

# The Heart 3

# Valves of the heart

## Two atrioventricular valves

Right atrioventricular  
or tricuspid valve

Left atrioventricular  
or bicuspid valve  
Mitral valve

## Two semilunar valves

Aortic valve

Pulmonary valve

**The main function of any valve is to maintain the Unidirectional flow of blood**

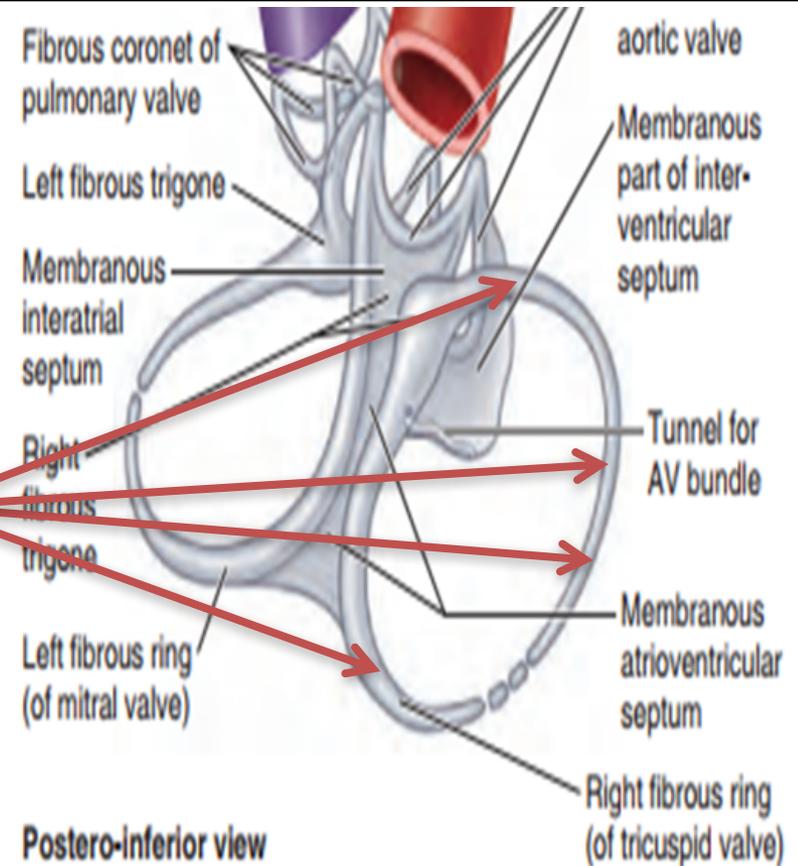
# 1- RIGHT ATRIOVENTRICULAR VALVE

The TRICUSPID valve

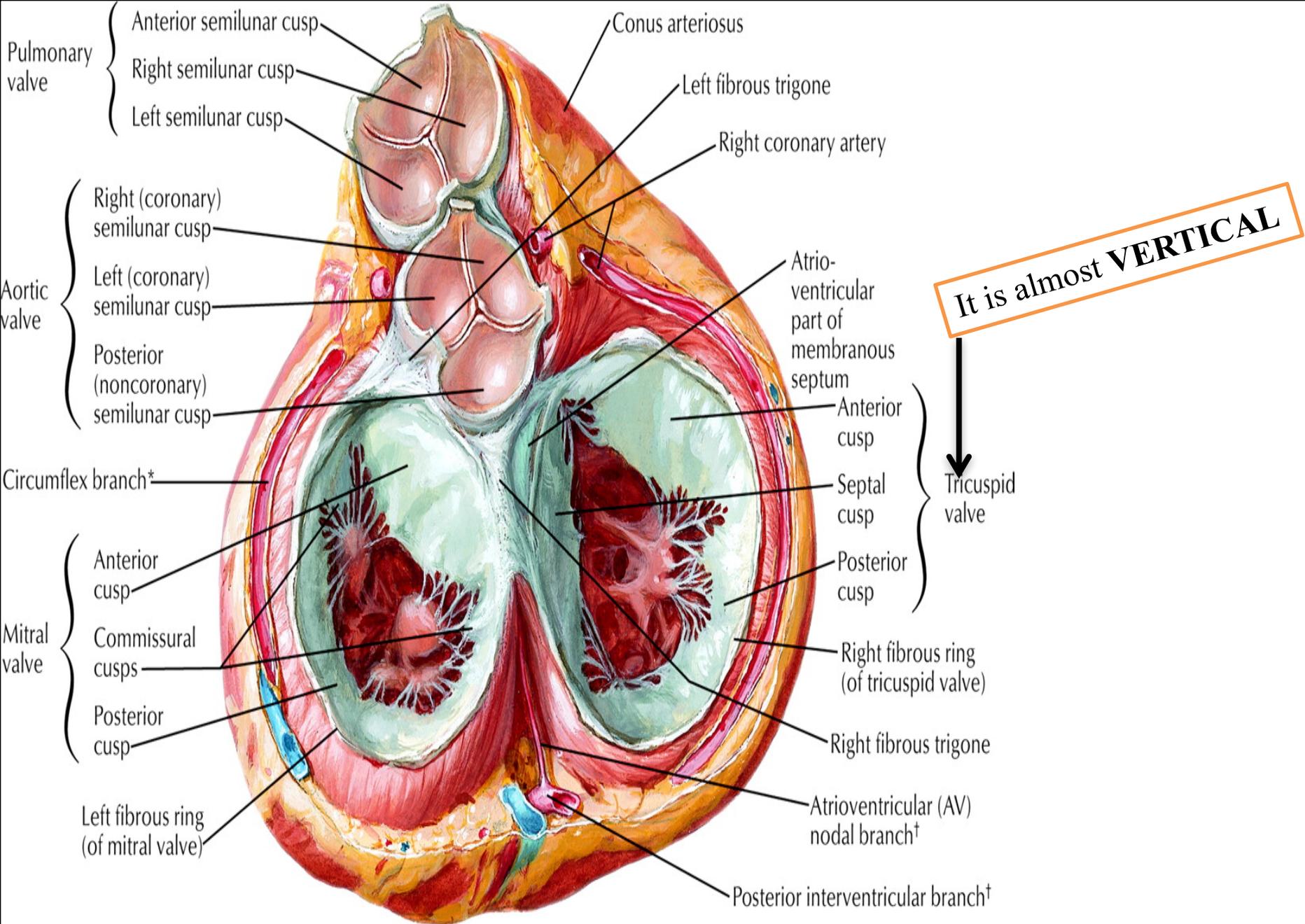
so-named because it usually consists of *three cusps or leaflets*

The bases of the valve cusps are attached to the fibrous ring around the orifice *annulus fibrosus*

- Its orifice is best seen from the atrial aspect and measures on average **11.4 cm**
- The fibrous ring keeps the caliber of the orifice constant (large enough to admit the tips of three fingers)
- It is almost **VERTICAL!!!!!!!!!!**, but at  $45^\circ$  to the sagittal plane
- The atrial surface of the AV valve is rather smooth.
- The ventricular surface is irregular because of the insertion of the chordae tendineae



guards the right atrioventricular orifice



**Heart in diastole:  
viewed from base with atria removed**

# The atrioventricular valvular complex

Consists of:

- 1- *The orifice and its associated anulus*
- 2- *The cusps*, the supporting *chordae tendineae* of various types and *the papillary muscles*

