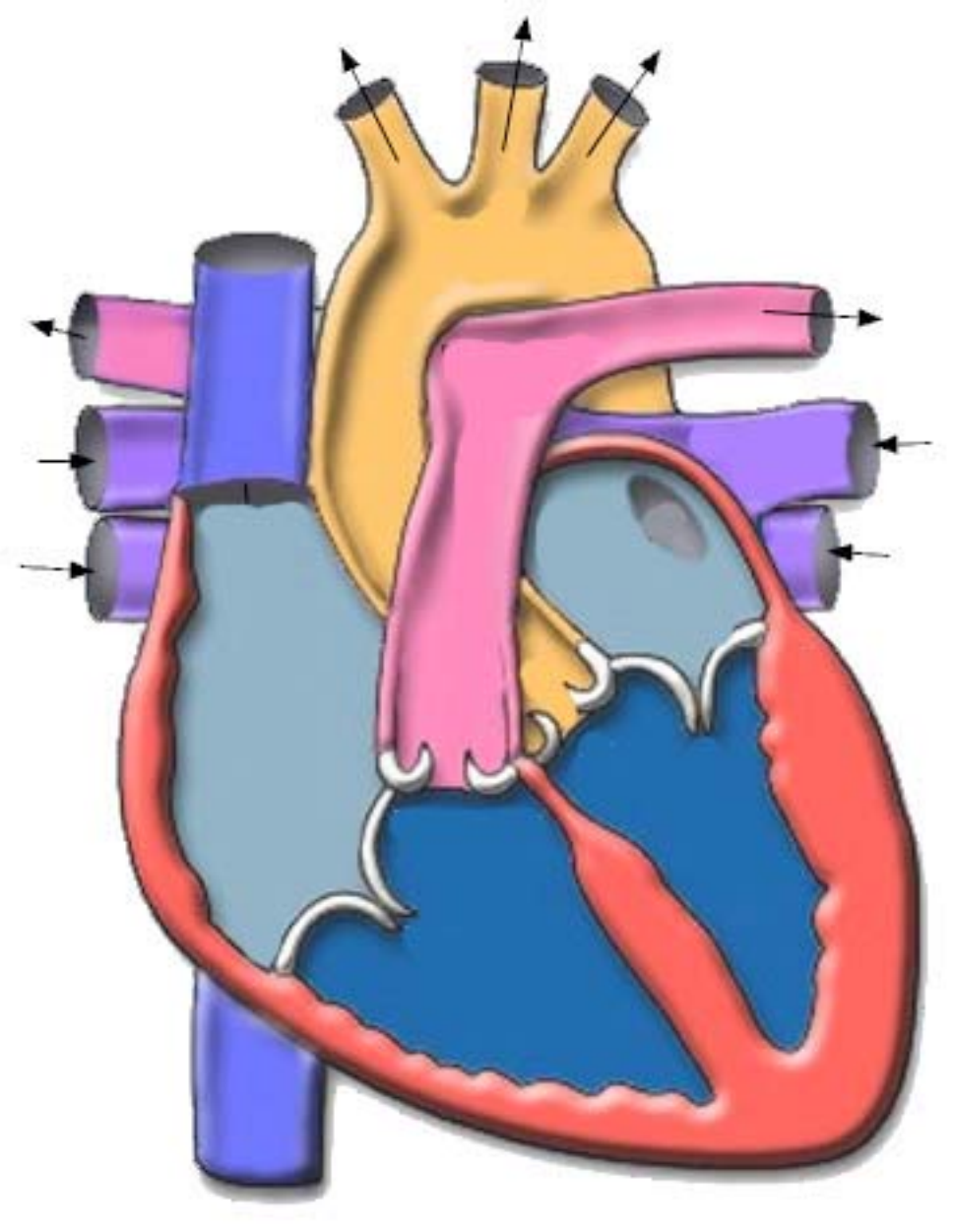
THE CARDIAC CYCLE

Objectives:

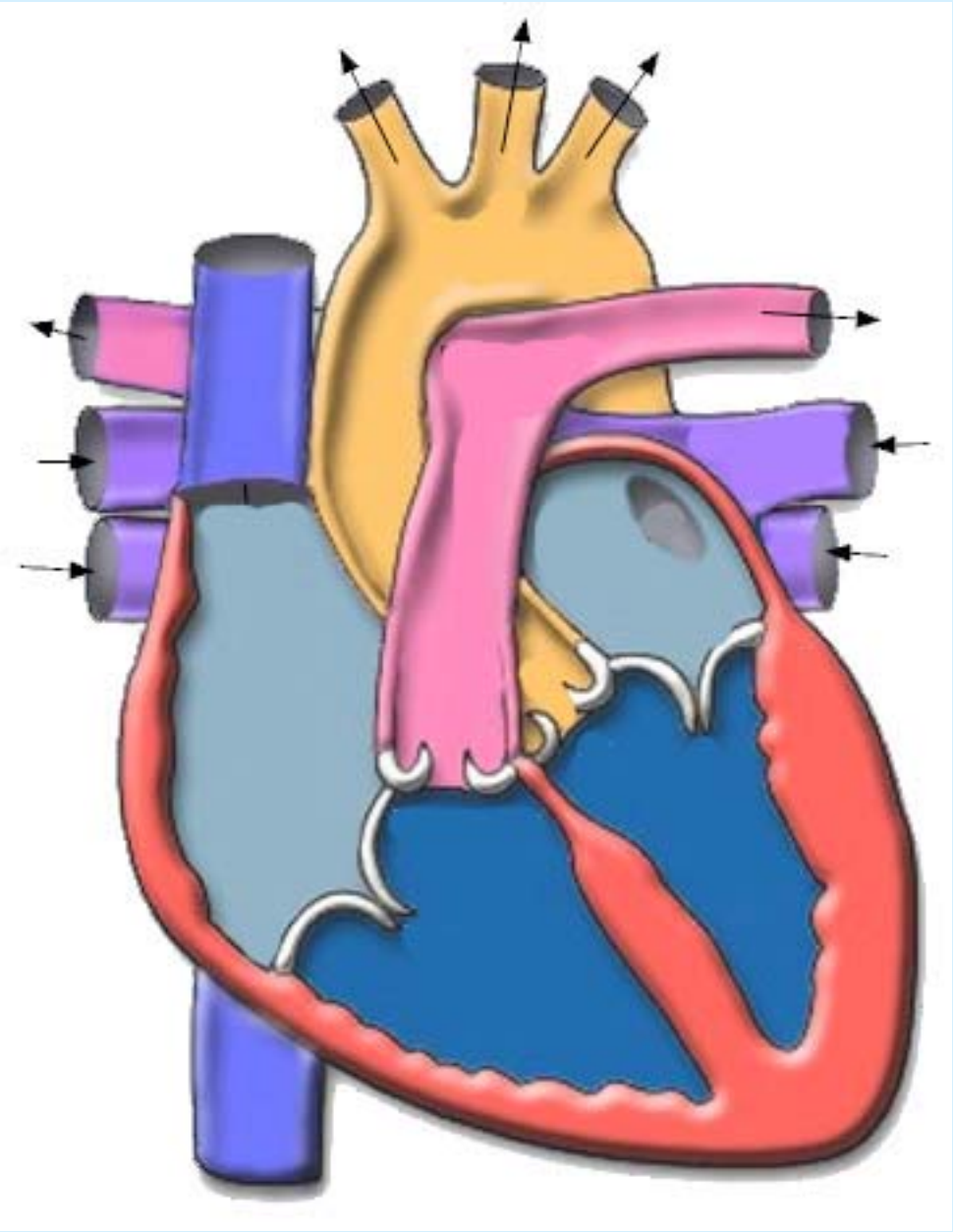
- **Identifying Factors which affect heart rate**
- **Describe Cardiac Functional Anatomy (including a review of blood flow and valves)**
- **Understand the Wiggers Diagram of Cardiac Cycle**
- **Differentiate between Wiggers Diagram and the Pressure Volume Curve**
- **Review the electrical basis of excitable cardiac tissue (nodal cells and working myocardium)**





