1st YEAR MBBS
PHYSIOLOGY
CONDUCTIVE SYSTEM OF HEART

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Learning objectives

At the end of lecture students of 1st year MBBS students should be able to

1. Describe the physiologic anatomy of conductive system of heart
2. Significance of AV nodal delay
3. Explain Normal pace maker of heart
4. Define ectopic pace makers and describe its causes

conductive system of heart

Contractile cells

- Mechanical work of pumping

Auto rhythmic cells

- Not contract but instead are specialized for initiating and conducting the action potentials responsible for contraction of contractile cells

Objective 1; Describe the physiologic anatomy of conductive system of heart

Significance ?

1)Atria contract about one sixth of a second ahead of ventricular contraction, which allows filling of the ventricles before they pump the blood through the lungs and peripheral circulation

2) Allows all portions of the **ventricles to contract almost simultaneously,** which is essential for most effective pressure generation in the ventricular chambers.

Characteristics of Cardiac Conduction Cells

- Automaticity: Ability to initiate an electrical impulse
- Excitability: Ability to respond to an electrical impulse
- Conductivity: Ability to transmit an electrical impulse from one cell to another

Characteristics of auto rhythmic cells

- In skeletal muscle the membrane remains at **constant resting potentia**l (-85 to - 90 mv in ventricular muscle) unless the cell is **stimulated**

membrane potential slowly depolarizes, **no true resting membrane potential** (-55 to -60, continuously leaky to Na , generate regular, **spontaneou**s action potentials

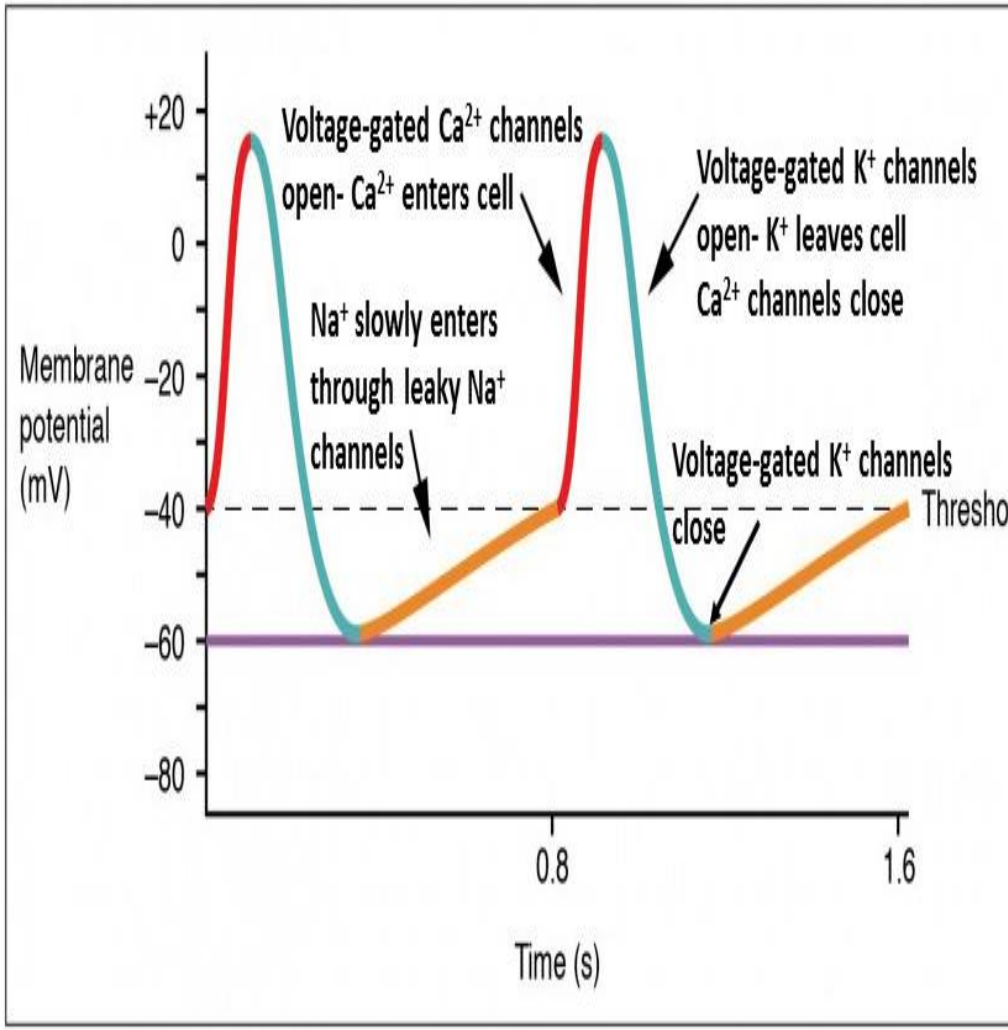
Characteristics of auto rhythmic cells

- Depolarizing current is carried into the cell primarily by fast sodium currents
- Depolarizing current is carried into the cell primarily by relatively slow Sodium - $Ca^{++,}$ currents

