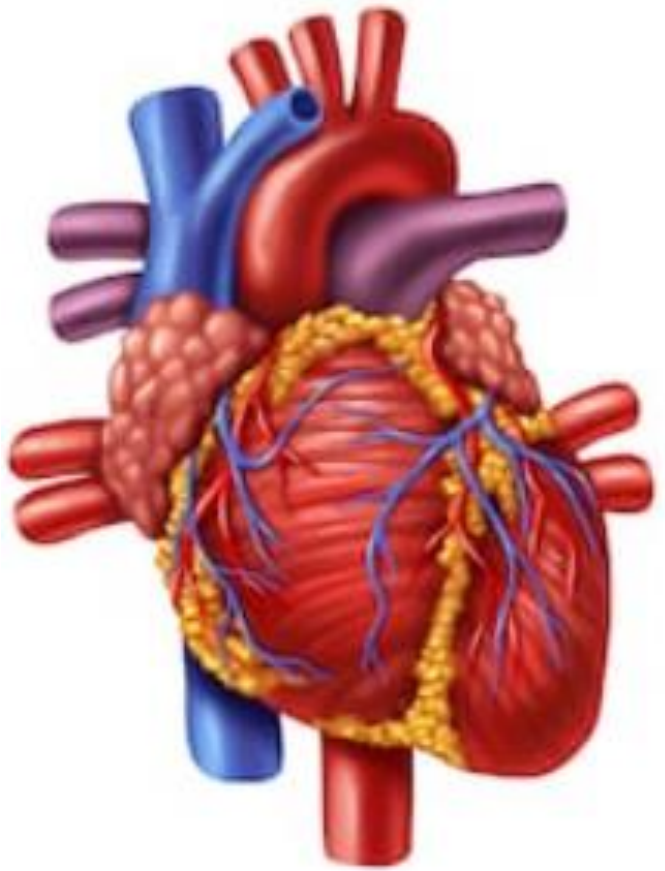
Lecture 8: The heart - C

-This is the last lecture for the mid exam
-Anything written in purple is said by the professor
-Edited by: Ameen Alsaras



Good Luck!!

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 <u>Unidirectional</u> flow of blood

For example: Blood flowing from the right atrium to the right ventricle should never go back to atrium

RIGHT ATRIOVENTRICULAR VALVE

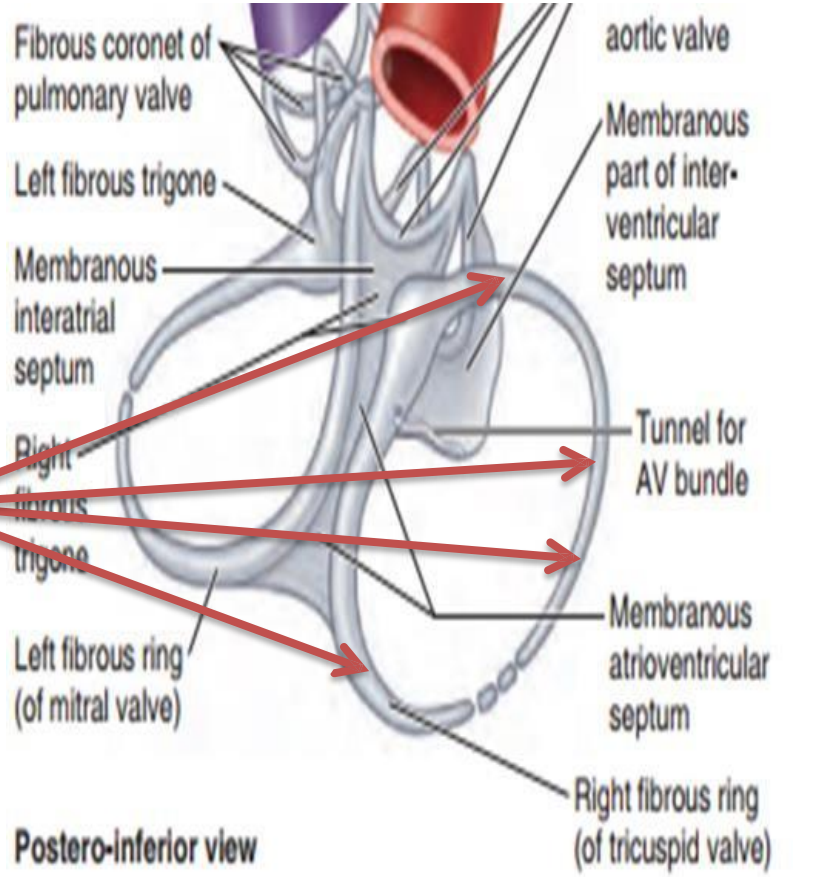
The TRICUSPID valve

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***

As you will see in the next slides

- **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)
- The atrial surface of the AV valve is rather smooth.
- The ventricular surface is irregular because of the insertion of the chordae tendineae



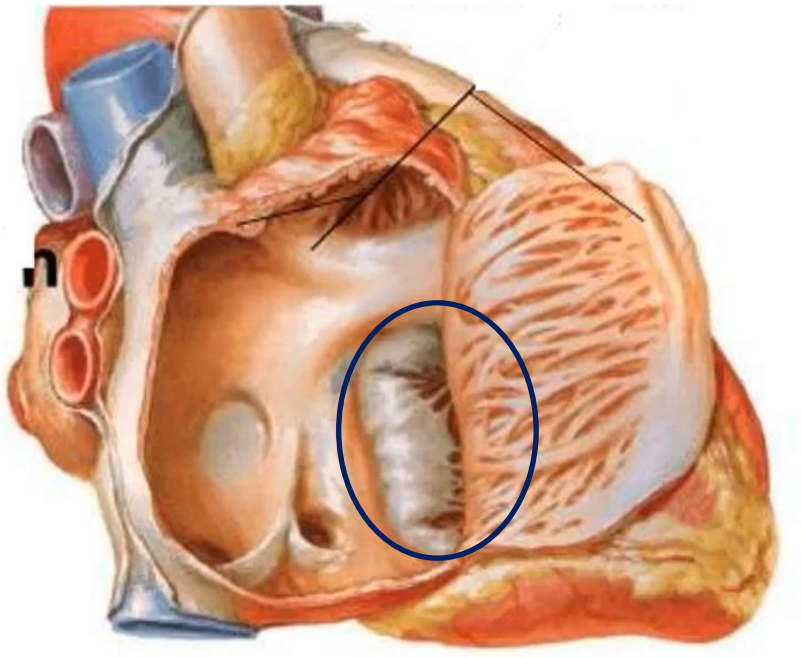
guards **the right atrioventricular orifice**

Remember the functions of fibrous skeleton: supports orifices, helps in muscle attachment, insulation of electrical currents, etc.

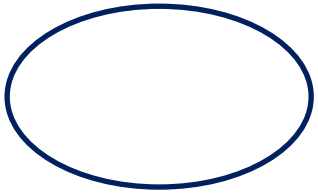
- It is almost **VERTICAL!!!!!!!!**, but at 45° to the sagittal plane

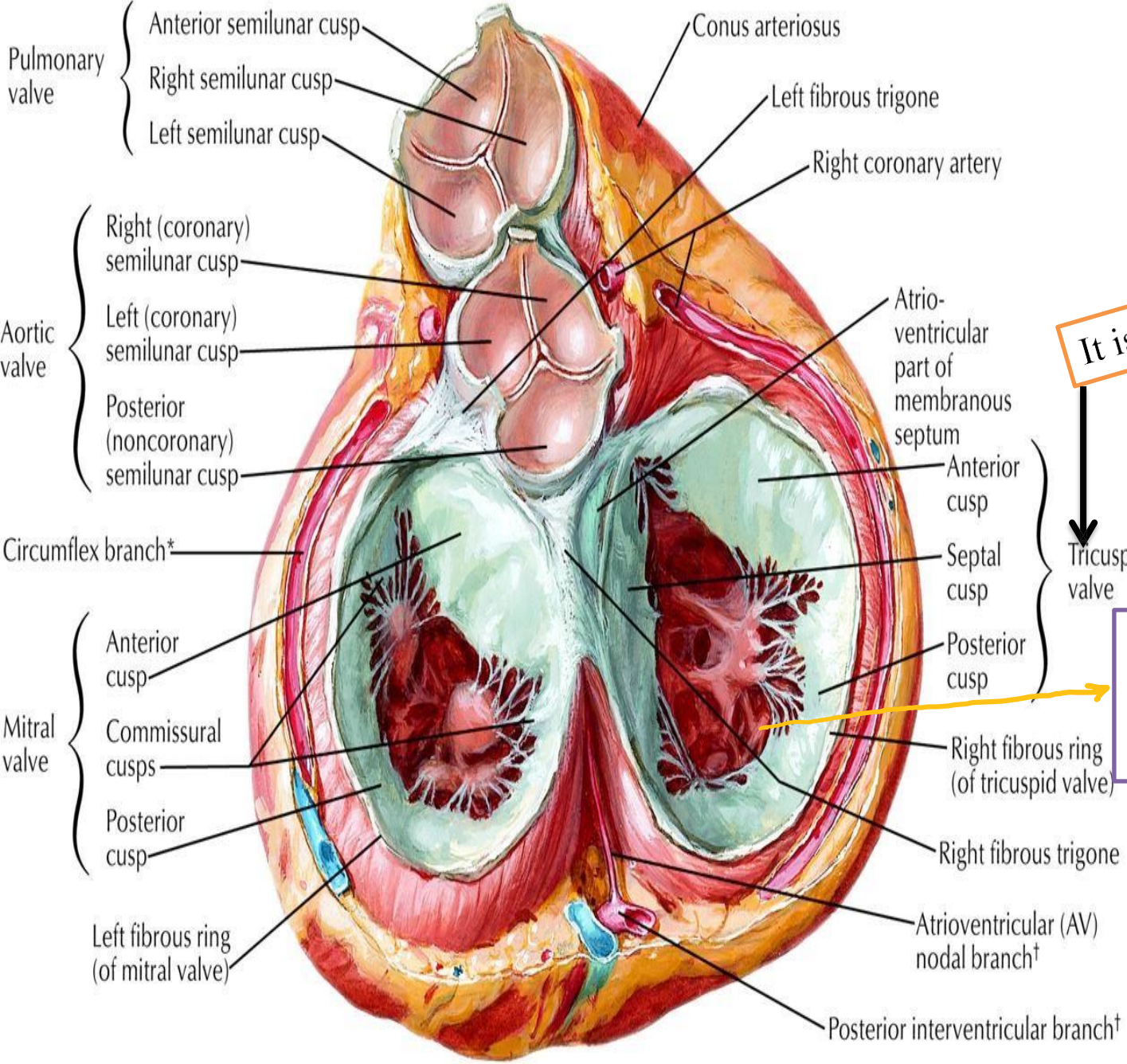
For clarification: As you can see here the heart is in anatomical position and the valve is almost vertical

Extra info: 45° to the sagittal plane means that it is lying a bit anterior, as expected.