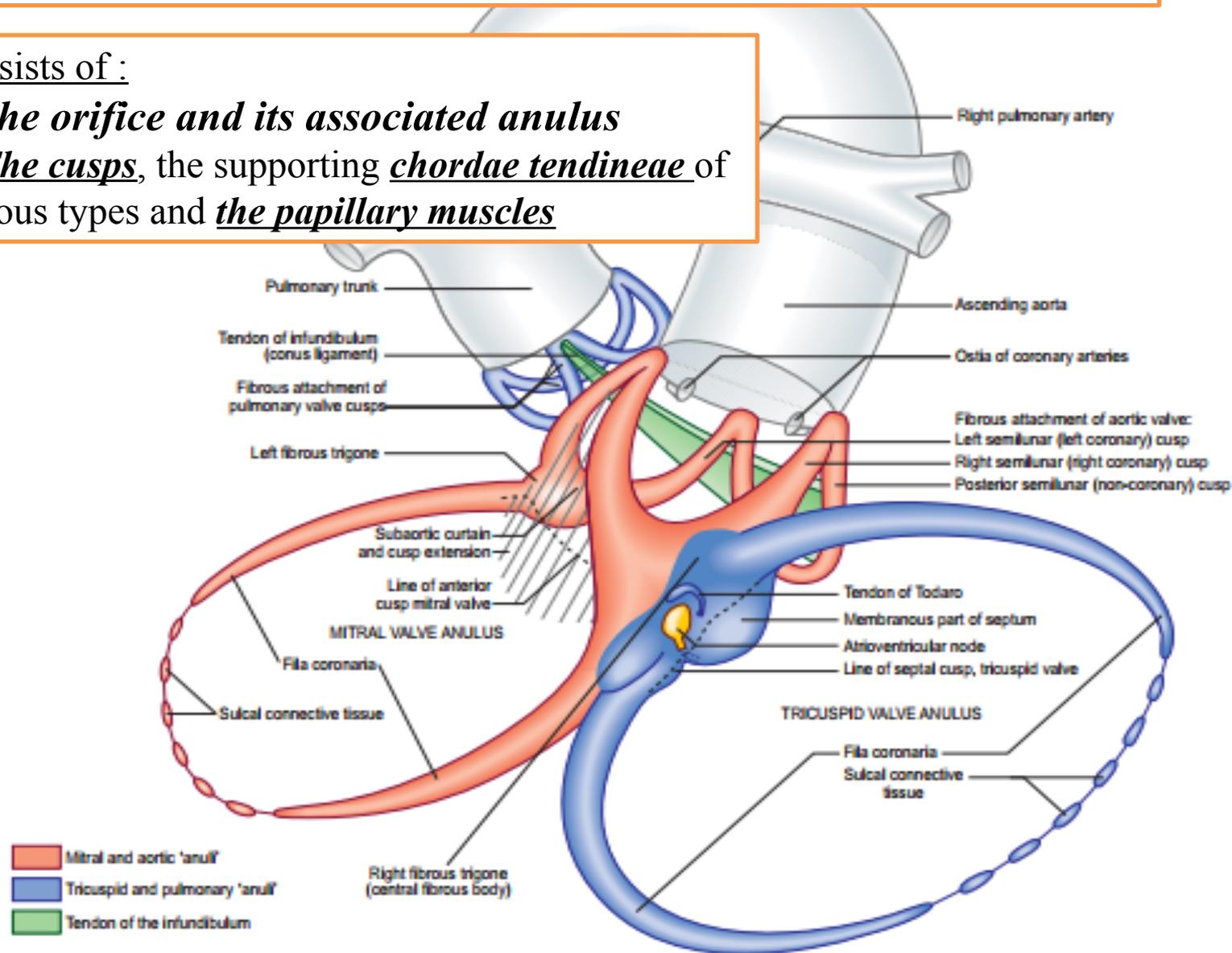


Fig. 56.10 Principal elements of the fibrous skeleton of the heart. For clarity, the view is from the right posteriosuperior aspect. Perspective causes the pulmonary anulus to appear smaller than the aortic anulus, whereas in fact the reverse is the case. Consult text for an extended discussion. (Copyright from The Royal College of Surgeons of England. Reproduced with permission.)

➤ **The Tricuspid Valve** consists of three cusps

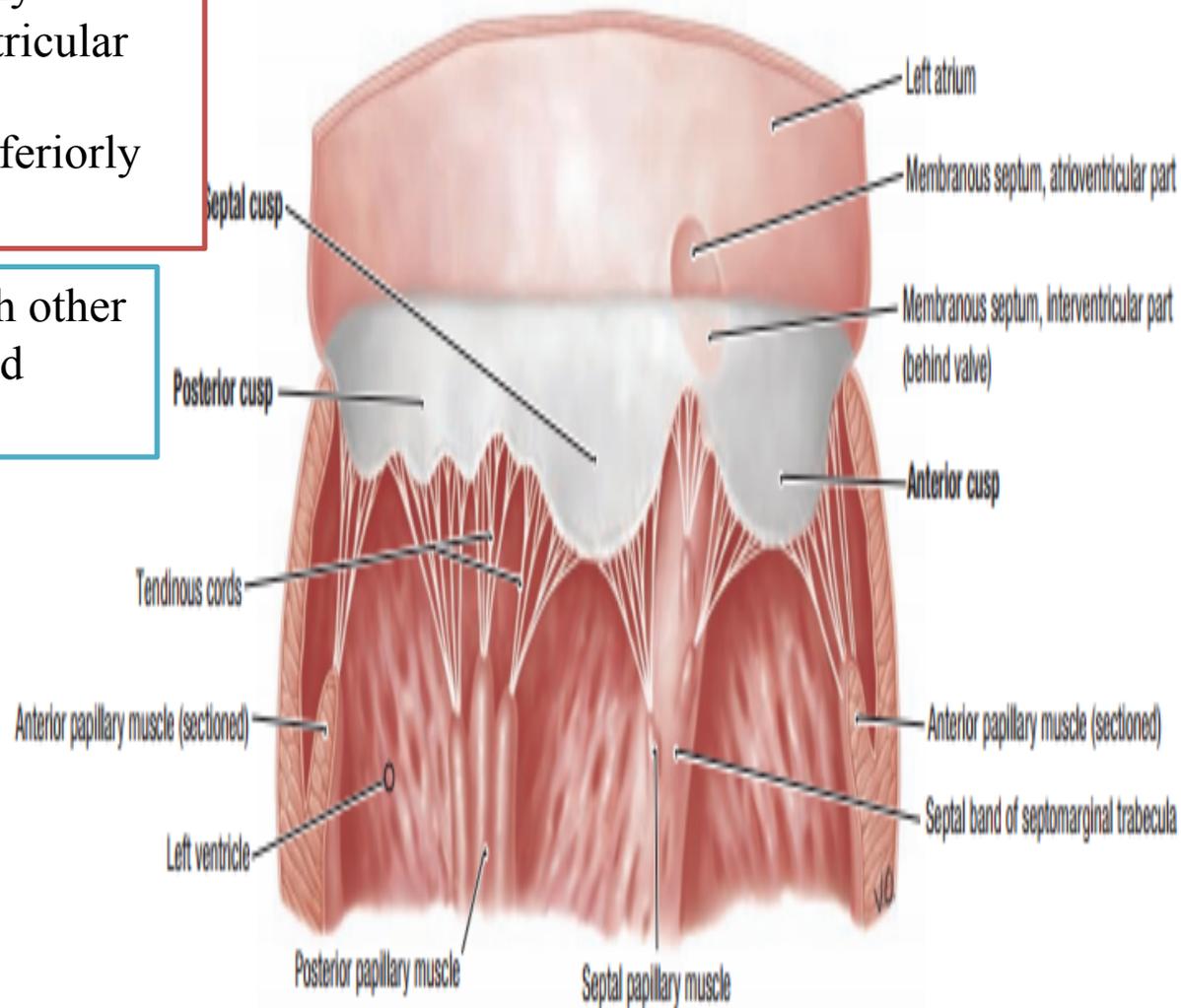
# A-Cusps....1

**Anterior cusp** lies anteriorly  
**Septal cusp** lies against the ventricular septum  
**inferior (posterior) cusp** lies inferiorly

The cusps are continuous with each other near their bases at sites termed **commissures**

The bases of the cusps are attached to the fibrous ring of the skeleton of the heart whereas their free edges and ventricular surfaces are attached to the chordae tendineae.

