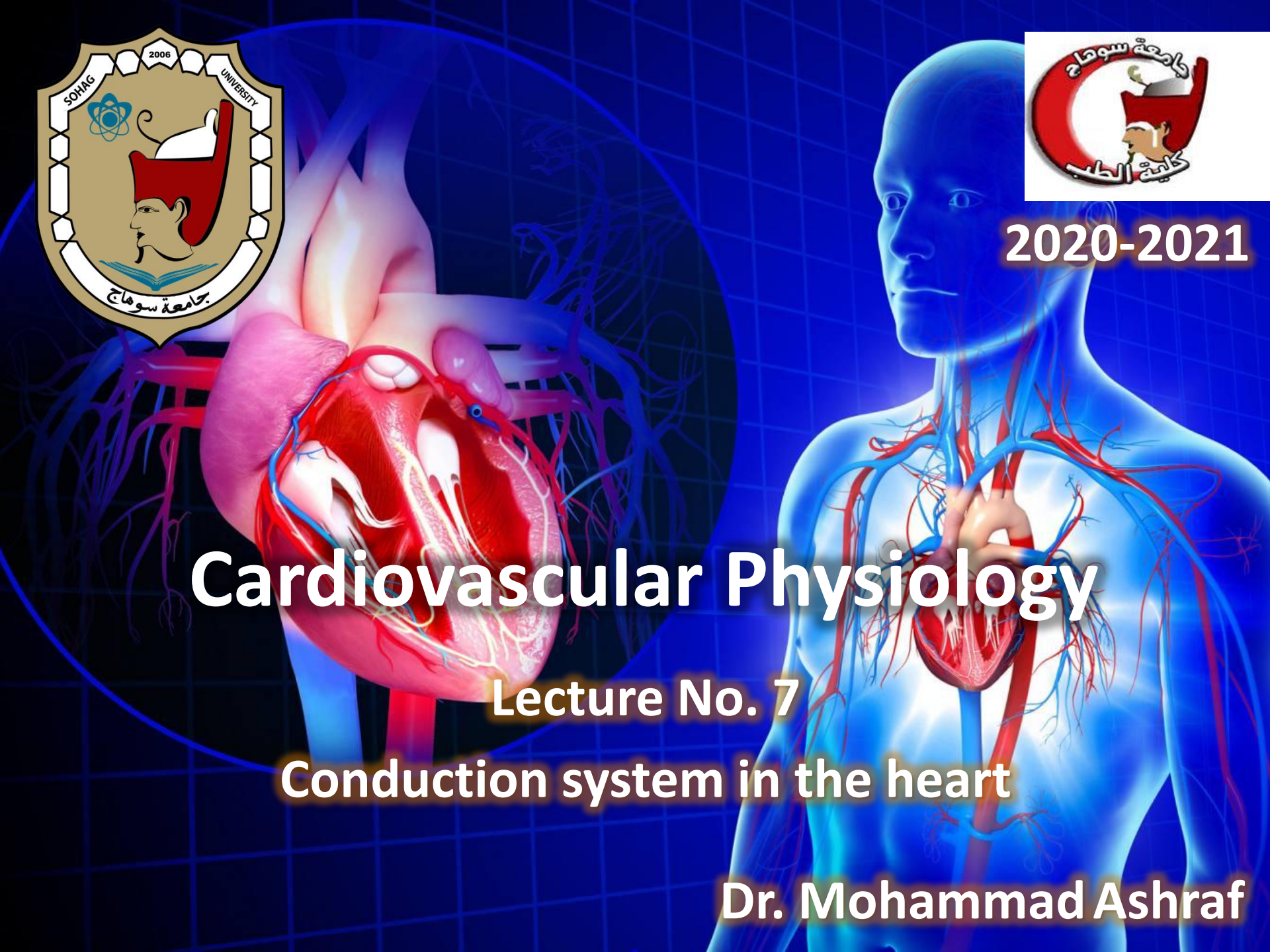


2020-2021

Cardiovascular Physiology

Lecture No. 7

Conduction system in the heart

Dr. Mohammad Ashraf

Conductivity

- **Definition**: it is the ability of the cardiac muscle to transmit the excitation wave all over the heart.