If it was horizontal it would be like this:





Heart in diastole: viewed from base with atria removed

It is almost **VERTICAL**

If you look into the orifice from atrial aspect it will be very clear and easy to identify

The atrioventricular valvular complex

Consists of :

1 The orifice and its associated anulus

2 <u>The cusps</u>, the supporting ***<u>chordae tendineae</u>*** of various types and ***<u>the papillary muscles</u>***

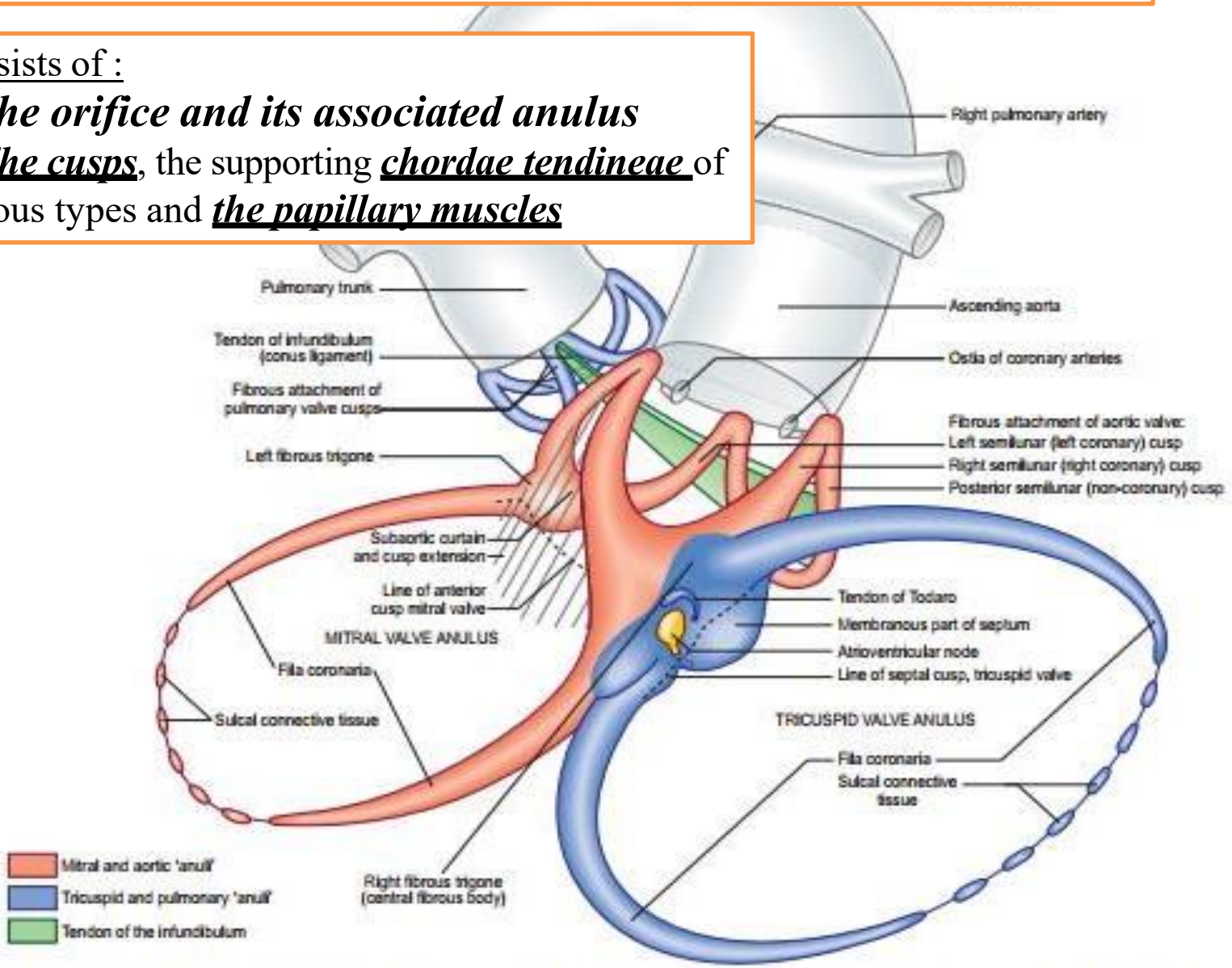
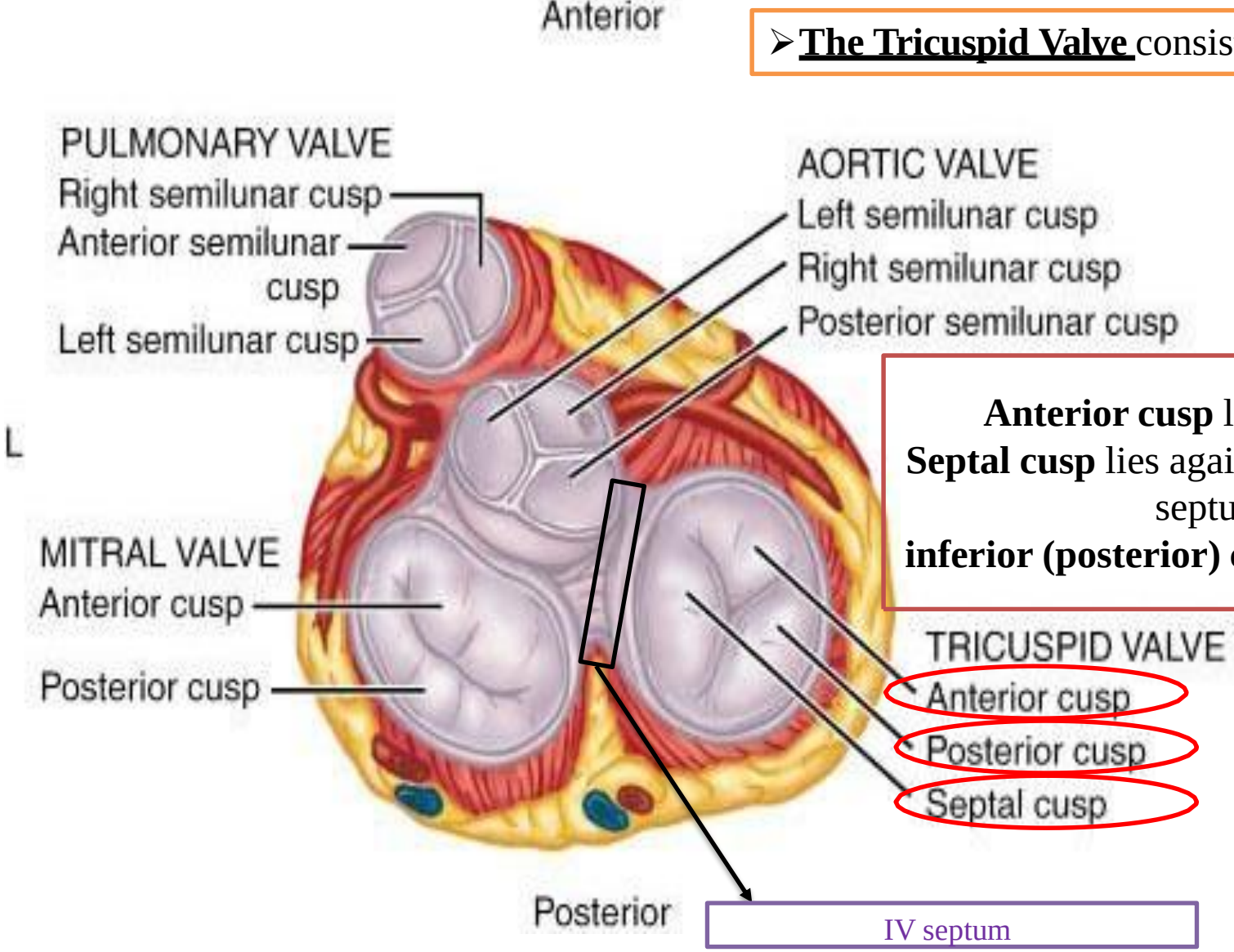


Fig. 56.10 Principal elements of the fibrous skeleton of the heart. For clarity, the view is from the right posterosuperior aspect. Perspective causes the pulmonary anulus to appear smaller than the aortic anulus, whereas in fact the reverse is the case. Consult text for an extended discussion. (Copyright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

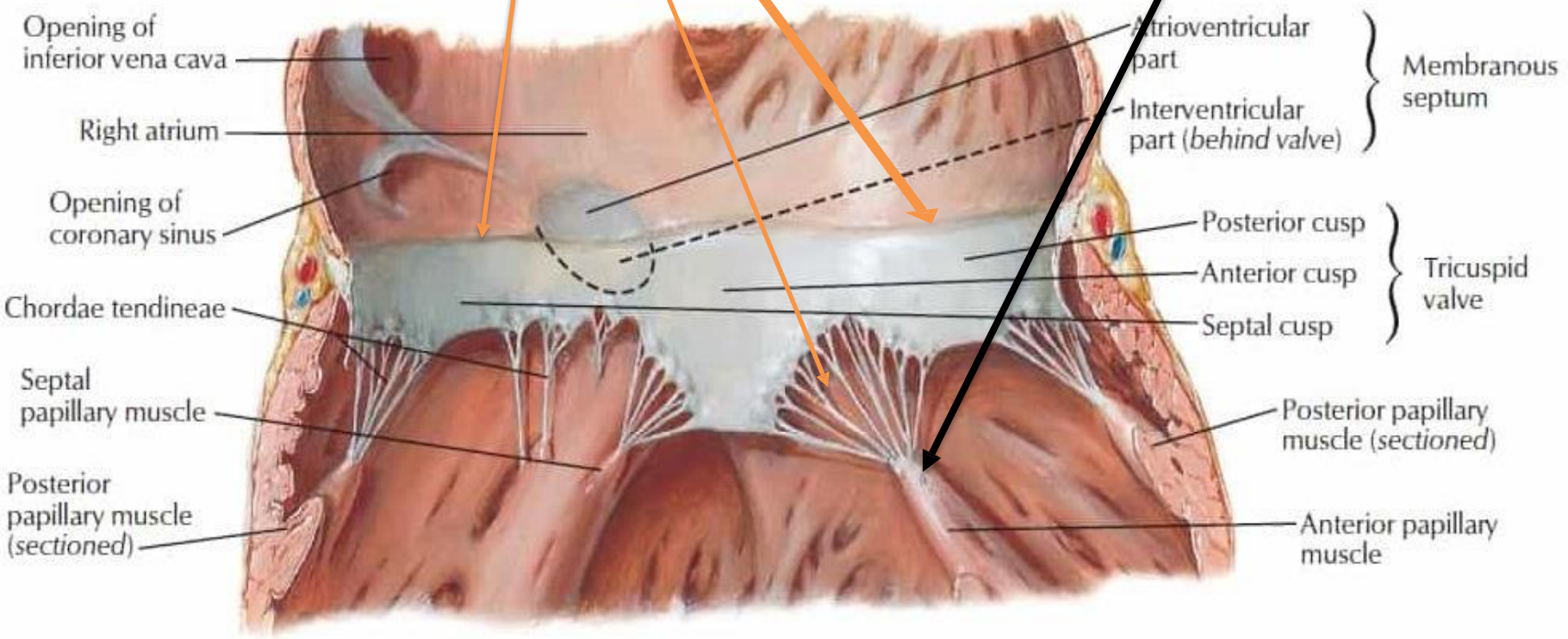
➢ **The Tricuspid Valve** consists of three cusps



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

- The bases of the cusps are attached ***to the fibrous ring of the skeleton of the heart (Not to the myocardium!)*** whereas their free edges and ventricular surfaces are attached to ***the chordae tendineae.***

