



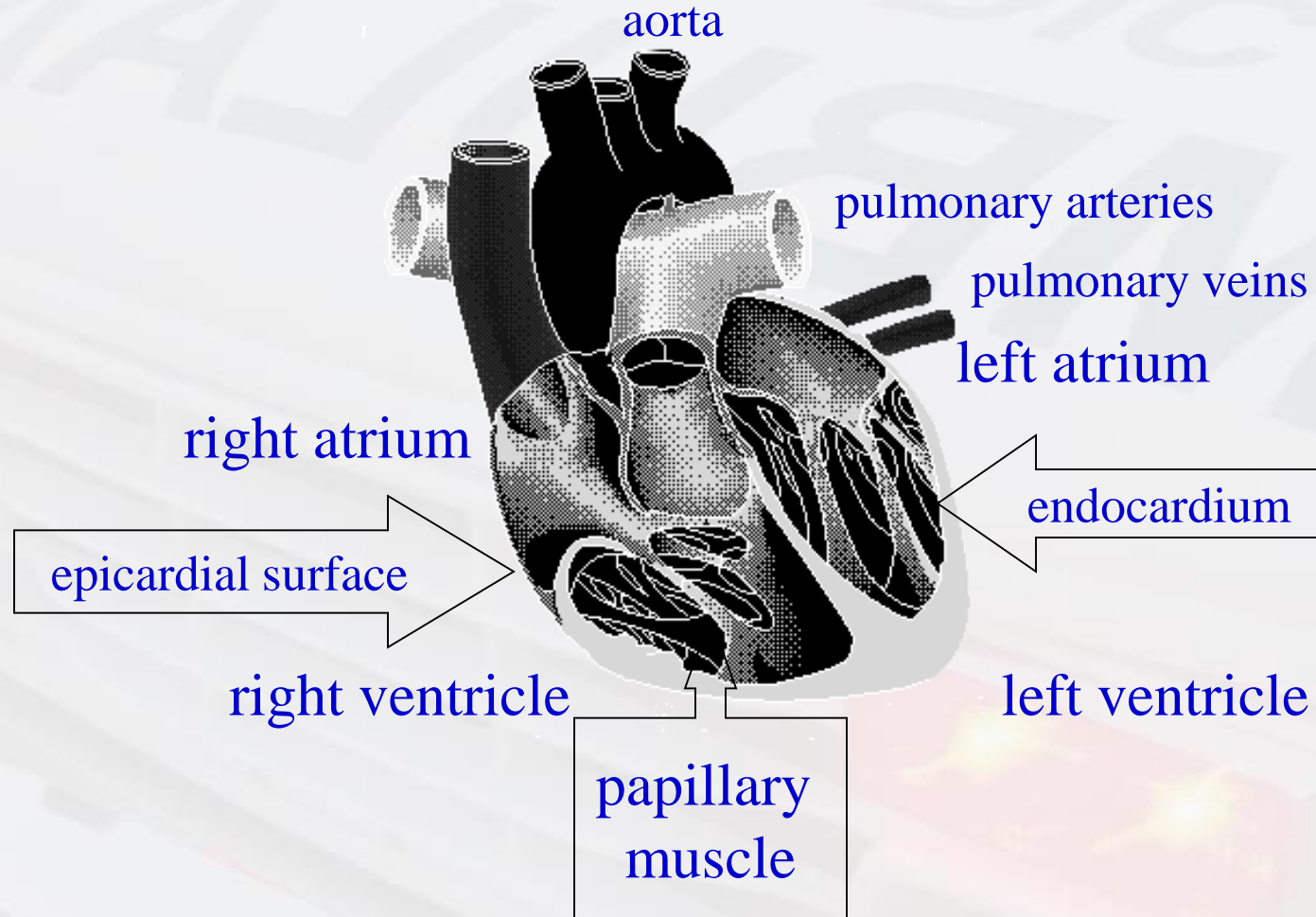
# PATIENT CARE THEORY 2

Unit 14 Part 1: Cardiac Rhythm Interpretation

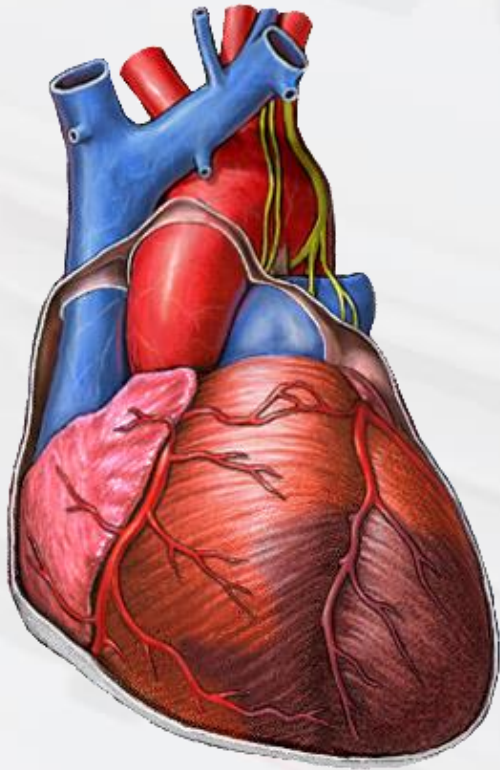
# Learning Outcomes

- ❖ Describe the anatomy of the heart and its blood supply
- ❖ Describe the cardiac conduction system
- ❖ Explain the unique properties of the myocardial cells
- ❖ Describe the cardiac cell action potential
- ❖ Define the parts of the ECG complex
- ❖ Define common terms associated with ECG interpretation

# *CARDIAC ANATOMY*

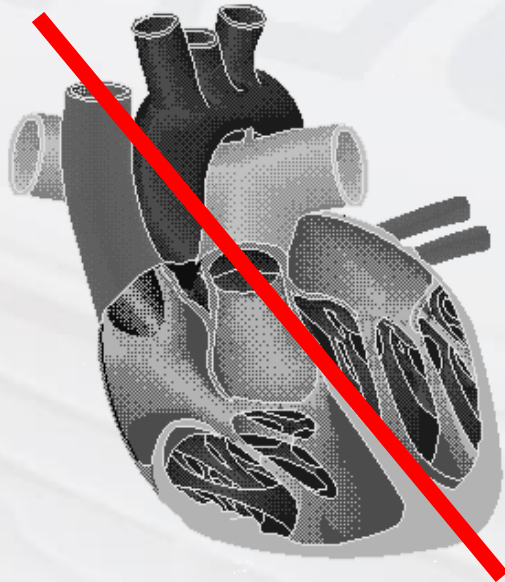


## *Coronary anatomy*



- ❖ First vessels to branch off the aorta
- ❖ They travel along the epicardial surface
- ❖ Coronary perfusion takes place during diastole