The chordae tendineae connect the cusps to the papillary muscles



A. Anterior View of Tricuspid Valve

# The Tricuspid Valve

The cusps

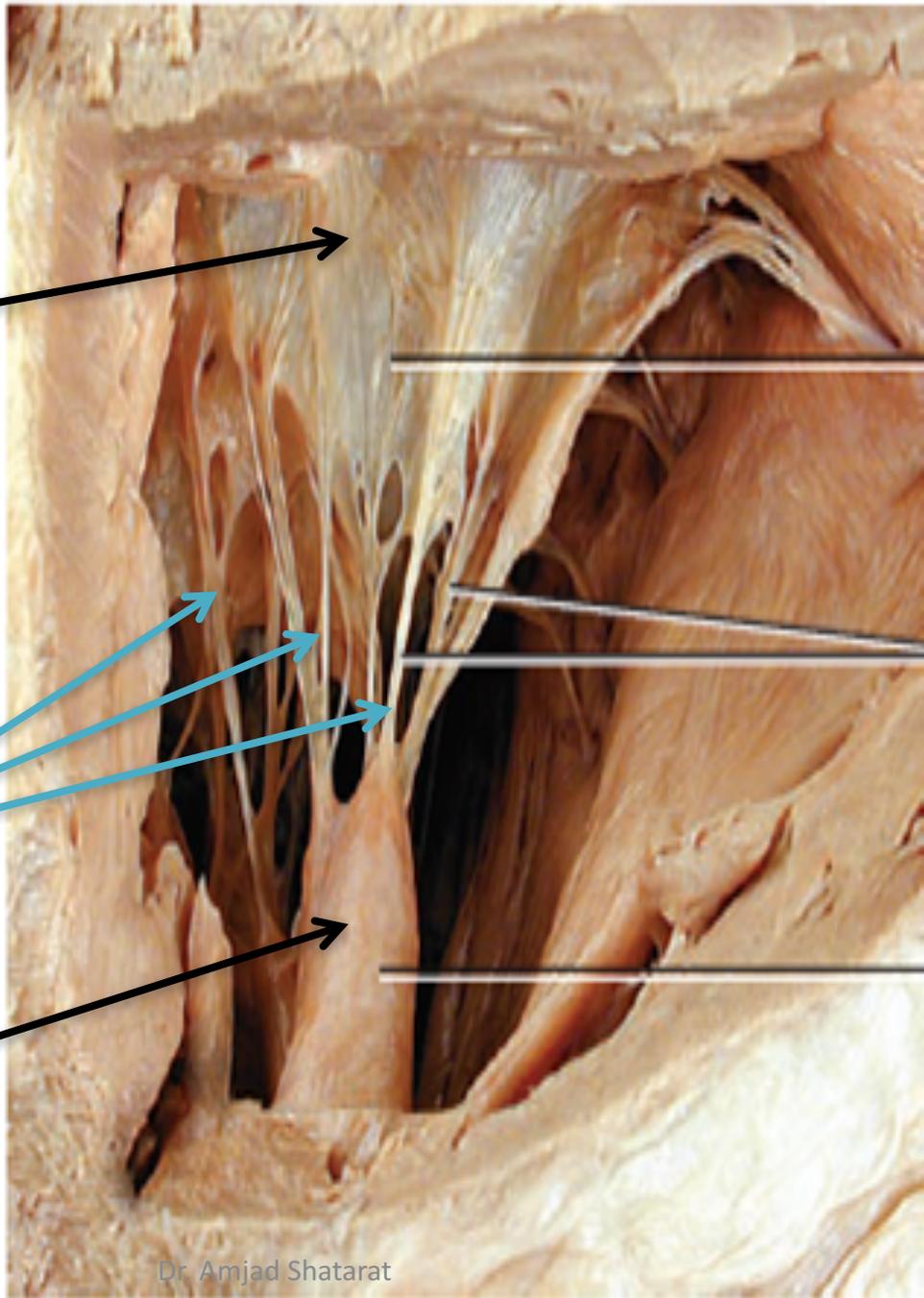
The chordae tendineae.

papillary muscles

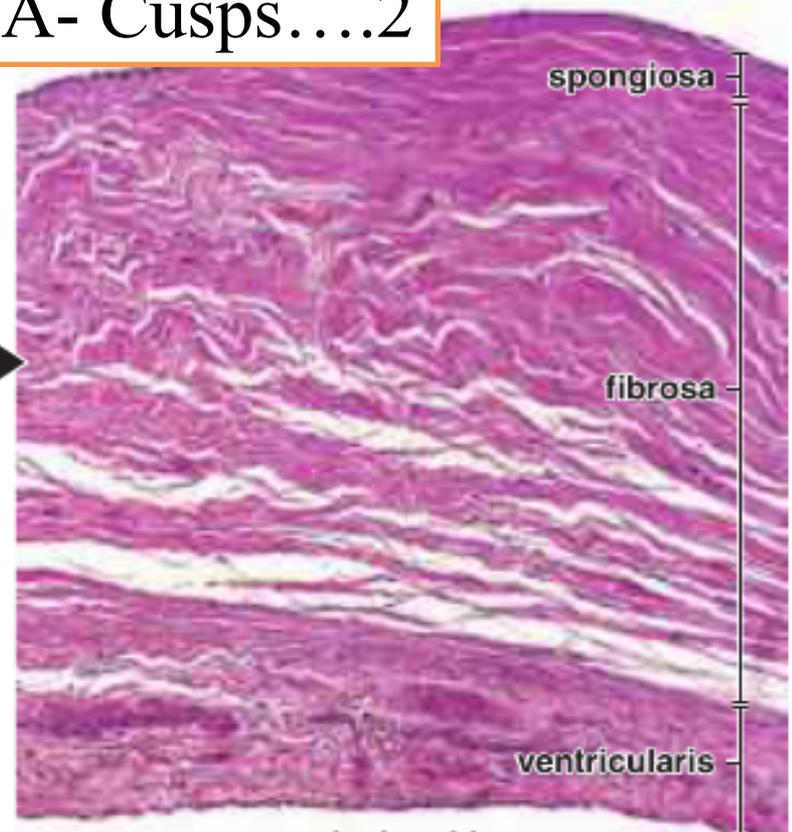
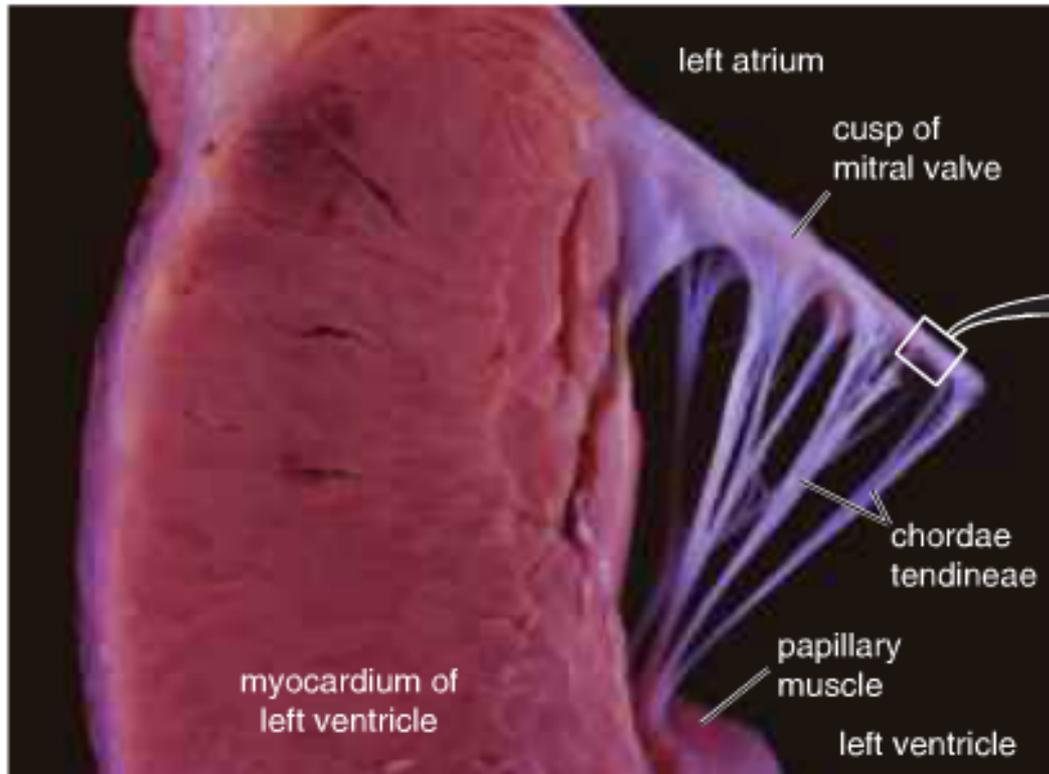
Cusp of tricuspid valve