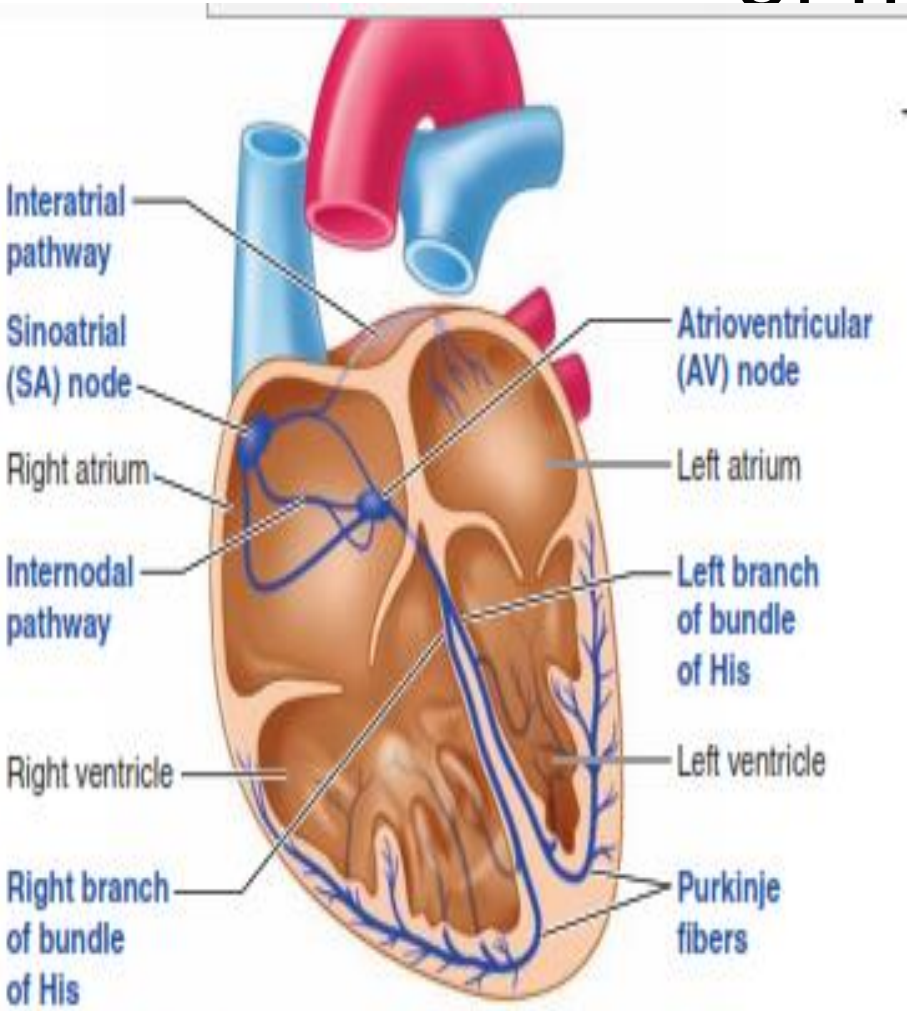
changes in ion movement that give rise to the Pacemaker potential

1. **Depolarization = slow Na Ca channels**
2. **Repolarization = K channels**
3. **hyperpolarization =**
4. **K channels remain open for some time**
5. **Towards threshold**

- **Decreased outward K current,**
- **Naturally leaky to Na**
- **Moderate number of already open sodium channels**