- The chordae tendineae connect the cusps to the papillary muscles



Tricuspid (right atrioventricular) valve

The Tricuspid Valve

Differs from mitral valve in numbers only, they have the same structure

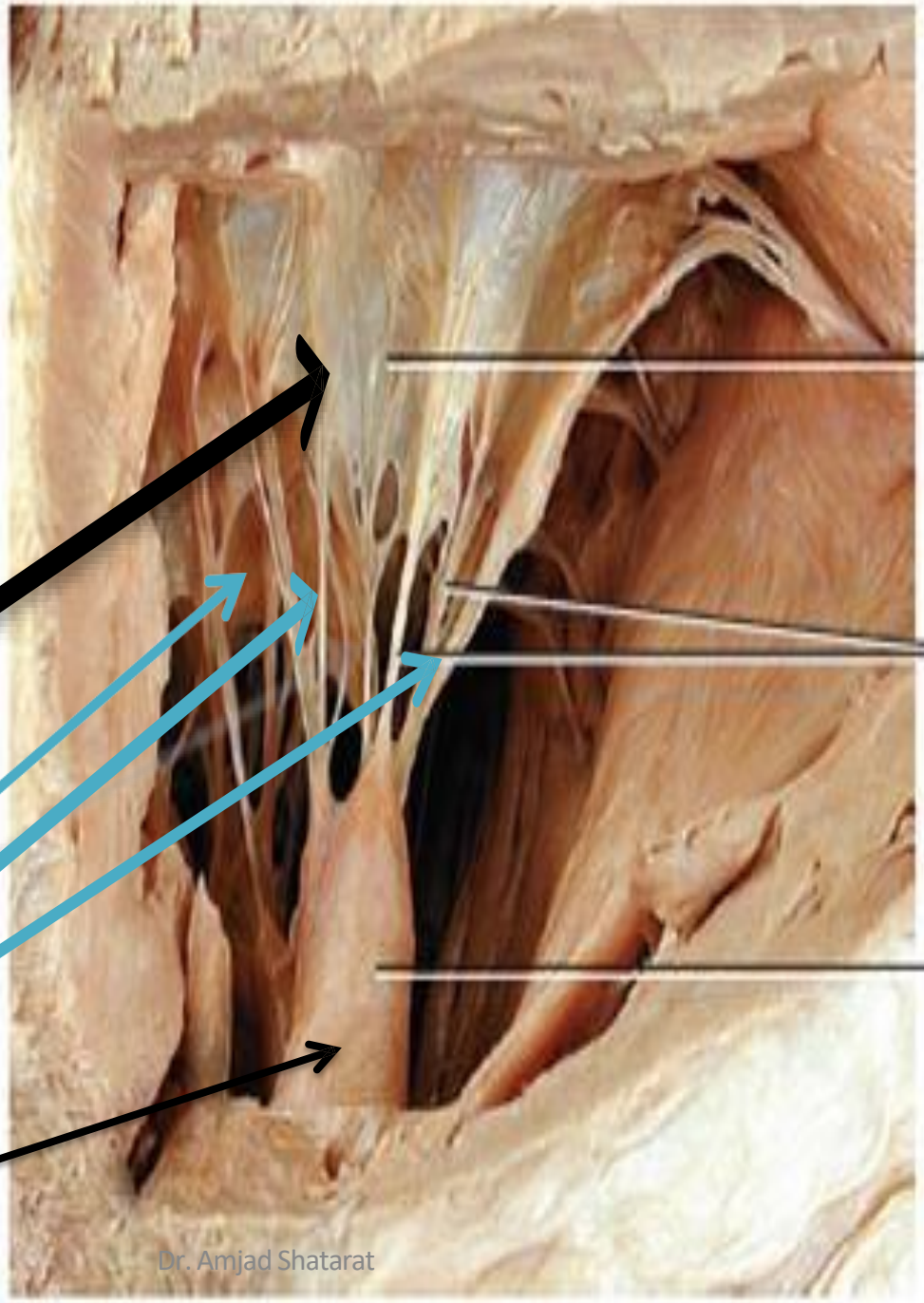
How to make a good orifice and guard it by a strong valve?

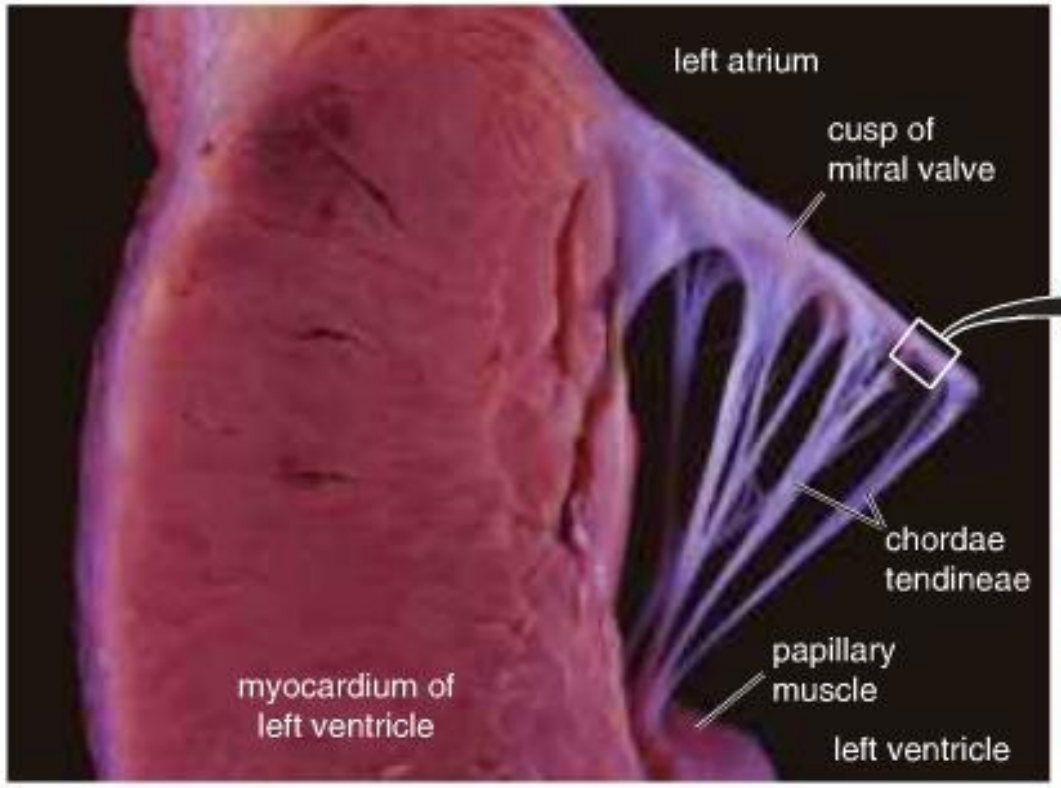
First, you start by the **fibrous** band which makes the frame of the opening. Next, we attach these three structures:

1-The cusps

2-The chordae tendineae.

3-papillary muscles





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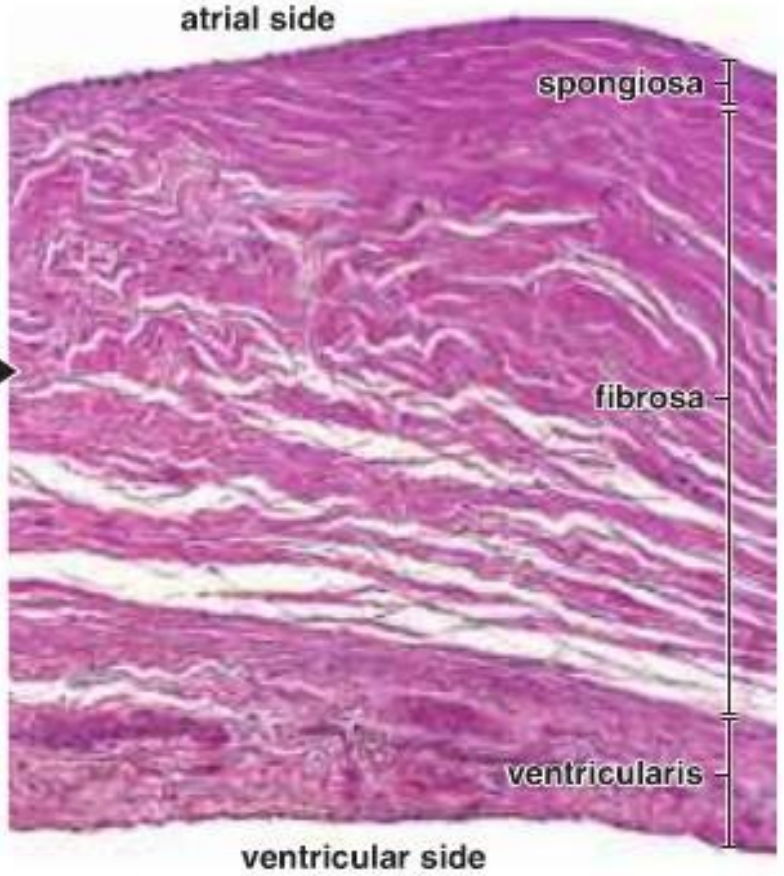


b

Histology

Note: Why are we so interested in each component on its own?

Each one of them can get damaged and affect the whole process as we will see later.

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

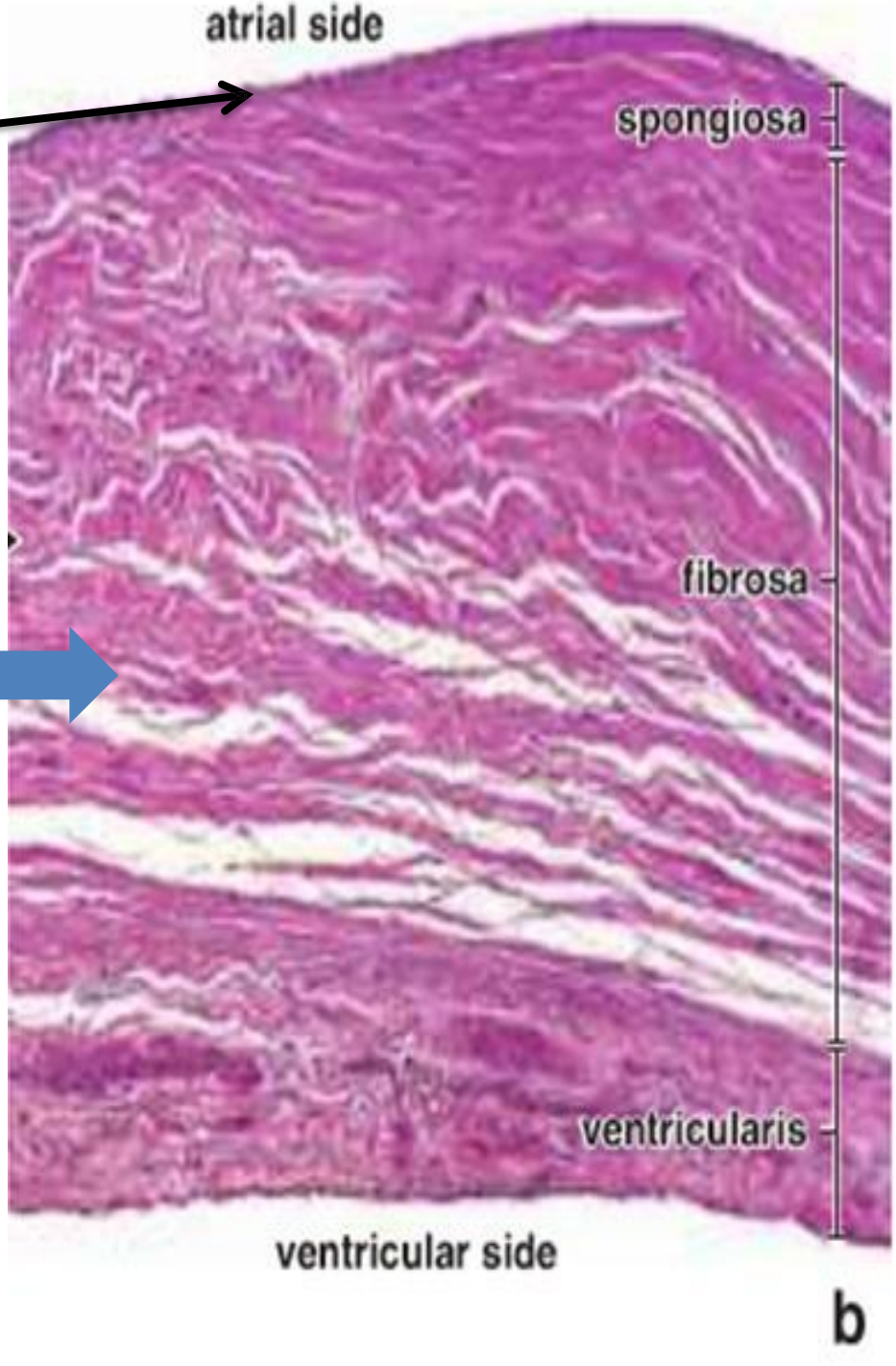
Each valve is composed of three layers

1- The spongiosa is loose connective tissue located on the **atrial or blood vessel side (aortic and pulmonary)** of each valve.