## Anatomical view



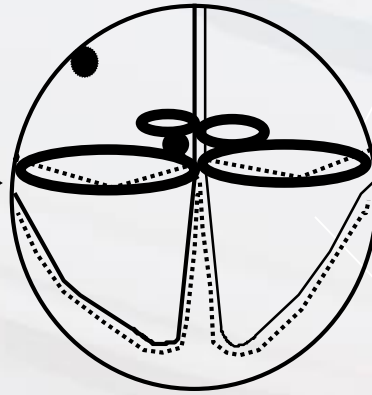
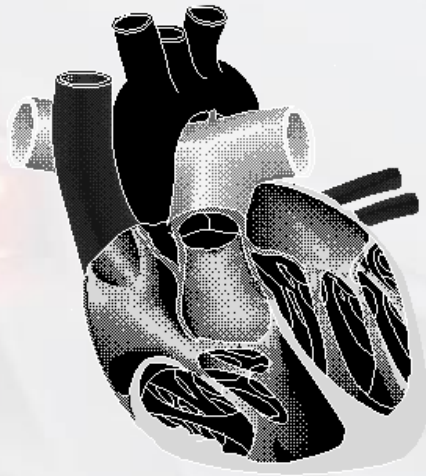
## Anatomical perspective:

4 chambered, two sided pump –  
Right side receives deoxygenated  
blood – Left side receives  
oxygenated blood

The right ventricle is thin walled - it  
pumps blood a short distance to the  
lungs

The left ventricle is thick walled - it  
pumps blood a great distance to the  
entire body

## The heart's “skeletal” system



Fibrous  
connective tissue  
rings support the  
AV valves

These rings isolate  
the atria from the  
ventricles  
electrically

# Cardiac Anatomy- Starlings Law



# Types of Cells

- ❖ Conduction cells (~ 1% of cardiac cells)
  - Nodal and pacemaker cells
  - Have the ability to generate action potential (at different rates depending on the location)
- ❖ Contractile cells (~99% of cardiac cells)
  - Respond to transmission of action potentials between myocardial cells -> muscle fibers shorten and muscle contraction occurs (systole)

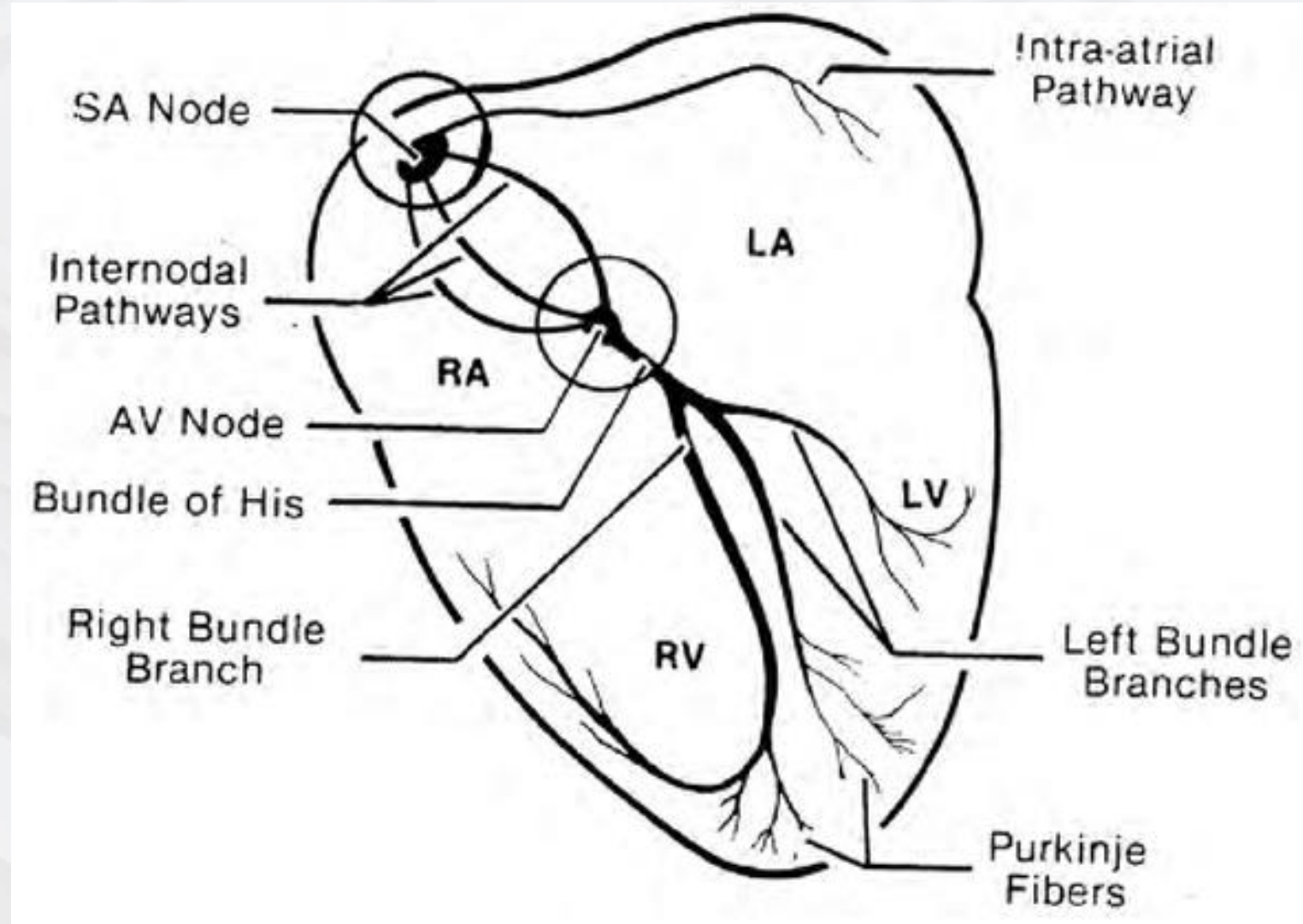
# Automaticity

- ❖ Unique to the myocardial cells
- ❖ The ability to generate impulses simultaneously
  - The pacemaker that fires the fastest sets the rate
  - This is generally the SA node
  - If the SA node fails to generate the impulse, the pacemaker cells in locations along the conduction pathway (around the AV node and purkinje system, as well as around the coronary sinus and inferior vena cava) possess automaticity and serve as back-up

# Rhythmicity

- ❖ Impulses are intended to be generated from a single location at regular intervals -> rhythmically
- ❖ Conduction disturbances can result in irregular rhythms