Right Atria
Right Ventricle
Pulmonary Artery

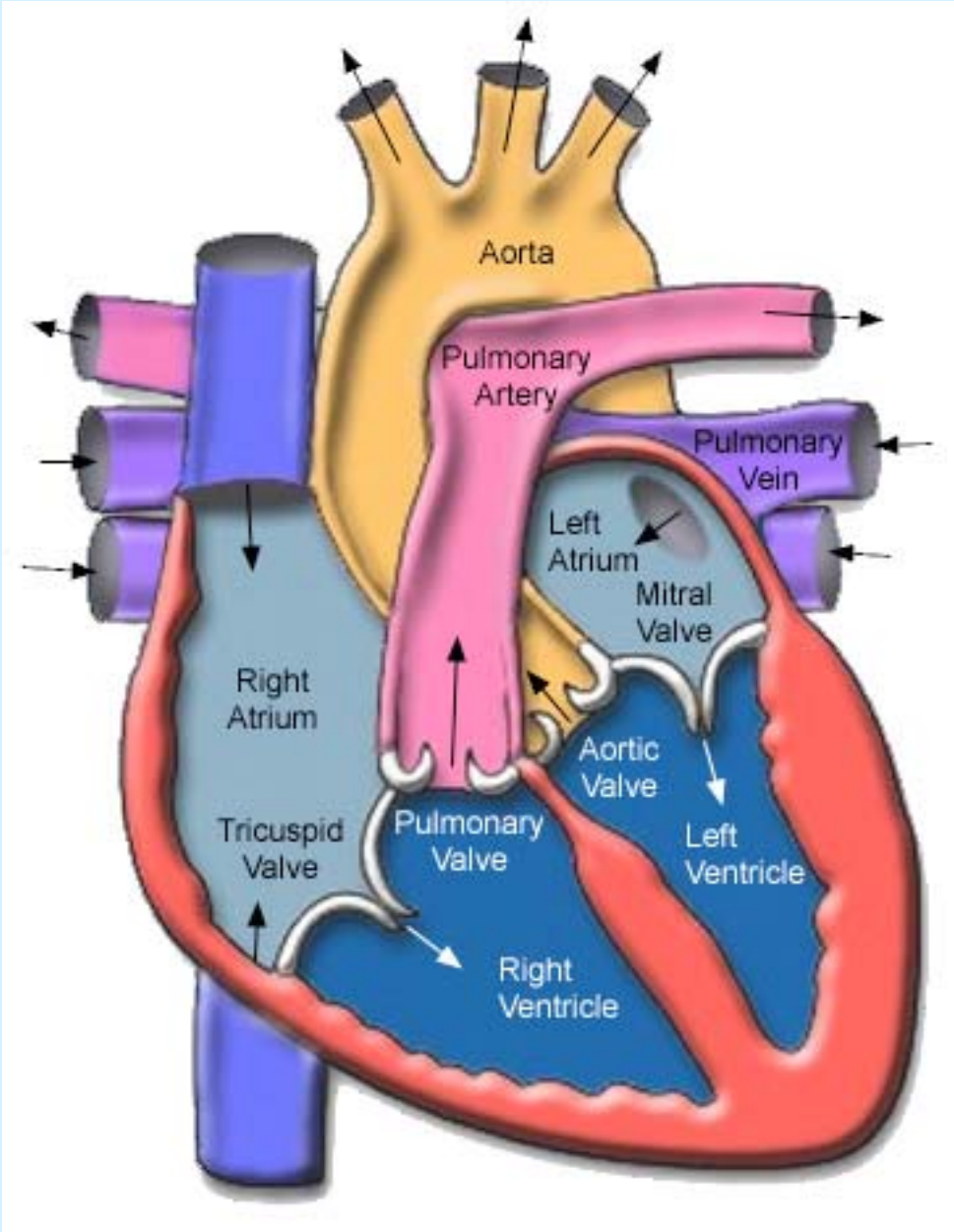
Left Atria
Left Ventricle
Aorta

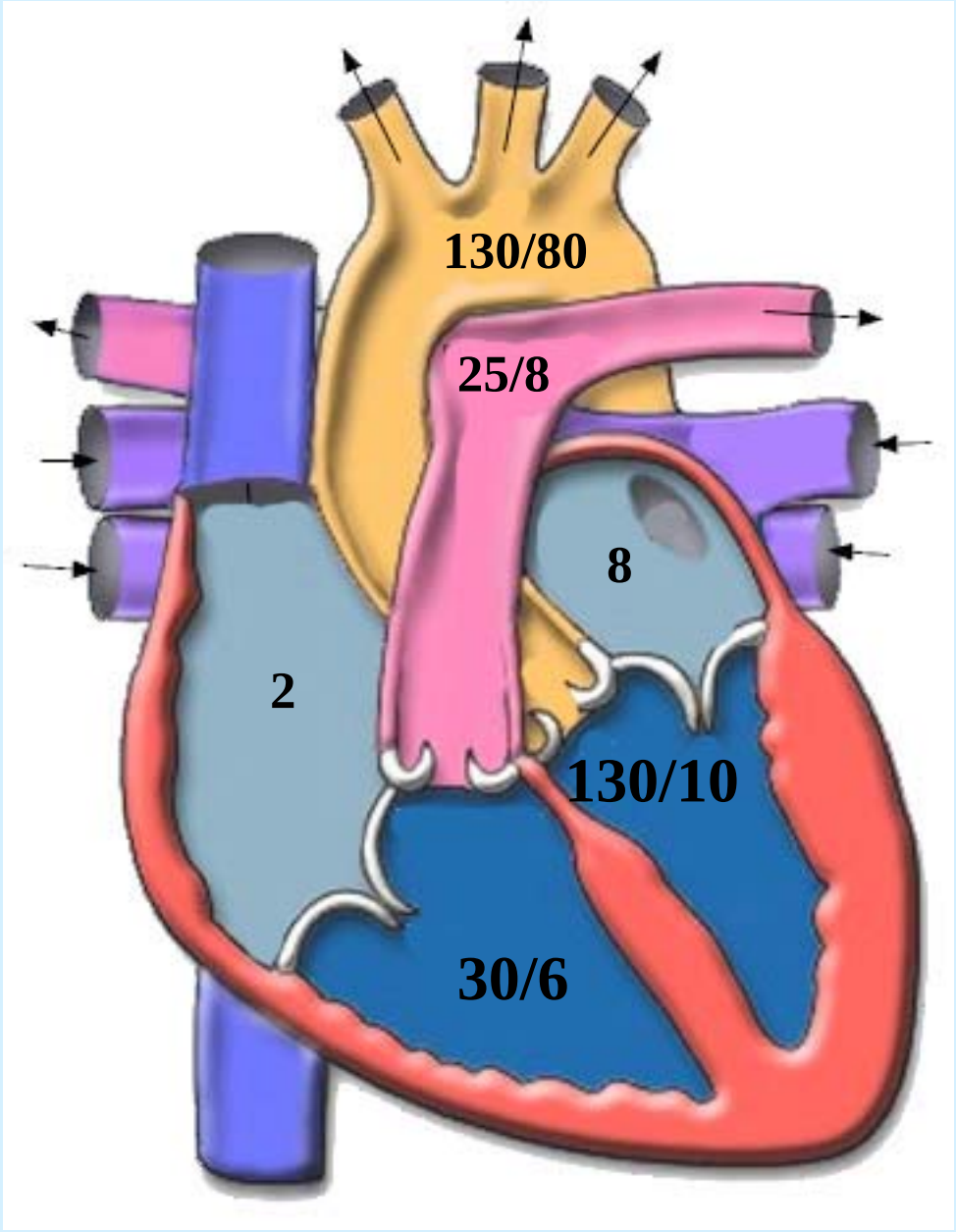


Valves:

Atrioventricular
- **Tricuspid Valve**
- **Mitral Valve**

Semilunar
- **Pulmonary Valve**
- **Aortic Valve**


Aorta
Pulmonary Artery
