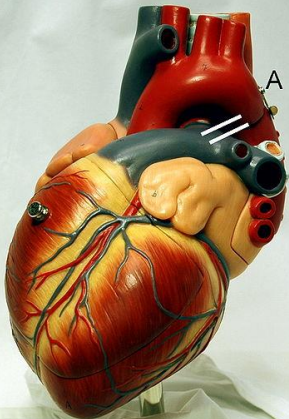


Cardiovascular System Block

Cardiac electrical activity

(Physiology)

Dr. Mona Soliman, MBBS, MSc, PhD
Head, Medical Education Department
Associate Professor of Physiology
Chair of Cardiovascular Block
College of Medicine
King Saud University



Cardiac Electrical Activity

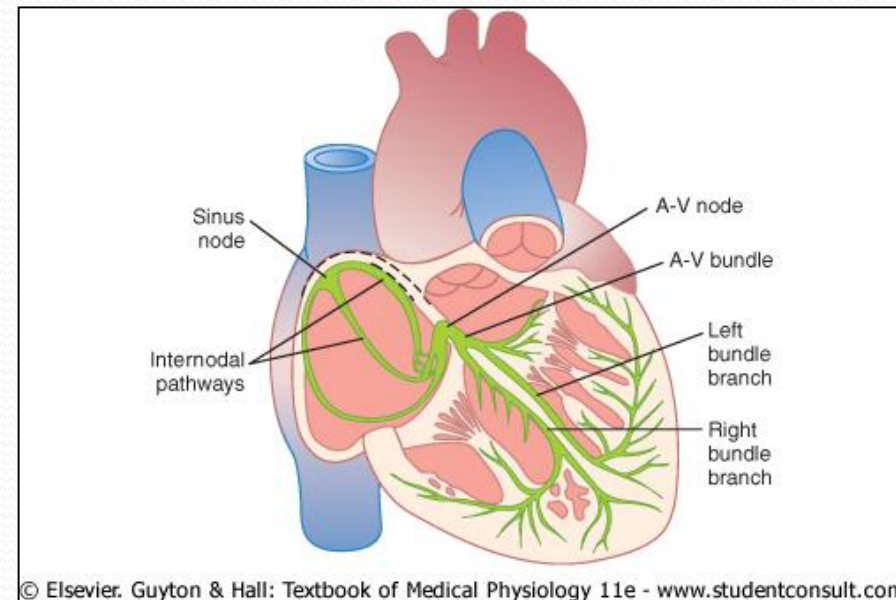
- **Automaticity of the heart:** the heart is capable of
 1. **Generating** rhythmical electrical impulses
 2. **Conduct** the impulses rapidly through the heart
- **The atria contract about one sixth of a second ahead of ventricular contraction**
 - To allow filling of the ventricles before they pump the blood into the circulation



Why?

The Specialized Excitatory and Conductive System of the Heart

1. **The sinoatrial (S-A node)**
2. **The internodal pathway**
3. **The atrioventricular (A-V node)**
4. **The atrioventricular bundle (Bundle of His)**
5. **Purkinje fibers**