# Conduction System

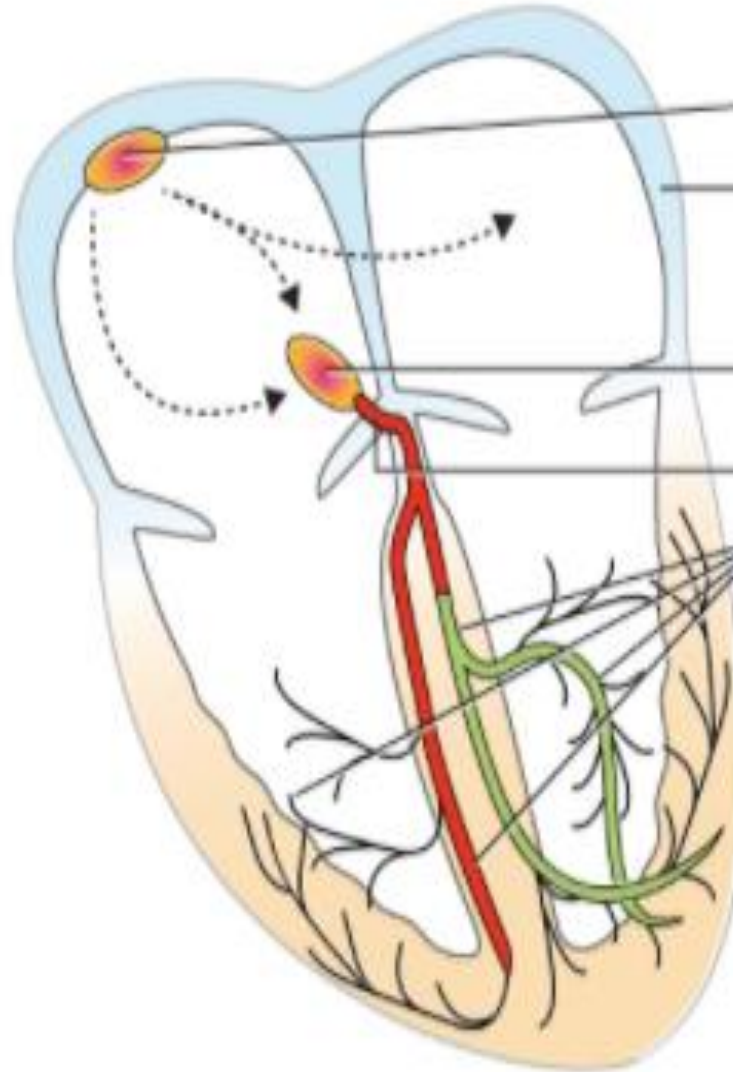


# Conductivity/Automaticity

The sinoatrial node is normally the heart's pacemaker because it has the highest intrinsic rate of spontaneous depolarization. The electrical impulse spreads from the sinoatrial node to the atria, which are activated by the impulse. Propagation of the impulse through the atria is facilitated by the inter-nodal pathways.

The atrial impulse reaches the AV node. Impulse transmission through the AV node is slow, which causes a delay.

The AV node continues in the bundle of His, which split up into the left and right bundle branches. The left bundle branch is further divided into an anterior and a posterior fascicle. Purkinje fibers, emanating from the bundle branches and fascicles, form an extensive network which delivers the impulse to contractile myocardial cells.

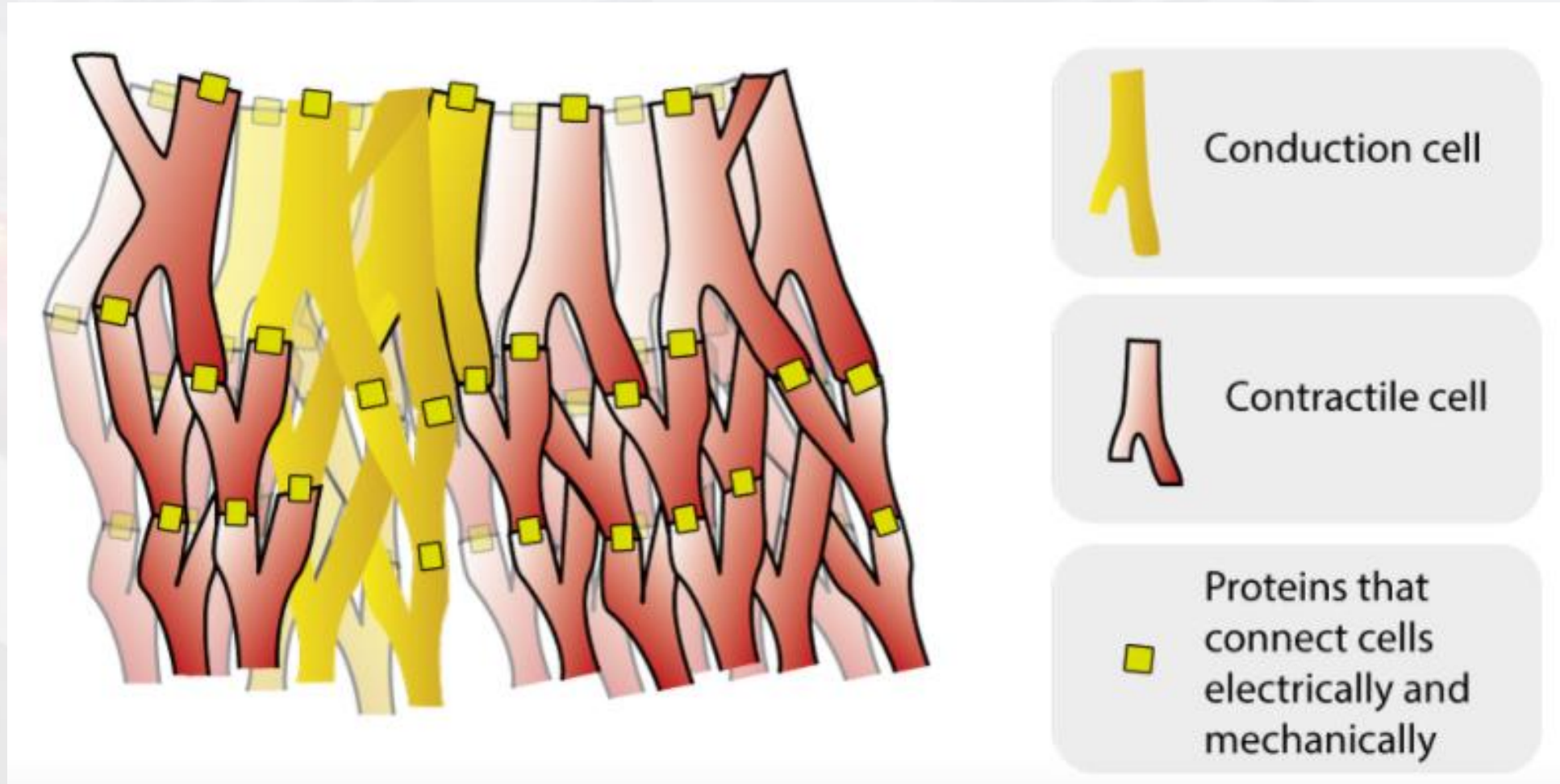


Pacemaker structure	Intrinsic frequency
Sinoatrial node	70/min
Atrial myocardium	60/min
AV node	40/min
Bundle of His	20-40/min
Purkinje fibers	20-40/min

