CARDIO VASCULAR SYSTEM

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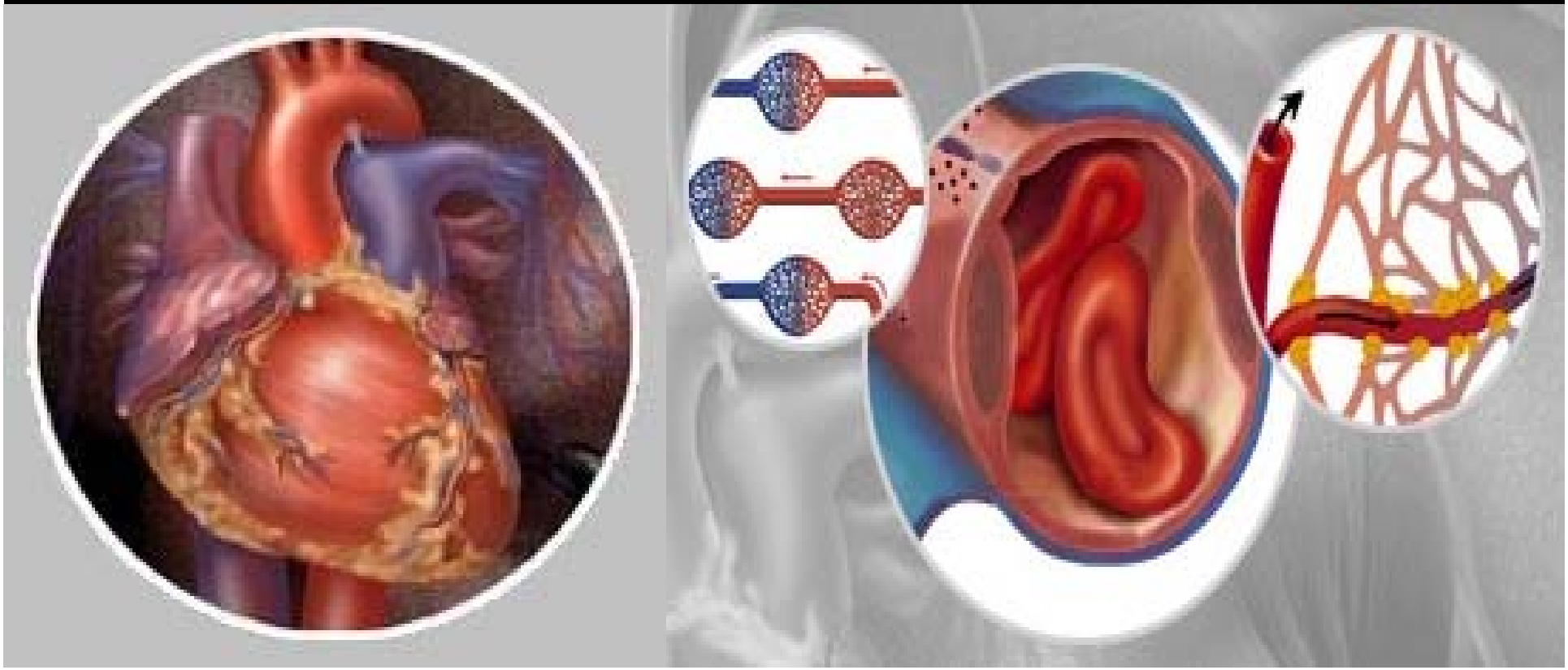


GROSS STRUCTURE OF THE HEART

Situation :

- Adult heart is conical in shape
- It is situated in the middle mediastinum about 1/3 on right side and 2/3 of it on left side
- The anterior surface faces to the sternum
- The posterior surface faces to the spine
- Inferior surface rests on diaphragm
- Two lungs form lateral borders of the heart

