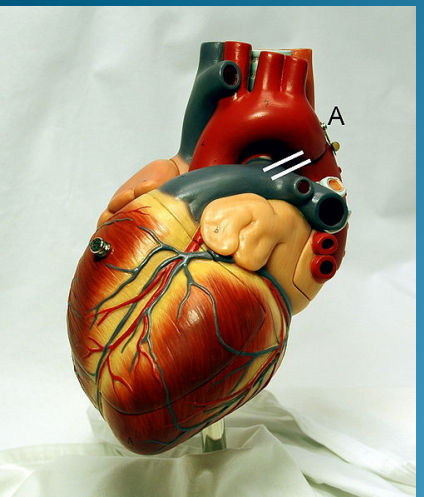
Cardiovascular System Block

Cardiac electrical activity (Physiology)



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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

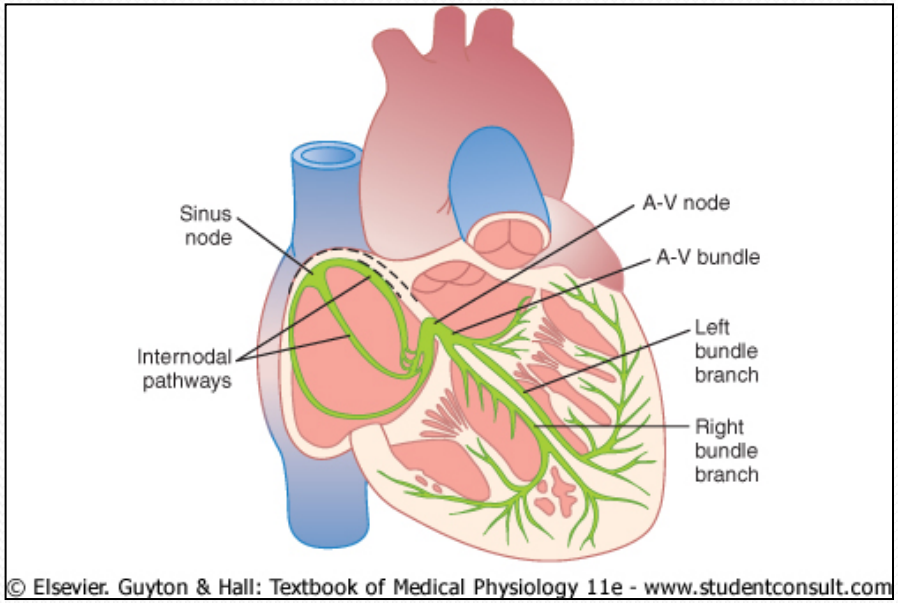
- **The atria contract about one sixth of a second ahead of ventricular contracti**

Why?

- To allows filling of the ventricles before they pump the blood into the circulation