# Cardiac muscle cells

- ❖ Much shorter and smaller than skeletal muscle cells
- ❖ Usually contain only one nuclei (vs multiple for skeletal muscle)
- ❖ Branch freely
- ❖ Joined by **intercalated discs** at the ends
  - forms both mechanical and electrical connection
- ❖ Proteins at the end of the plasma membrane form channels (**gap junctions**)
  - These gap junctions allow for seamless transmission of the electrical impulse
- ❖ Limited ability to repair or replace themselves

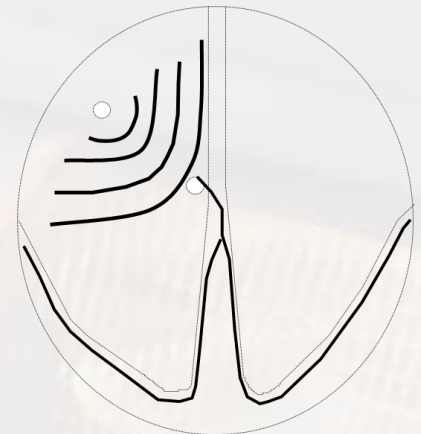
# Syncytium



This structure of cardiac cells is known as **syncytium**: the entire network of cardiac cells working as if a single unit

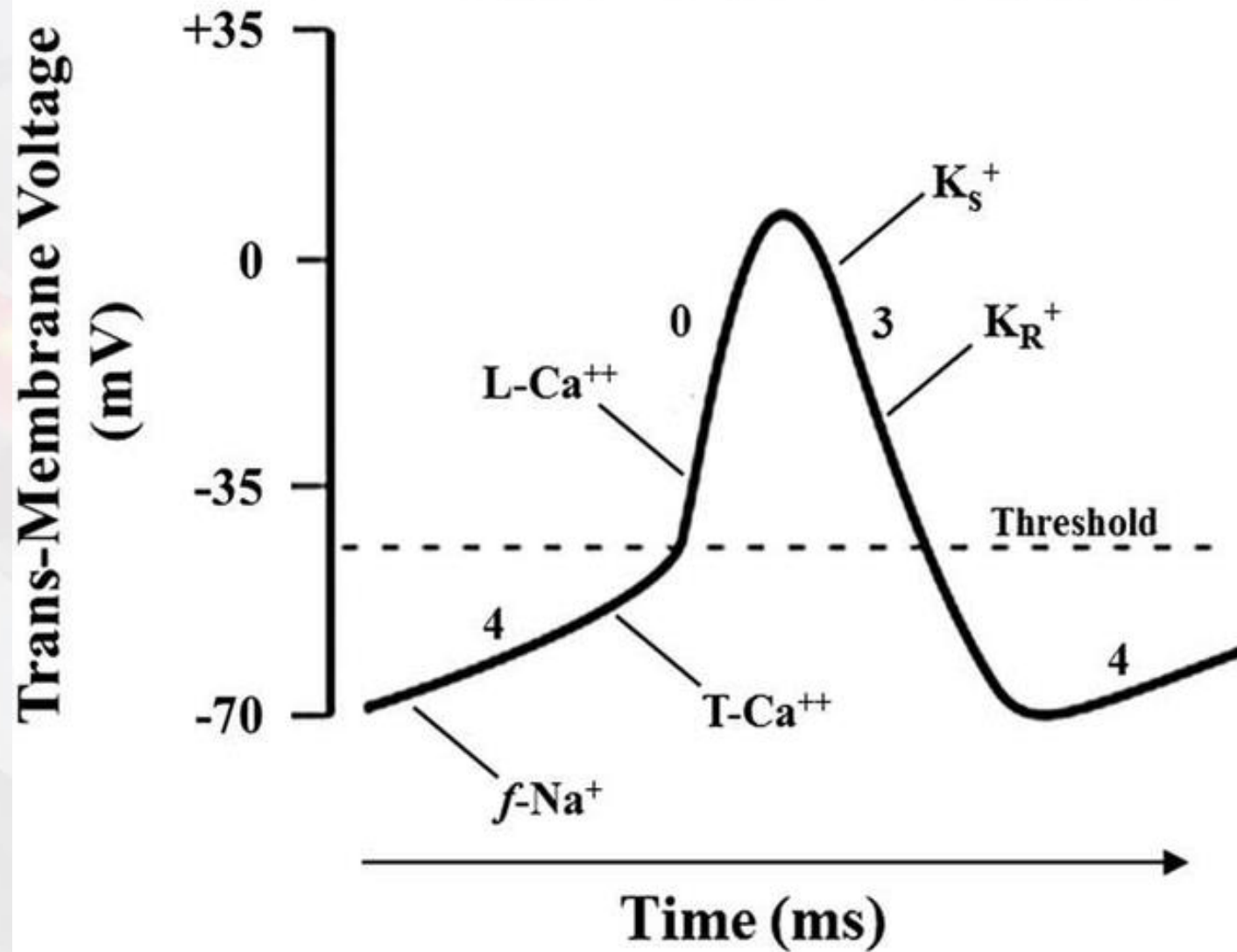
# Cardiac Action Potential

- ❖ The electrical activity of the myocardial cells created by movement of ions across the membrane changing polarity
- ❖ includes a depolarization (contraction) followed by a repolarization (recovery or relaxation)
- ❖ Spreads like a wave
- ❖  $\text{Na}^+$  and  $\text{K}^+$  are primary ions
  - $\text{Ca}^{++}$  also playing an important role
- ❖ Slightly differs between Pacemaker cells and contractile cells