Chordae tendineae

Papillary muscle



# A- Cusps....2



**a**

**b**



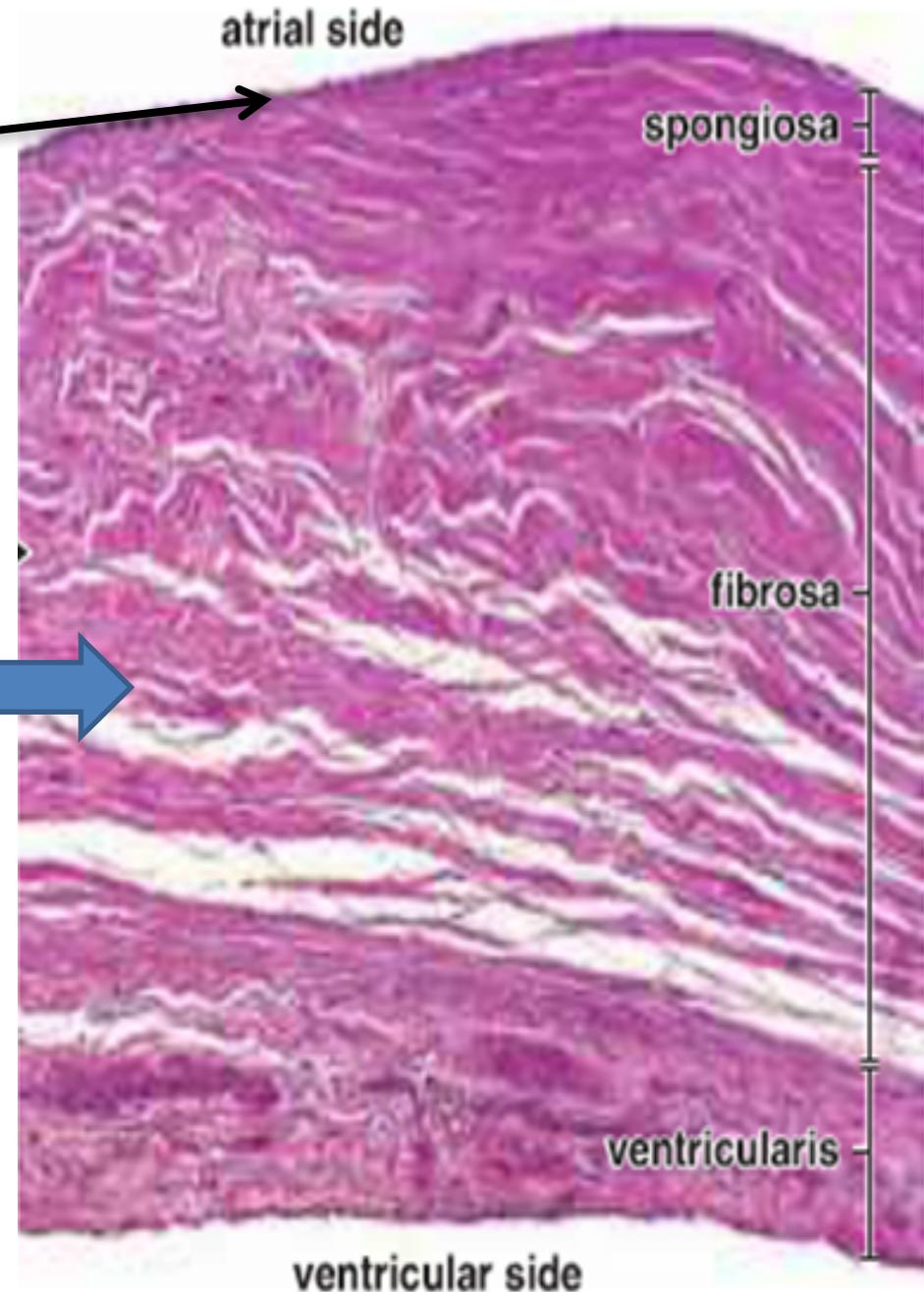
Valves **Cusps** are composed of connective tissue with over-lying endocardium.

Each valve is composed of three layers

***The spongiosa*** is loose connective tissue located on the **atrial or blood vessel side** of each valve.

***The fibrosa*** forms the core of the valve and contains **fibrous extensions from the dense irregular connective tissue of the skeletal rings** of the heart

***The ventricularis*** is immediately adjacent to the ventricular or atrial surface of each valve and is covered with endothelium. It contains **dense connective tissue with many layers of elastic fibers**. In the AV valves, the ventricularis continues into **the chordae tendineae**



## Valve cusps are normally **avascular**

Small blood vessels and smooth muscle can be found only in the base of the cusp  
The surfaces of the valve are exposed to blood, and the cusps are thin enough to allow nutrients and oxygen to diffuse from the blood

Normal conditions

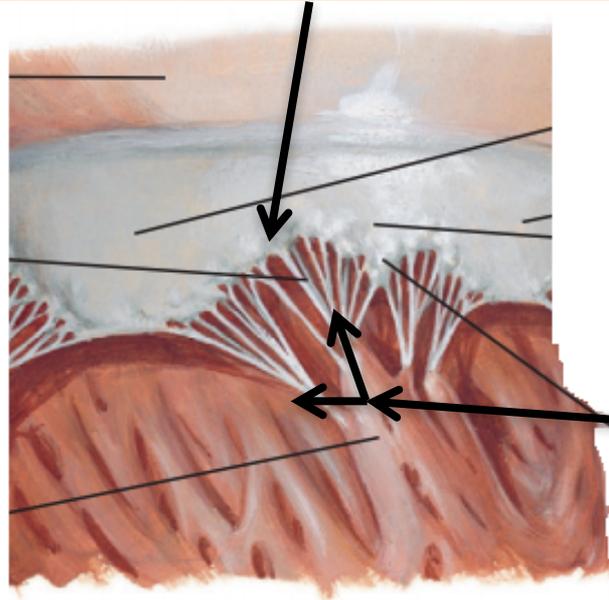
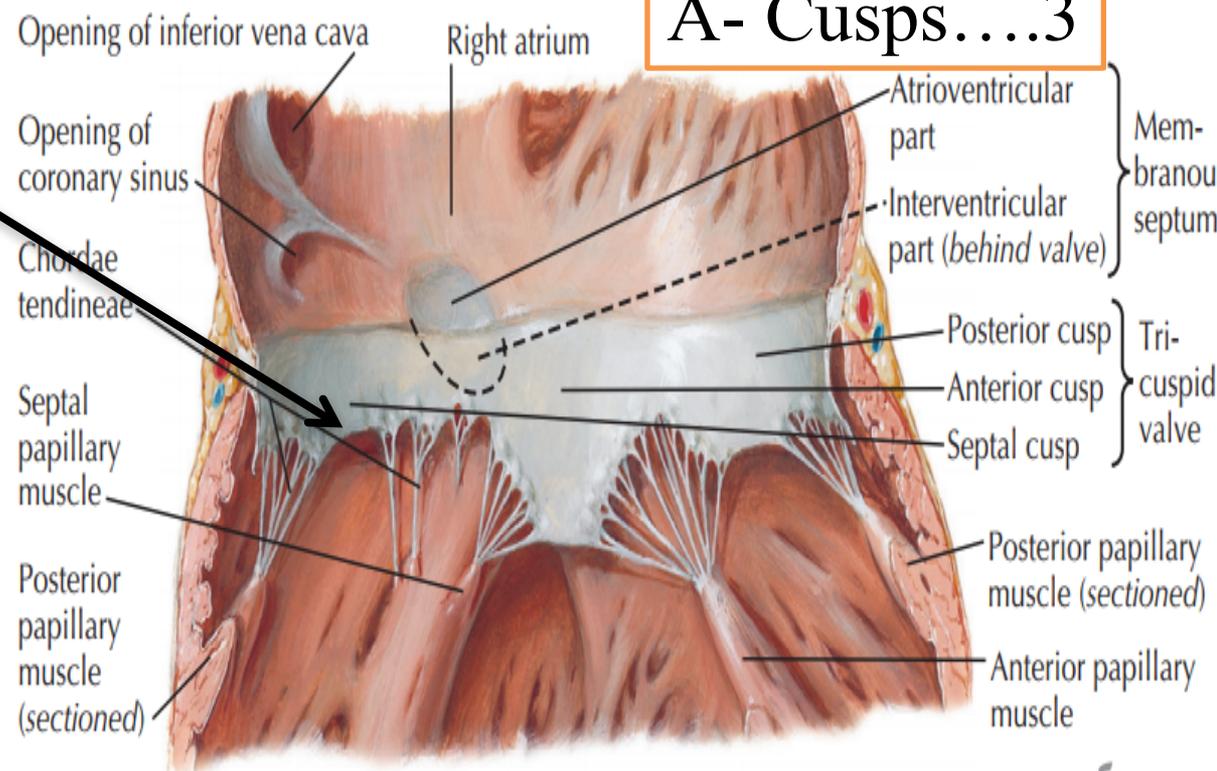
(**valvulitis**).