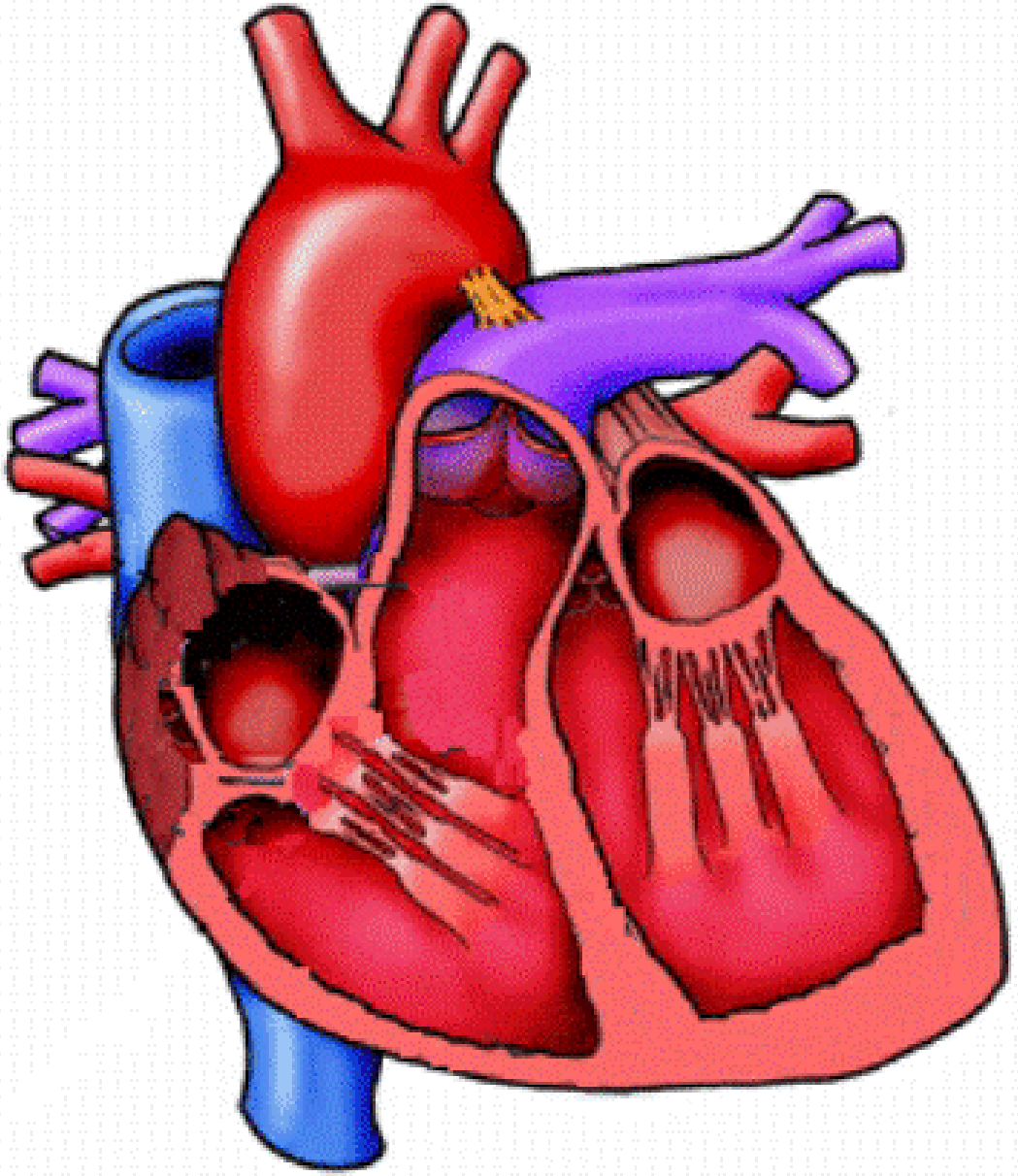
GROSS STRUCTURE OF THE HEART

General Features:

- ❖ Ensheathed by a double layered PERICARDIUM
- ❖ Weight is about 0.43% of total body weight
- ❖ Heart is formed of Four Chambers

UPPER: Atria → Right
UPPER: Atria → Left

LOWER: Ventricles → Right
LOWER: Ventricles → Left



FUNCTIONS OF HEART

GENERAL:

Heart acts as a “central pump” and because of its pumping action various pressure gradients are created which maintains circulation of blood in the CVS

The primary function of the Cardio Vascular System is to provide O_2 and other nutrient material to all the cells of the body via blood which is required for their function and to carry out CO_2 and other waste products.

Functions of ATRIA

- It collects the blood during diastole

Functions of Ventricles:

- They act as a receiver of blood during systole
- During the contraction of ventricles, they pump blood in to the systemic and pulmonary circulation

Functions of valves:

- They maintain the unidirectional flow of the blood in to the cardiac chambers

- They prevent back flow of blood from one chamber to another chamber

LAYERS OF THE HEART

There are four layers of the heart

⇒ Endocardium

⇒ Myocardium

⇒ Epicardium

⇒ Pericardium → Visceral

Parietal

LAYERS OF THE HEART

❖ ***Endocardium:***

It is made up of single lining of the endotheilial cells.

Due to its smooth surface it prevents the formation of local thrombus.

LAYERS OF THE HEART

- ***Myocardium:***

It is made up of striated muscle and during the contraction of striated muscles, it generates the force during the systole of heart.

LAYERS OF THE HEART

- ***Epicardium:***

It is made up of fibrous tissue.

Its main function is to support the myocardium.

LAYERS OF THE HEART

❖ ***Pericardium:***

In between the two layers of pericardium, there is a potential space which is called “Pericardial Cavity” which is filled up by “Pericardial Fluid” which lubricates the opposite surfaces of the two layers of pericardium and smoothens the movements of heart.

Functions of Pericardium:

- Pericardium is the supportive and protective layer of heart

- It smoothens the movements of heart due to the presence of lubricant fluid inside the sac

APPLIED ASPECTS:

Endocarditis:- Inflammation of endocardium

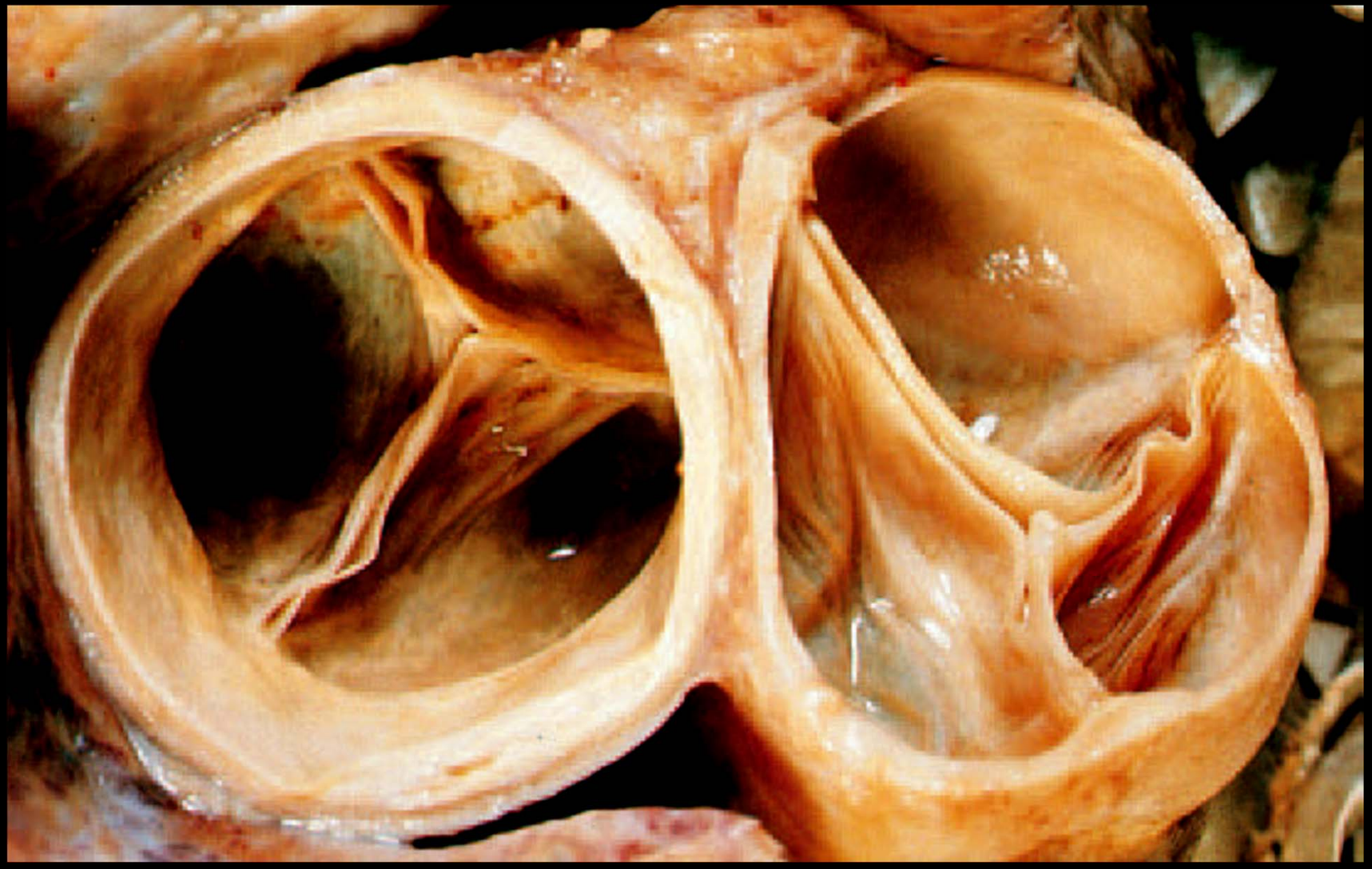
Myocarditis:- Inflammation of myocardium

