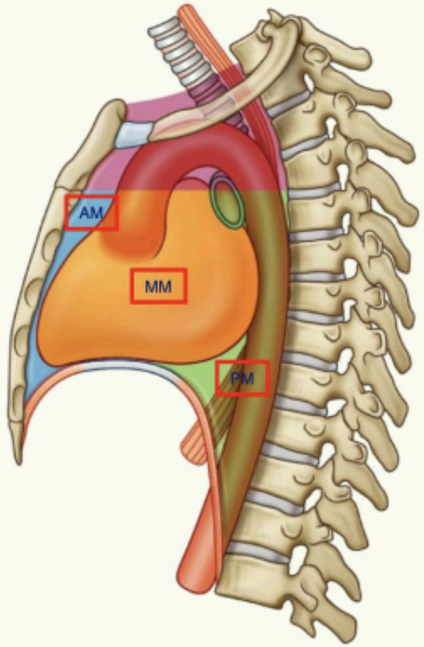
Cardiovascular Anatomy

1. Anatomy of heart in space + chambers and valves

2.Great vessels and vascular anatomy

3.Blood supply of heart + innervation

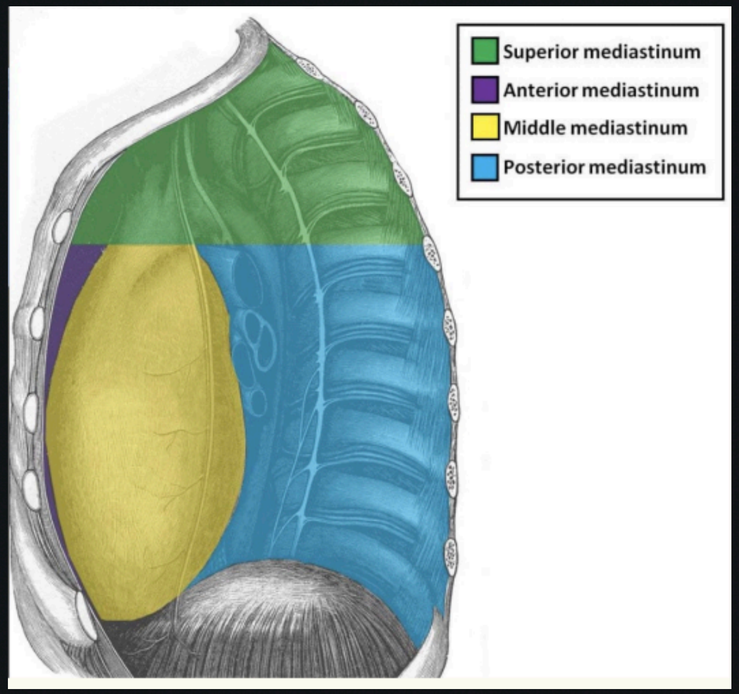
I. Anatomy of heart in space + chambers and valves