Components of the conductive system of heart

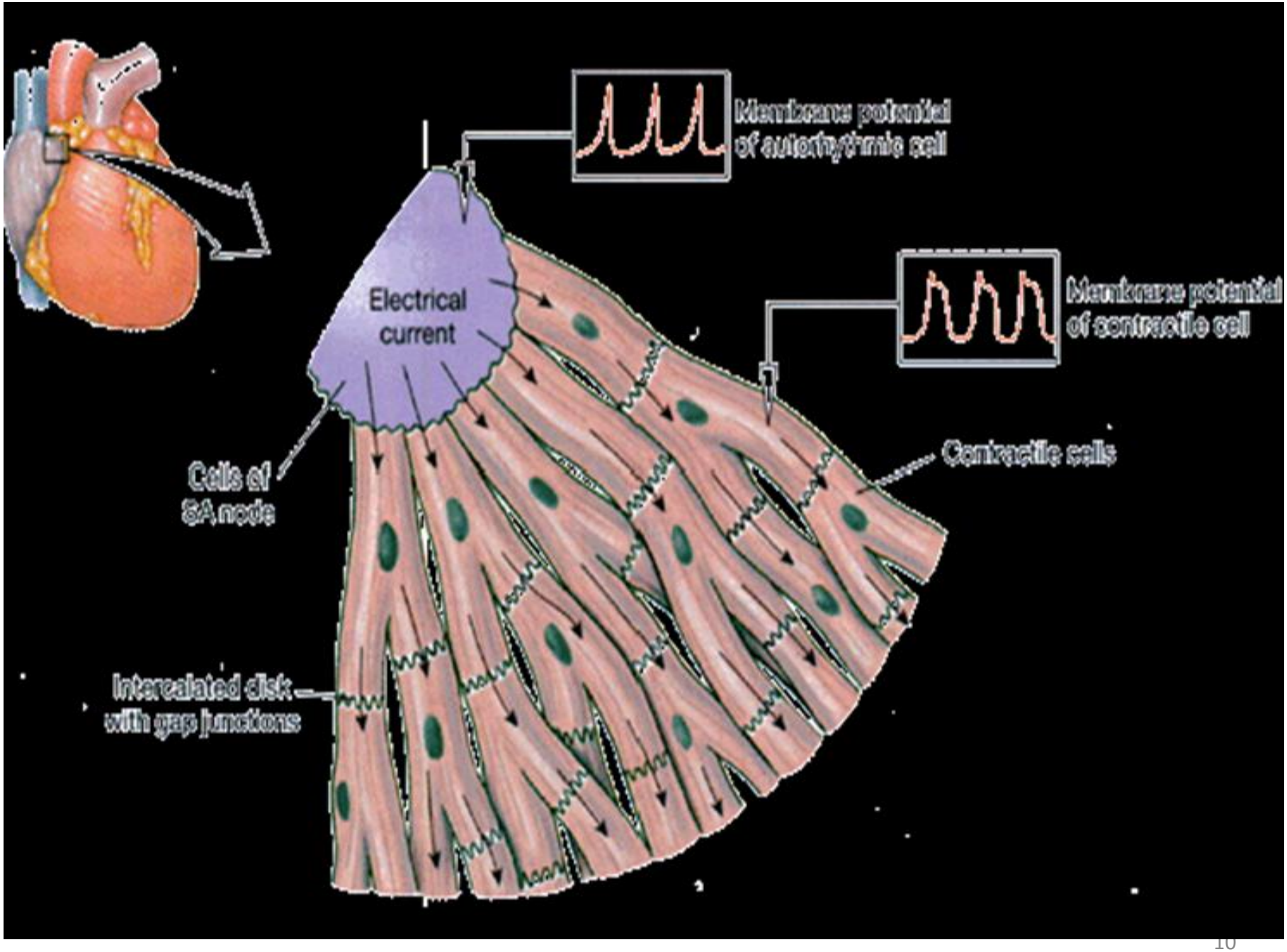


(a) Specialized conduction system of the heart

Sinoatrial node (SA) a small, specialized region in the right atrial wall near the opening of superior vena cava **Atrioventricular node (AV)** specialized cardiac muscle cells located at the base of the right atrium near the septum

Bundle of His originates at the AV node and enters the septum between the ventricles

Purkinje fibers


Membrane potential of autorhythmic cell
Membrane potential of contractile cell
Electrical current
Cells of SA node
Contractile cells
Intercalated disk with gap junctions

RATE OF IMPULSE GENERATION

TISSUE	RATE OF IMPULSE GENERATION
SA NODE	70-80/MIN
AV NODE	40 – 60/MIN
BUNDLE OF HIS	40/MIN
PURKINJE SYSTEM	24/MIN

Conduction pathway

The action potential is conducted relatively slowly through the AV node.

delayed about 0.09+0.04=0.13 sec

Advantageous

1. Enables the **atria to become completely depolarized** and to contract, emptying their contents into the ventricles, before ventricular depolarization and contraction occur
2. Allows time for **complete ventricular filling**.