Pericarditis:- Inflammation of pericardium

Pericardial :- It is the accumulation of

Effusion excessive amount of pericardial fluid in the pericardial sac.

VALVES OF THE HEART



VALVES OF THE HEART

The circulation through CVS is strictly one way. There are four sets of valves in the heart

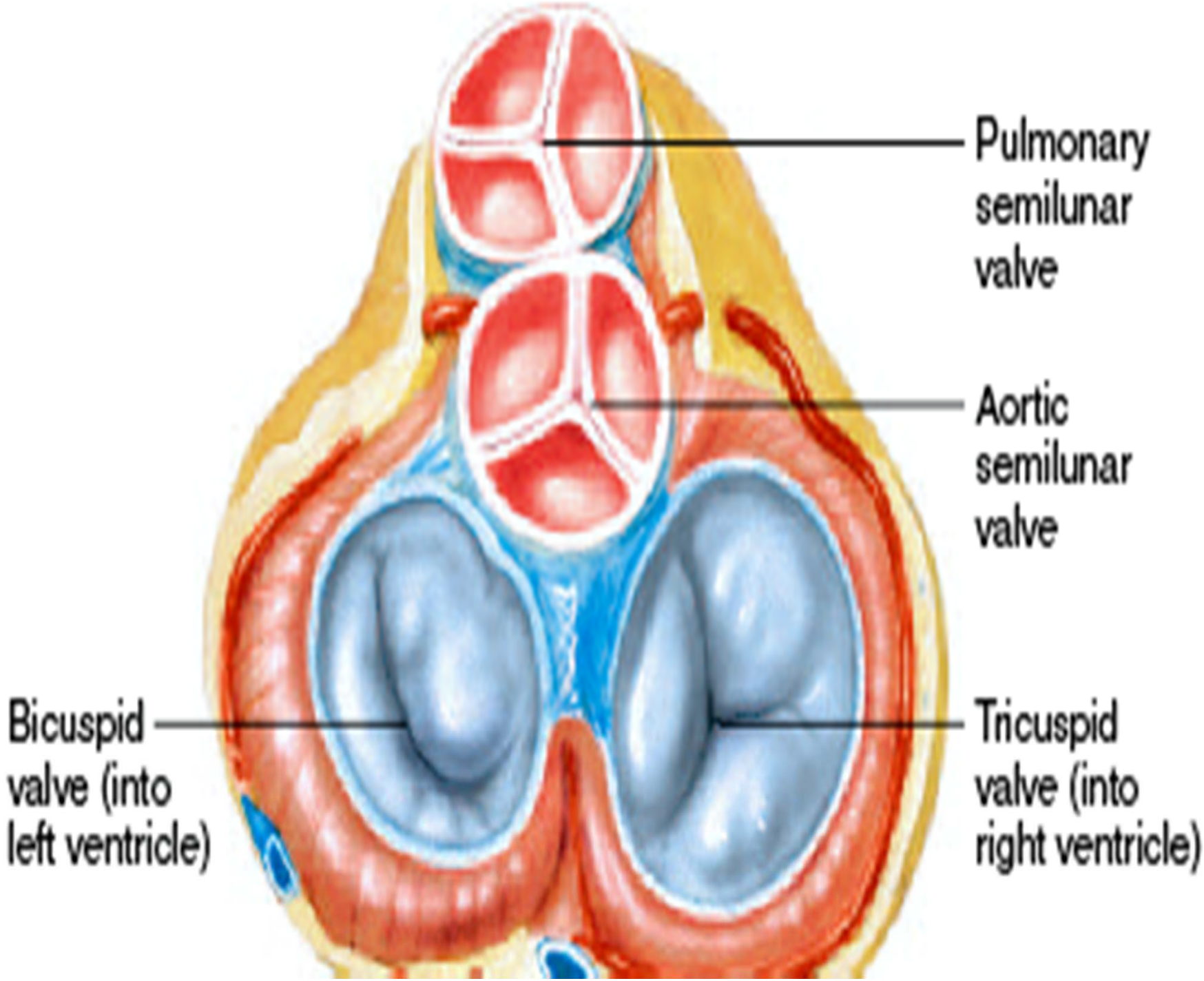
- Right A-V valve is called **"Tricuspid"** Valve

It consists of three cusps: Anterior, Posterior and Medial (Septal)