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*



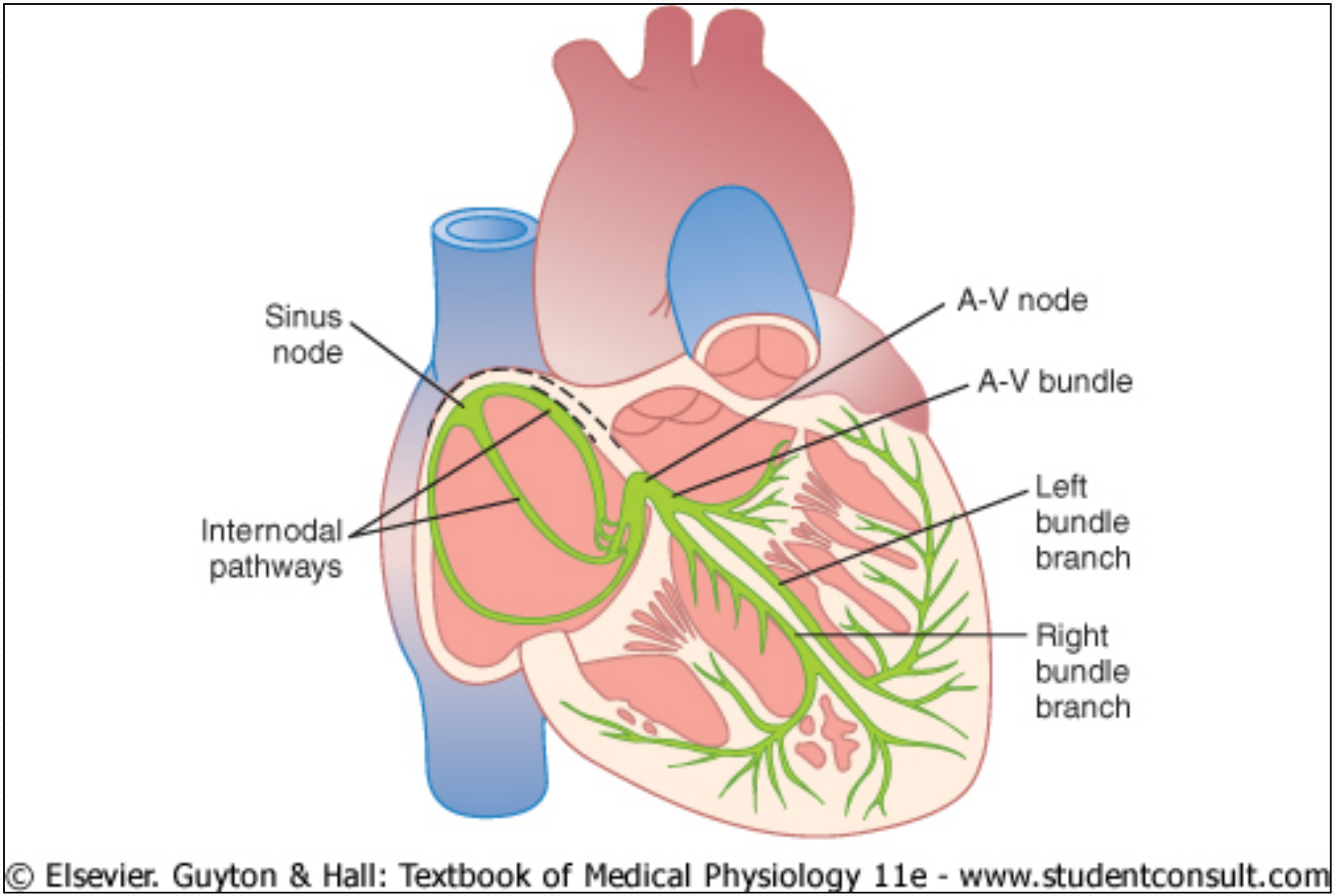
Conduction of Impulses

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



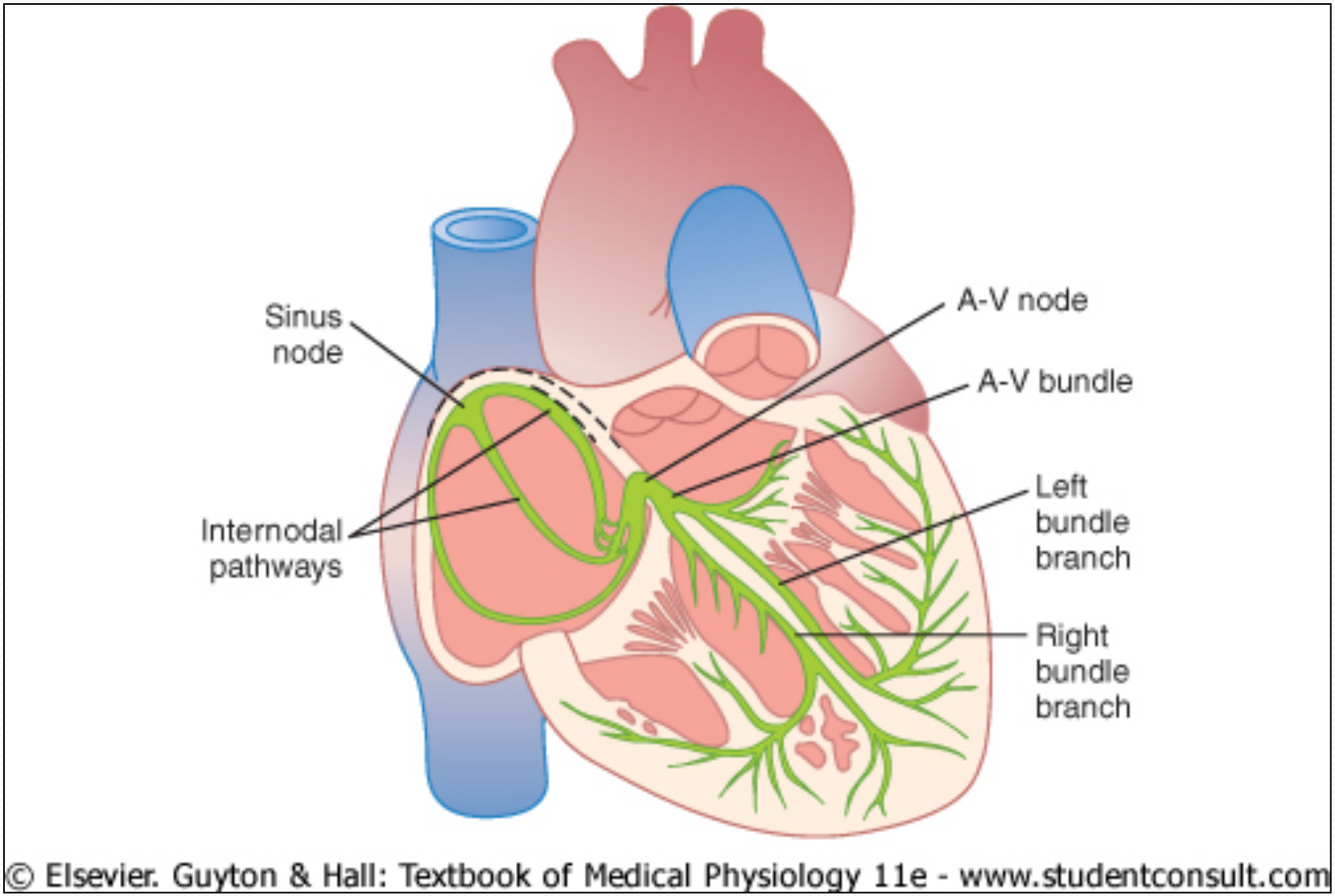
Conduction of Impulses