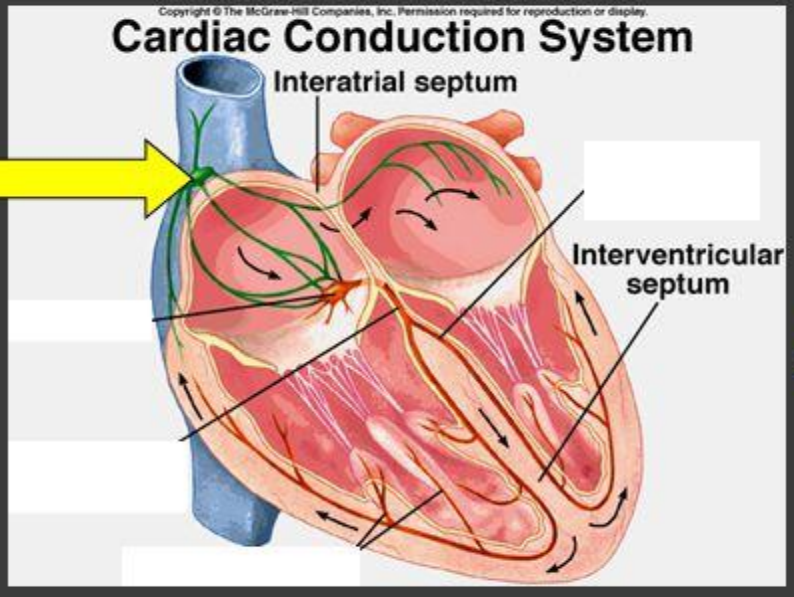
The conducting system inside the heart

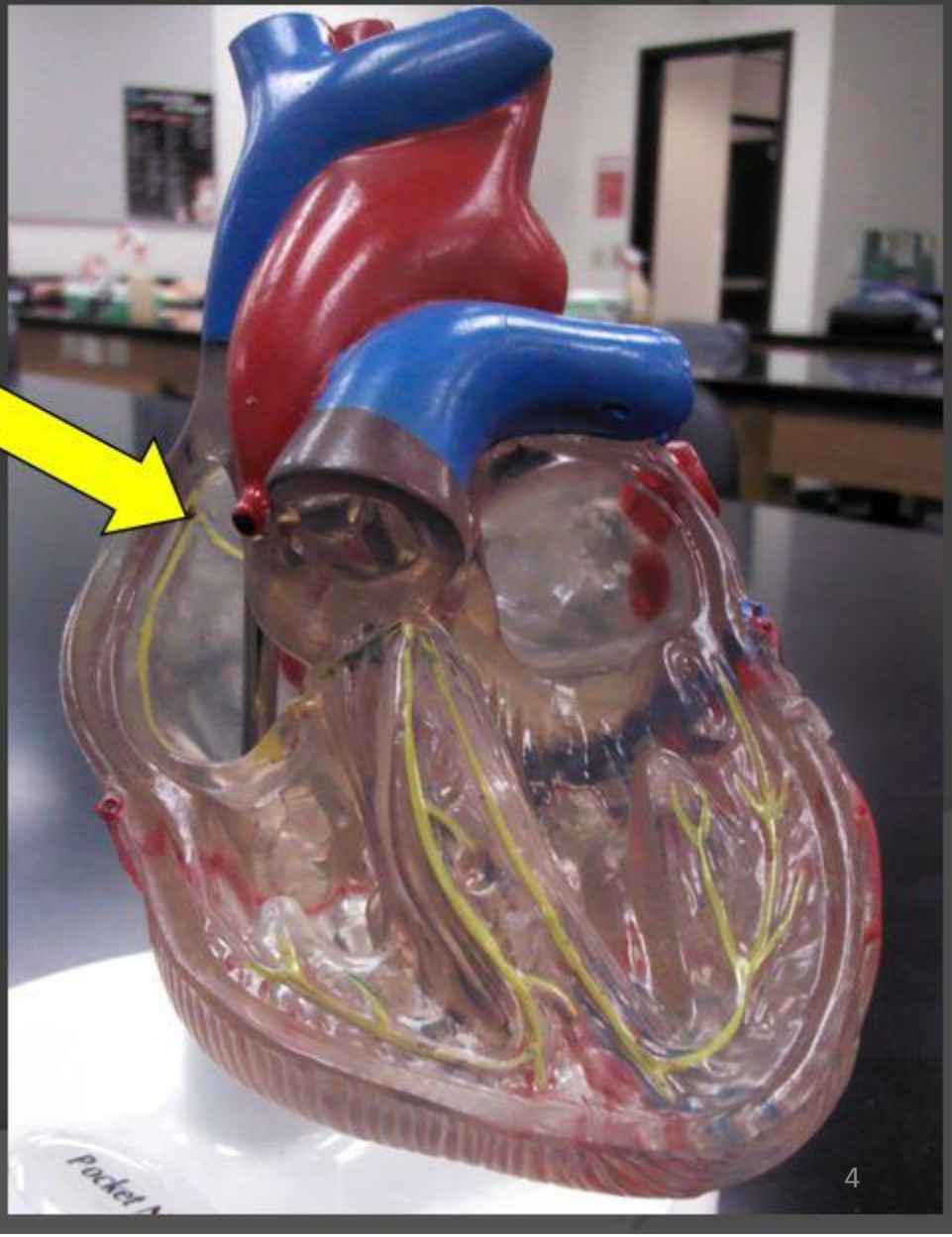
consists of:

1. Sinoatrial node (SAN):

The SAN is **a group of muscle cells** that normally initiate the heart beats. It is located at the junction of superior vena cava and the right atrium.