- Left A-V valve is called **"Mitral"** Valve

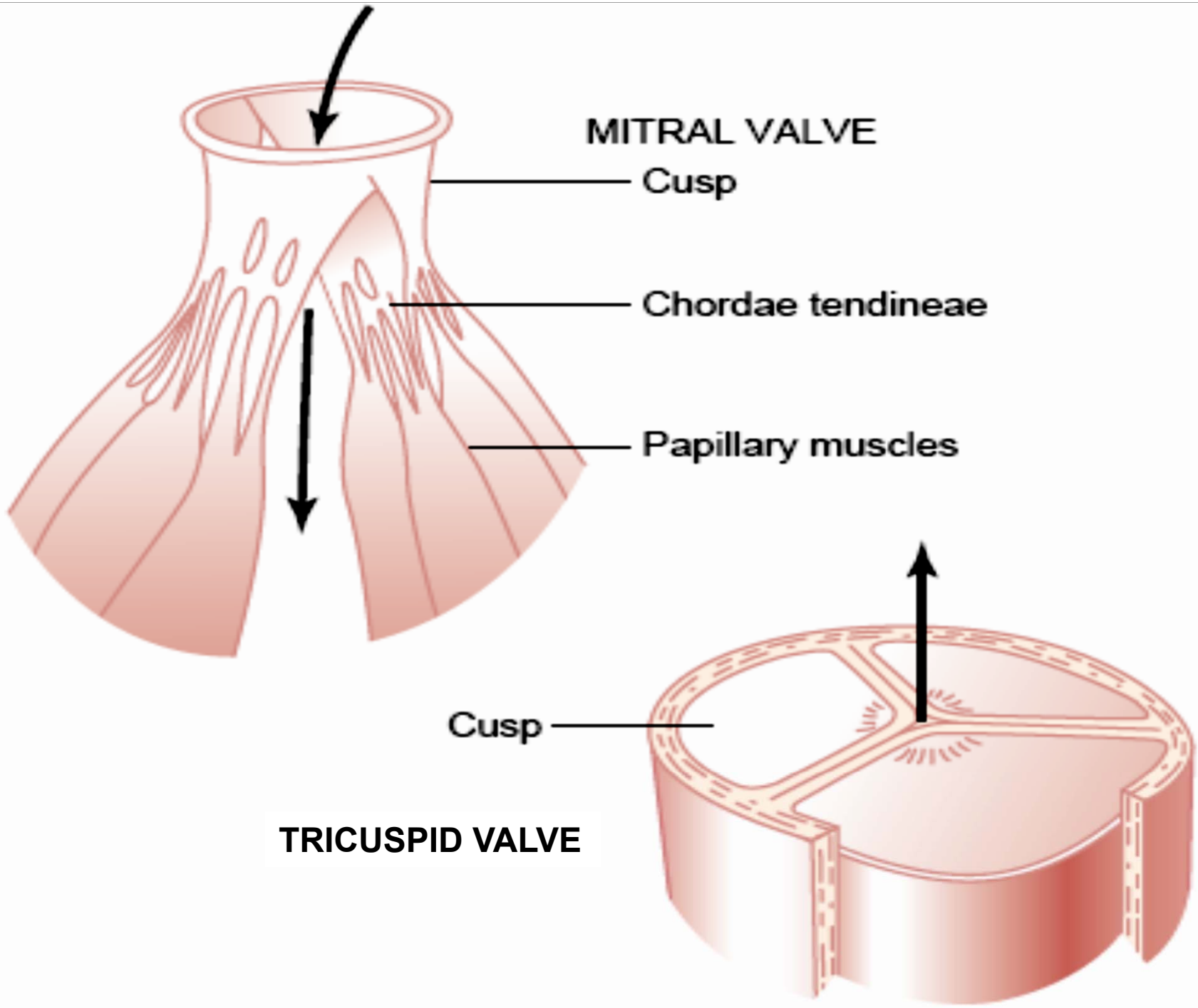
It consists of two cusps: Anterior and Posterior

The cusps of valve are triangular in shape. The base of cusp is attached to atrio-ventricular margin by connective tissue.


Pulmonary semilunar valve
Aortic semilunar valve
Bicuspid valve (into left ventricle)
Tricuspid valve (into right ventricle)

VALVES OF THE HEART

- The **Tricuspid** and the **Mitral** valves open when the blood passes from Atria to Ventricles.
- When the ventricle contracts, these A-V valves get closed and they buldge in to the respective atria.
- The buldging is restricted by **"Chordae Tendinae"** which is attached to the apex of the valve on side and by papillary muscles to the ventricular walls on the other side.


MITRAL VALVE
Cusp
Chordae tendineae
Papillary muscles
Cusp
TRICUSPID VALVE

The AORTIC and PULMONARY Semi-lunar Valves

- They guard Aorta and Pulmonary trunk respectively

- They open away from the ventricles

The Aorta divides successively in to diminishing caliber and then Gradually in increasing caliber the Vena Cava is formed

Aorta ⇒ Big Arteries ⇒ Arterioles

⇑ ⇓

Meta arteries

Heart ⇓

Capillaries

⇑ ⇓

Vena Cava ⇐ Veins ⇐ Venules

The capillaries are guarded by pre-capillary sphincter which is under control of sympathatic system

The whole circulatory system has 3 layers

1) Outer : tunica Advenetia
2) Middle: tunica Media
3) Inner: tunica Intima

Large arteries and veins are supplied by nutrient artery which arises from the adjacent small artery which is known as “Vasa Vasorum”

STRUCTURE OF CARDIAC MUSCLES

PHYSIOLOGY OF THE CARDIAC MUSCLE:

i) **Atrial Muscles:** Atria are thin walled and subserve a capacity function as well as that of contraction

ii) **Ventricular Muscles:** Ventricles are thick walled (More Muscles) and they serves as pumps