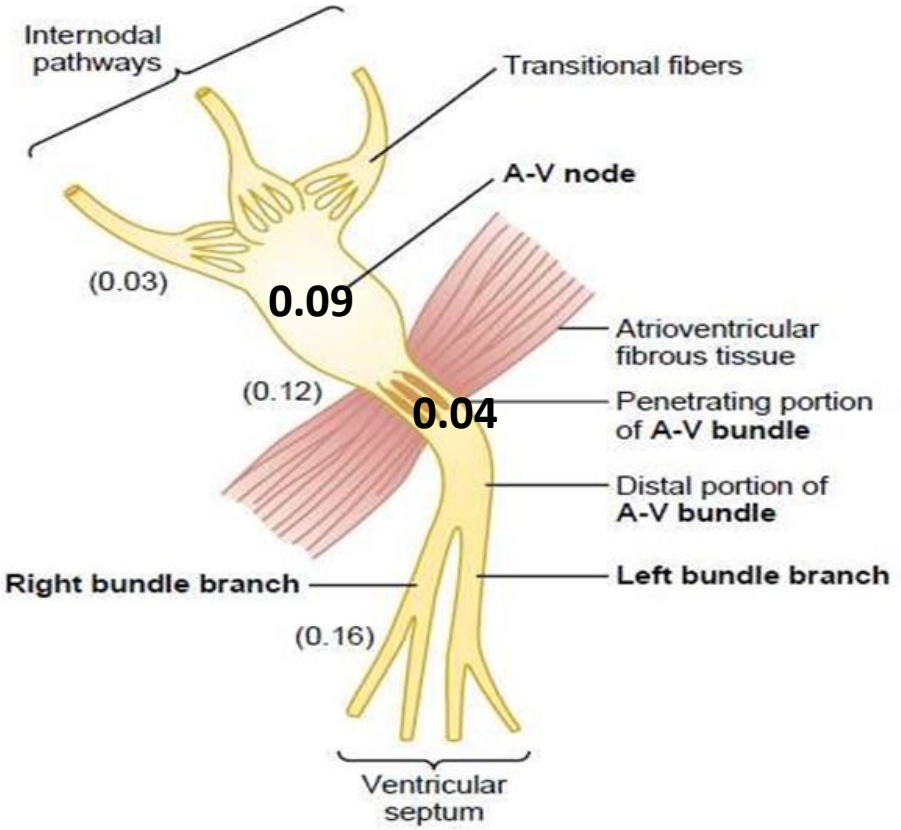


Figure 10–3

Organization of the A-V node. The numbers represent the interval of time from the origin of the impulse in the sinus node. The values have been extrapolated to human beings.