2- 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

3- The ventricularis is immediately adjacent to the ventricular 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**

*So they are thin, fragile, and simple structures



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

Clinical Application (valvulitis).

**The prof. said he ALWAYS asks about them in exams

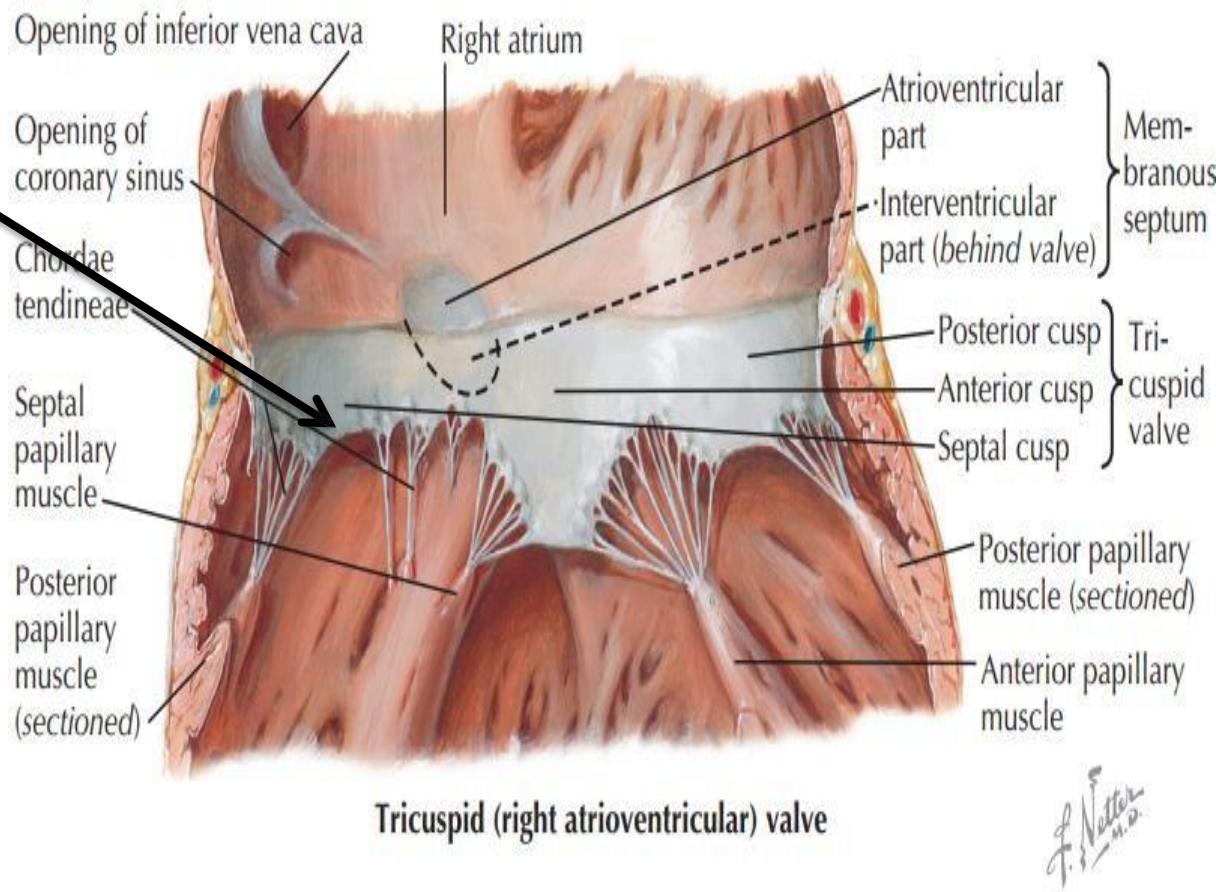
- Rheumatic fever causes inflammation of the heart valves (valvulitis)
- Inflammation induces **<u>angiogenesis in the valve and vascularization</u>** in the normally avascular layers of the valve.
- These changes most commonly affect the ***<u>mitral valve (65% to 70%) ????!!</u>*** and aortic valve (20% to 25%).

Because cusps of the mitral valve (especially the anterior one) are subjected to two currents of blood
1-Lt. Atrium → Lt. Ventricle 2-Lt. Ventricle → Aorta

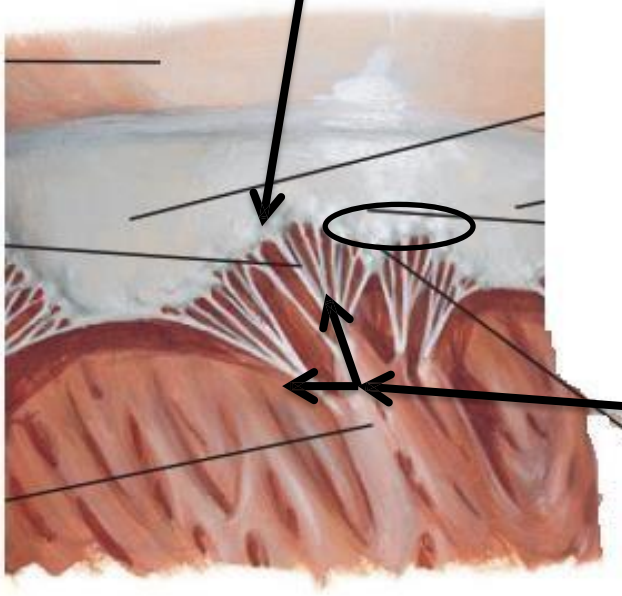
- This inflammation can lead to ***progressive replacement of elastic tissue by irregular masses of collagen fibers***, causing the valve **<u>to thicken.</u>**
- The valves become rigid and inflexible, which **<u>affects their ability to open and close</u>**

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

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



Tricuspid (right atrioventricular) valve



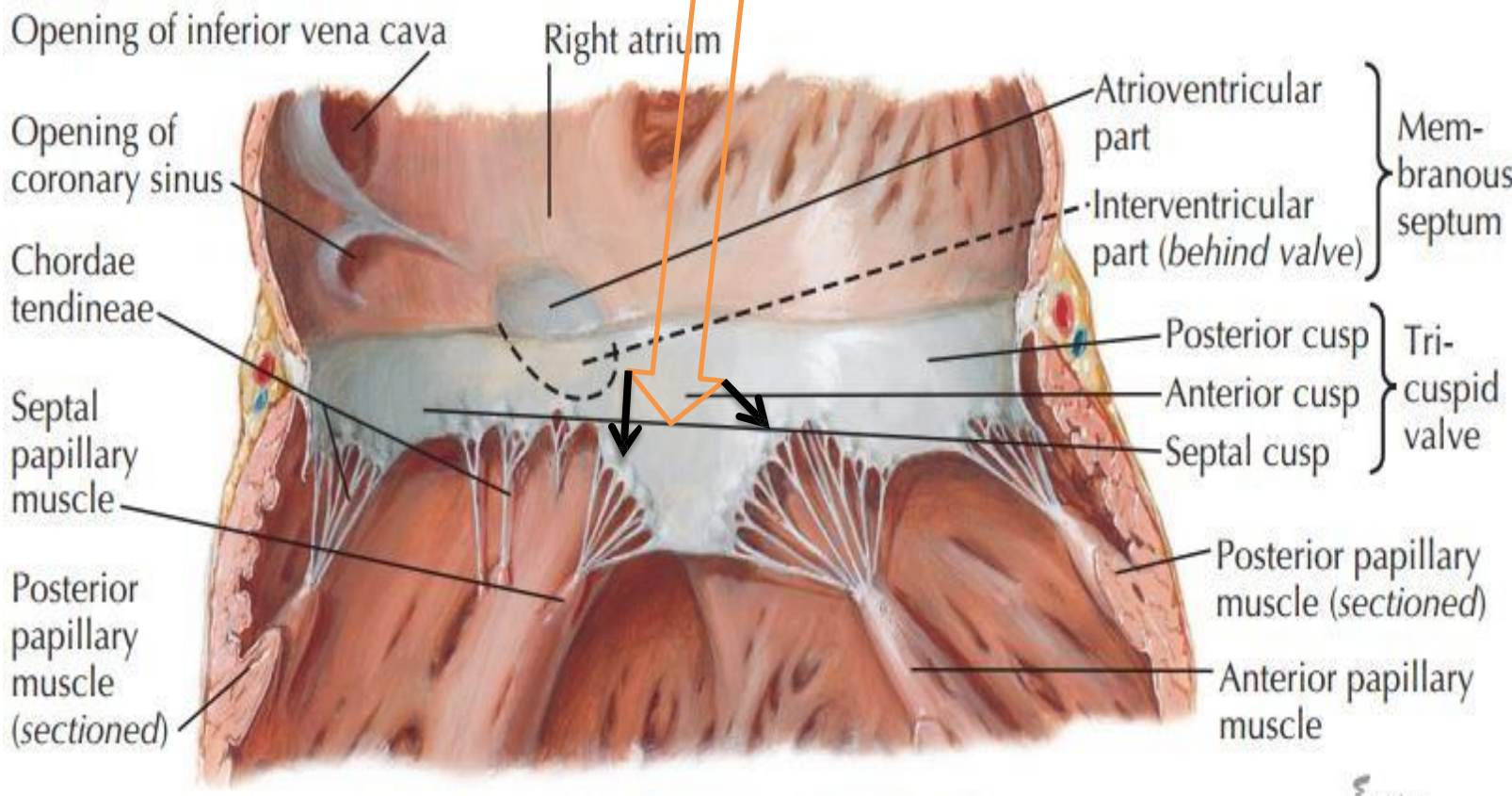
<u>The noduli Albini</u>

minute fibrous nodules on the margins of the mitral and tricuspid valves of the <u>heart</u>