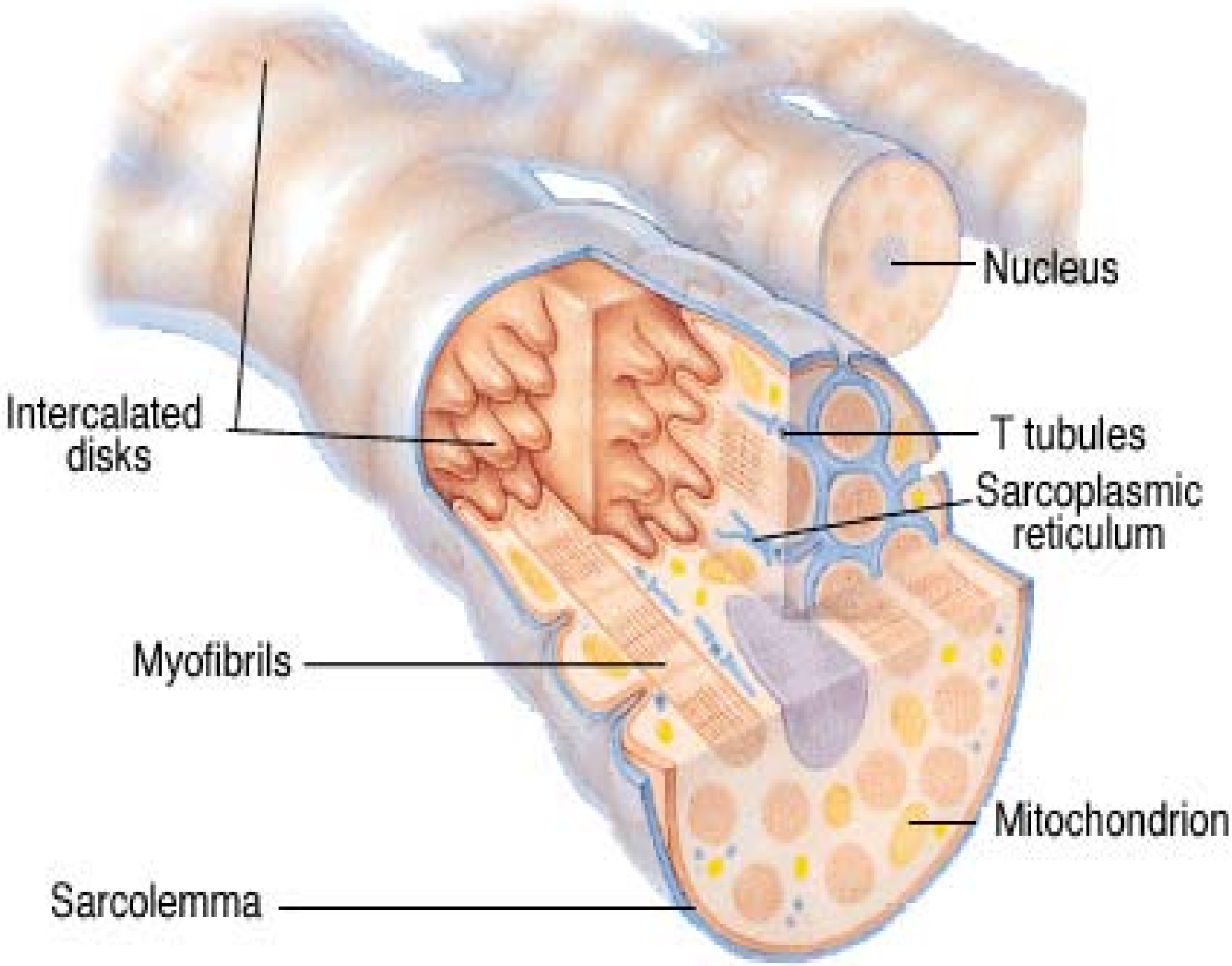
iii) **Specialized excitatory and conductive Muscles:** They contract freely but show rhythmicity and show varying rates of conduction

STRUCTURE OF CARDIAC MUSCLES

Intercalated Discs:

- They are cell membrane and they separate individual cardiac muscle cells from one another.

- They are highly permeable to ions.


Nucleus
Intercalated disks
T tubules
Sarcoplasmic reticulum
Myofibrils
Mitochondrion
Sarcolemma