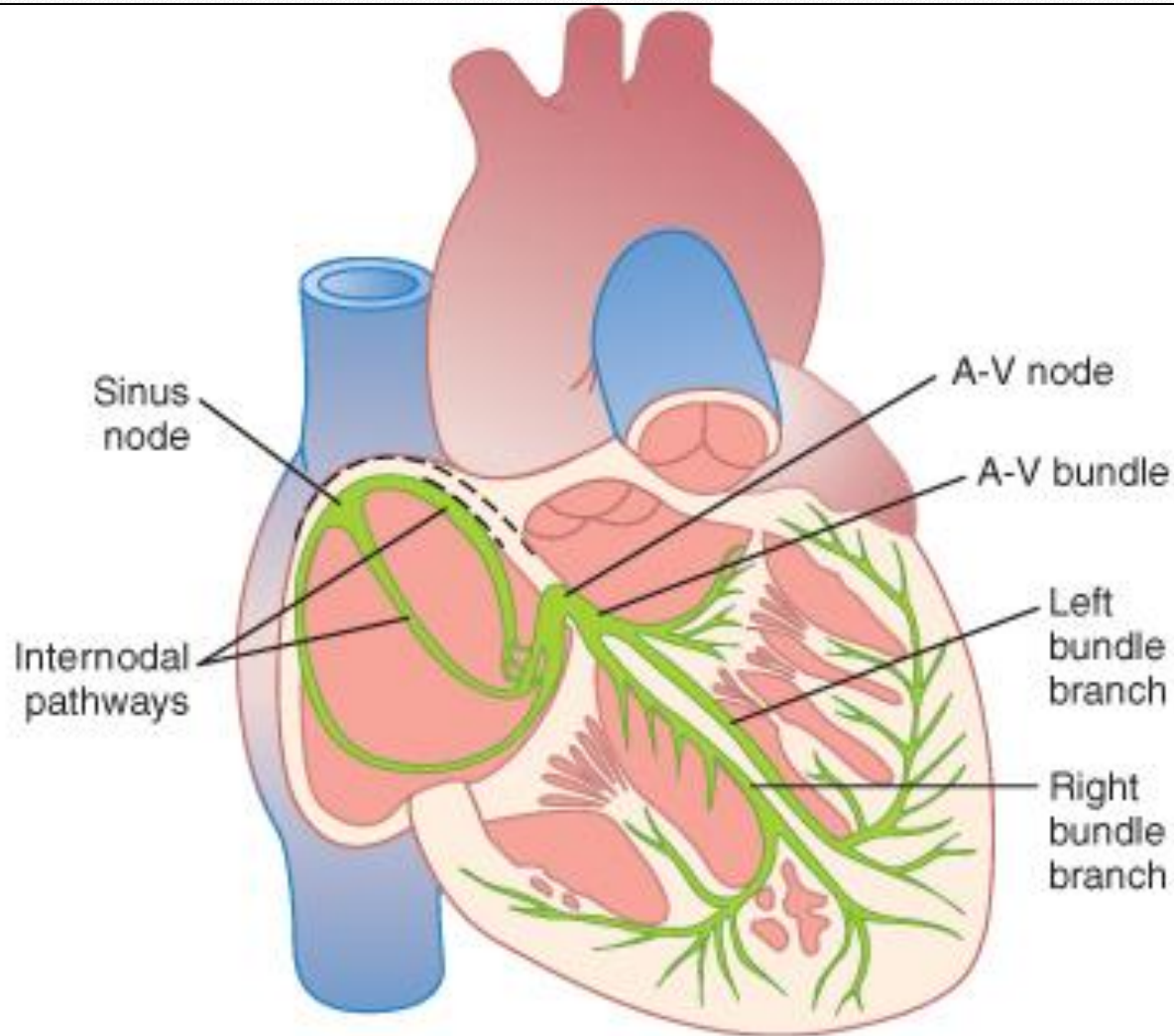
Conduction of Impulses

Sinoatrial node (S-A node):

- Located in the superior lateral wall of the right atrium near the opening of the superior vena cava
- Pacemaker of the heart
 - Its rate of rhythmic discharge is ***greater*** than any other part in the heart
 - **Highest frequency**
 - Is capable of ***originating*** action potentials