Anterior mediastinum
- Thymus

Middle mediastinum
- Heart
- Pericardium

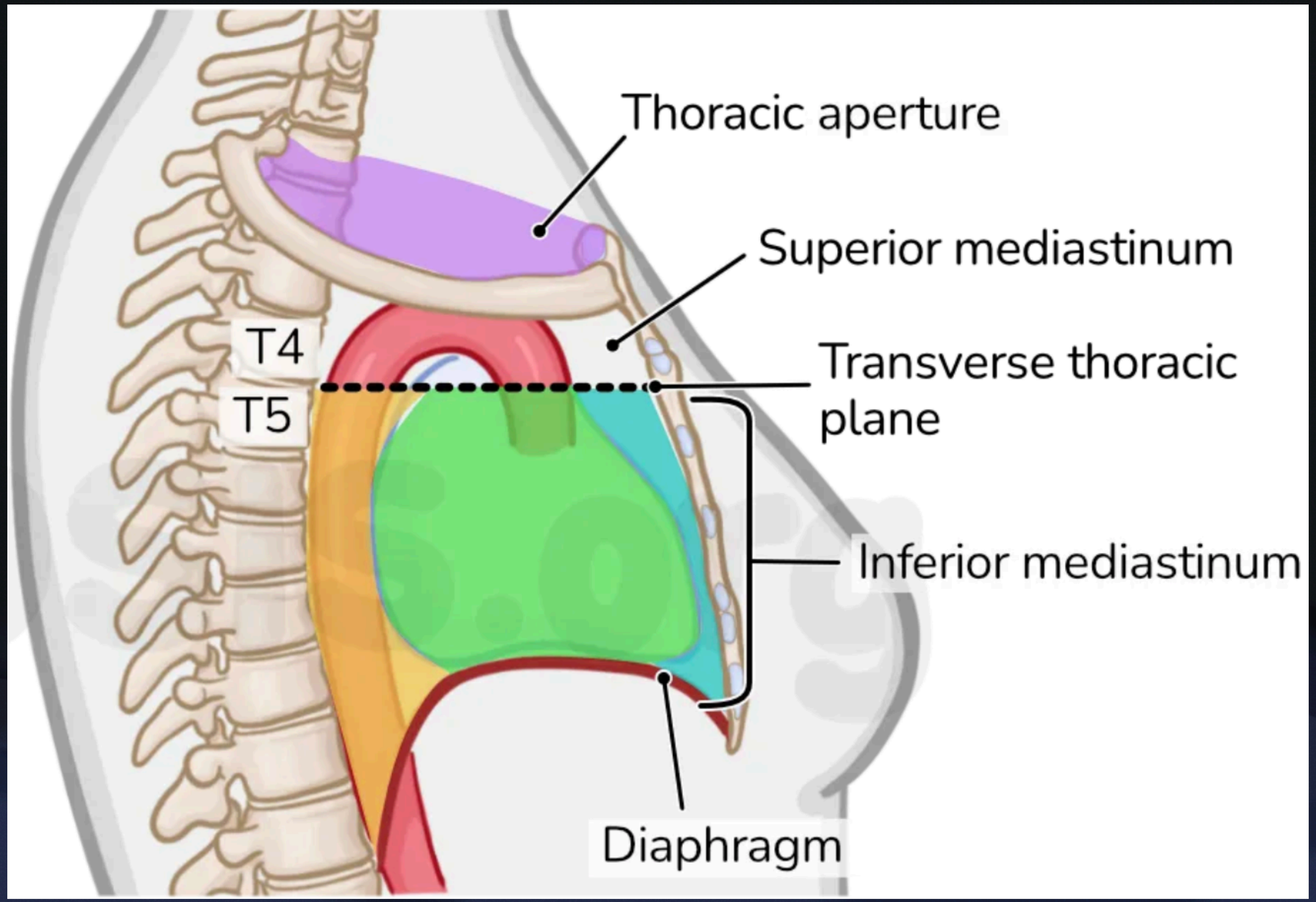
Posterior mediastinum
- Great vessels
- Oesophagus



The mediastinum is divided in two ways:
into superior and inferior (lower and upper), divided by the angle of Louis (sternal angle between T4-5) into anterior (front), middle and posterior (back).

The anterior, middle and posterior are all within the inferior mediastinum.

It is between the left and right thoracic cavities.


Thoracic aperture
Superior mediastinum
T4
T5
Transverse thoracic plane
Inferior mediastinum
Diaphragm

Pericardium

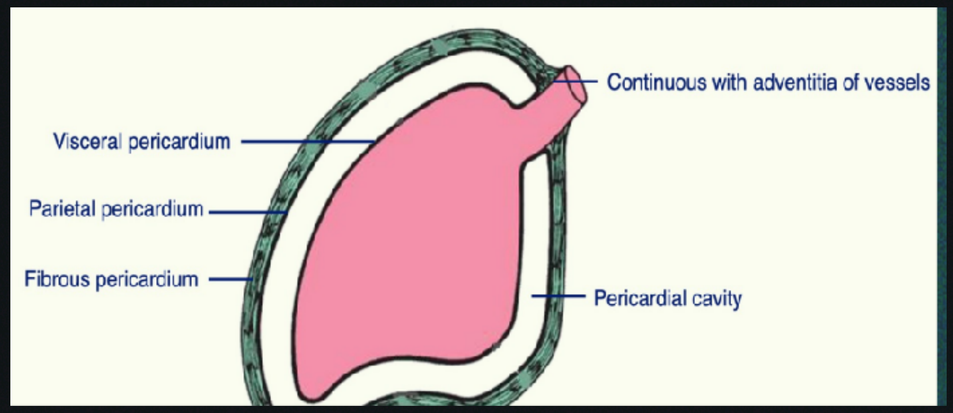
The pericardium is a protective, serous layer surrounding the heart.

More specifically, the pericardium helps to anchor

the heart to structures around it, prevents

overfilling and lubricates the heart as it moves.

It consists of the three layers; the visceral, parietal and fibrous.



The visceral layer is touching the myocardium and

the vessels coming off it.

The parietal layer is a continuation of the visceral

and between the two layers, there is a space. If this space fills up you're in trouble.