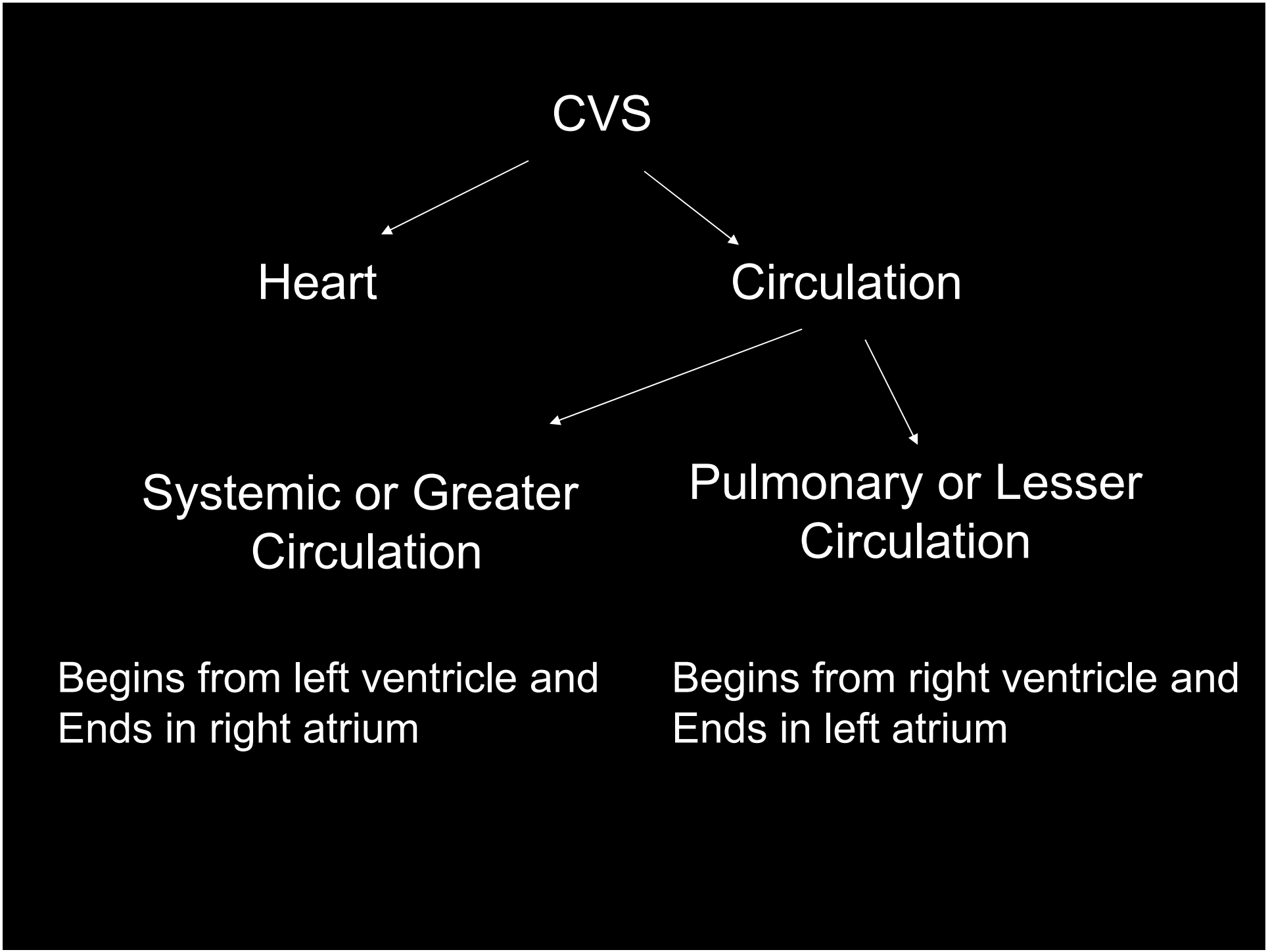
STRUCTURE OF CARDIAC MUSCLES

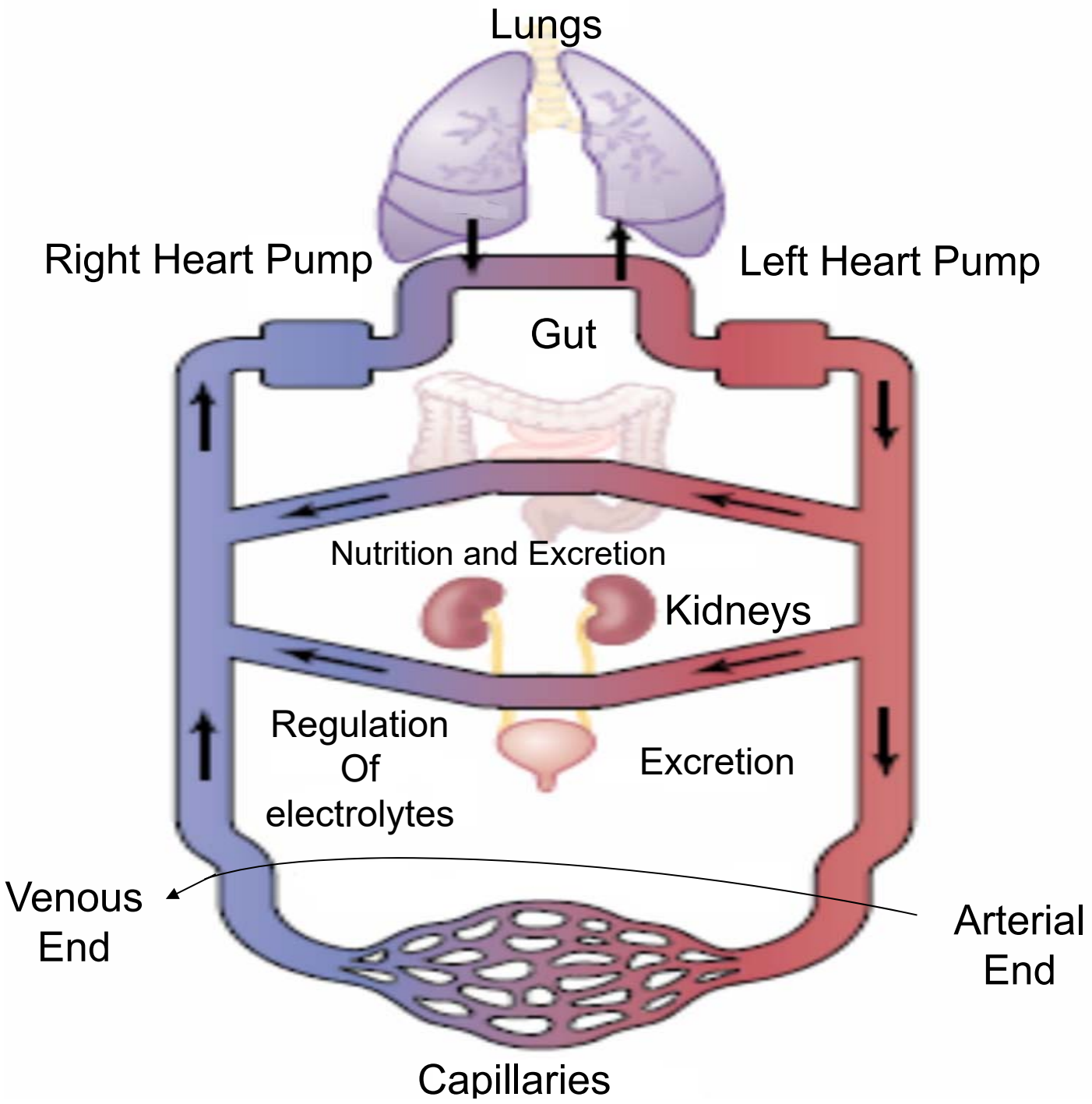
Cardiac muscle is a “syncytium” of many heart muscle cells, in which the cardiac cells are so connected that when one of these cells become excited, the action potential spreads to all of them.

STRUCTURE OF CARDIAC MUSCLES

ULTRA MICROSCOPIC STRUCTURE OF HEART:-

- Each cardiac muscle is composed of various cardiac cells. The cells fuses with each other at the intercalated disc.
- Each cardiac cell has outer sarcolemma and inside sarcoplasm which contains single central nucleus, sarcoplasmic reticulum, mitochondria and contractible myofibrils.
- They contract involuntarily but their contraction are guarded by specialized conducting system of heart having a pace - maker.