- Rheumatic fever causes inflammation of the heart valves (valvulitis)
- Inflammation induces **angiogenesis in the valve and vascularization** in the normally avascular layers of the valve.
  - These changes most commonly affect the **mitral valve (65% to 70%)** ?????!!  
and aortic valve (20% to 25%).
- This inflammation can lead to ***progressive replacement of elastic tissue by irregular masses of collagen fibers***, causing the valve **to thicken**.
- The valves become rigid and inflexible, which **affects their ability to open and close**

# A- Cusps....3

The extreme edges of the cusps are thin and delicate with a **sawtooth appearance** from the insertion of **chordae**

Away from the edge, the atrial surface of the cusps is finely **nodular**, the nodule particularly in small children. These nodules are called **The noduli Albin**



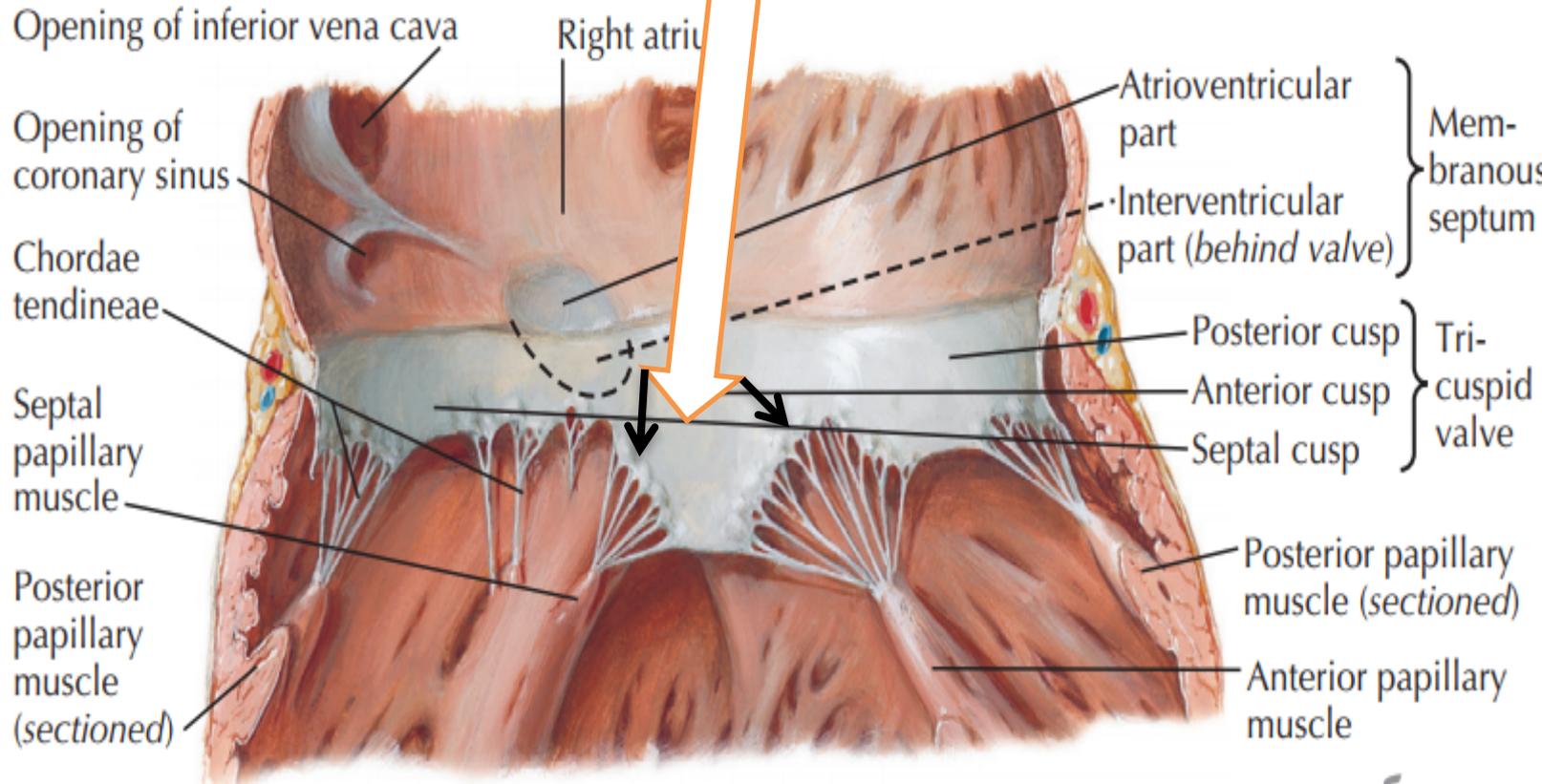
## **The noduli Albini**

minute fibrous nodules on the margins of the mitral and tricuspid valves of the heart

When the ventricle contracts, **the papillary muscles contract** and prevent the cusps from being forced into the atrium and turning inside out as the intraventricular pressure rises

To assist in this process, the chordae tendineae of one papillary muscle are connected to the **adjacent parts of two cusps**

On closure of an AV valve, the narrow border between the **row of Albinic nodules** and the free edge of each cusp presses against that of the next, resulting in a secure, **watertight closure**



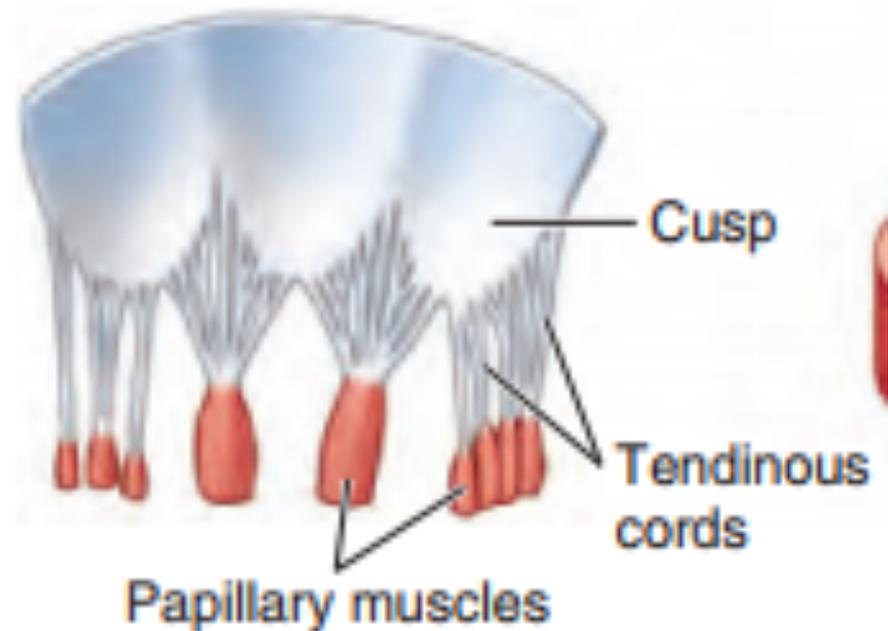
Tricuspid (right atrioventricular) valve

## B-Chordae tendineae (tendinous cords)

are fibrous collagenous structures supporting the cusps of the atrioventricular valves

Tendinous cords attach to the free edges and ventricular surfaces of the anterior, posterior, and septal cusps, much like the cords attaching to a parachute