Sinoatrial (SA) node



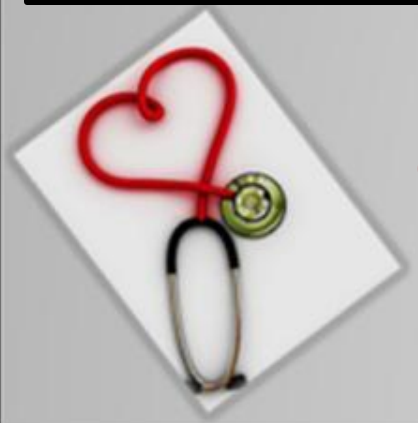


The conducting system inside the heart

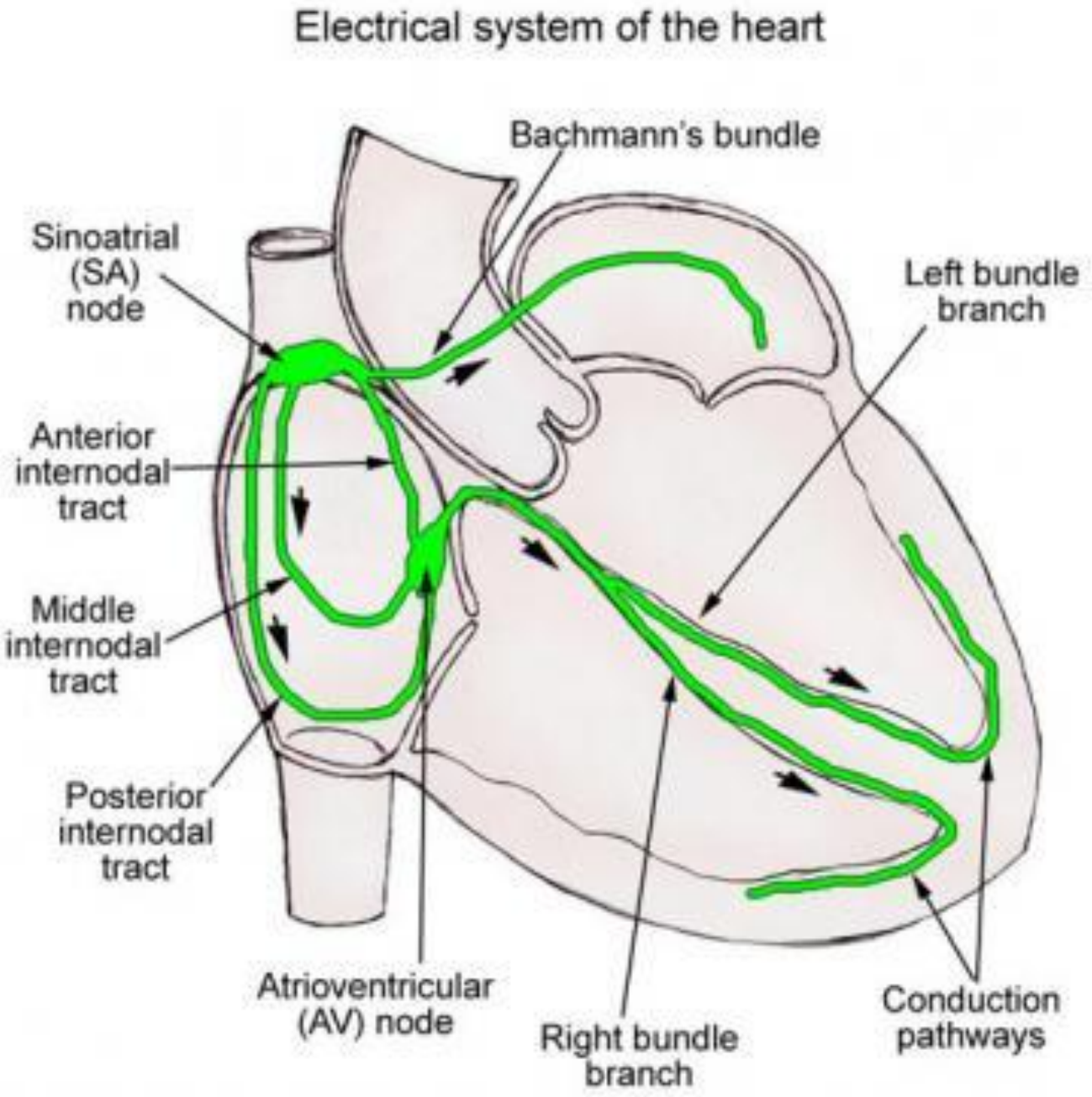
***2. Internodal fibers*:**

- *anterior (Bachmann).*
- *middle (Wenckebach).*
- *posterior* (*Thorel*) fibers.