Pulmonary Vein
Left Atrium
Mitral Valve
Right Atrium
Aortic Valve
Tricuspid Valve
Pulmonary Valve
Left Ventricle
Right Ventricle

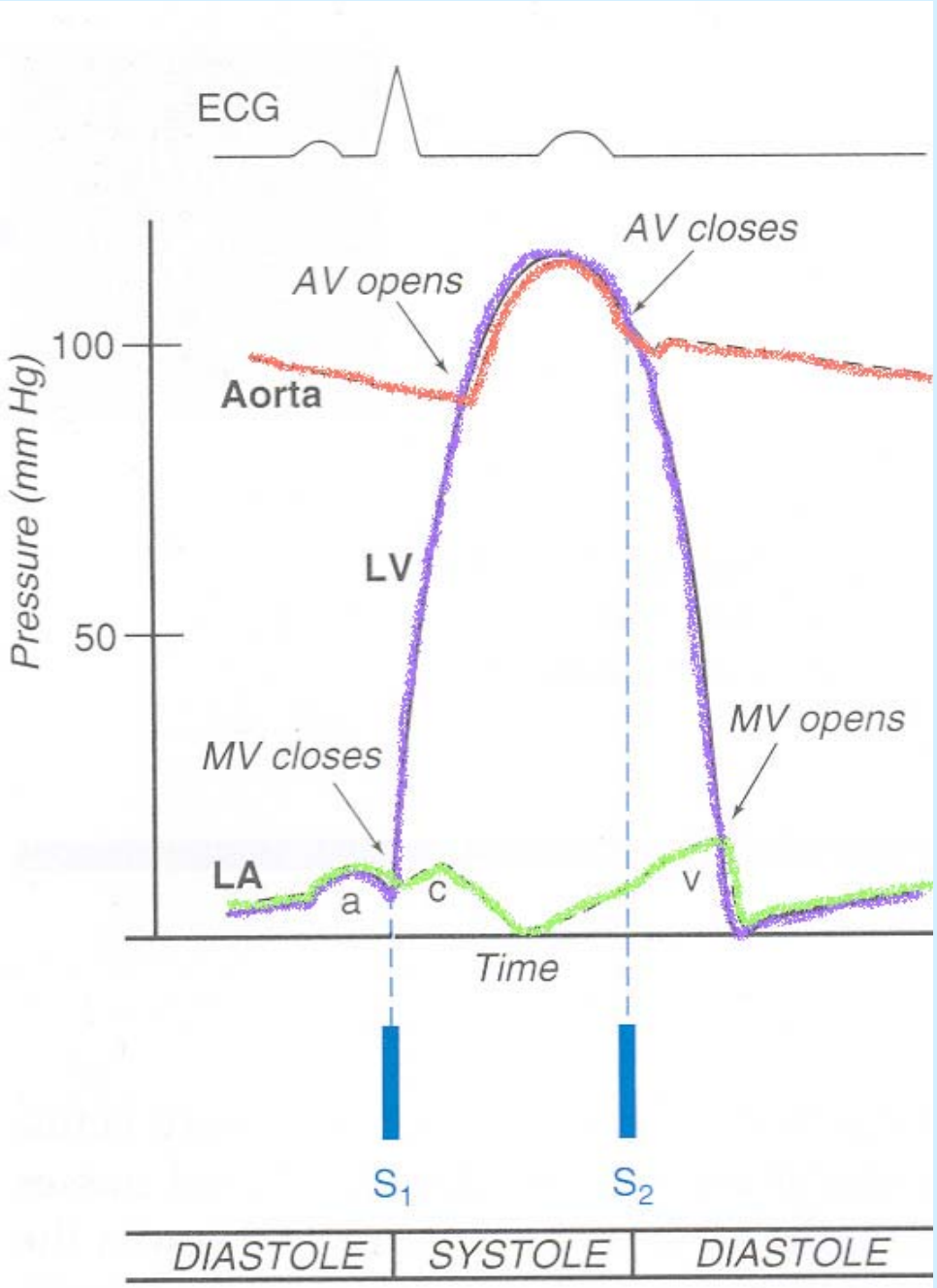


Pressures:

Right Atria (2)
Right Ventricle (30/6)
Pulmonary Artery (25/8)

Left Atria (8)
Left Ventricle (130/10)
Aorta (130/80)