The tendinous cords arise from the apices of papillary muscles



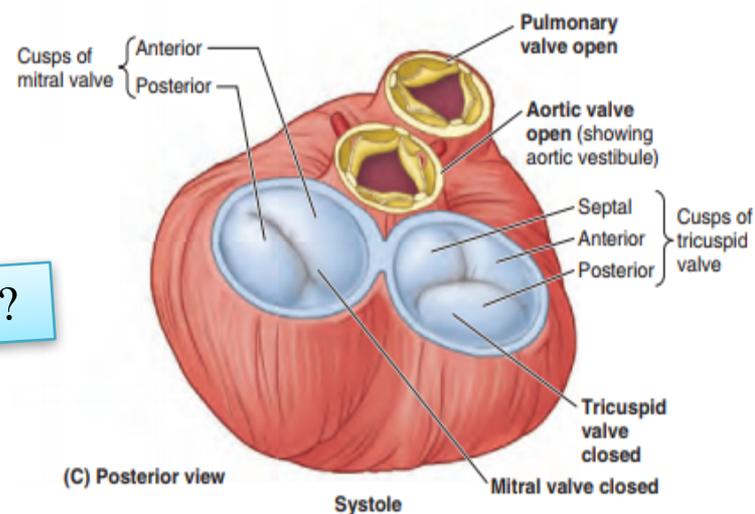
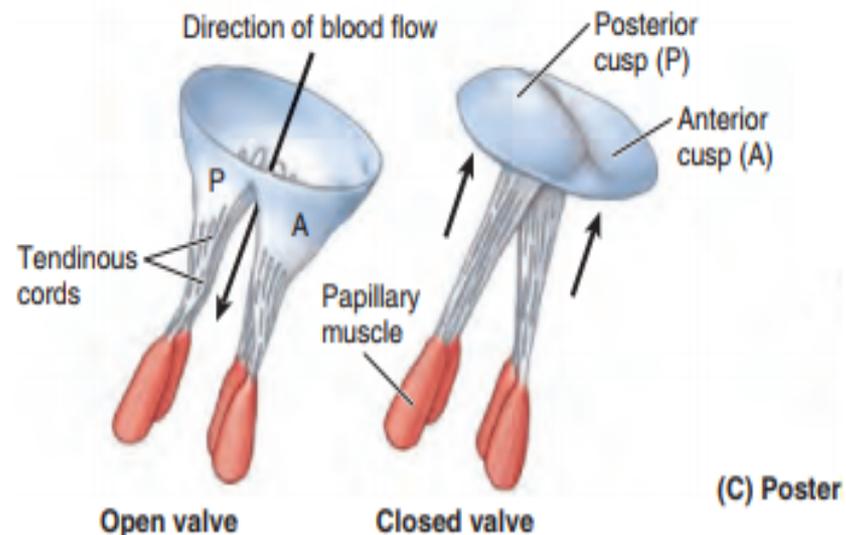
**C- Papillary muscles** begin to contract before contraction of the right ventricle, tightening the tendinous cords and drawing the cusps together.

Because the cords are **attached to adjacent sides of two cusps**,

they prevent separation of the cusps and

prevented from prolapsing (being driven into the right atrium) as ventricular pressure rises.

Thus, **regurgitation of blood** (backward flow of blood) from the right ventricle back into the right atrium is blocked during ventricular systole by the valve cusp

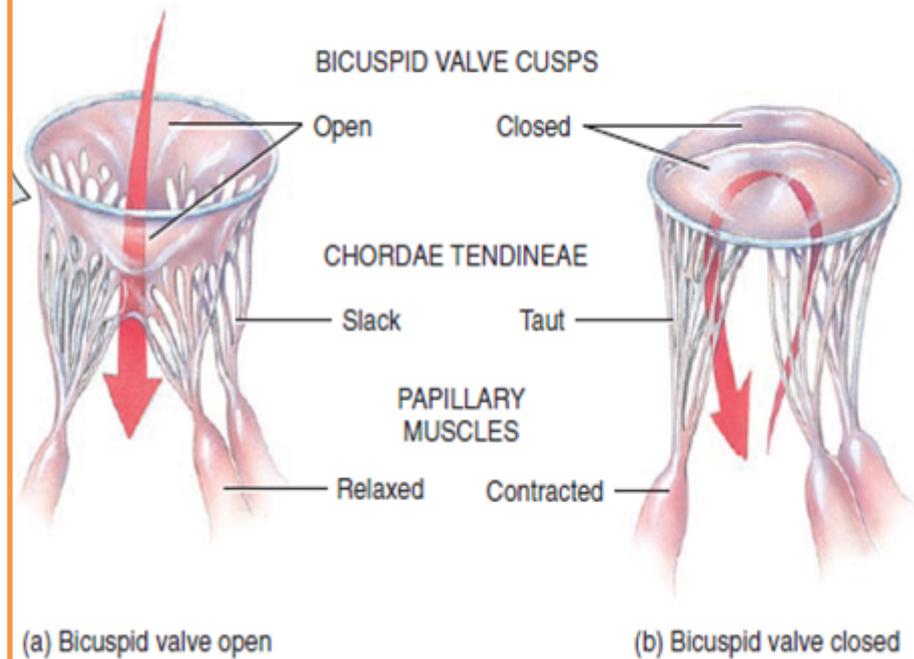


Do papillary muscles close valve or do they open it?

**Papillary muscles insure Competence of the valve**

## 2-The mitral valve

- ❖ Has two cusps, anterior and posterior.
- ❖ The adjective mitral derives from the valve's resemblance to a bishop's miter (headdress)
- ❖ **The anterior cusp** (aortic cusp) is the larger and intervenes between the left atrioventricular and the aortic orifices.
- ❖ Each of its cusps receives tendinous cords from more than one papillary muscle
- ❖ These muscles and their cords support the mitral valve, allowing the cusps to resist the pressure developed during contractions (pumping) of the left ventricle
- ❖ The cords become taut just before and during systole, preventing the cusps from being forced into the left atrium.



(a) Bicuspid valve open

(b) Bicuspid valve closed

The bloodstream undergoes two right angle turns, which together result in a  $180^\circ$  change in direction. This reversal of flow takes place around **the anterior cusp of the mitral valve**

Commonly affected

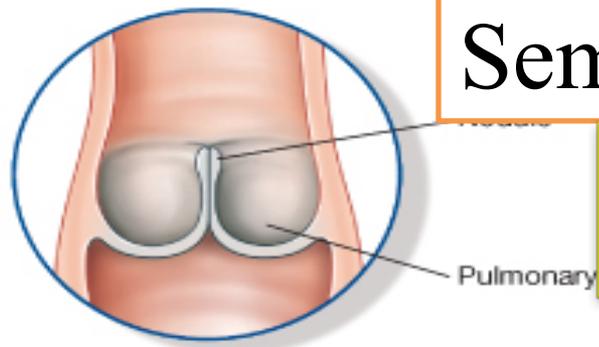
It should be noted that

The orifices and the cusps of both atrioventricular valves undergo considerable changes in position, form and area during a cardiac cycle.

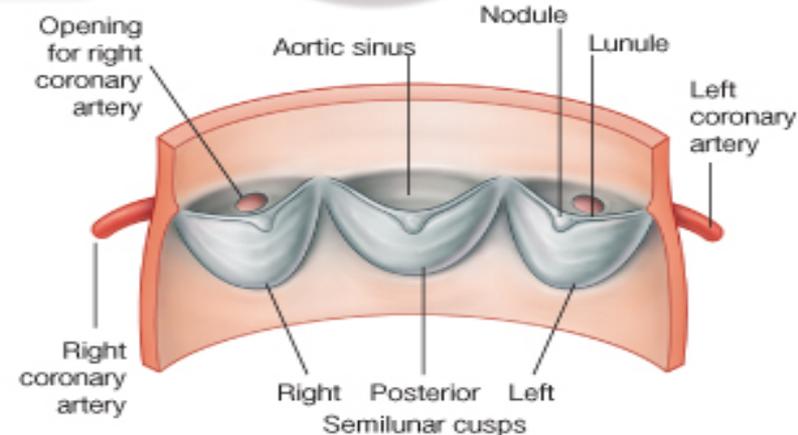
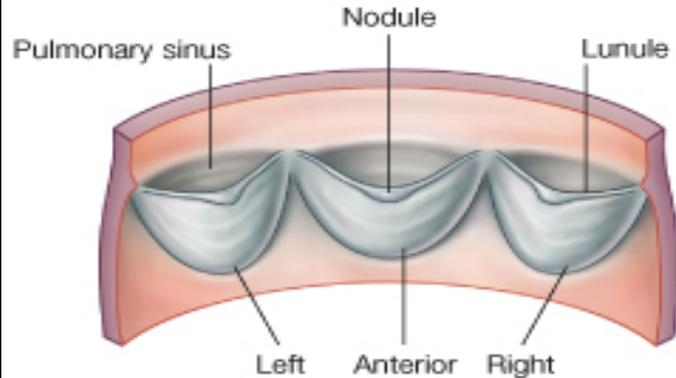
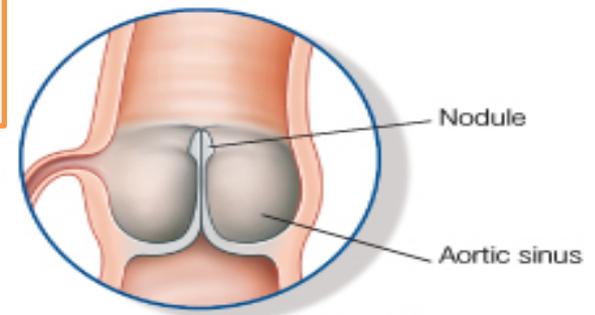
Both valves *move anteriorly and to the left during systole,*  
and *reverse their motion in diastole.*