- facilitate conduction in the right and left atria for the impulse to reach the AVN.



Conduction velocity is 1 meter / second.


Electrical system of the heart
Bachmann's bundle
Sinoatrial (SA) node
Left bundle branch
Anterior internodal tract
Middle internodal tract
Posterior internodal tract
Atrioventricular (AV) node
Right bundle branch
Conduction pathways

The conducting system inside the heart

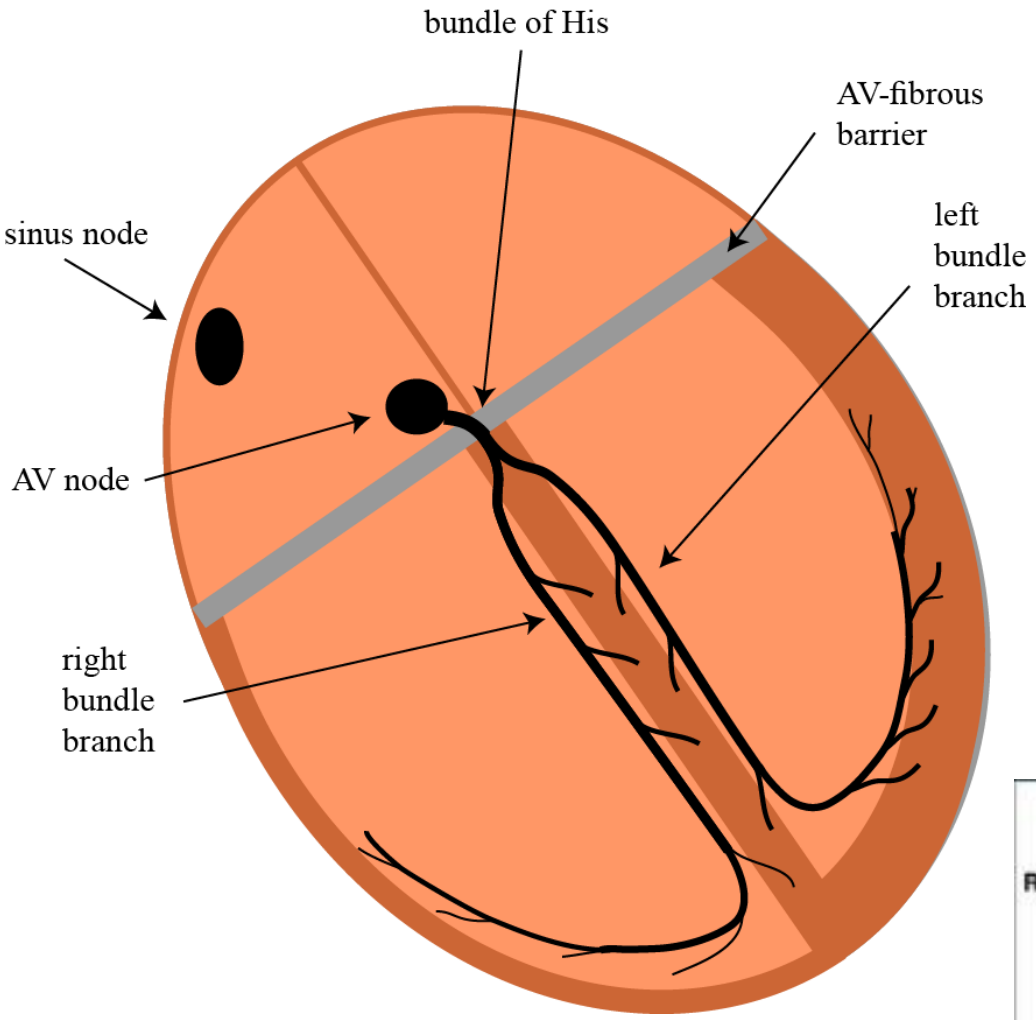
3. AVN:

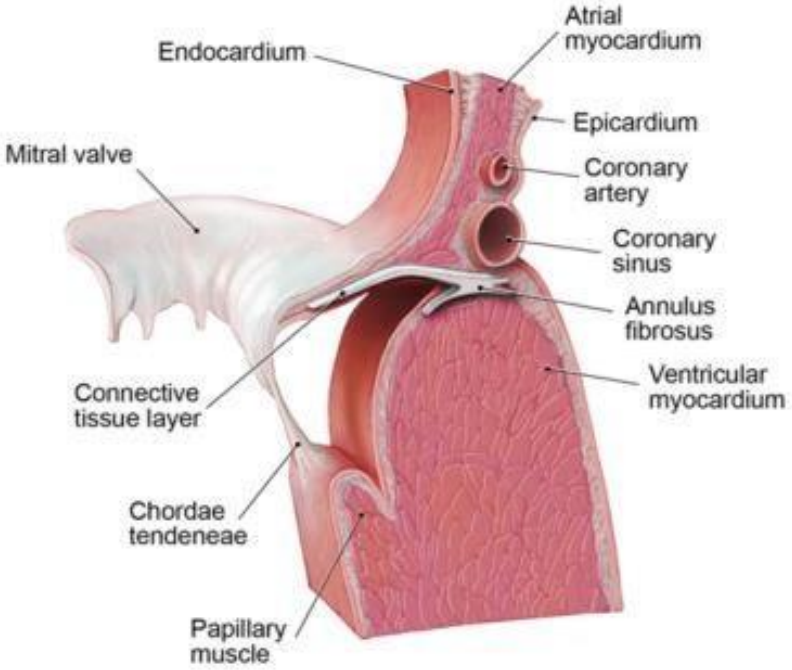
it represents the upper region of the only conducting route through the annulus fibrosus which separates the atria from ventricles.

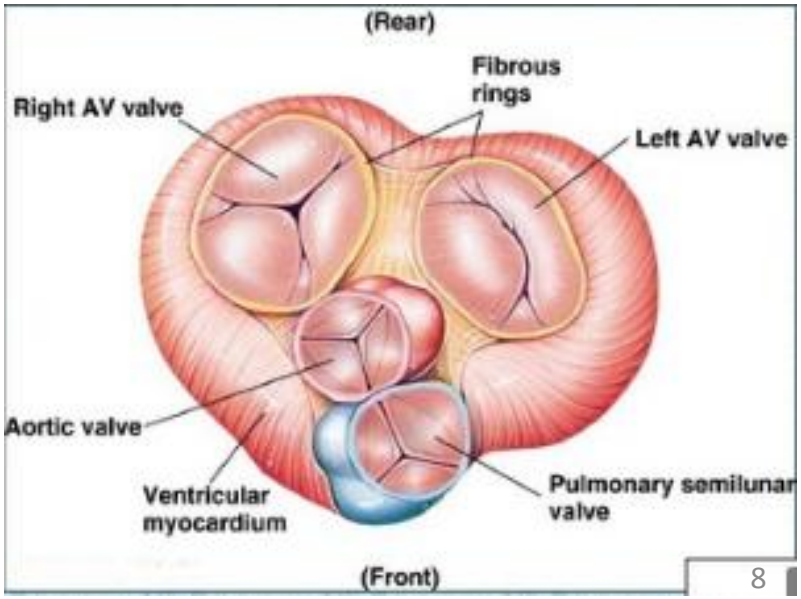
AVN is similar in structure to SAN and is situated near the interatrial septum.

Conduction velocity is 0.05 meter / second.

This conduction velocity is accelerated by sympathetic and slowed by parasympathetic.


bundle of His
AV-fibrous barrier
sinus node
left bundle branch
AV node
right bundle branch

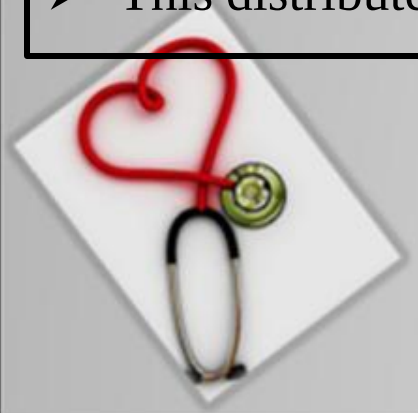

Endocardium
Atrial myocardium
Epicardium
Mitral valve
Coronary artery
Coronary sinus
Annulus fibrosus
Ventricular myocardium
Connective tissue layer
Chordae tendeneae
Papillary muscle