Wiggers Diagram



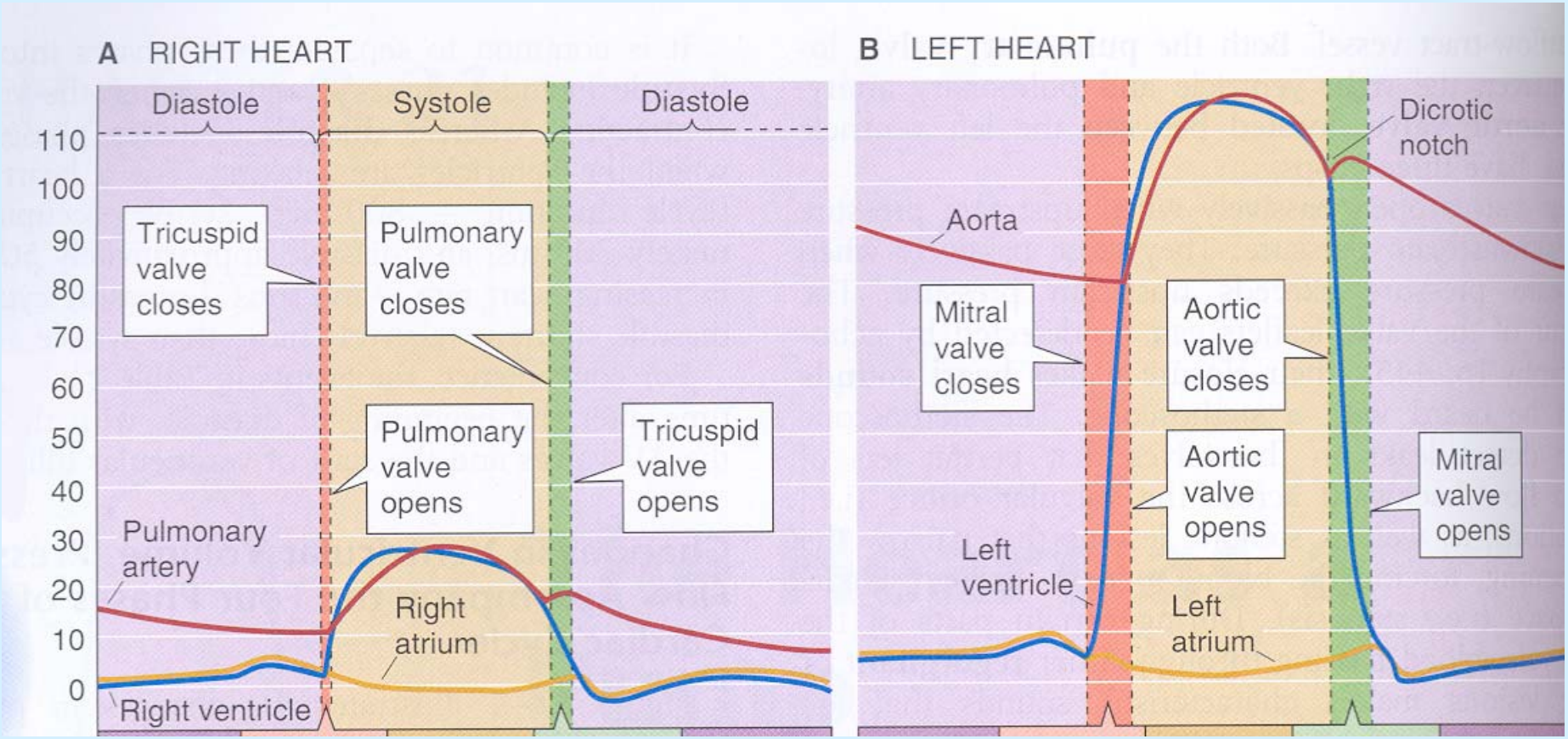
Using this diagram, answer the following questions:

Grp 1
What is Systole? Diastole?
When is the ventricle filling?

Grp 2
What causes the "a", "c" and "v" waves?

Grp 3
Is there a time when both mitral and aortic valves are closed? What is it called?

Grp 4
What causes the aortic valve to open?
When is blood flowing into the aorta?



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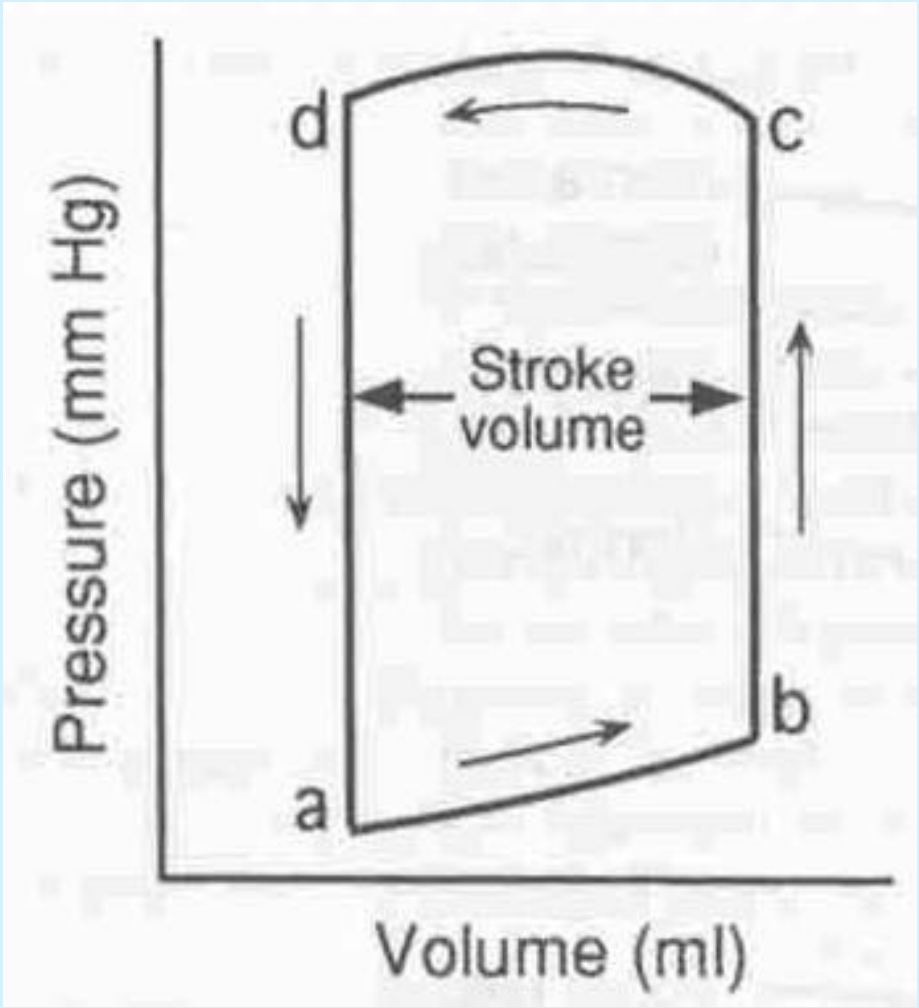

Place the following terms on this diagram:

1. **Ventricular filling**
2. **Ventricular ejection**
3. **Isovolumetric contraction**
4. **Isovolumetric relaxation**

5 Electrical Premises

1. **What property of cardiac cells is critical for initiation of the electrical activity?**

2. **How would you ensure synchronous cardiac muscle contraction?**

3. **What back up systems are in place incase of electrical failure of the SA node (what are the consequences of using the back ups?)**

4. **What prevents all four chambers (both atria & both ventricles) from contracting together?**