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

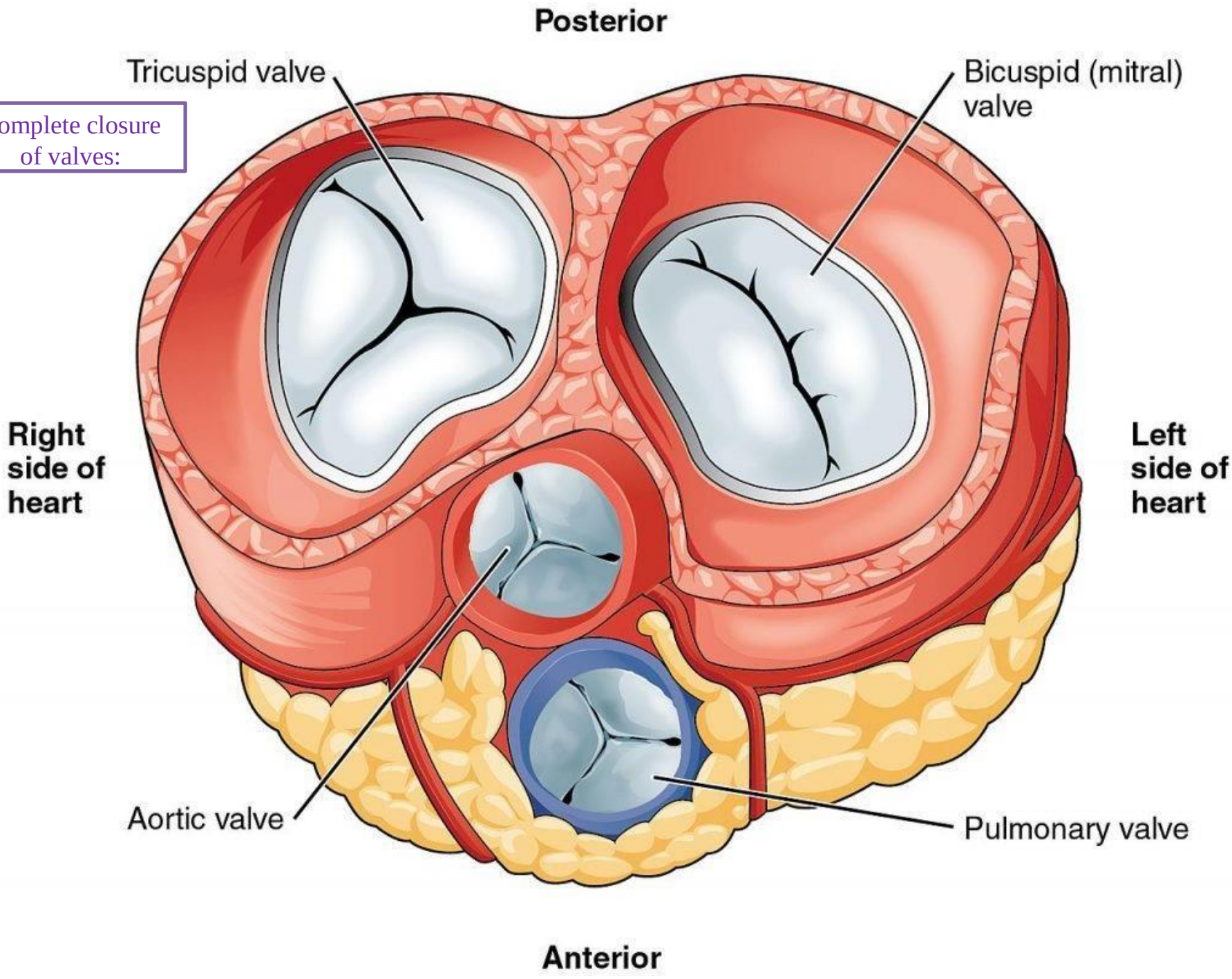
To assist in this process, the chordae tendineae of one papillary muscle are connected to the **adjacent parts of two cusps** **(So there is coordination between cusps)**

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



Tricuspid (right atrioventricular) valve

Complete closure of valves:

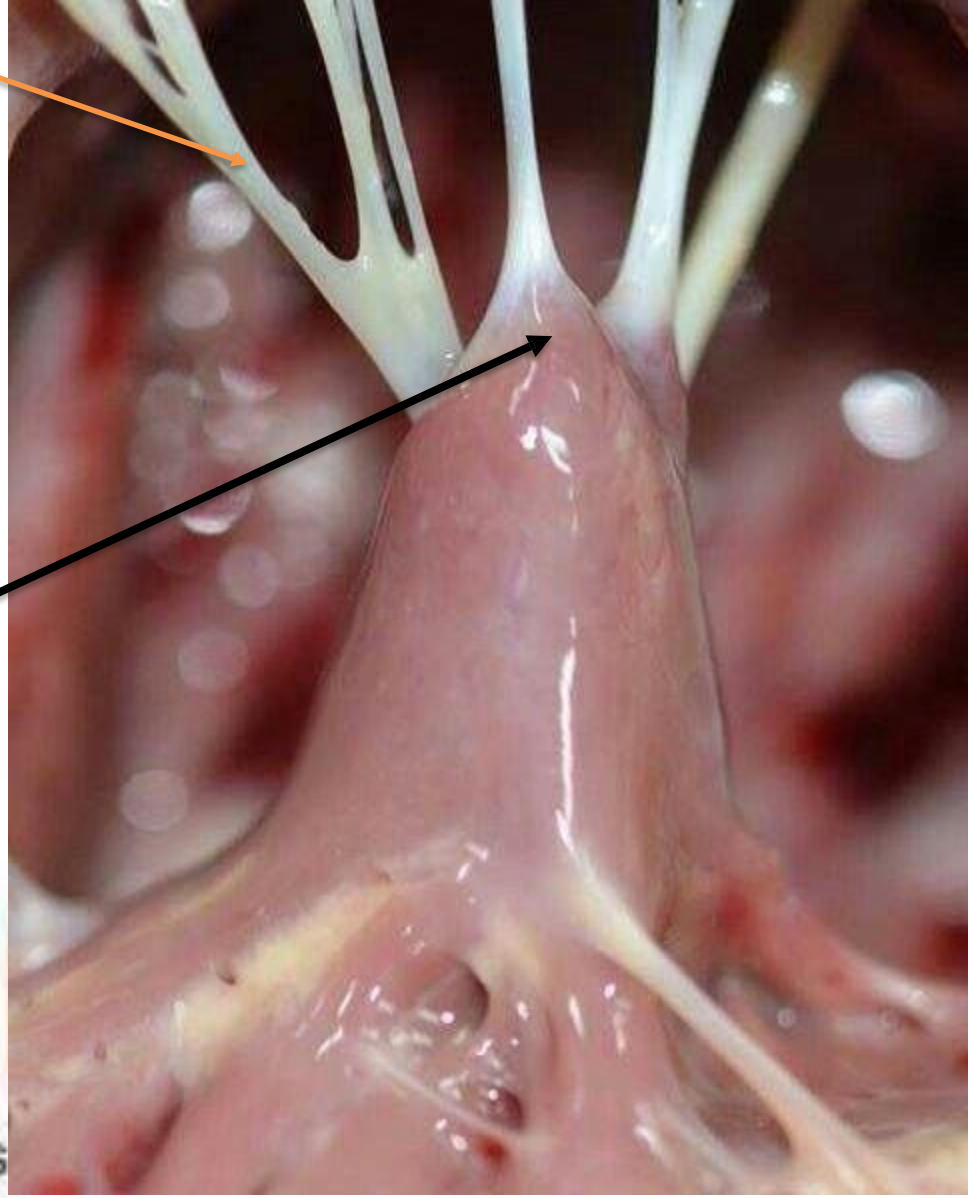


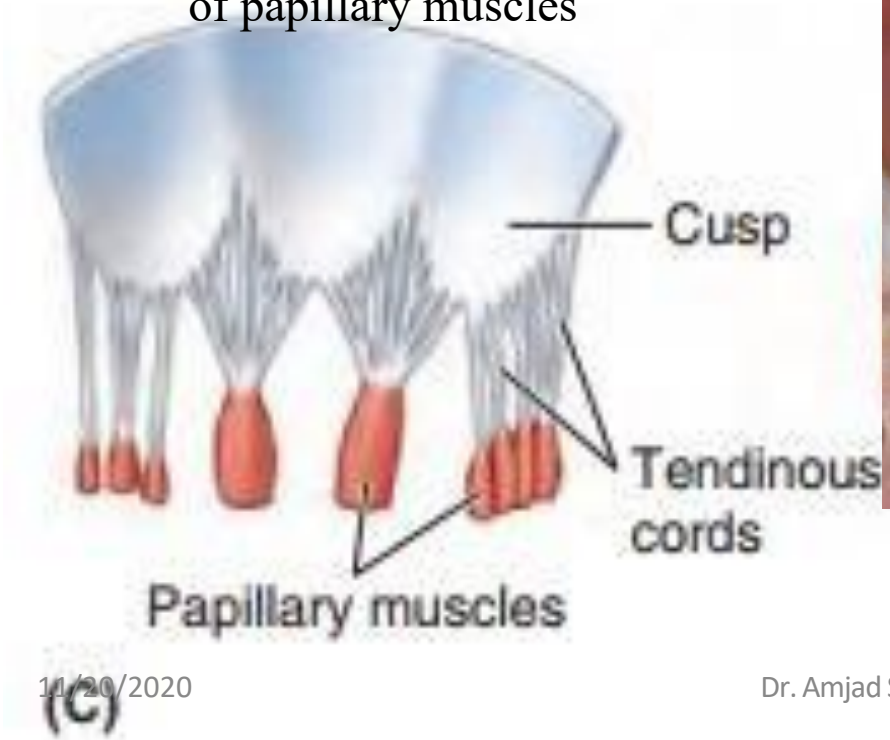
Chordae tendineae (tendinous cords)

are fibrous collagenous structures supporting the cusps of the atrioventricular valves

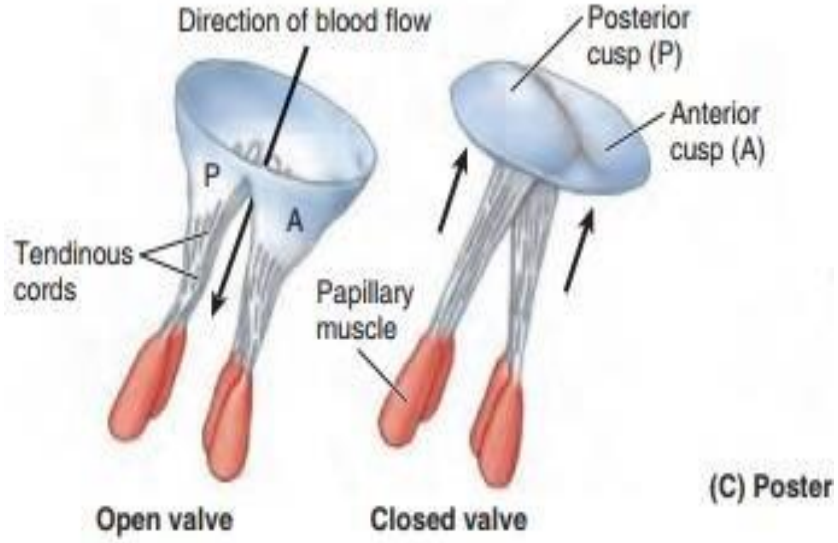
Tendinous cords attach to the free edges and ventricular surfaces of the anterior, posterior, and septal cusps, much like the cords attaching to a parachute

The tendinous cords arise from the apices of papillary muscles



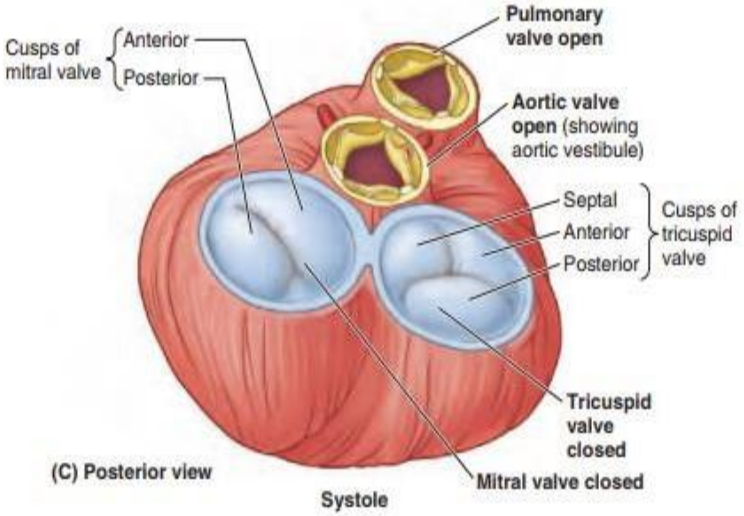


When the right ventricle is full of blood, papillary muscles begin to contract before contraction of the right ventricle, tightening the tendinous cords and drawing the cusps together. Because the cords are **attached to adjacent sides of two cusps**, they prevent separation of the cusps and prevented 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