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

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

Conduction of Impulses

The Purkinje System

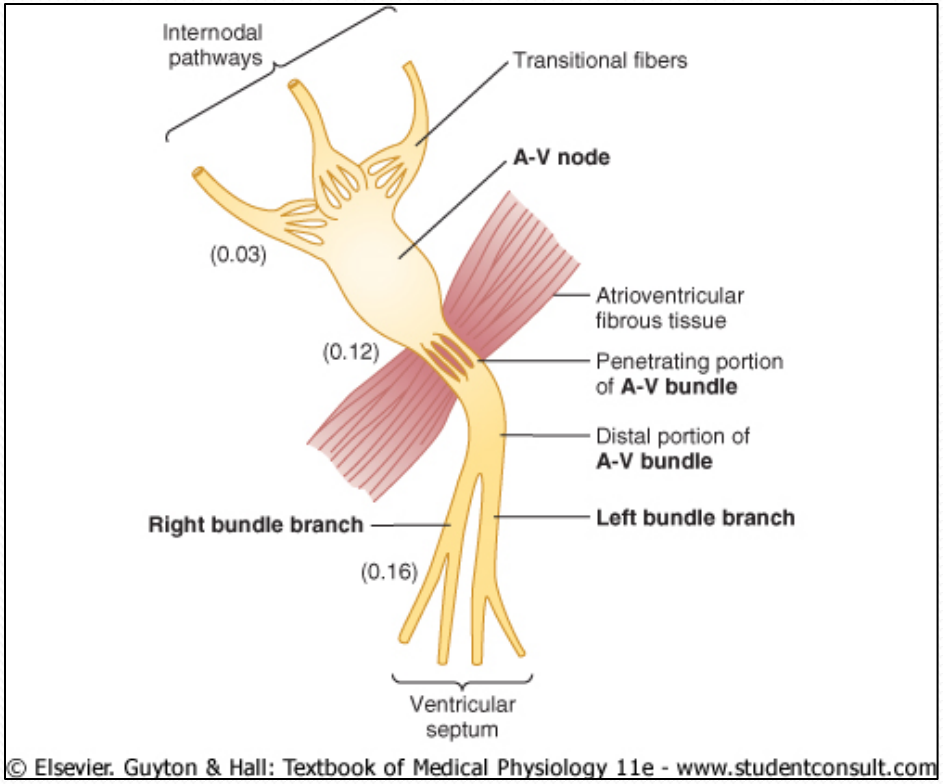
Penetrate atrioventricular fibrous tissue