5. **How to allow for flexibility of rate (faster/slower)?**

5 Electrical Premises

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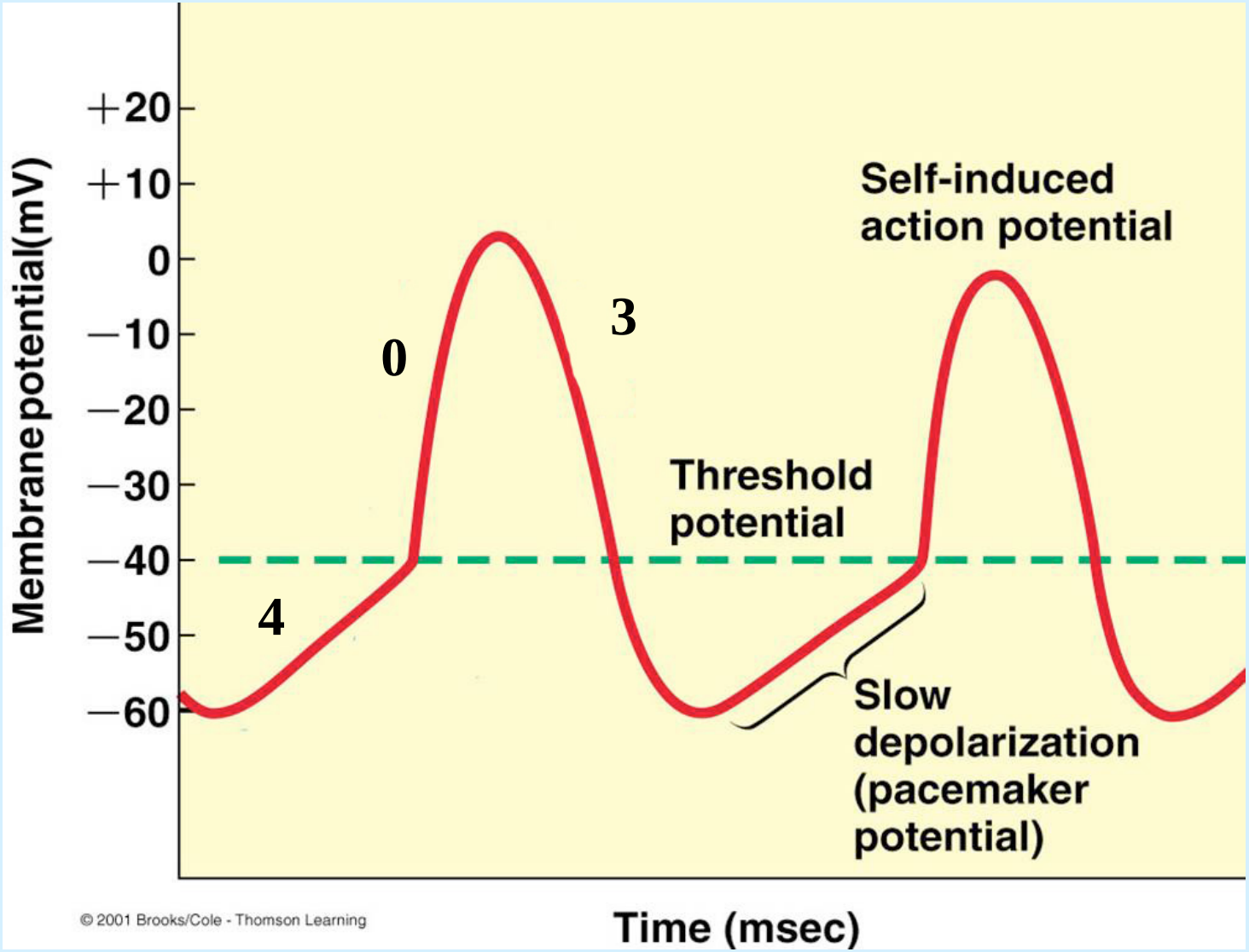
- **<u>Initiation</u> of the signal should occur in the absence of nervous input and outside of conscious thought ***spontaneously depolarizing cells*****

Primarily cells in Sinoatrial Node & Atrioventricular Node



5 Electrical Premises

2. How would you ensure synchronous cardiac muscle contraction?

5 Electrical Premises

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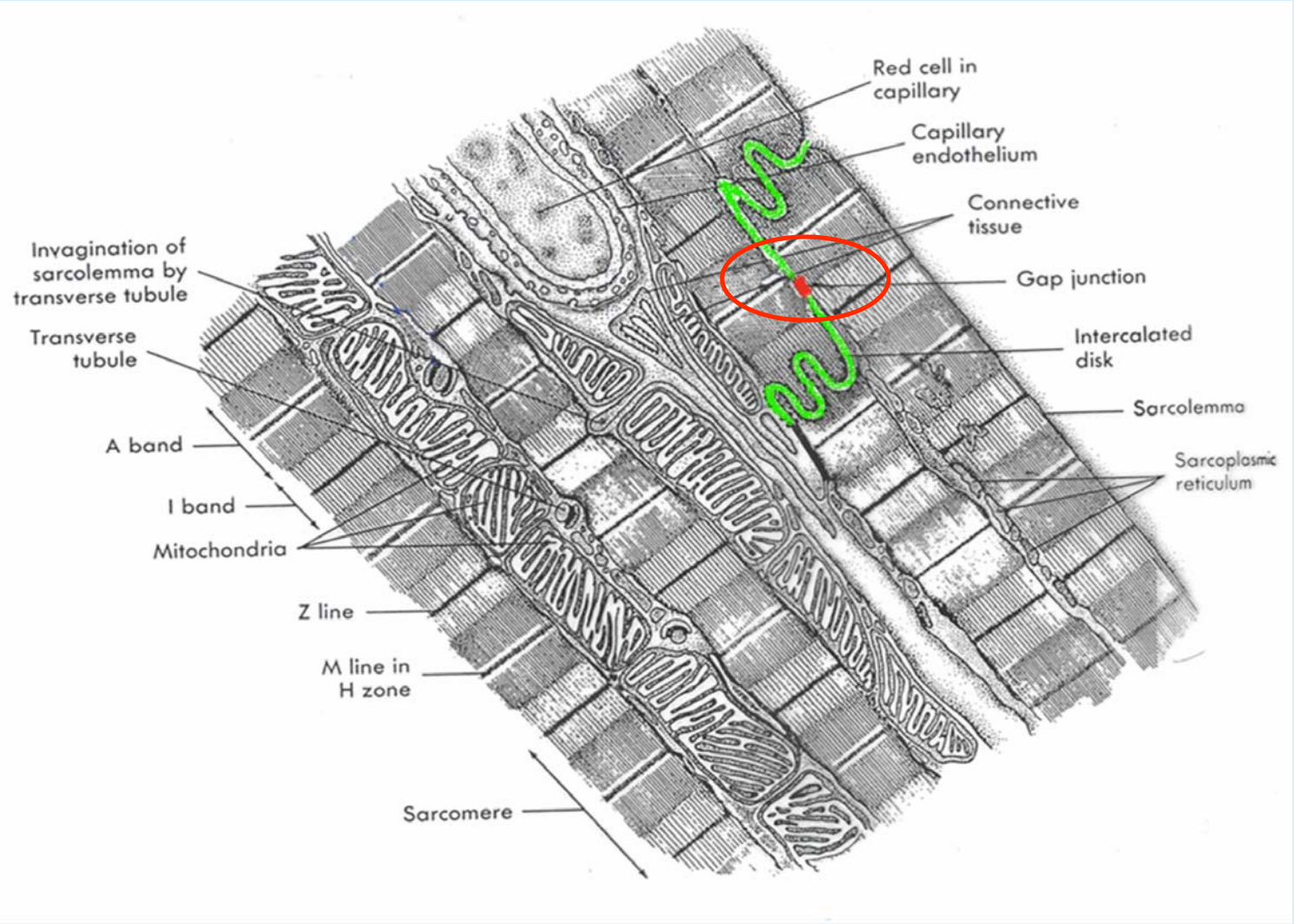
- **All muscle cells must be activated synchronously to produce uniform contraction of the heart chambers ***electrical syncitium*****