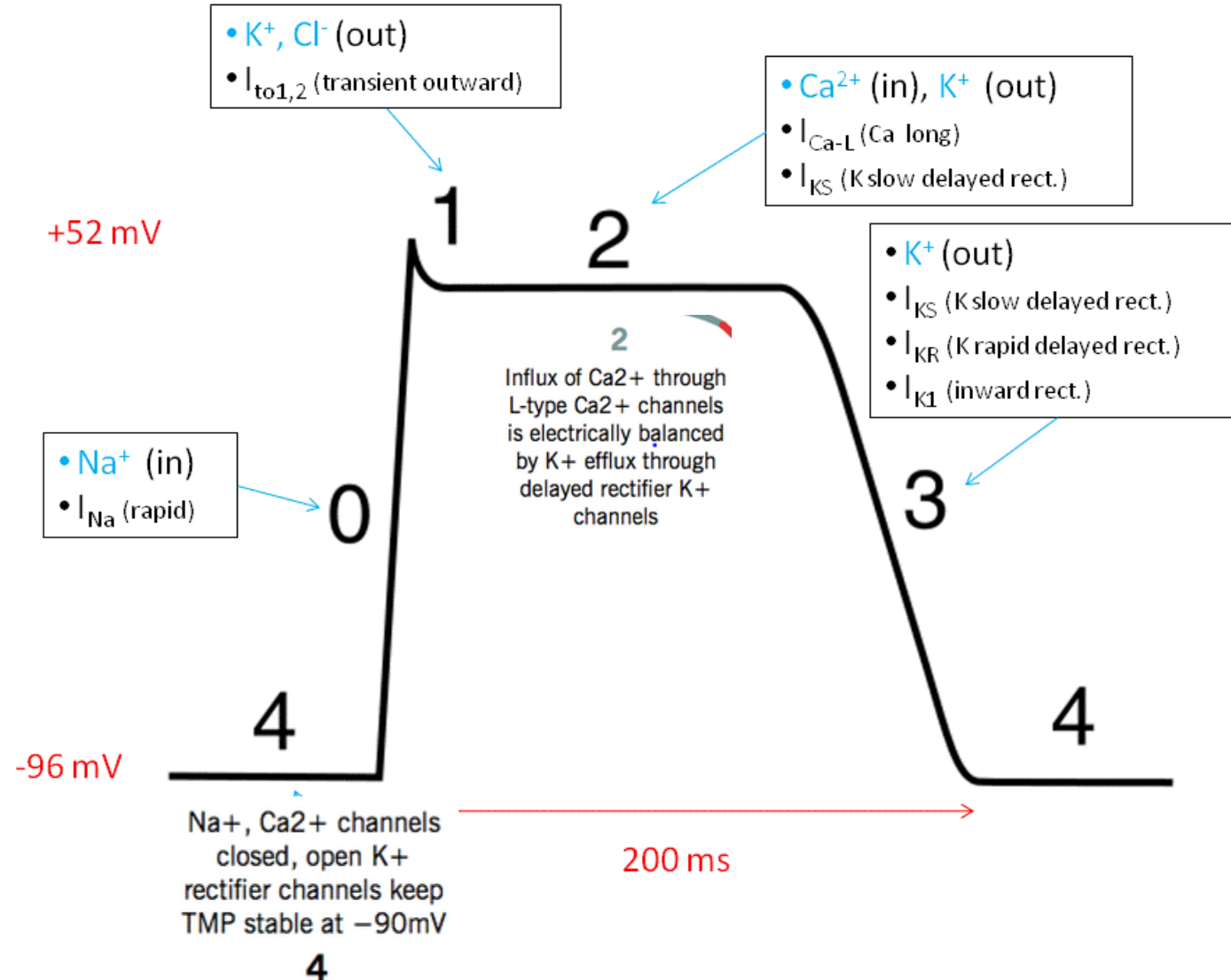
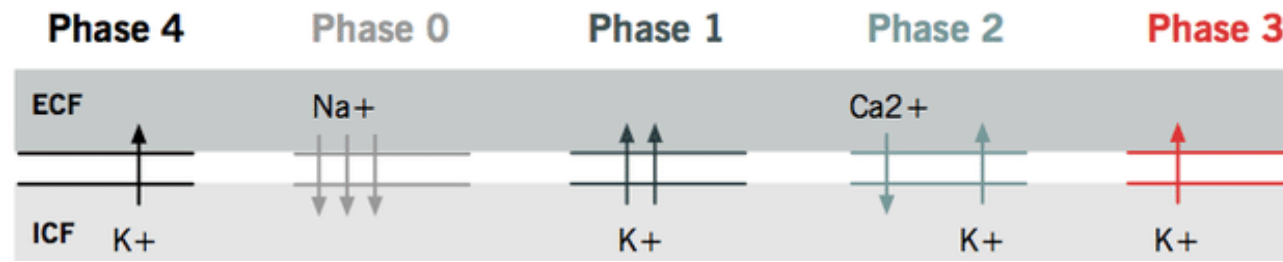


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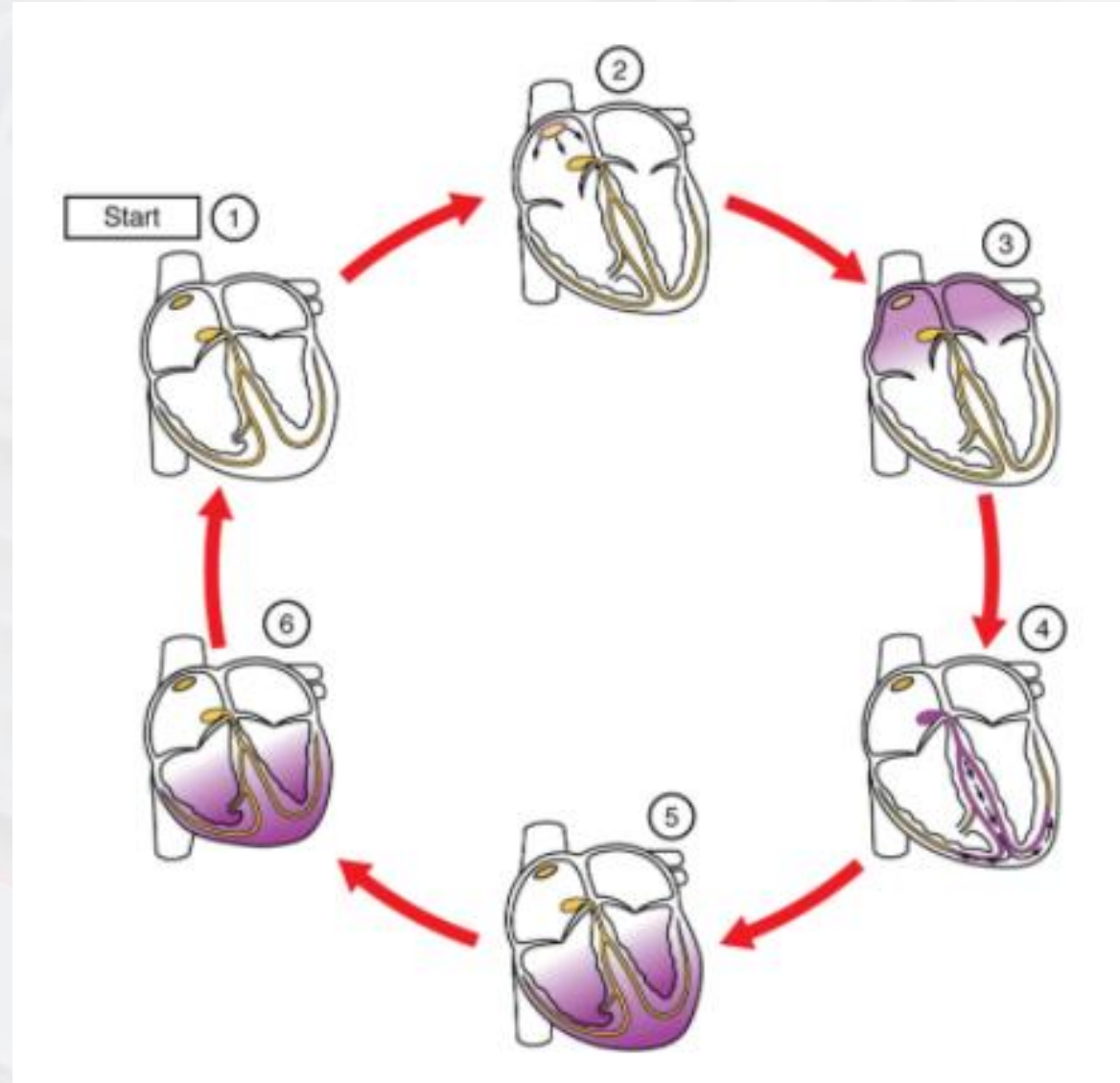
## Pacemaker Cell Action Potential