The *mitral valve reduces its orificial* (anular) area by *as much as 40% in systole.*

# Semilunar valves



**No chordae or papillary muscles are associated with these valves**



**The pulmonary valve guards the pulmonary orifice and**

**The aortic valve guards the aortic orifice.**

Each consists of three pocketlike cusps of approximately equal size

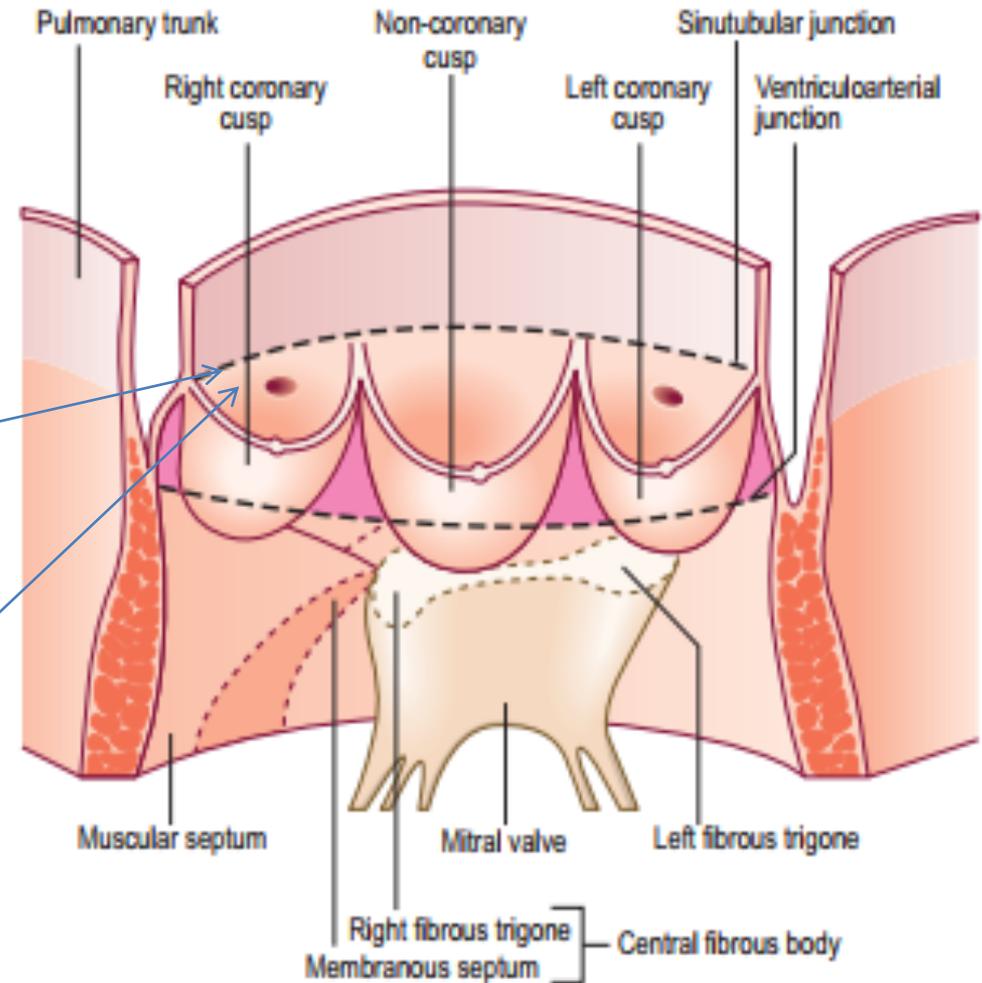
There is no distinct!!!!, circular ring of fibrous tissue at the base of the arteries from which these and the valve cusps arise

The arterial wall **expands into three dilated pouches**, the sinuses of **Valsalva**

## sinuses (of Valsalva)

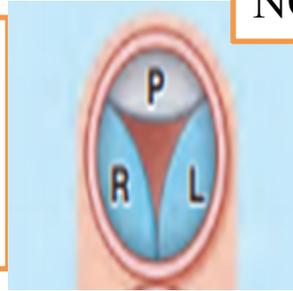
- The aortic sinuses are more prominent than those in the pulmonary trunk
- The upper limit of each sinus reaches considerably beyond the level of the free border of the cusp and forms a well-defined complete circumferential sinotubular ridge when viewed from the aortic aspect

Coronary arteries usually open near this ridge within the upper part of the sinus



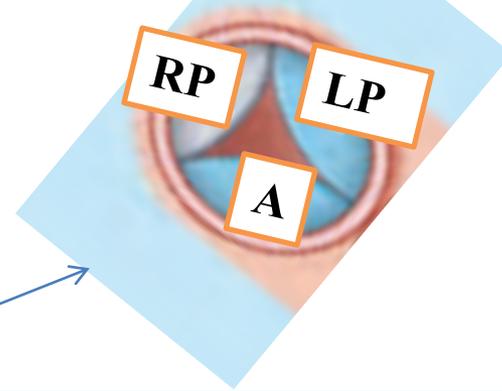
Currently, three sets of names are used to describe the aortic cusps

Refer to presumed fetal positions before full cardiac rotation has occurred  
Posterior, right and left



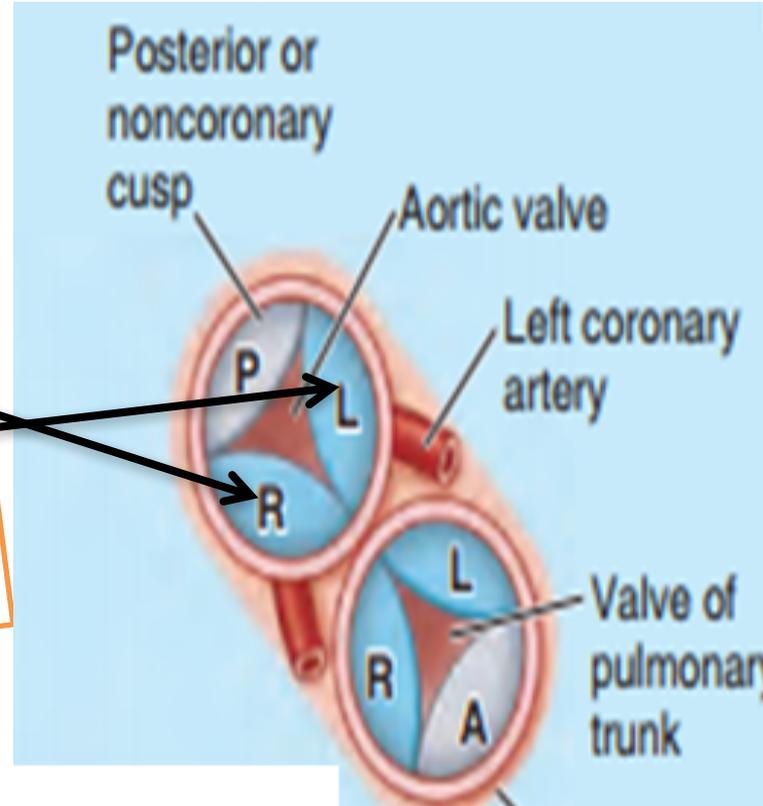
NO rotation

45 degrees rotation to the left



Corresponding terms based on the approximate positions in maturity are **anterior, left posterior** and **right posterior**