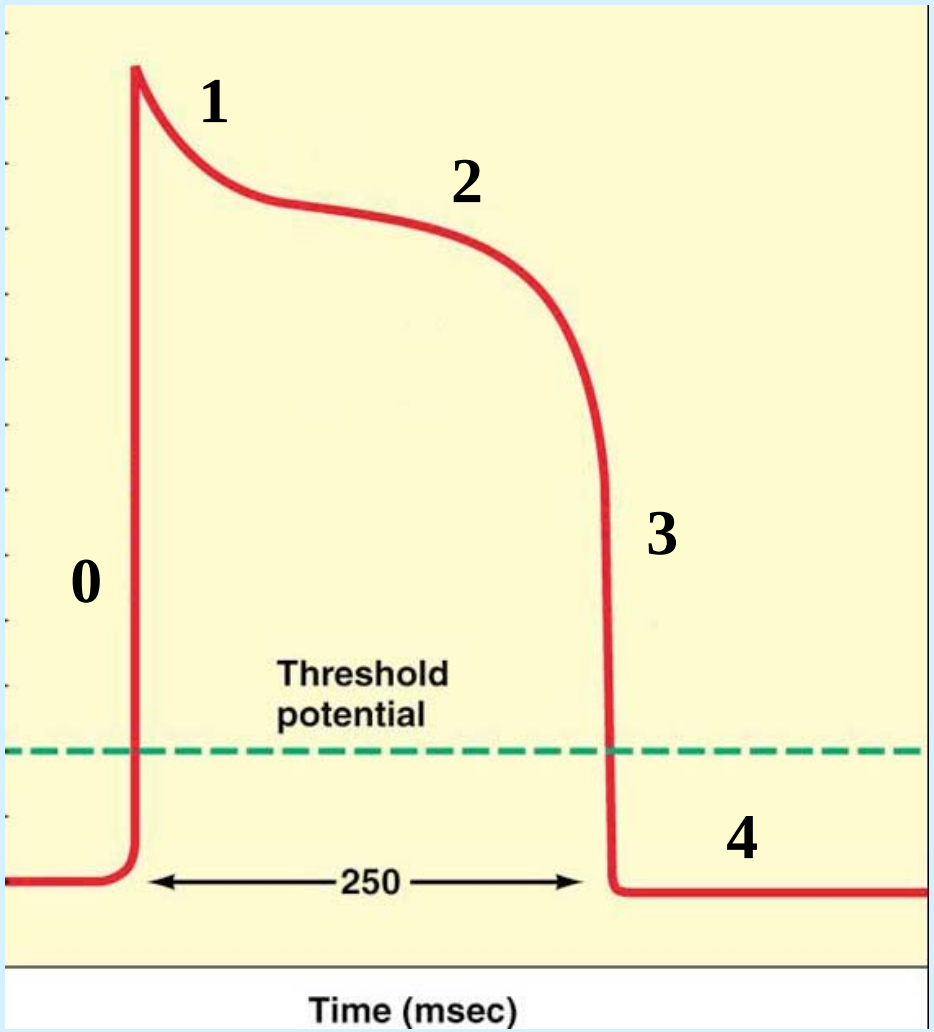
Electrical Syncitium



Cardiac muscle cells linked together electrically such that Action Potentials travel directly from cell to cell