Conduction of Impulses



Conduction of Impulses

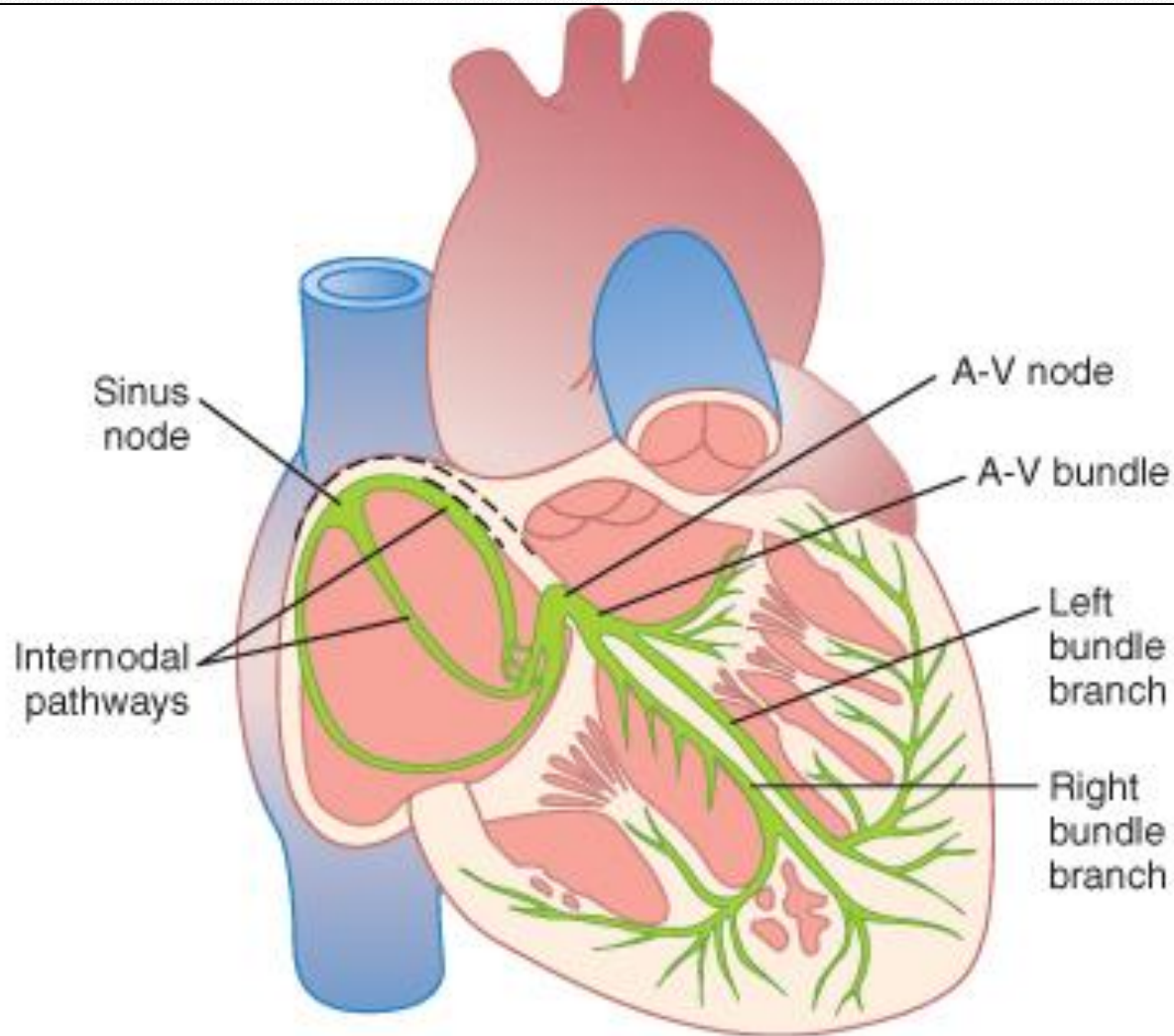
Atrioventricular (A-V) node:

- Located in the posterior wall of the right atrium
- Delay in the conduction of impulses (0.1 sec)
- Allows time for the atria to empty the blood into the ventricles before ventricular contraction begin



Why?

Conduction of Impulses



Conduction of Impulses

The Purkinje System

- Purkinje fibers are very large fibers
- Transmit action potentials at a very high velocity (0.1-4.0 m/sec)
 - very high permeability of gap junctions
 - → ions are transmitted easily from one cell to the next
 - → enhance the velocity of transmission
- Ventricular muscle contract at almost the same time



Why?