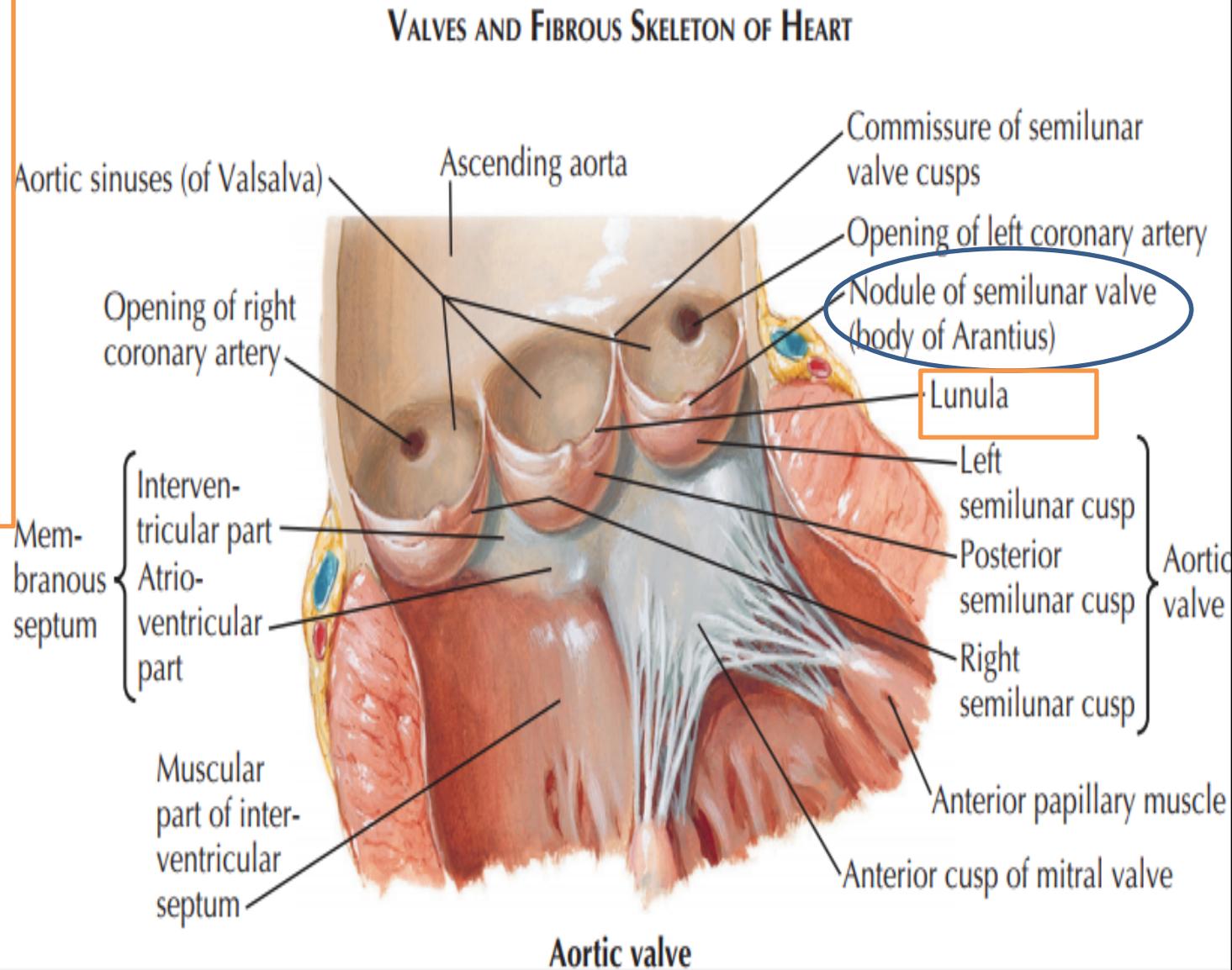
However, as already indicated, widespread clinical terminology links both cusps and sinuses to the origins of the coronary arteries. Thus, the **anterior is termed the right coronary cusp**, the **left posterior is the left coronary**, and the **right posterior is the noncoronary**: these clinical terms are preferable, in the normal heart, because they are simple and unambiguous.



The cusps of the arterial semilunar valve are largely smooth and thin.

At the center of the free margin of each cusp is a small fibrous nodule called

## The nodulus Arantii



On each side of the nodules of Arantius, along the entire free edge of the cusp, there is a thin, halfmoon-shaped area called the **lunula** that has fine striations parallel to the edge

Therefore, we will use the clinically based names

## The aortic valve

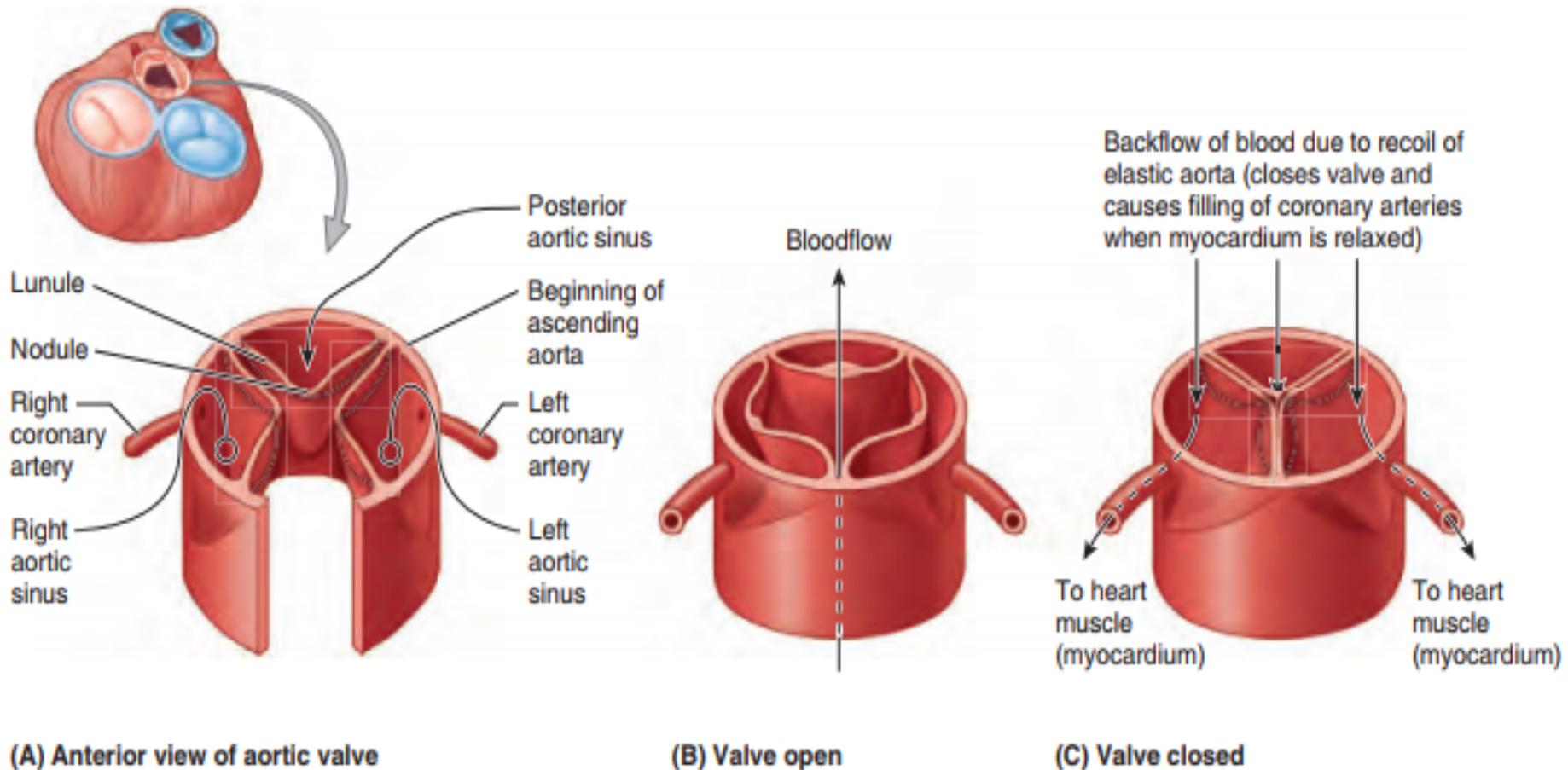
consists of three semilunar cusps

**Posterior** (non-coronary) cusp

Right coronary

Left coronary

Just superior to right and left cusps in the Sinus of **Valsalva** are the openings of the right and left coronary arteries, respectively



## 2-Pulmonary valve

At the apex of the infundibulum, the outflow tract of the right ventricle, the opening into the pulmonary trunk is closed by the **pulmonary valve**

consists of three **semilunar cusps** with free edges projecting upward into the lumen of the pulmonary trunk

3 semilunar cusps

Anterior

Right

Left

Opening of the pulmonary valve

During diastole, the pulmonary valve is closed and all three cusps of the valve are tightly apposed.

The pulmonary valve opens passively during ventricular systole and then closes rapidly at the end of systole