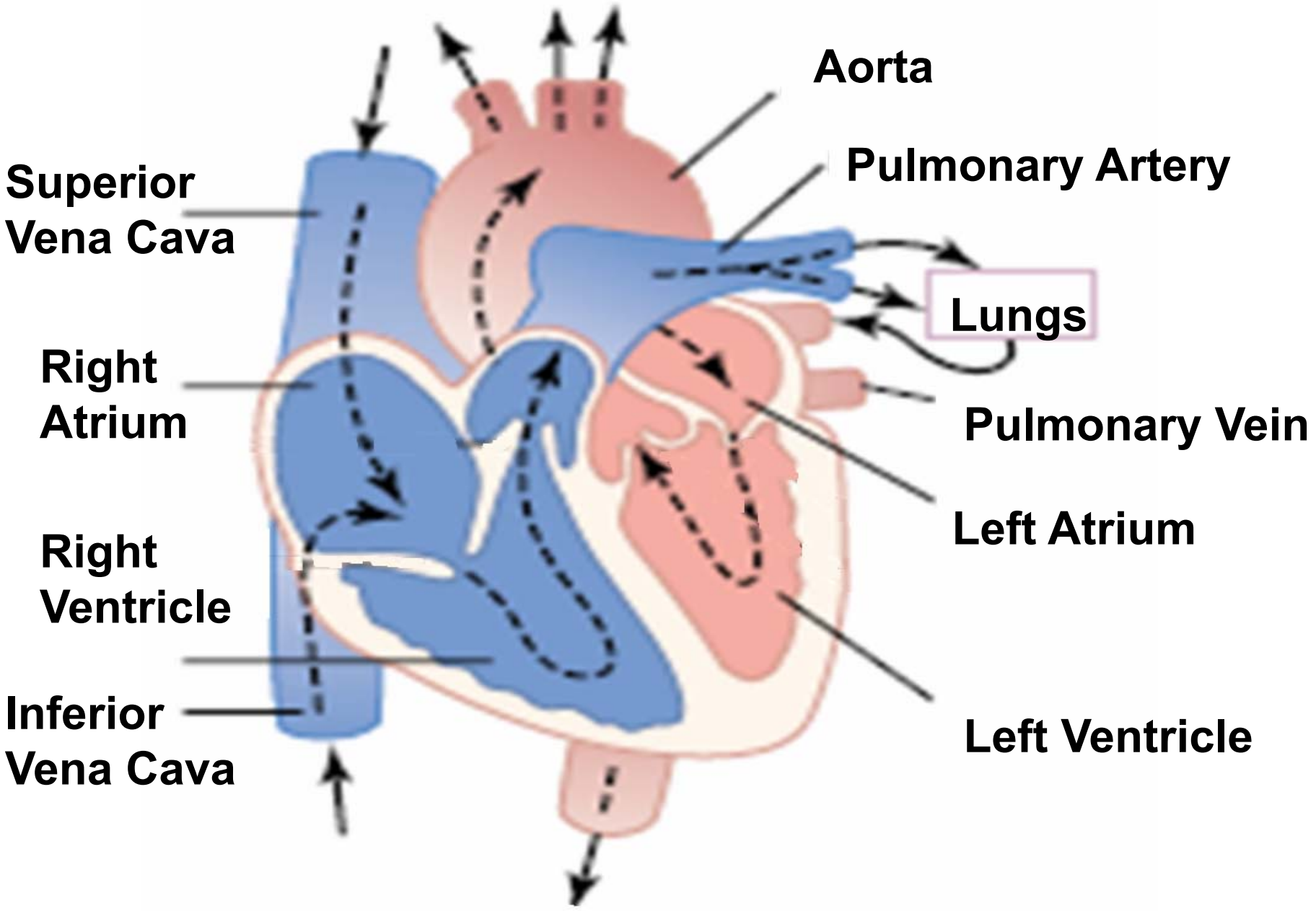

CVS
Heart
Circulation
Systemic or Greater Circulation
Pulmonary or Lesser Circulation
Begins from left ventricle and Ends in right atrium
Begins from right ventricle and Ends in left atrium


Lungs
Right Heart Pump
Left Heart Pump
Gut
Nutrition and Excretion
Kidneys
Regulation
Of
electrolytes
Excretion
Venous
End
Arterial
End
Capillaries

- Blood is pumped out of the left ventricle with a pressure head
- Then it flows through the aorta and capillaries to the tissues.
- From the tissues (where waste products and CO_2 are exchanged for nutrient products and $O_{2)}$ it passes in venules, veins and superior and inferior vena cava and ultimately to right atrium

- Then it passes through right ventricle which pumps it in to pulmonary arteries to lungs

- The purified blood passes through the pulmonary veins to left atrium which sends blood to left ventricle for re-circulation.


Aorta
Pulmonary Artery
Superior Vena Cava
Lungs
Right Atrium
Pulmonary Vein
Left Atrium
Right Ventricle
Inferior Vena Cava
Left Ventricle
TRUNK AND LOWER EXTREMITY