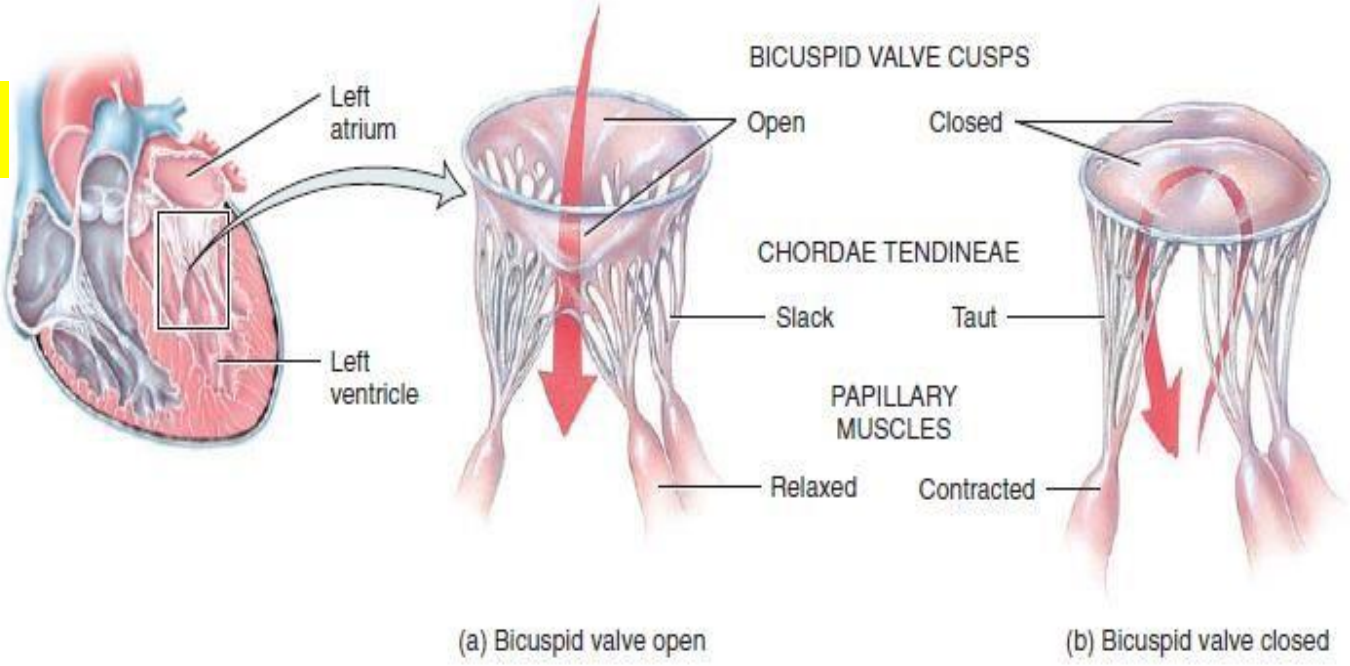


Do papillary muscles close valve or do they open it?

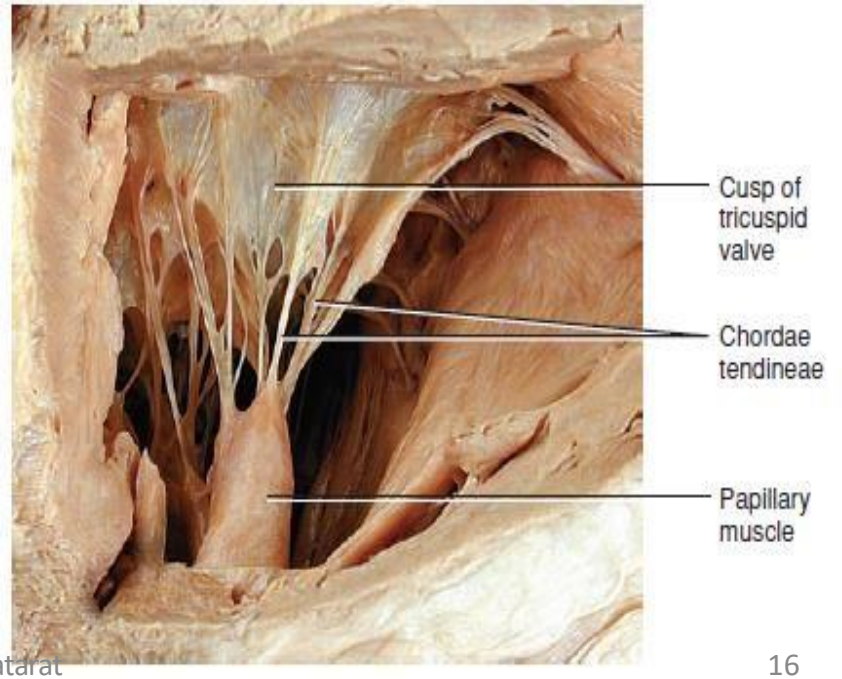
Pressure is what opens and closes valves. Papillary muscles insure Competence (closure) of the valve only!



The mitral valve



- guards the left atrioventricular orifice
- It consists of two cusps.



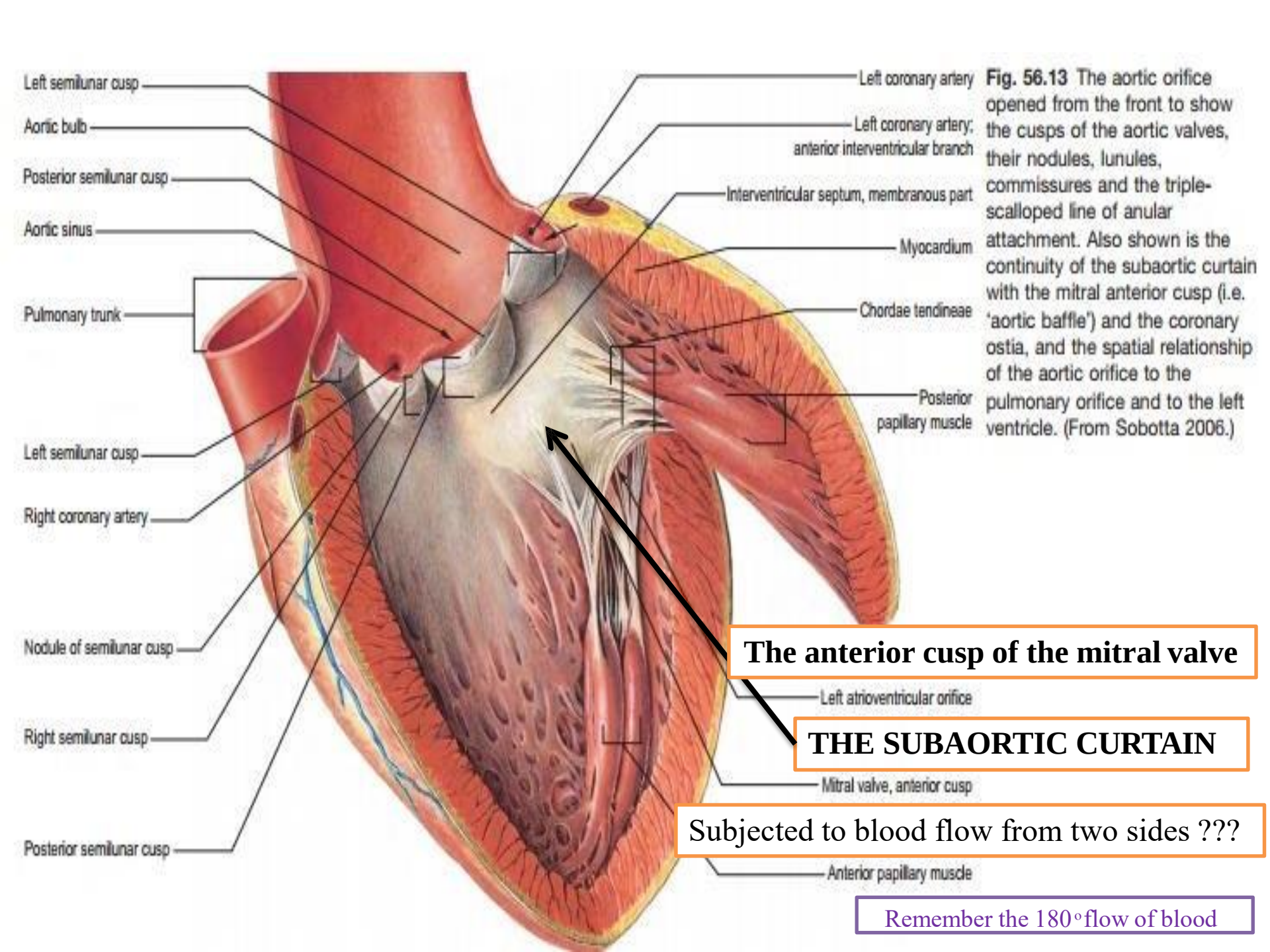


Fig. 56.13 The aortic orifice opened from the front to show the cusps of the aortic valves, their nodules, lunules, commissures and the triple-scalloped line of anular attachment. Also shown is the continuity of the subaortic curtain with the mitral anterior cusp (i.e. 'aortic baffle') and the coronary ostia, and the spatial relationship of the aortic orifice to the pulmonary orifice and to the left ventricle. (From Sobotta 2006.)

The anterior cusp of the mitral valve

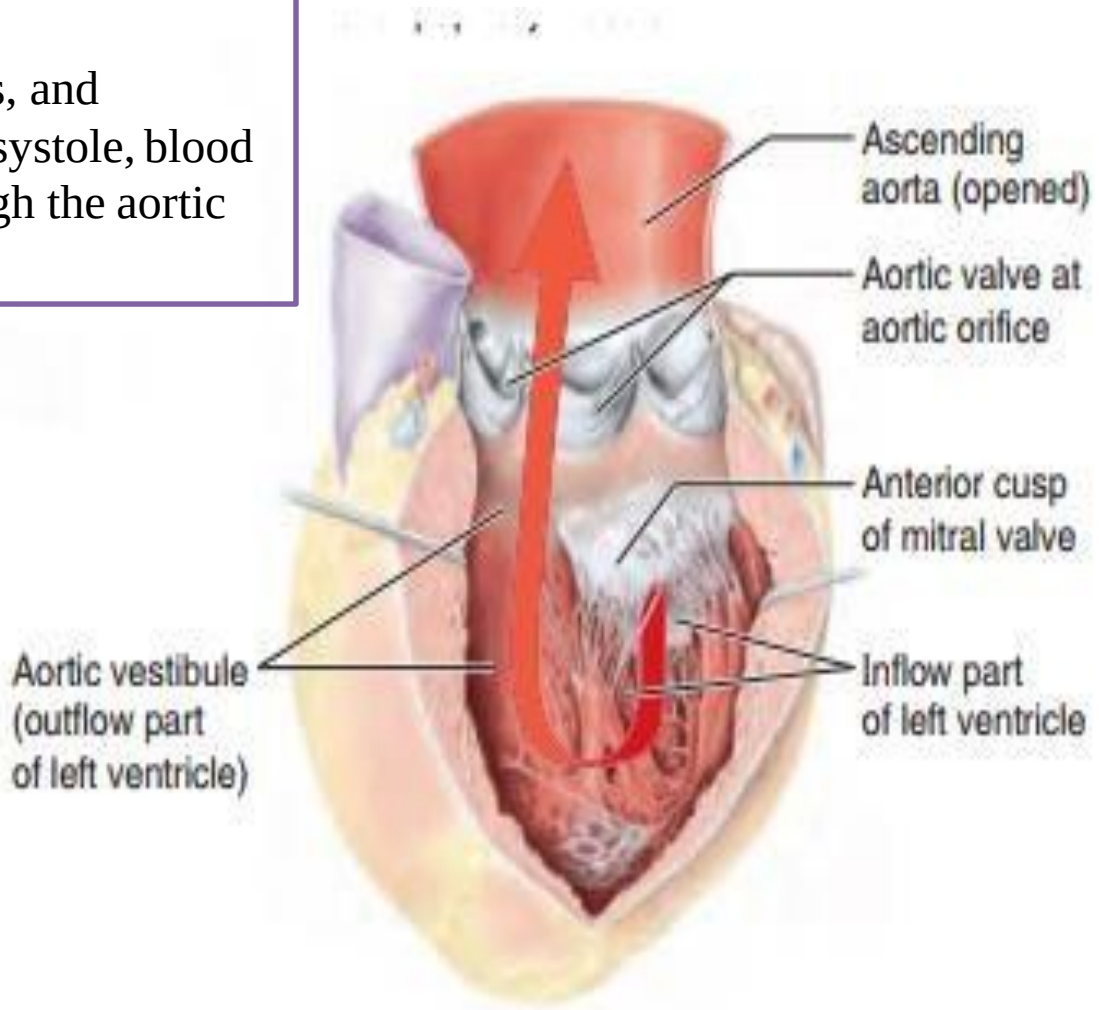
THE SUBAORTIC CURTAIN

Subjected to blood flow from two sides ???