# Contractile Cells Action Potential

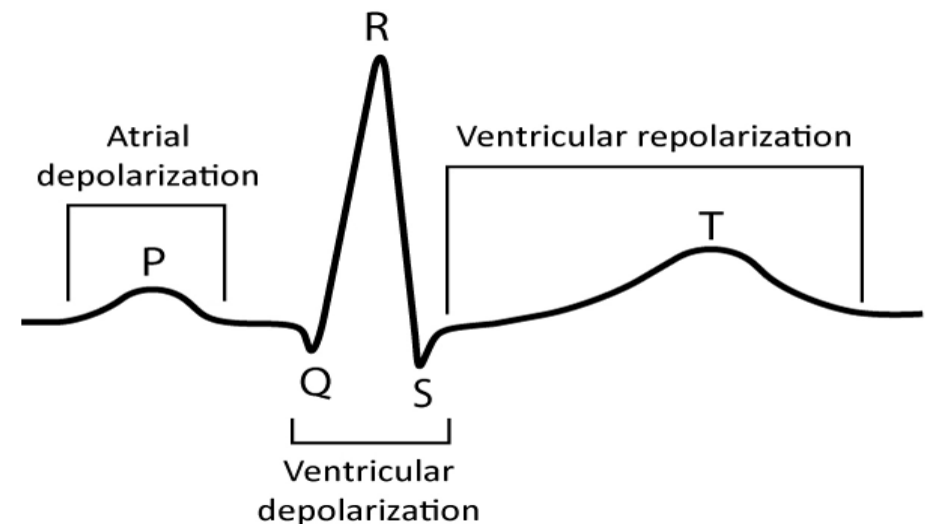
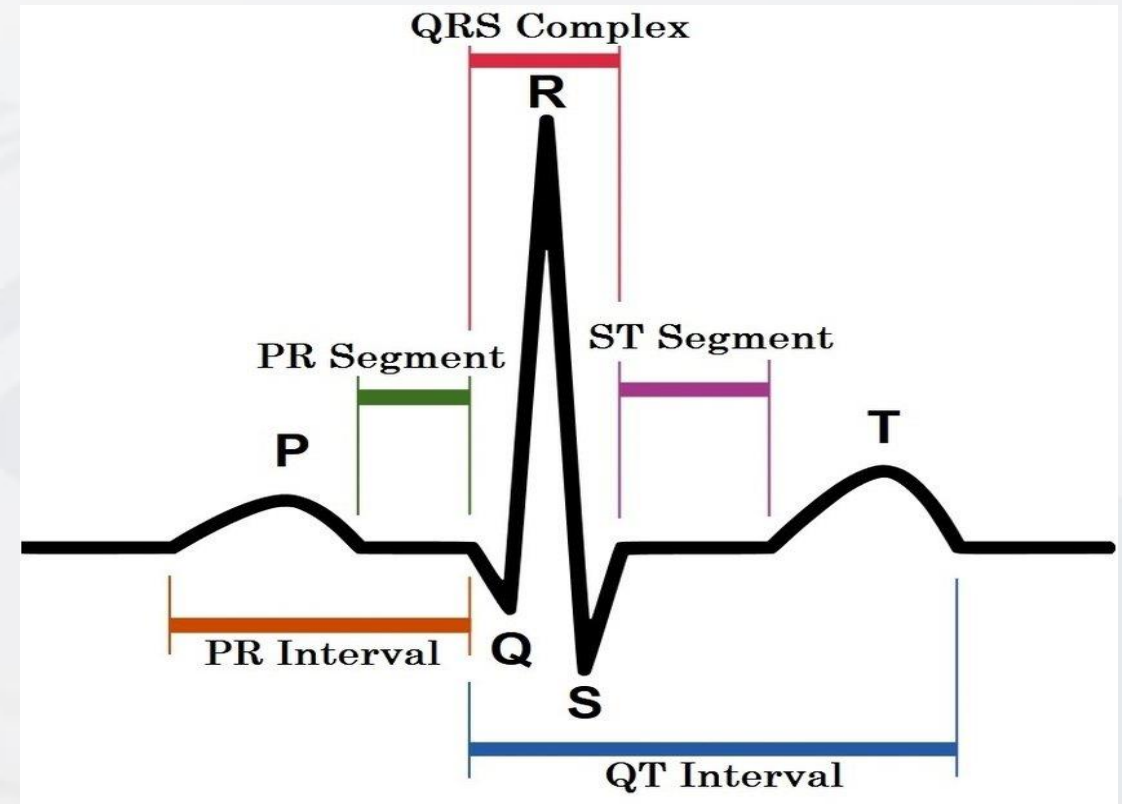