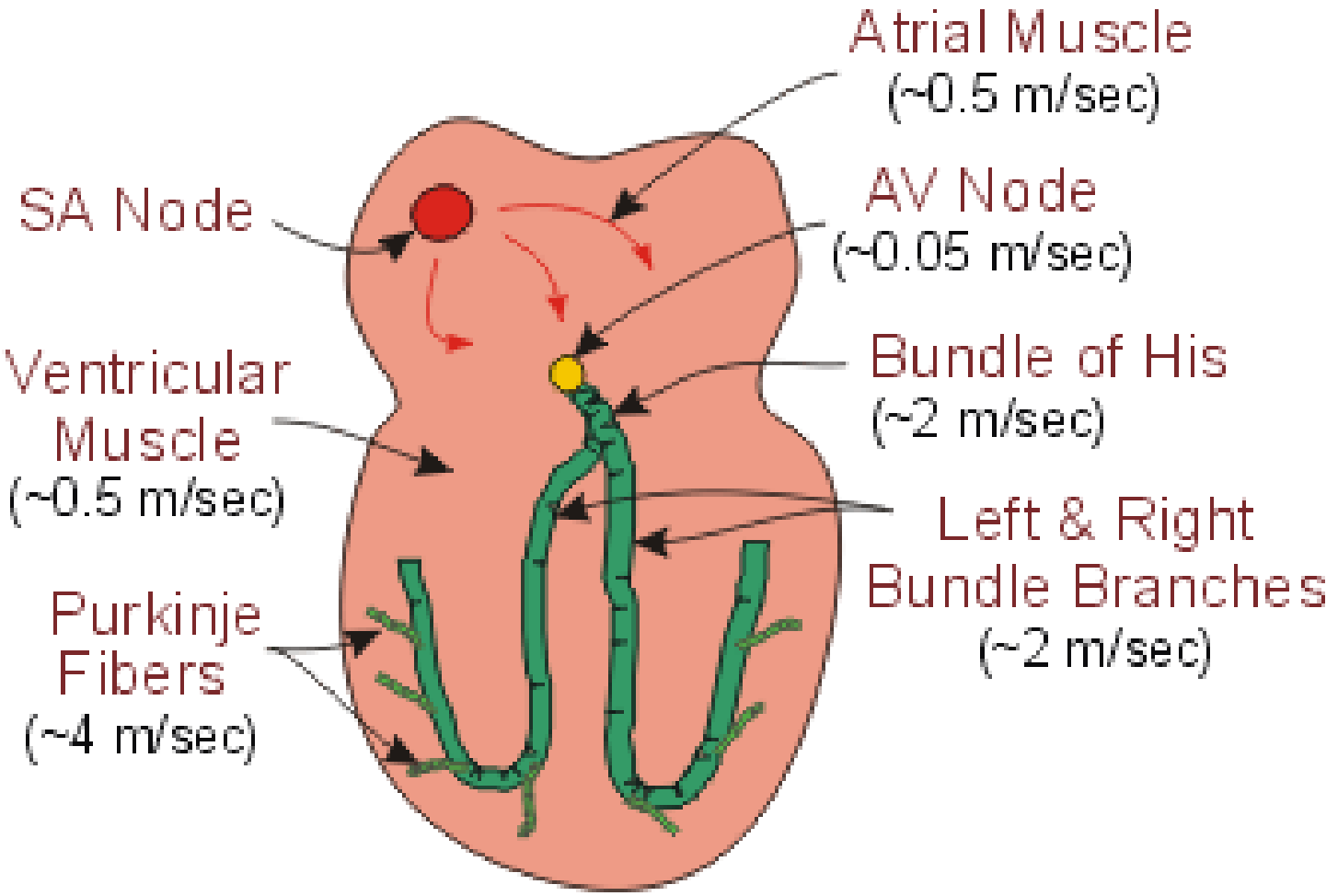
Mechanism of AV delay

Diminished numbers of gap junctions between successive cells in the conducting pathways, so that there is great resistance to conduction of excitatory ions from one conducting fibre to the next.

Rapid Transmission in the Ventricular Purkinje System

- Very large fibers, even larger than the normal ventricular muscle fibers,
- Transmit action potentials at a velocity of 1.5 to 4.0 m/sec, a velocity about 6 times that in the usual ventricular muscle and 150 times that in some of the A-V nodal fibers.
- Allows almost instantaneous transmission of the cardiac impulse throughout the entire remainder of the ventricular muscle

Speed of conduction



(Cont)Criteria for the spread of cardiac excitation

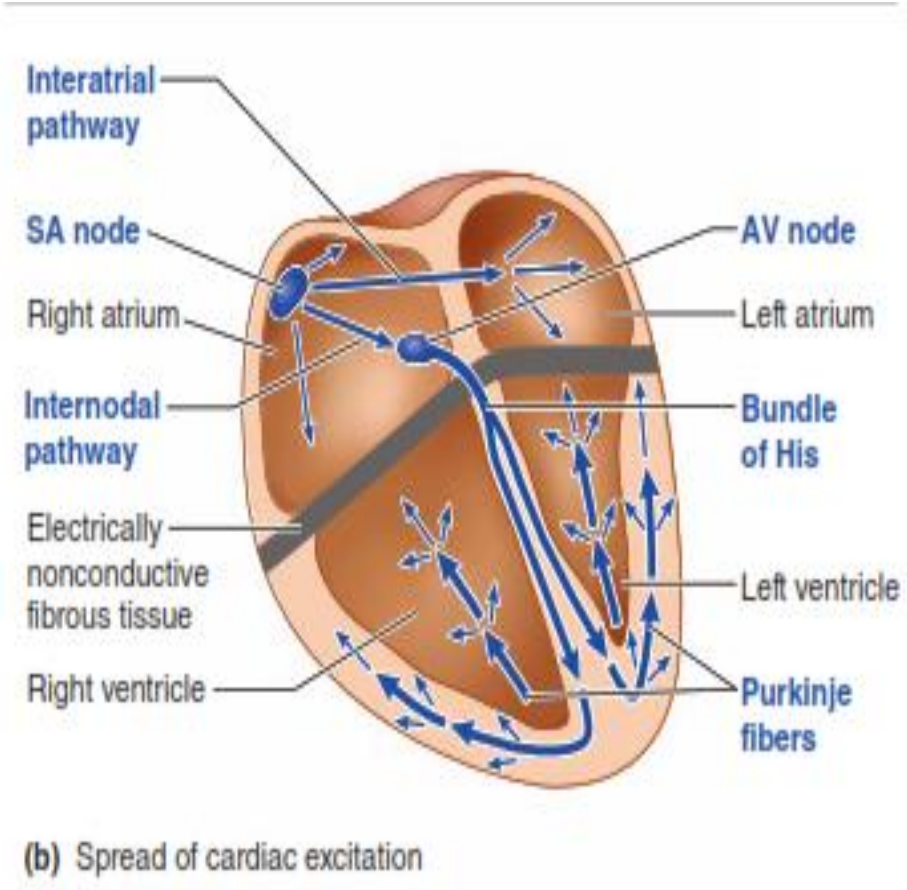
Excitation of cardiac muscle fibers should be coordinated to ensure that each heart chamber contracts as a unit to pump efficiently.