Cells which don't spontaneously depolarize…

Atrial or Ventricular Muscle Cells



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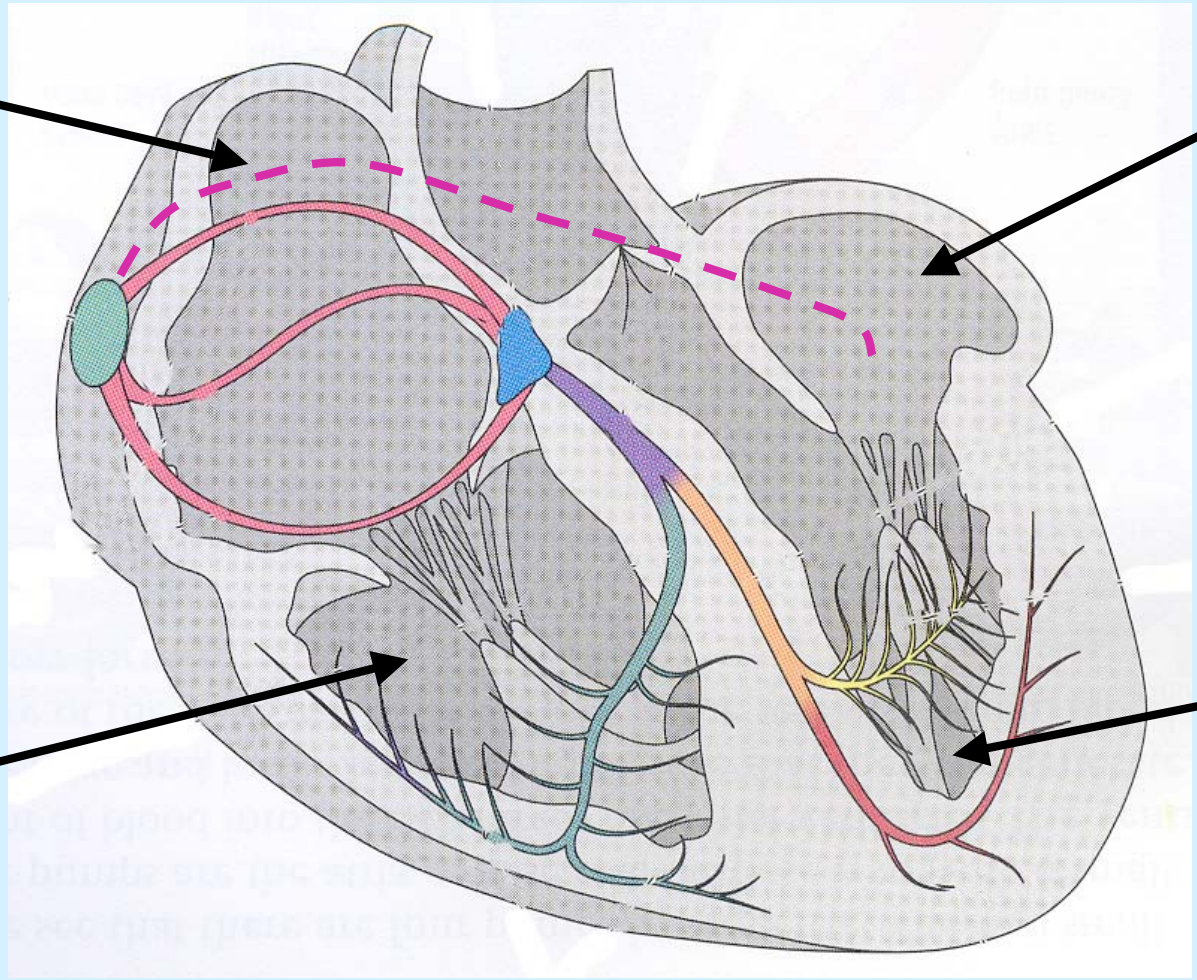
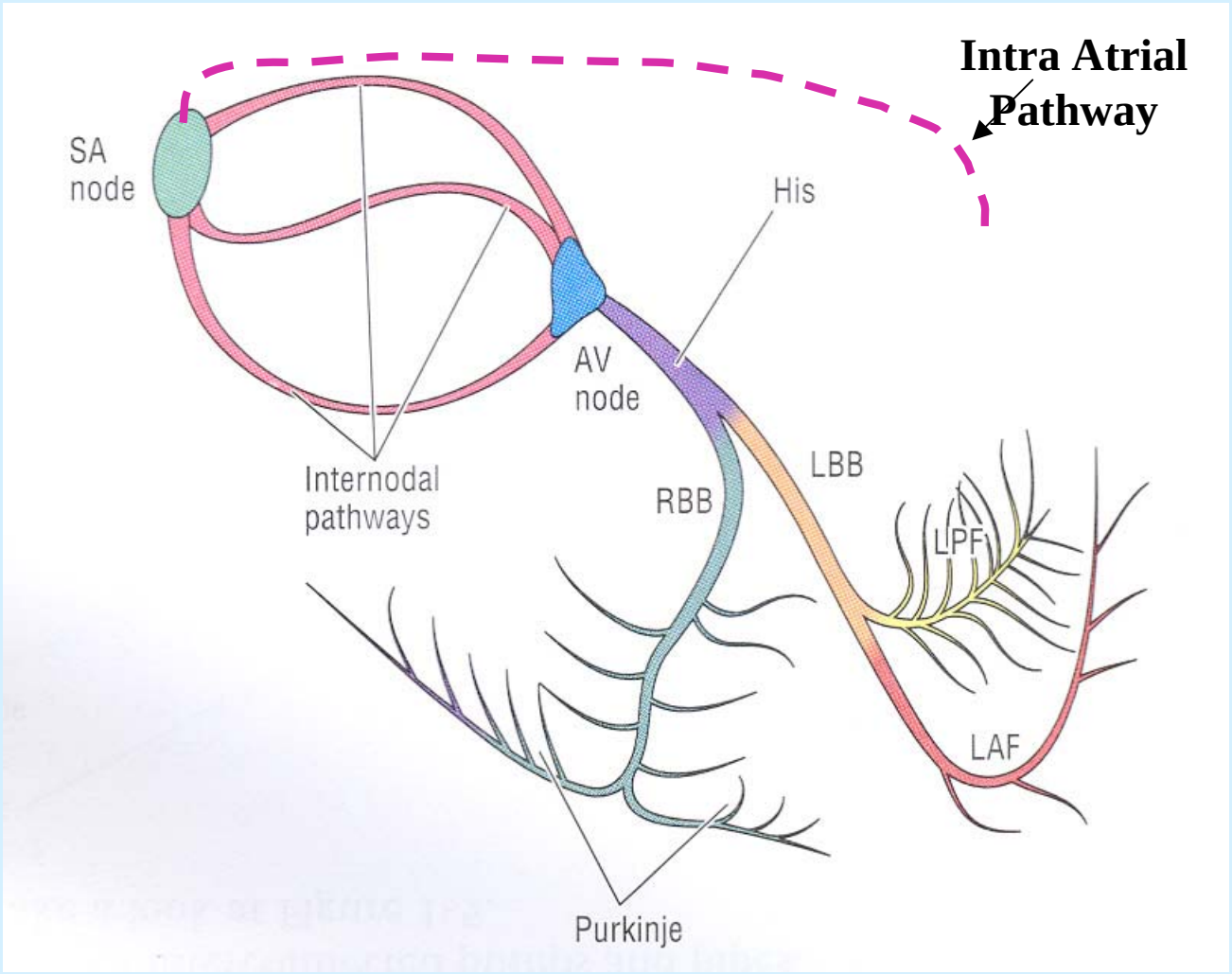
- **Electrical signals are initiated in the same place each time *** hierarchy of rate of depolarization*****

The Electrical Conducting System



A system of <u>fast conducting</u>, specialized cardiac muscle cells



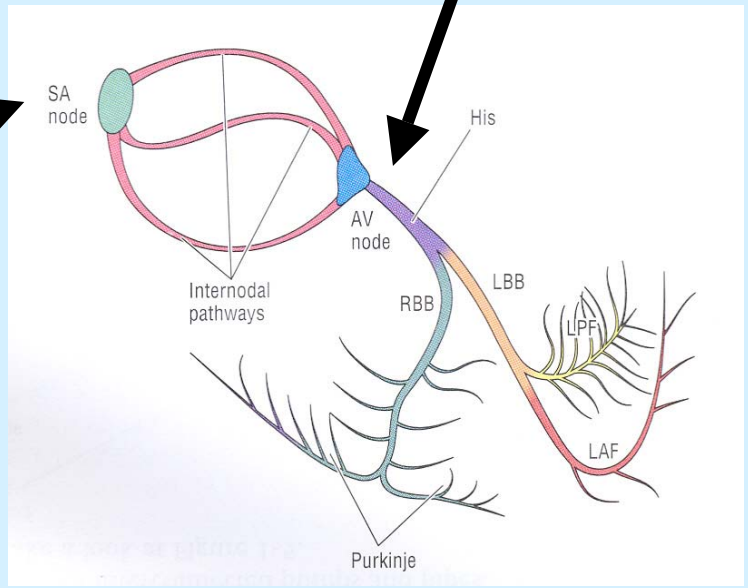
SA Node: Sinoatrial Node
Internodal Pathways / Interatrial Pathway
AV Node: Atrioventricular Node
His: His Bundle

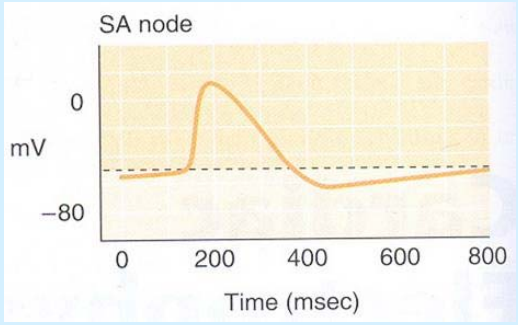
LBB: Left Bundle Branch
RBB: Right Bundle Branch
Purkinje: Purkinje Fibers
LAF:Left Anterior Fascicle
LPF:Left Posterior Fascicle

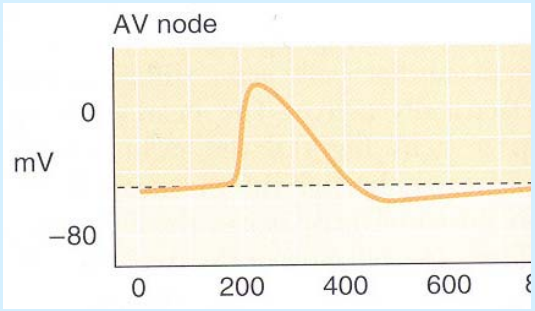
Hierarchy of Rate of Depolarization
All conducting cells are capable of self-depolarizing.

