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
Pressures:

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

Left Atria (8)
Left Ventricle (130/10)
Aorta (130/80)
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?
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 in case 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

1. What property of cardiac cells is critical for initiation of the electrical activity?
5 Electrical Premises

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

• Initiation 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

2. How would you ensure synchronous cardiac muscle contraction?

- 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

-80 mV

Threshold potential

Time (msec)
5 Electrical Premises

3. What back up systems are in place in case of electrical failure of the SA node (what are the consequences of using the back ups?)
5 Electrical Premises

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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 fast conducting, 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.

- **60-100 BPM**
- **45-50 BPM**
- **20-30 BPM**

The inherent rate of self depolarization slows, the further away from SA node.
4. What prevents all four chambers (both atria & both ventricles) from contracting together?
5 Electrical Premises

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

- 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 **slows** 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)?
5 Electrical Premises

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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 $I_{Ca}$