WHAT IF THERE IS CONTRACTION OF INDIVIDUAL MYOCYTES?

Objective 1:Describe the physiologic anatomy of conductive system of heart

- Ventricular fibrillation
- Atrial fibrillation

WHAT DO YOU THINK WHICH ONE IS DANGEROUS AND WHY?



Objective 1:Describe the physiologic anatomy of conductive system of heart

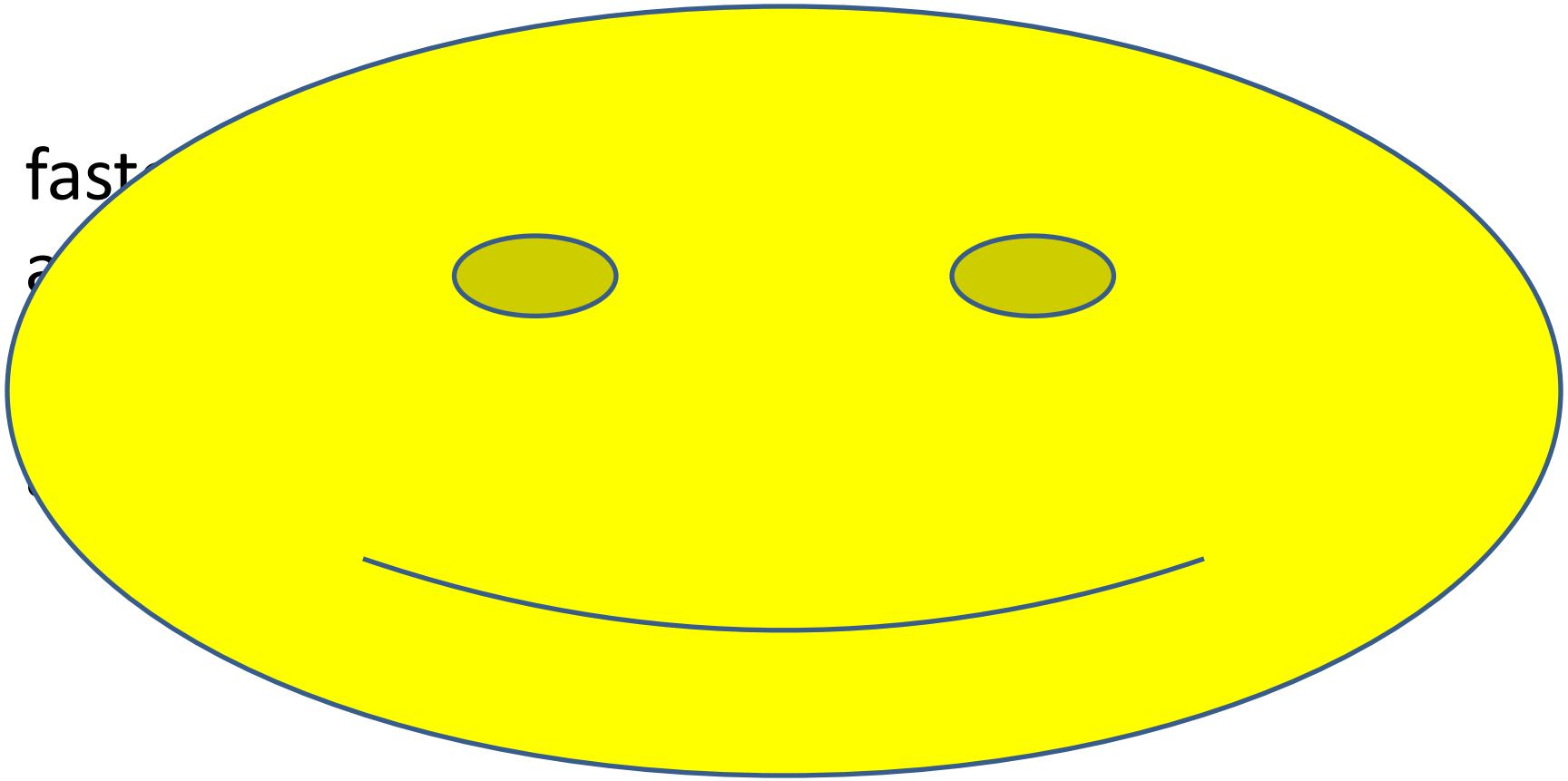
Pace maker of heart

- auto rhythmic Cells have different rate of slow depolarization threshold, The rates at which they can generate action Potentials also differ.
- The rate for the SA node is 70–80
- The rate for the AV node is 40–60
- Bundle of His and Purkinje fibers is 20–40