Conduction of Impulses

The Purkinje System

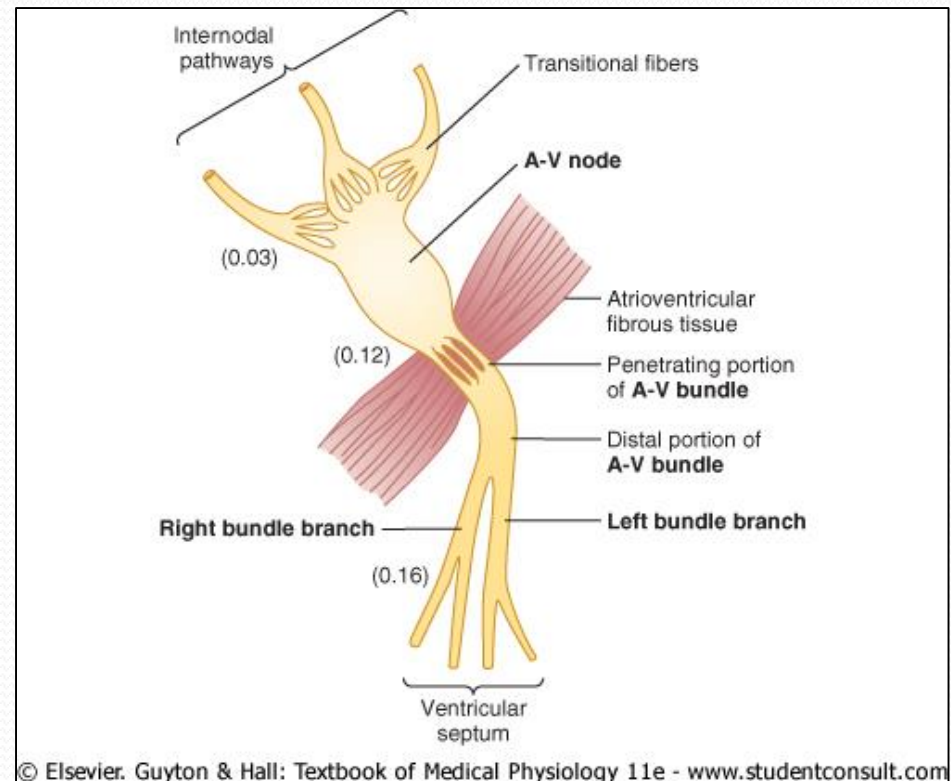
Penetrate atrioventricular fibrous tissue

→ divides into right and left bundle branches

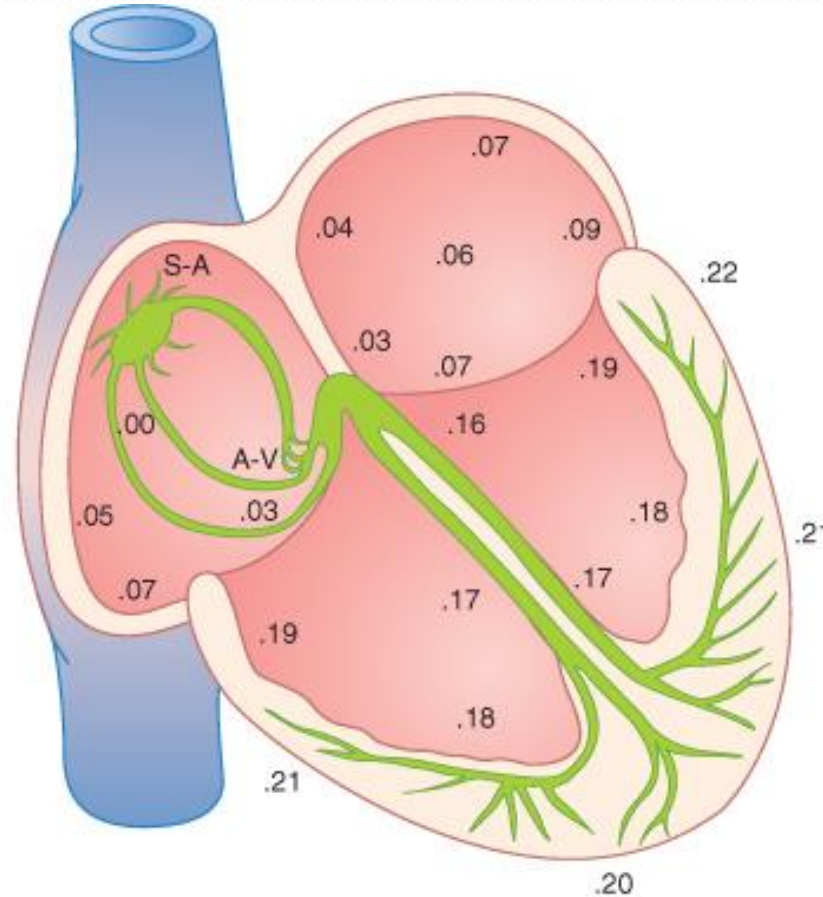
→ each branch spread toward the apex of the heart