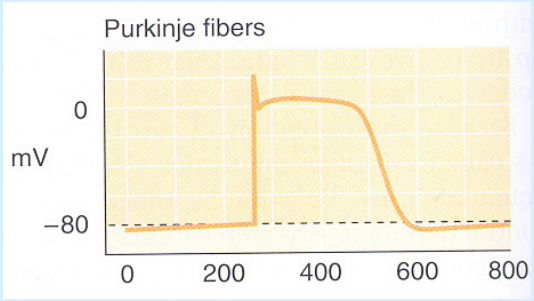
45-50 BPM

60-100 BPM









20-30 BPM

The inherent rate of self depolarization slows, the further away from SA node.

5 Electrical Premises

4. What prevents all four chambers (both atria & both ventricles) from contracting together?

5 Electrical Premises

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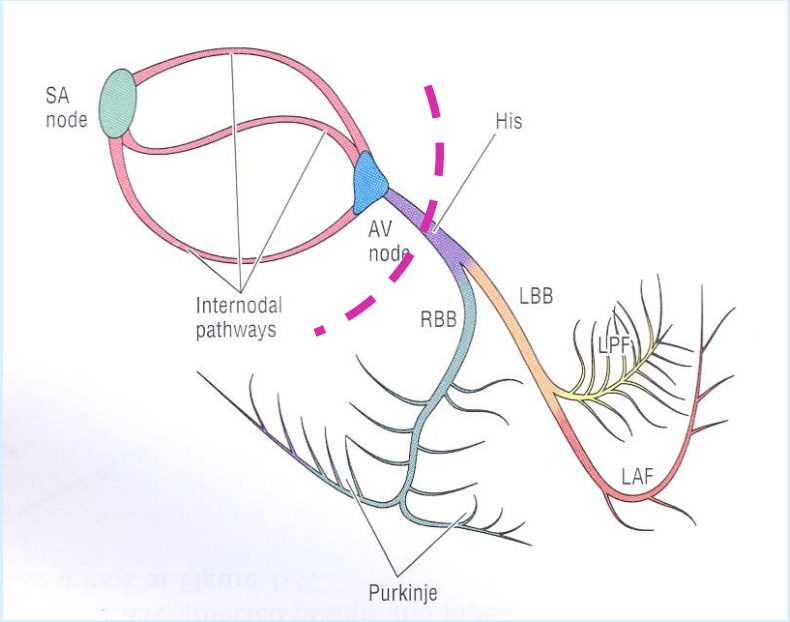
- **Optimally, both atria should contract together first, followed by both ventricles **fibrous non conducting band separating the atria & ventricles*****

Independent Contraction of the Atria and Ventricles

- Due to the presence of a non electrically conducting band of tissue which separates the atria and ventricles.
- The only means of electrically communicating between the atria and ventricles is the Bundle of His and His Purkinje System.



- Conduction <u>slows</u> at the AV node giving time for the atria to fully contract before the ventricles are electrically activated

5 Electrical Premises

5. How to allow for flexibility of rate (faster/slower)?

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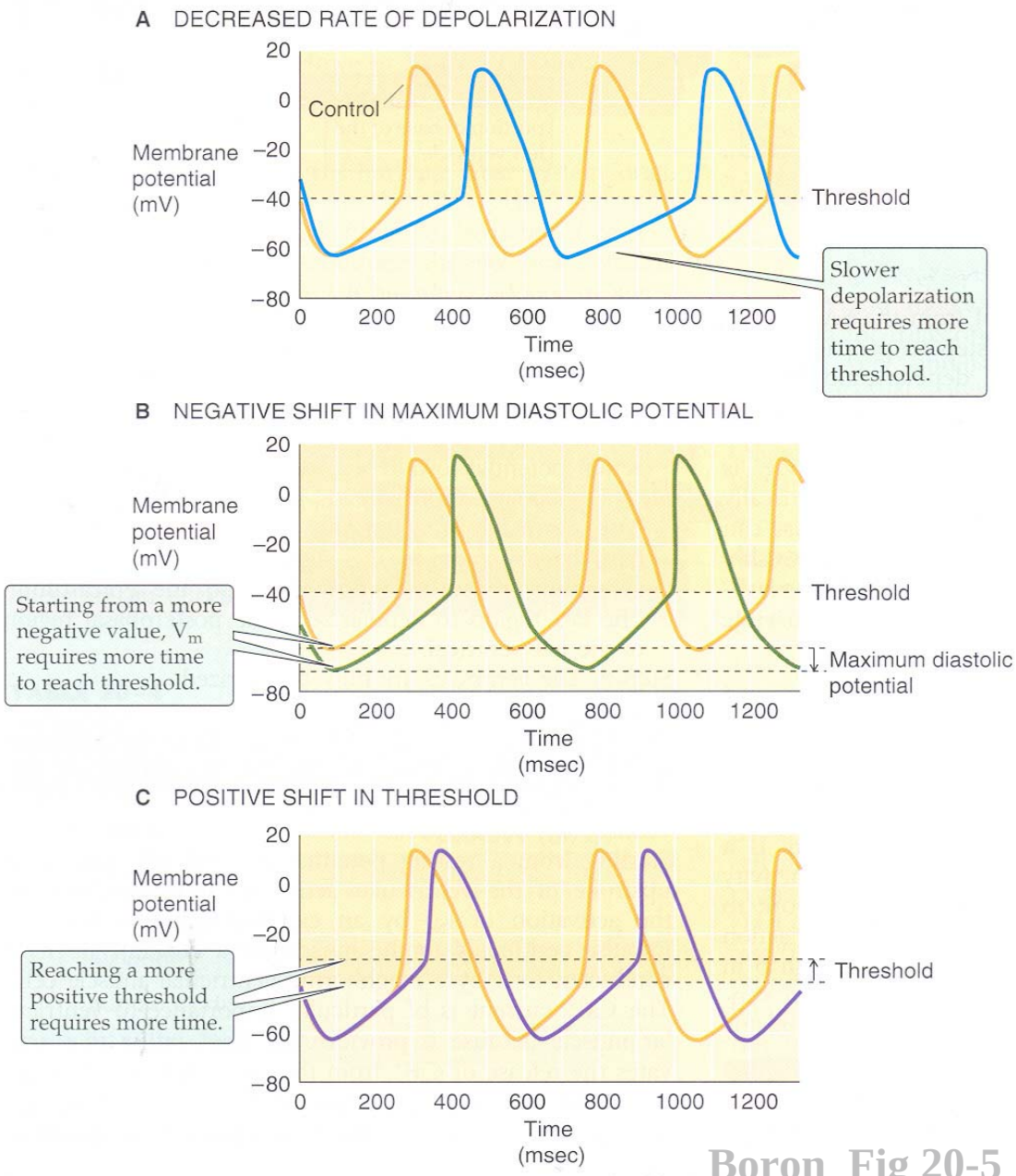
Cardiac electrical activity should respond to nervous input to allow increases and decreases in heart rate when necessary ***SYMP & PSYMP control of HR***



Acetylcholine in SA Node:

- **Decreases I_f (A)**
- **Opens GIRK channels thus increasing K+ conductance (B)**
- **Reduces I_{Ca} (A & C)**

IN CONTRAST…

Norepinephrine & Epinephrine in SA Node:

- **Increase I_f**
- **Increase I_{Ca}**