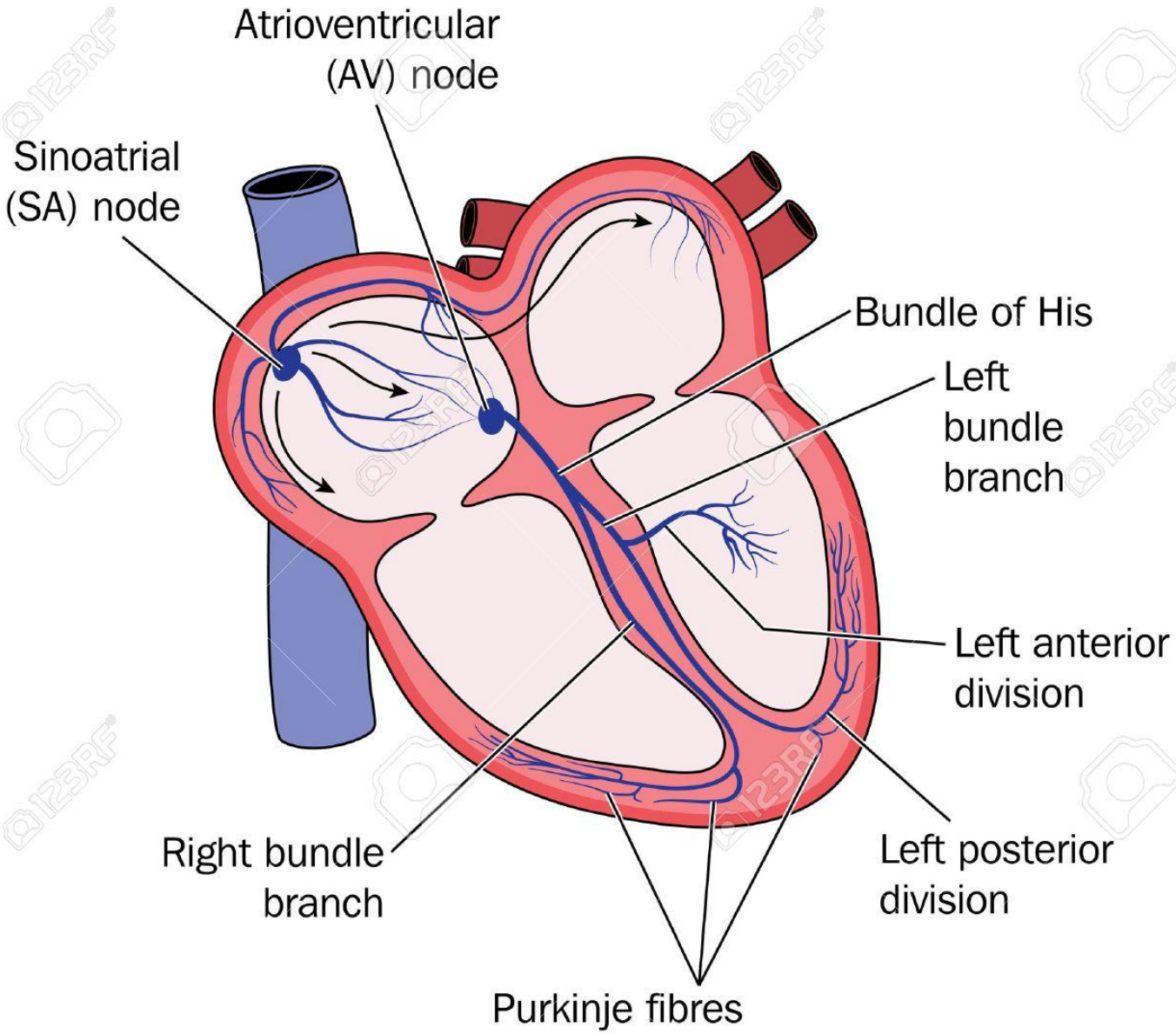

(Rear)
Fibrous rings
Right AV valve
Left AV valve
Aortic valve
Ventricular myocardium
Pulmonary semilunar valve
(Front)

The conducting system inside the heart

4. A.V. bundle (bundle of His) & Purkinje fibers:

- the bundle of His transfers impulses through the annulus fibrosus to the top of the interventricular septum.
- Then it branches into right and left bundle branches. The left bundle divides into anterior and posterior fascicles.
- The bundle travels under the endocardium the walls of the septum and at the base divides into multiple fibers of the Purkinje system.
- This distributes the impulses over the inner walls of the ventricles.




Atrioventricular
(AV) node
Sinoatrial
(SA) node
Bundle of His
Left
bundle
branch
Left anterior
division
Right bundle
branch
Left posterior
division
Purkinje fibres

The conducting system inside the heart

Cells of bundle of His and Purkinje system have large diameter and Rich in gap Junctions & consequently rapid rate of conduction velocity (about 4 m/sec).

This allows an immediate transmission of cardiac impulse to both ventricles.

The rate of conduction in atrial & ventricular muscles is 0.5 meter/ sec.

AV nodal delay

- The slowest conduction is at the AVN, this is called (AV nodal delay).
- **This is because the fibers of AVN are of:**
  - Very small diameter (velocity α r).
  - Complex arrangement.
  - Less gap junctions between these fibers.

Significance of AV nodal delay:

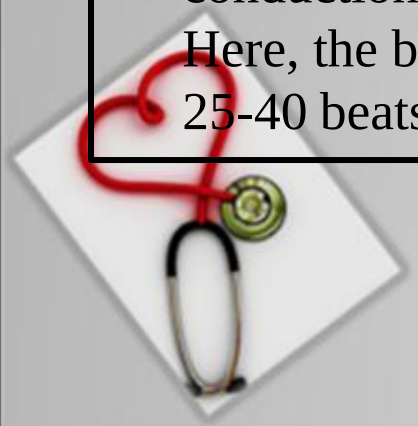
a) Delay ventricular contraction to the end of atrial contraction i.e. gives time for atria to empty their content in ventricles.

b) Protect the ventricles from high pathological atrial rhythm.