Which component is the normal pace maker for heart and why?

fast

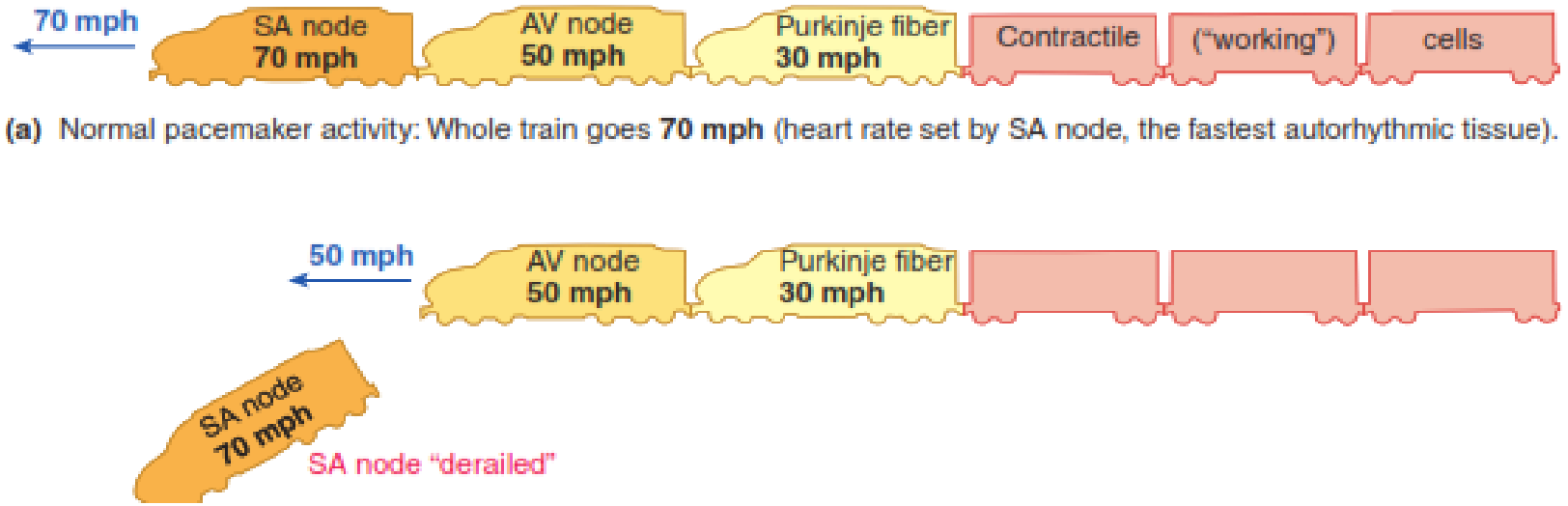
a



Why other auto rhythmic cells cannot work in the presence of normal SA node?