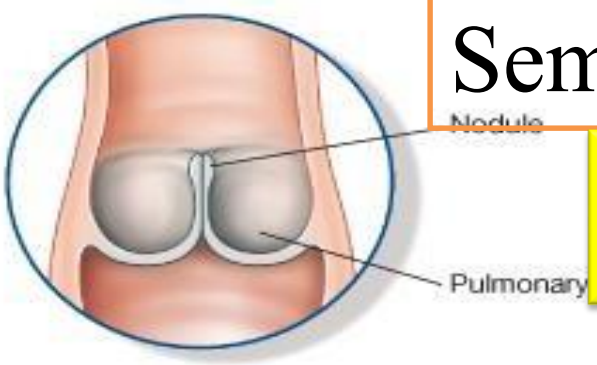
Remember the 180° flow of blood

- The left atrioventricular orifice admits atrial blood during diastole, flow being towards the cardiac apex.
  - After closure of the mitral cusps, and throughout the ejection phase of systole, blood is expelled from the apex through the aortic orifice

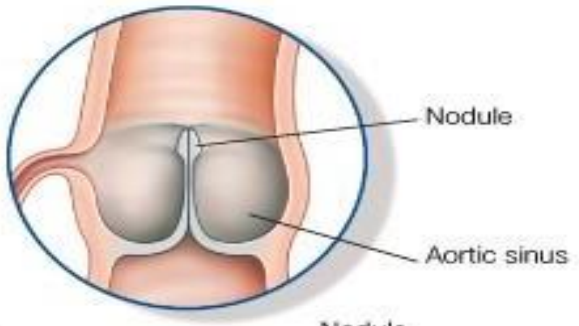
The bloodstream undergoes two right angle turns, which together result in a 180° change in direction. This reversal of flow takes place around **the anterior cusp of the mitral valve**

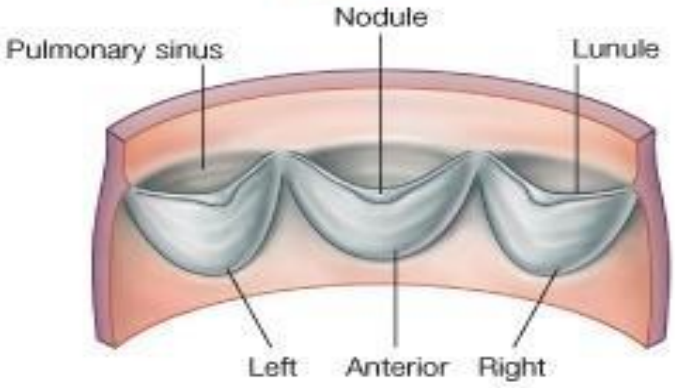


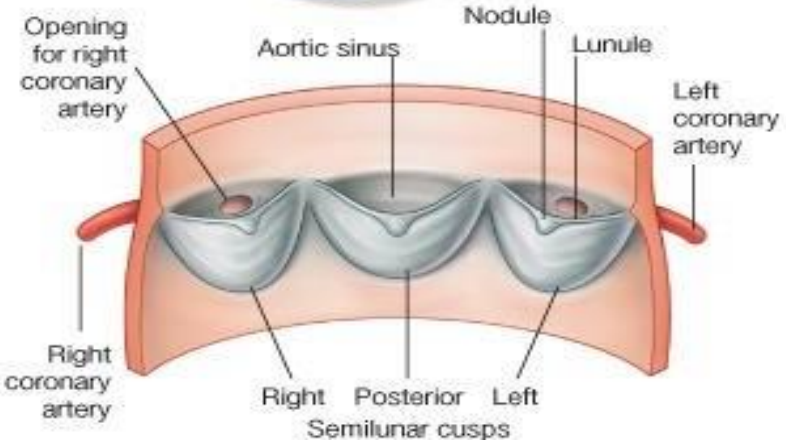
Semilunar valves



No chordae or papillary muscles are associated with these valves







<u>The pulmonary valve</u> guards the pulmonary orifice and

<u>The aortic valve</u> guards the aortic orifice.

Each consists of three pocketlike cusps of approximately equal size

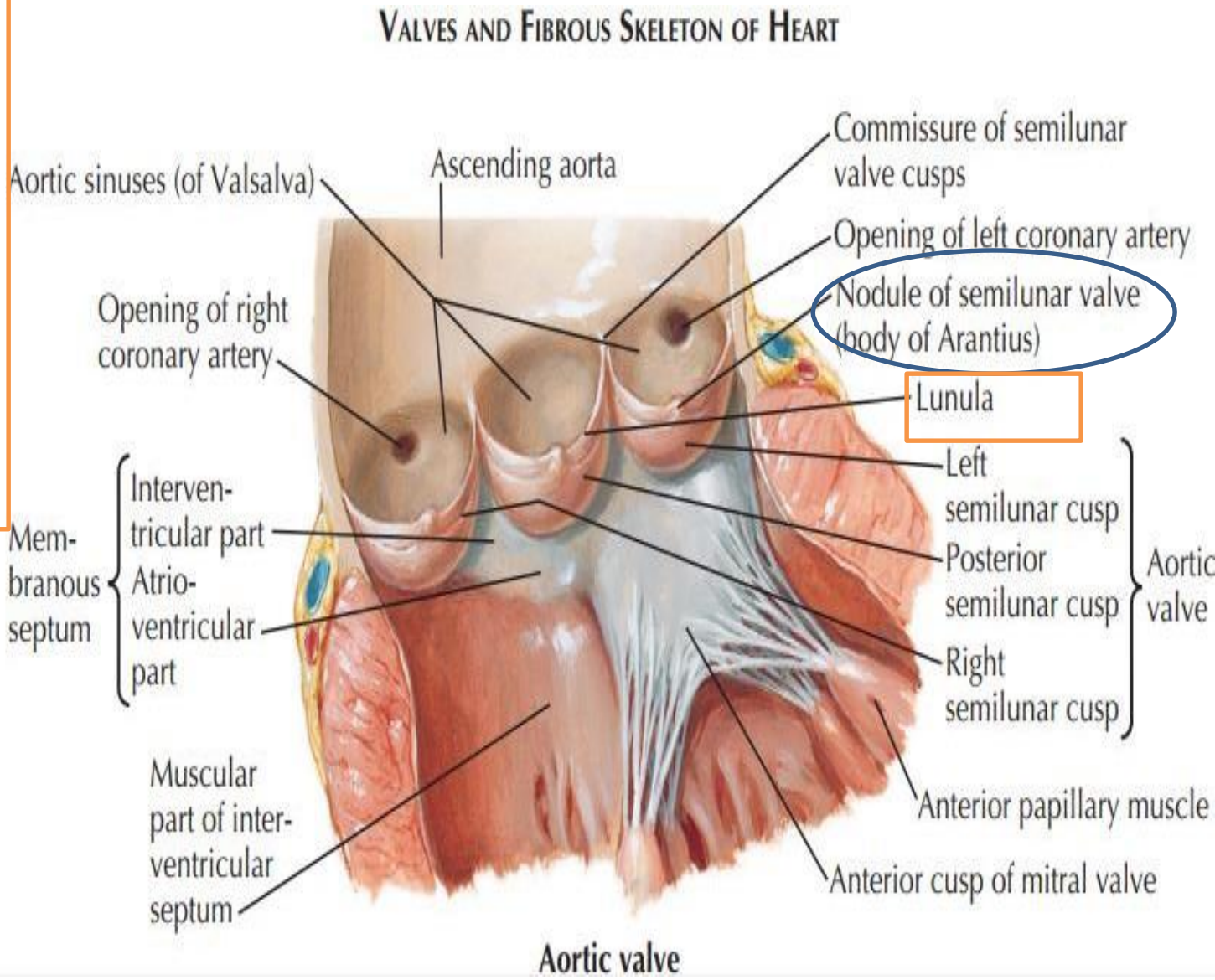
There is no distinct, circular ring of fibrous tissue at the base of the arteries from which these and the valve cusps arise

(According to the prof. and Gray's anatomy, there IS a fibrous ring)

The arterial wall **expands into three dilated pouches**, the **<u>sinuses</u>** of **Valsalva**

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

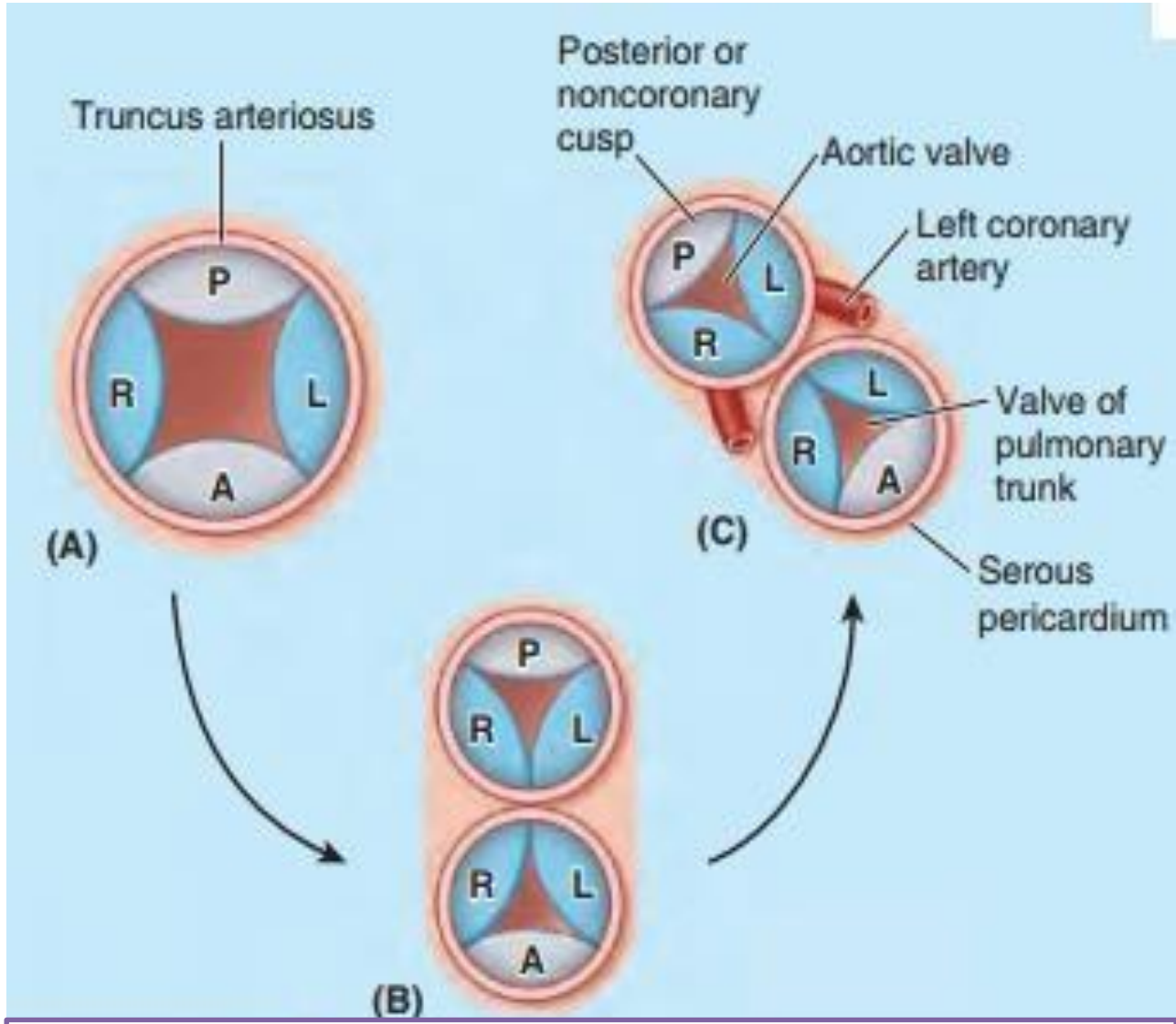
The cusps of the pulmonary and aortic valves are named according to their position in the fetus before the heart has rotated to the left. This, unfortunately, causes a great deal of unnecessary confusion