# Action Potential from the SA node

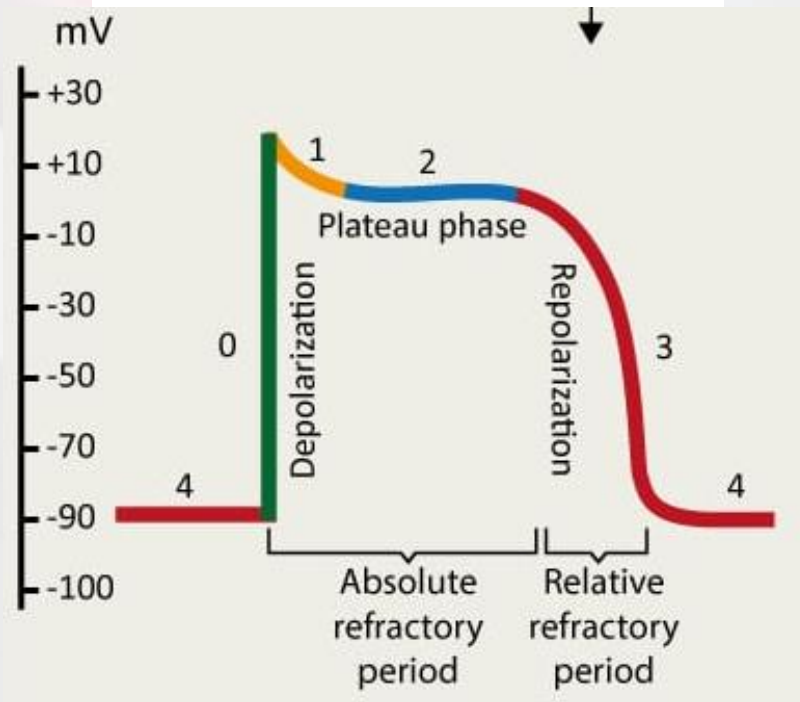
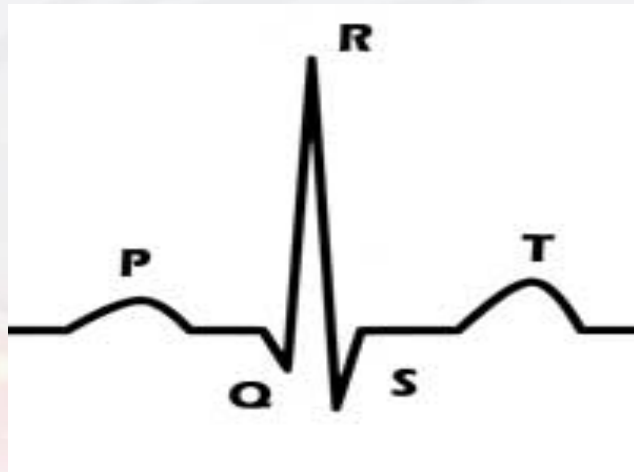


# ECG Wave

- ❖ P wave – atrial depolarization
  - (atrial repolarization is not seen as it is lost in the QRS)
- ❖ QRS – ventricular depolarization
- ❖ T wave – ventricular repolarization