Defects of conduction

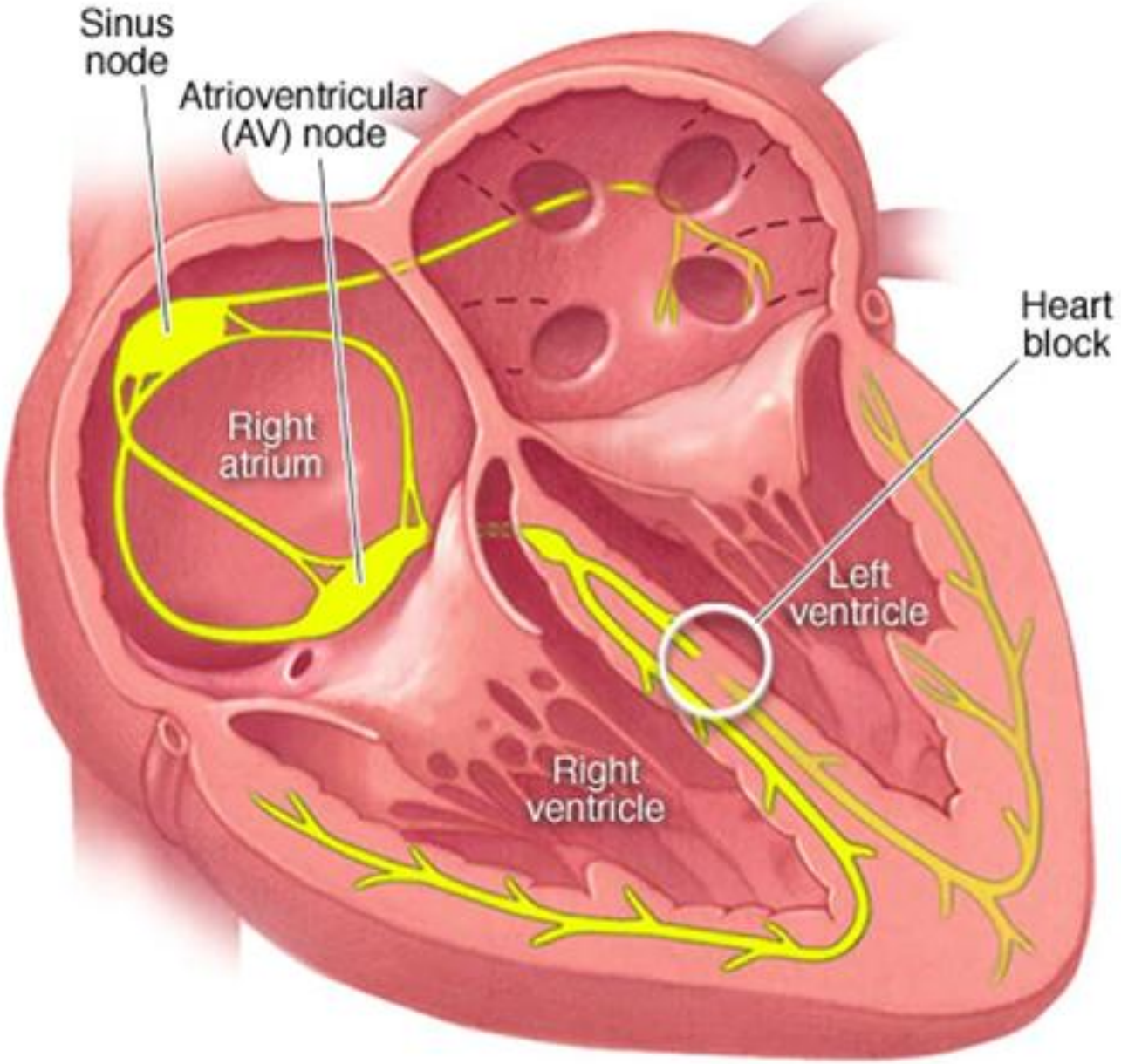
1. ***Heart block.***

- **Abnormal slow conduction in the AVN** results in:
  - ✓ ***First degree heart block***: when delay is much greater than normal.
  - ✓ ***Second degree heart block***: occurs when only fraction of impulses from the atria are conducted to the ventricles (2:1 , 3:1 or 4:1)
- **Complete heart block** (***3rd degree heart block***): when the conduction between atria and ventricles are completely abolished. Here, the bundle of His or Purkinje system can start discharge at a rate 25-40 beats / min.



Heart block

- **Bundle branch block: when one branch of the bundle doesn't conduct**, the part of the ventricle that it serves will still be stimulated by conduction through the myocardium from unaffected areas. This form of conduction is **delayed** and **slower**.