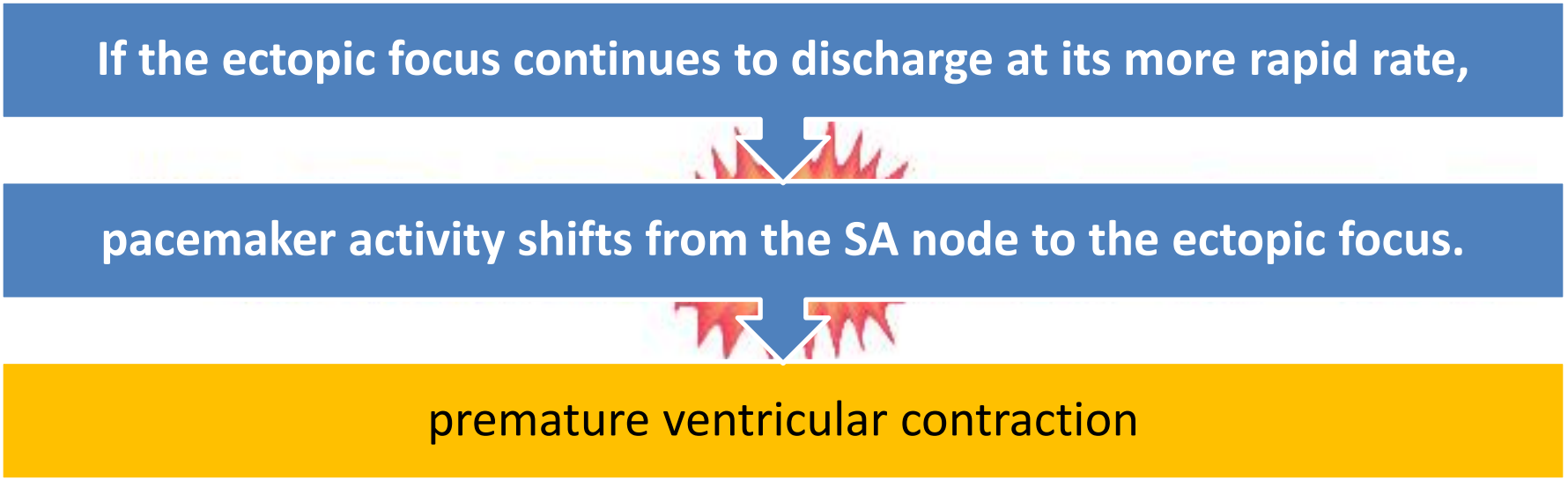
Objective 3: Define ectopic pace makers and describe its causes

- if the SA node becomes nonfunctional such as from a heart attack, the AV node assumes pacemaker activity



ectopic pace makers

- Ectopic means out of place (abnormal)



Objective 4 Define ectopic pace makers and describe its causes

Causes of ectopic foci

- associated with heart disease
- but more frequently they occur in response to anxiety
- lack of sleep
- excess caffeine, nicotine, or alcohol consumption.

Nerve supply of conductive system

Sympathetic

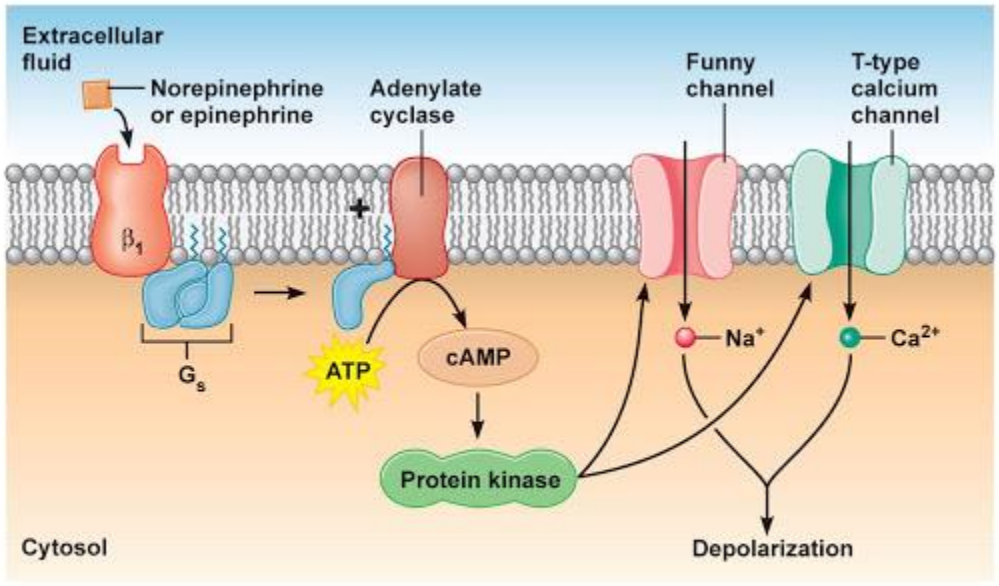
- All parts of heart
- Strong supply to ventricular muscle

Parasympathetic

- Mainly to SA and AV node
- Lesser extent to atria and ventricular muscle

- The effect of B1-adrenergic stimulation in pace making cells, augmenting L-type Ca current thus increasing rate of depolarization
- • Enhanced sympathetic nervous system activity can dramatically increase the rate of firing of SA nodal cells, producing sinus tachycardia with rates >200 beats/min

- **Parasympathetic nervous** system is a result of the release of acetylcholine that binds to muscarinic receptors, **activate a potassium current** in nodal and atrial cells.
- the resulting increase in K+ conductance opposes membrane depolarization, membrane is more hyperpolarized



(a) Sympathetic

THANK YOU

AND

STAY BLESSED