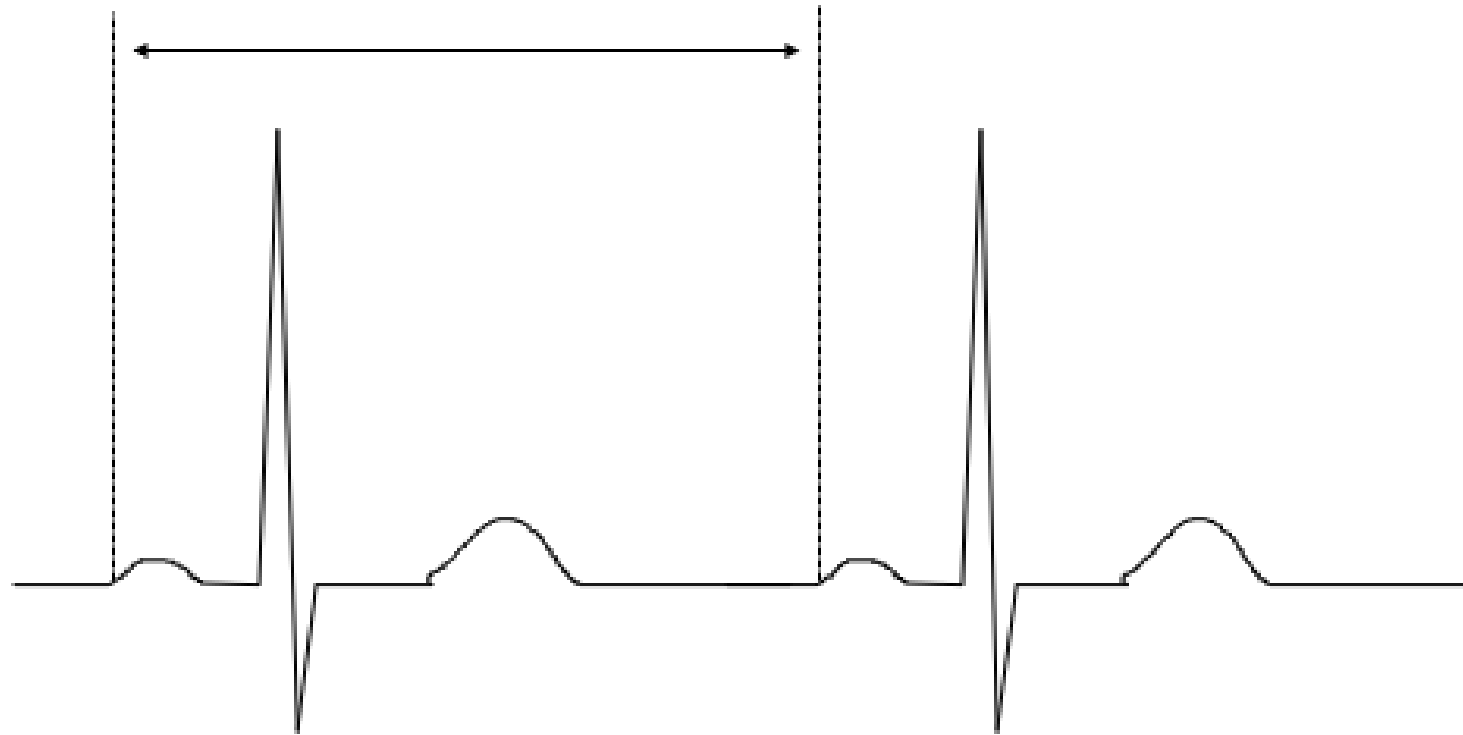


# Cardiac Action Potential

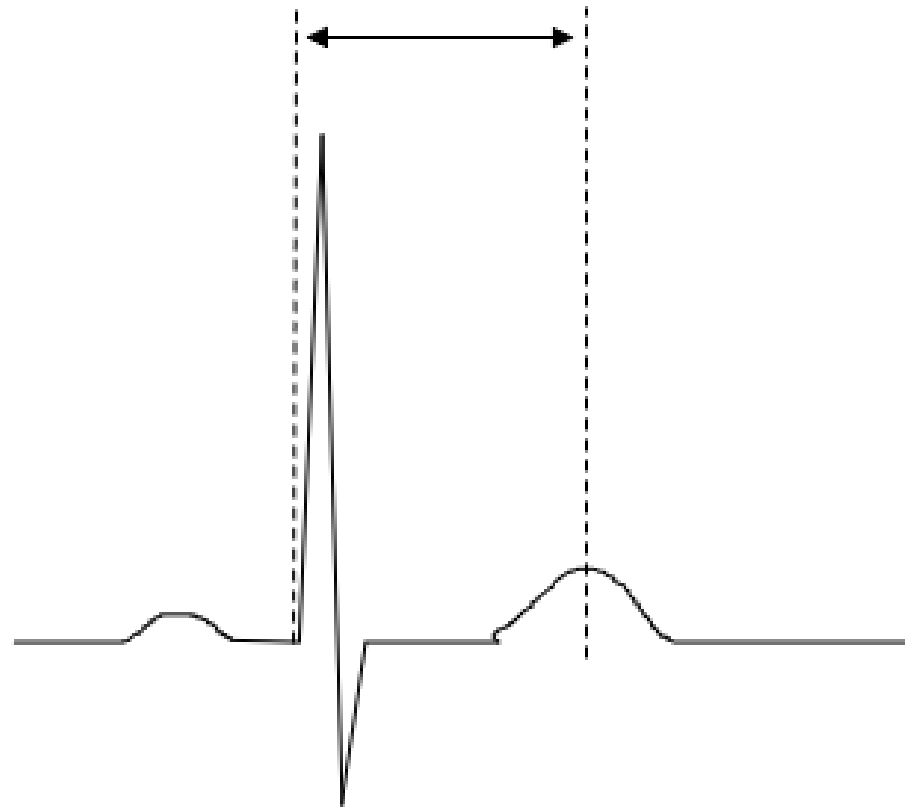


- ❖ **Cardiac Cycle** – represented by **one PQRST** or from one R wave to the next
- ❖ **Absolute Refractory period** – Begins at the onset of the QRS and ends at the peak of the T wave
  - The heart does not respond to another impulse
- ❖ **Relative Refractory period** – begins at the peak of the T wave and ends at the base of the T wave
  - The heart will respond if a strong enough impulse is generated (R on T)

## *Cardiac cycle*



## *Absolute Refractory Period*



*Relative Refractory Period*  
*Vulnerable phase*



Normal beat

Normal beat

Premature ventricular complex  
R-on-T-phenomenon

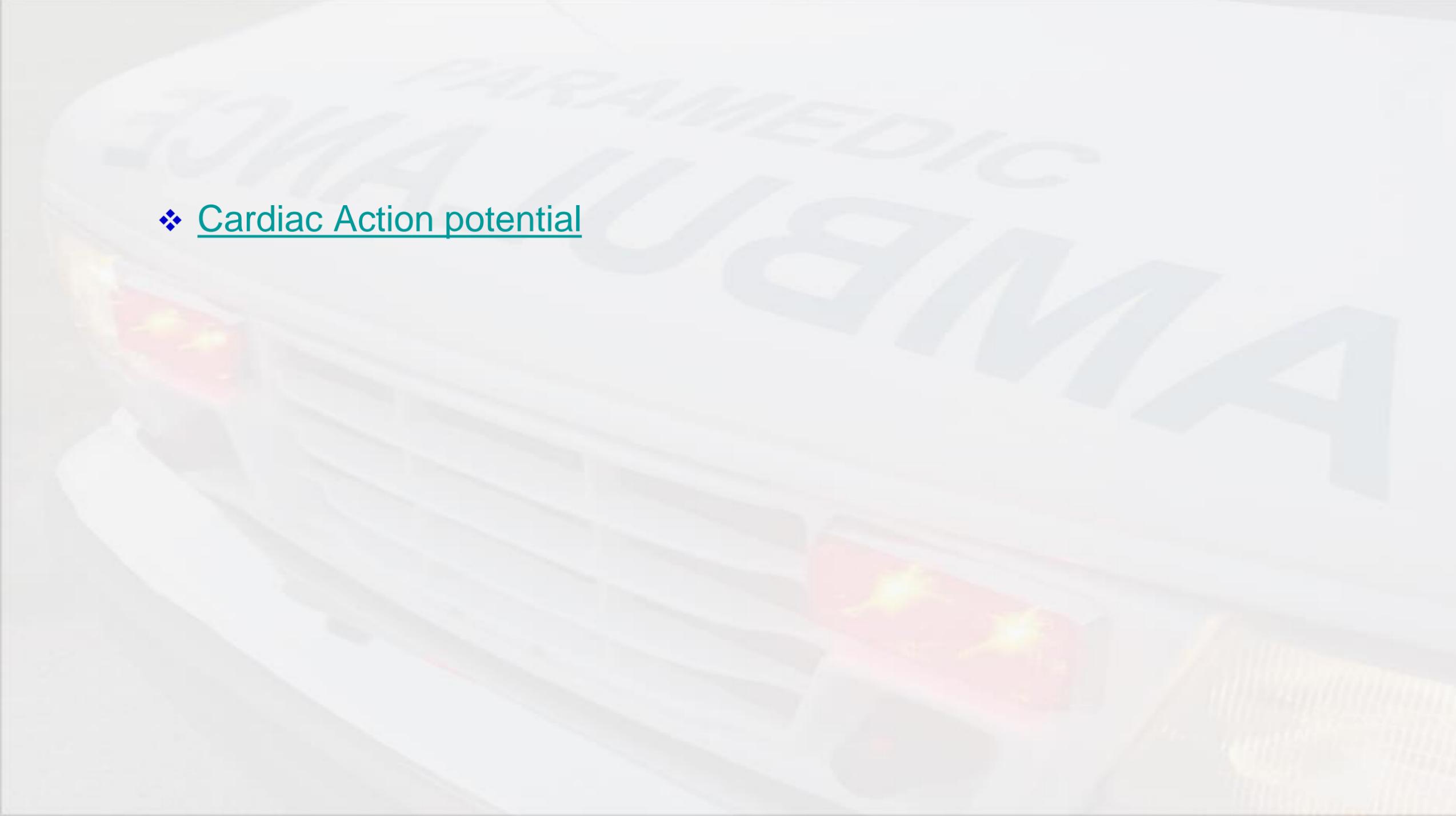


Normal beat

Normal beat

R-on-T phenomenon leading  
to ventricular fibrillation





❖ Cardiac Action potential



**Questions??**

# References

- ❖ Cardiac Muscle and Electrical Activity – Anatomy and Physiology ([opentextbc.ca](http://opentextbc.ca))
- ❖ Clinical electrocardiography and ECG interpretation – ECG & ECHO ([ecgwaves.com](http://ecgwaves.com))