NERVES OF HEART

Heart is supplied by both autonomic nervous system

1)Parasympathatic and

2) Sympathatic

Heart is controlled by higher centers

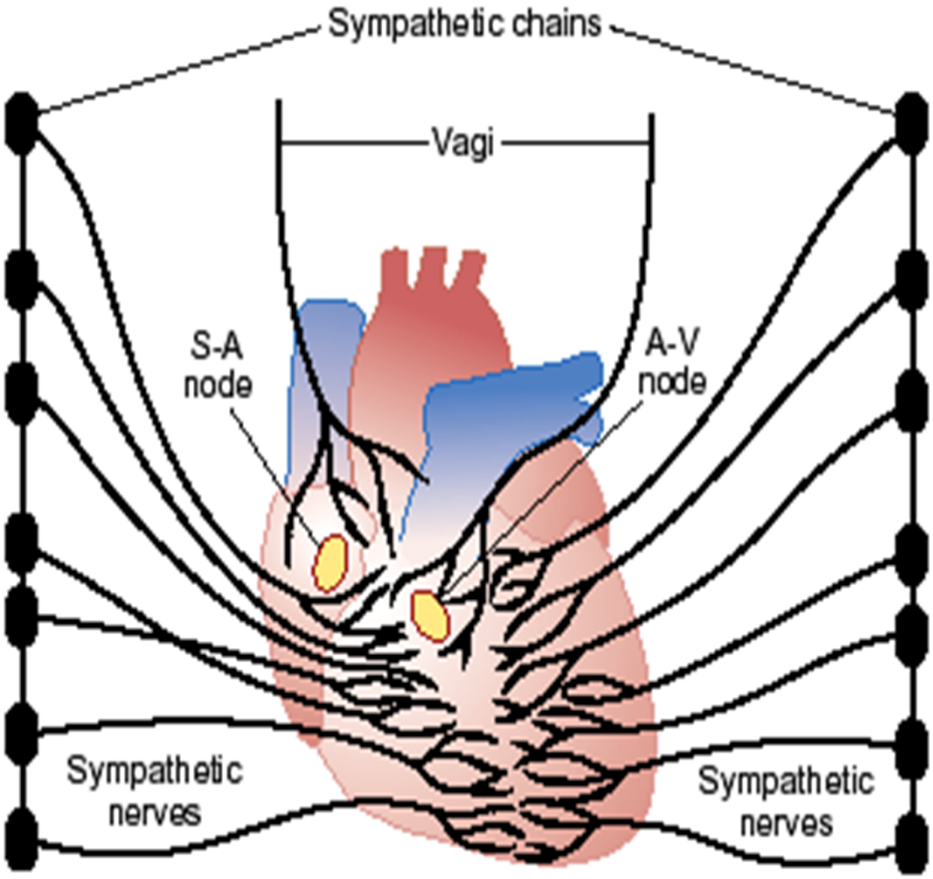
1) Cardiac centre
2) Vasomotor centre

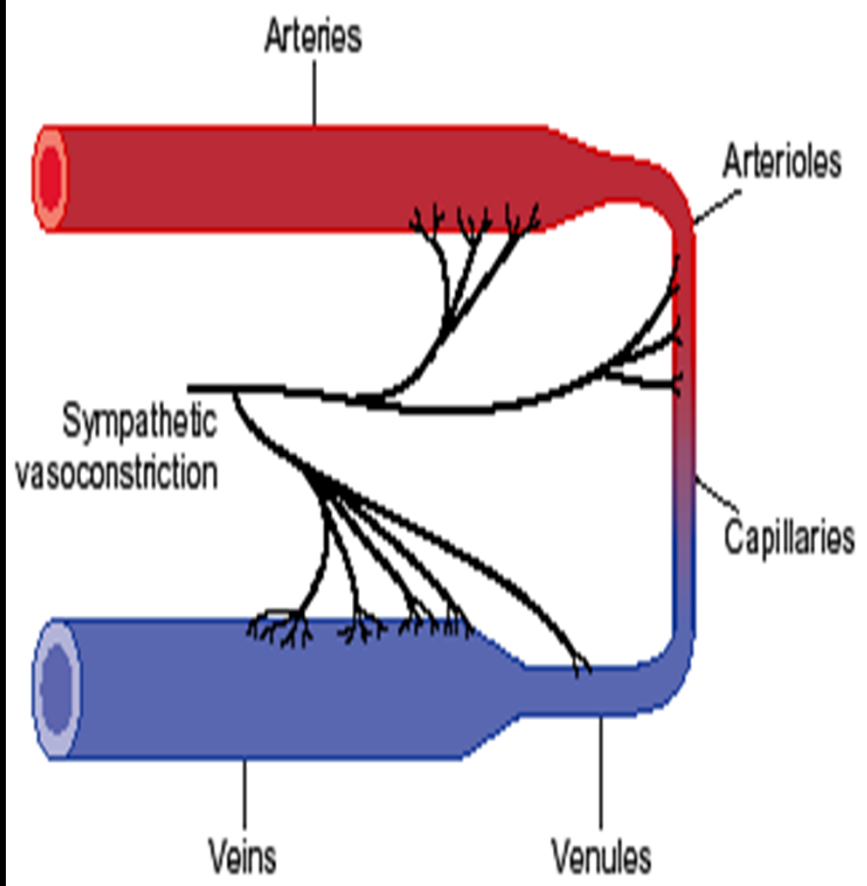
} Situated in Medulla Oblangata

3) Vaso constrictor area – C_1
4) Vaso dilator area – A_1
5) Sensory area – A_2

Autonomic innervations of heart

	Parasympathetic N. S.	Sympathetic N. S.
Origin & distribution	by vagus nerve. Innervate- sinus & AV nodes, less to muscle of two atria very less to ventricular muscle	from T1 to T5 of spinal cord. supply- all parts of the heart (SA & AV nodes, atrial & ventricular muscles) especially to ventricular muscle


Sympathetic chains
Vagi
S-A node
A-V node
Sympathetic nerves
Sympathetic nerves


Arteries
Arterioles
Sympathetic vasoconstriction
Capillaries
Veins
Venules

Organ	Parasympathetic	Sympathetic Stimulation
Heart	Decreases	Increases
-SA **-Atria** **-A-V** **Ventricles**	Heart rate Contraction &Conduction	b1 - Heart rate b1 - Contraction & Conduction
Arterioles	dilatation only In face & external genitals	alpha-constriction of all vessels b2 - dilatation
Veins	_	alpha - constriction b2 - dilatation
Lungs	Broncho constriction	Broncho dilatation (b2)

	Parasympathetic N. S.	Sympathetic N. S.
M/A	Ach -increases the permeability of the fibre membrane for K^+ ions. this causes K^+ efflux causing hyperpolarization, decreasing excitability of the tissue.	norepinephrine - increases permeability of cardiac muscle fiber to Na^+ & Ca^{++}

vagal escape - strong stimulation may completely block the transmission & ventricles may stop beating for 4 to 10 secs. If it happens, Purkinje system initiates the rhythm (idioventricular) causing ventricular contraction at a rate of 15 to 40/min. (emotional stimuli- stokes adams syndrome)

vagal tone - basal discharge of vagal hyperpolarizes S.A. node fibers by increasing permeability of SA nodal K. This slows the firing rate of SA node from its automatic rate of 100 beats/min to the actual heart rate of about 72 beats/min. This normal vagal activity is called vagal tone. In denervated heart, vagal tone is lost & heart rate becomes more.

DISCLAIMER

- All figures are taken from Guyton and Hall Textbook of Medical Physiology, 12th Edition.