Sinus node
Atrioventricular (AV) node
Heart block
Right atrium
Left ventricle
Right ventricle

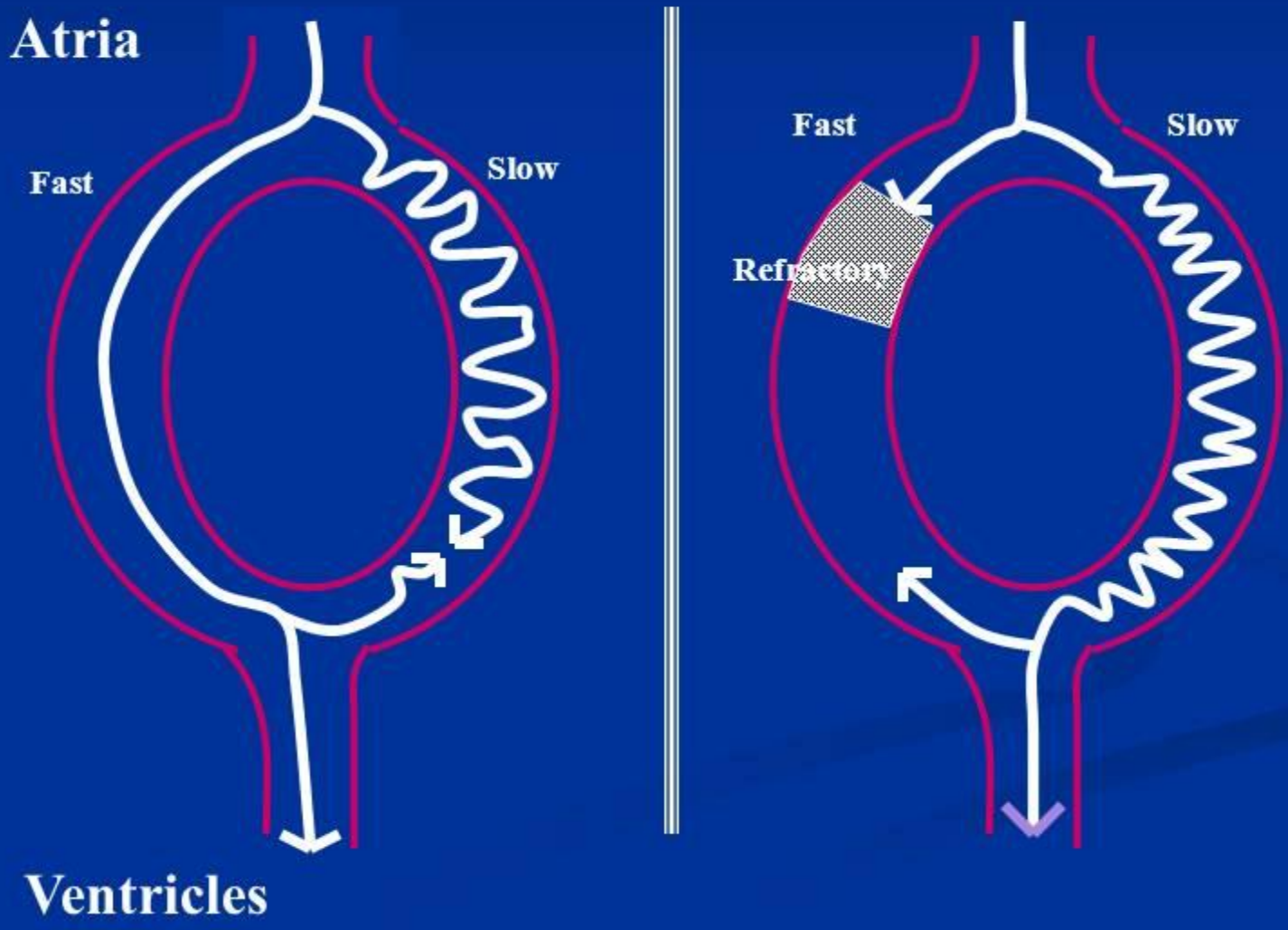
Congenital accessory conduction pathways

- **AV nodal re-entrant tachycardia (AVNRT):**
  - occurs when there is an accessory conducting pathway between atrial muscle and the AVN.
  - The normal AV pathway (termed α) conducts rapidly and has a long refractory period, while the accessory pathway (termed β) conducts slowly and has a short refractory period.
  - This is results in re-entrant tachycardia.

AV Node Re-entry

Sinus rhythm

Premature atrial contraction



- **Pre-excitation syndrome as Wolff- Parkinson – white syndrome**: It is due to abnormal fast accessory conducting pathway between atrium and ventricle (bundle of Kent) predisposing to a re-entry circuit and SVT.