It is difficult to name the cusps and corresponding sinuses of the pulmonary valve and trunk precisely according to the coordinates of the body, because the valvular orifice is obliquely positioned.

The official nomenclature (Terminologia Anatomica 1998)

refers to **an anterior**, a **posterior** and a **septal cusp**, based on their position in **the fetus**.

The position changes with development and in the adult ***there is one anterior semilunar cusp***, and ***right and left semilunar cusps***



We'll talk about this in embryology

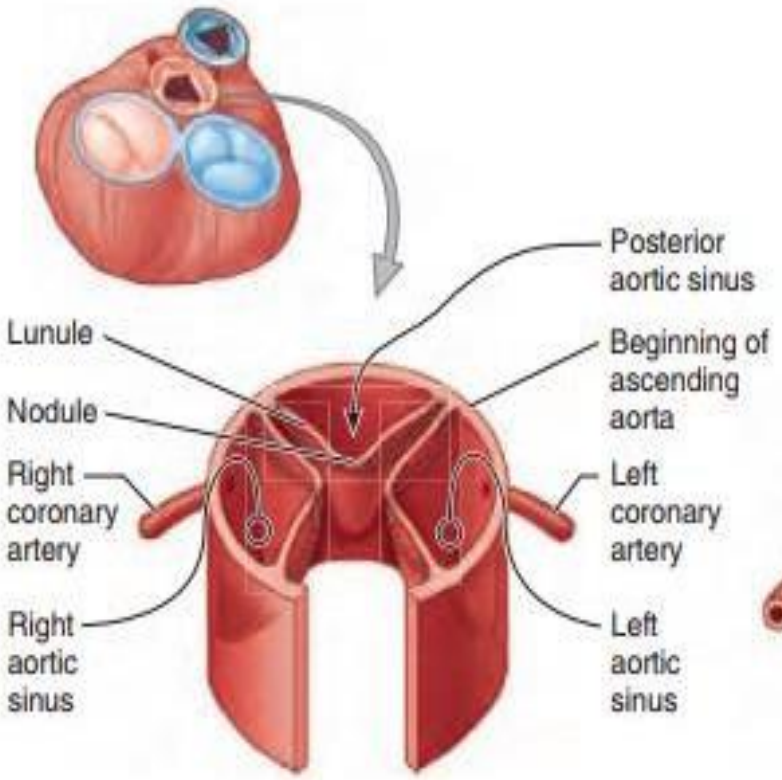
What we need to know for the mid exam:

The aortic valve

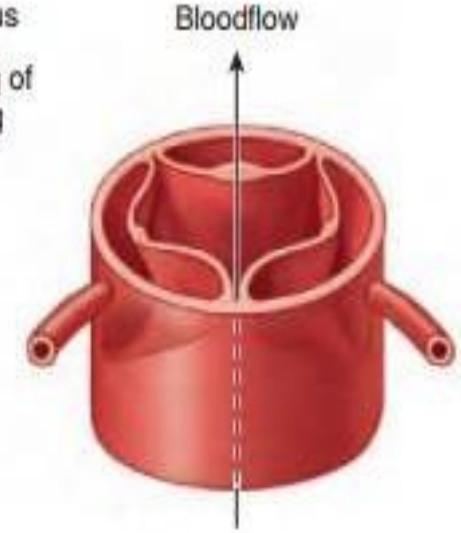
consists of three semilunar cusps

Posterior (non-coronary) cusp
Right
Left

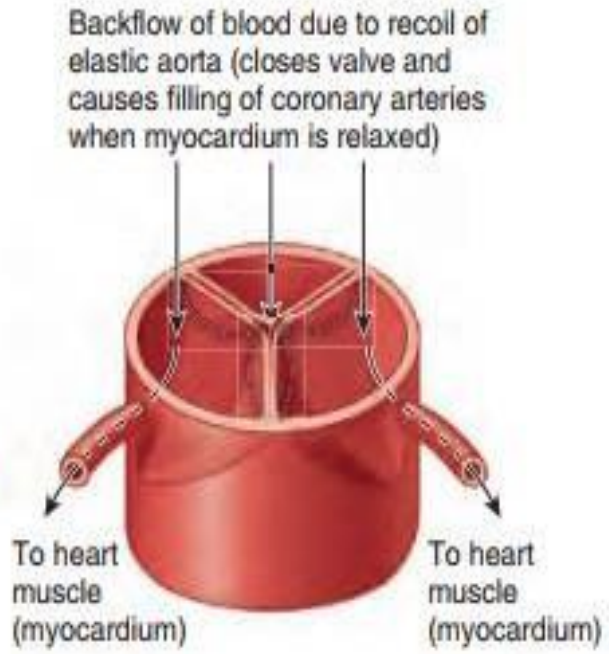
Just superior to right and left cusps in the Sinus of **Valsalva** are the openings of the right and left coronary arteries, respectively



(A) Anterior view of aortic valve



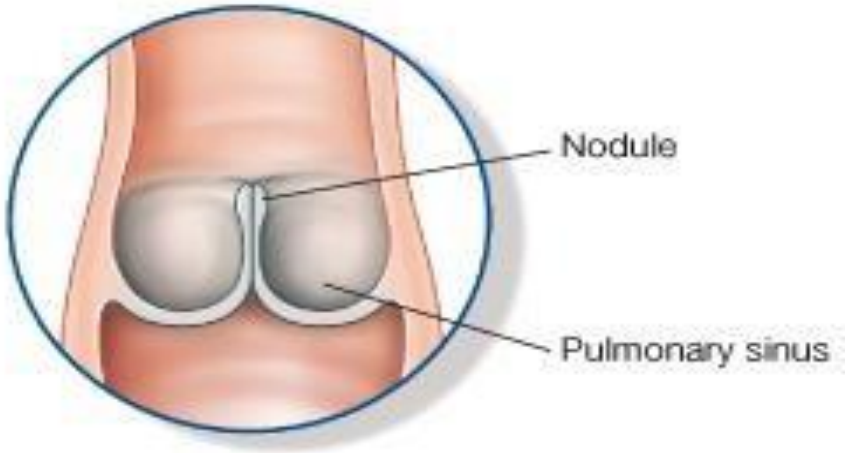
(B) Valve open



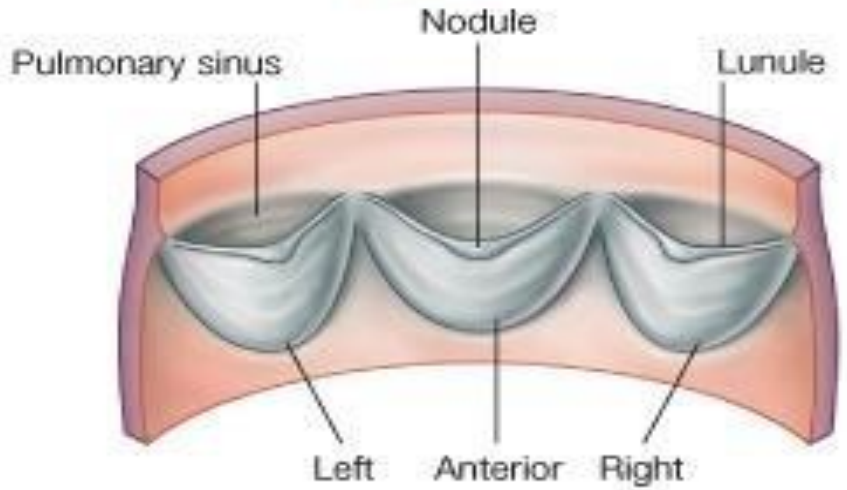
(C) Valve closed

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



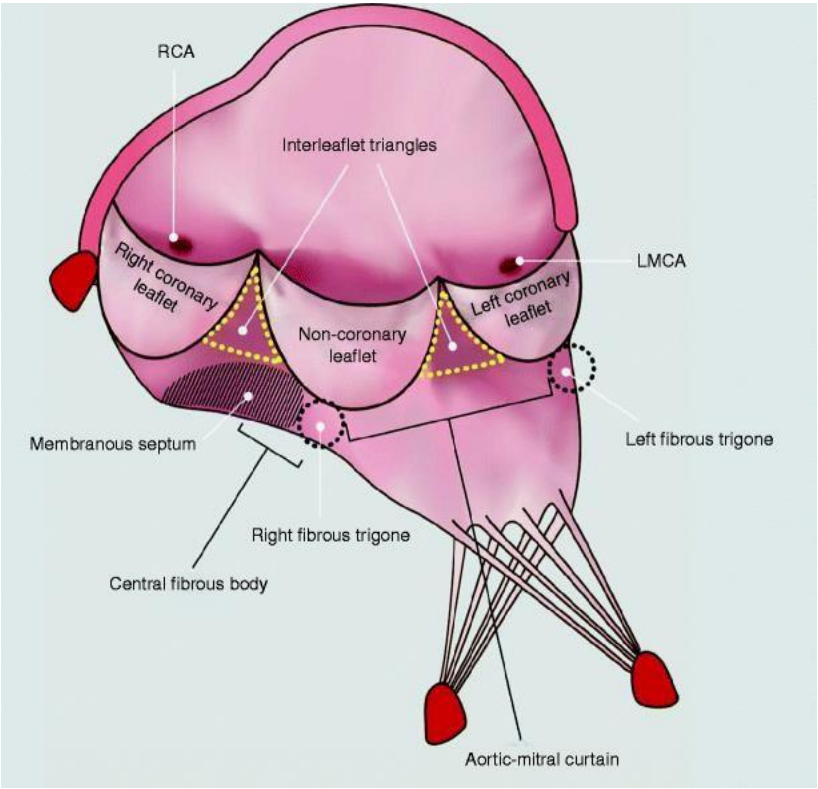
3 semilunar cusps
- Anterior
- Right
- Left

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

Unlike aortic valve, it has no openings for coronary arteries, obviously

This slide is not required



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***.

The **edge of each cusp** is thickened in the region of contact, forming **<u>the lunule</u>**;
the apex of the angulated free edge is thickened further as