→ divide into small branches

→ penetrate and become continuous with cardiac muscle fibers



Spread of the cardiac impulse through the heart



Control of Excitation and Conduction in the Heart

- The impulse normally arise s in the sinus node
- The Sinus Node is the **Pacemaker** of the Heart
- Its rate of rhythmical discharge is faster than that of any other part of the heart



Why?

Abnormal Pacemakers

- Ectopic pacemaker: a pacemaker elsewhere than the sinus node
- The cause:
 1. Any other part of the heart develops a rhythmical discharge rate that is more rapid than that of the sinus node

Example: the A-V node or in the Purkinje fibers

Abnormal Pacemakers

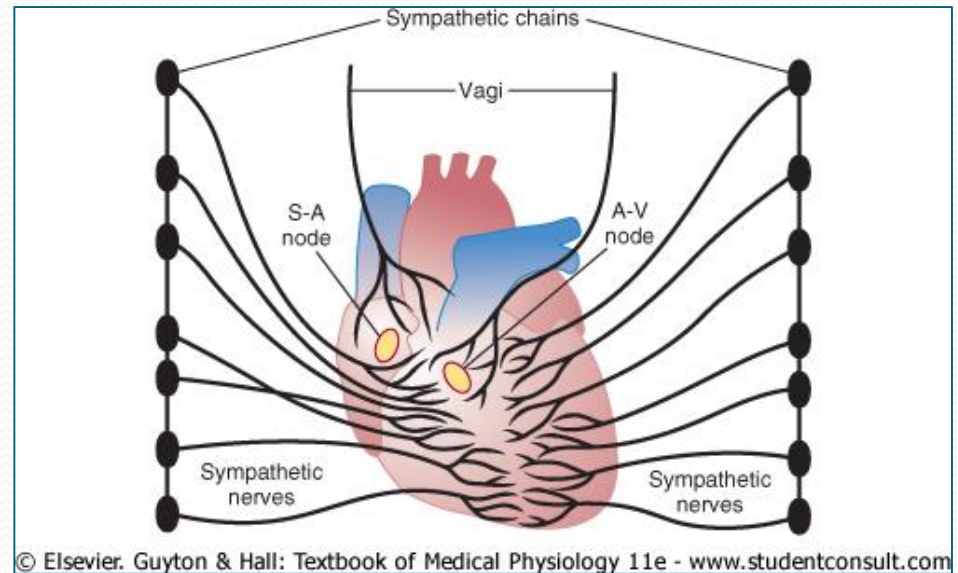
2. Blockage of transmission of the cardiac impulse from the sinus node to the other parts of the heart

Example: A-V block

- cardiac impulses fails to pass from atria into the ventricles
- the atria continues to beat at the normal rate of rhythm of the S-A node
- a new pacemaker develops in the Purkinje system with a new rate

Control of Heart Rhythmicity and Impulse Conduction by the Cardiac Nerves

- The heart is supplied with both sympathetic and parasympathetic nerves
- Parasympathetic nerves (vagi): mainly to the S-A and A-V nodes
- Sympathetic nerves: all parts of the heart with strong supply to the ventricles



Parasympathetic stimulation of the heart

- ↓ rate of rhythm of the S-A node
- ↓ transmission of impulses to the A-V node
- **Strong stimulation of the vagi:**
 - Stop completely the rhythmical excitation by the S-A node
 - Block completely transmission of cardiac impulses from the atria to the ventricle
 - Some point in the Purkinje fibers develops a rhythm of its own

“Ventricular Escape”

Sympathetic stimulation of the heart

- ↑ rate of rhythm of the S-A node
- ↑ transmission of impulses to the A-V node
- ↑ force of contraction

For further readings and diagrams:

Textbook of Medical Physiology by Guyton & Hall
Chapter 10 (Rhythmical Excitation of the Heart)



Good Luck