→ divides into right and left bundle branches

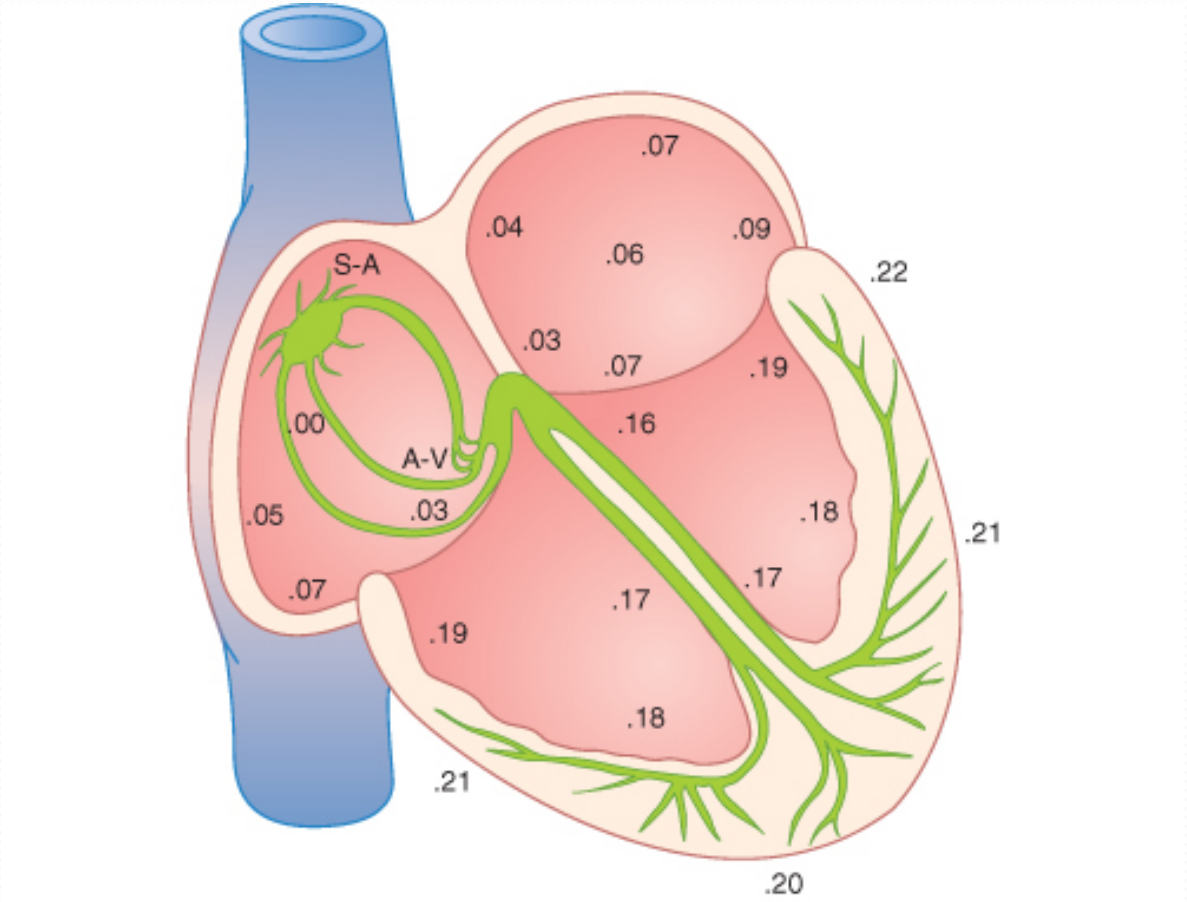
→ each branch spread toward the apex of the heart

→ divide into small branches

→ penetrate and become continuous with cardiac muscle fibers

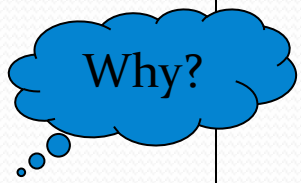


Spread of the cardiac impulse through the heart



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

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**

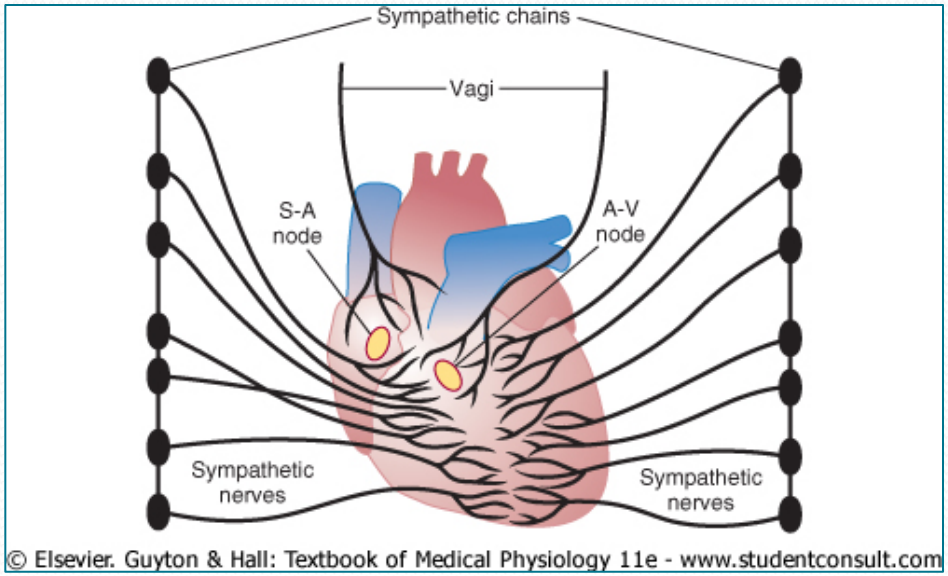
→ cardiac impulses fails to pass from atria into the ventricles

→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