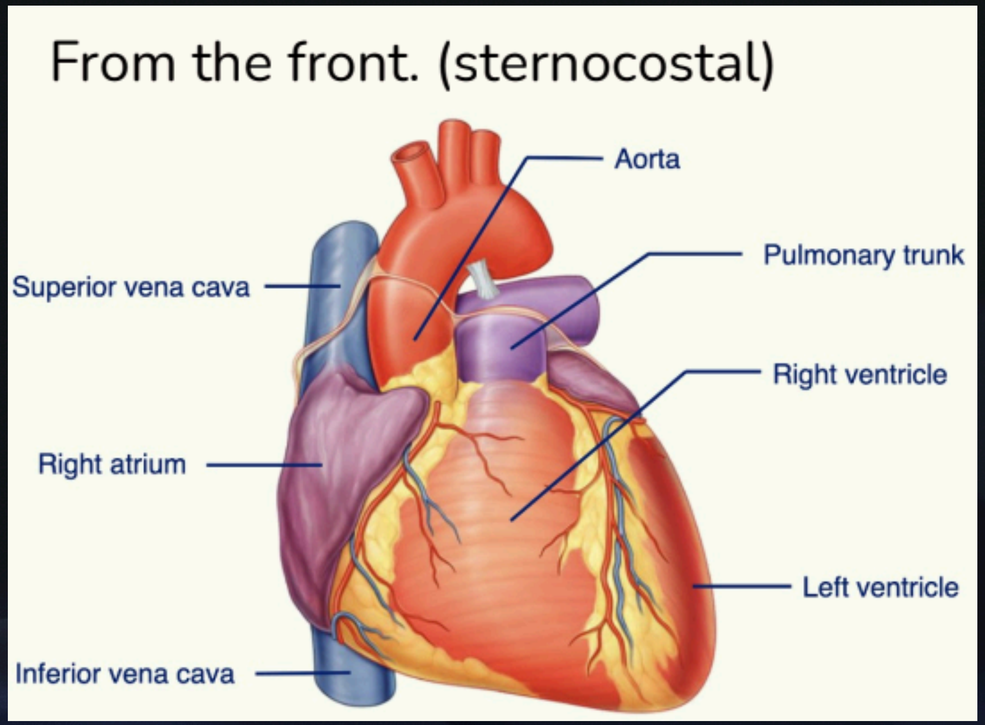
The fibrous pericardium is the tough outer layer,

and this is where the pericardium attaches to

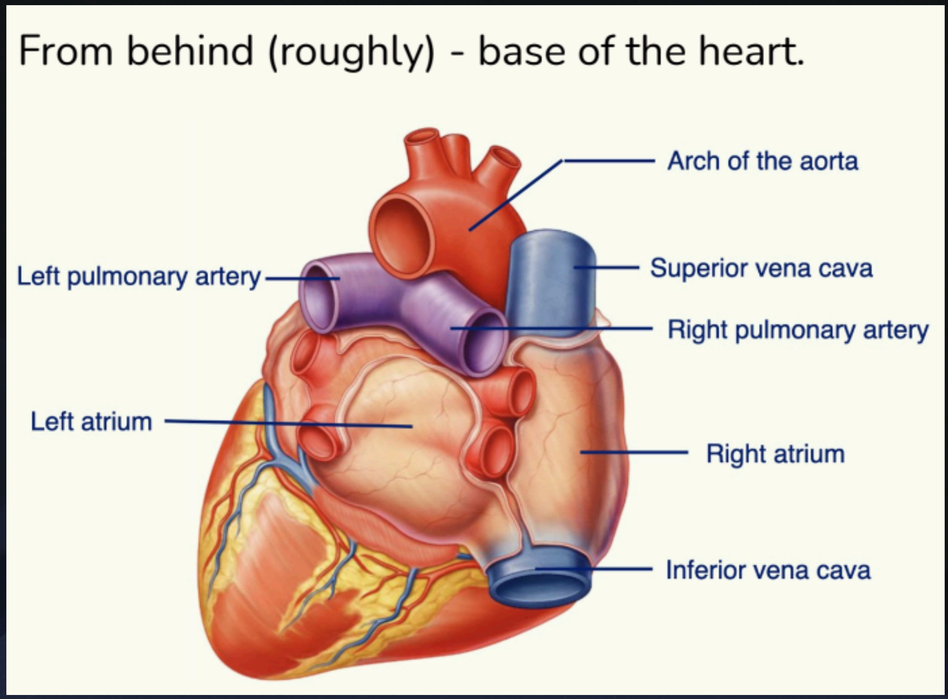
other structures via ligaments i.e sternopericardial.

Heart Surfaces

From the front. (sternocostal)



From behind (roughly) - base of the heart.

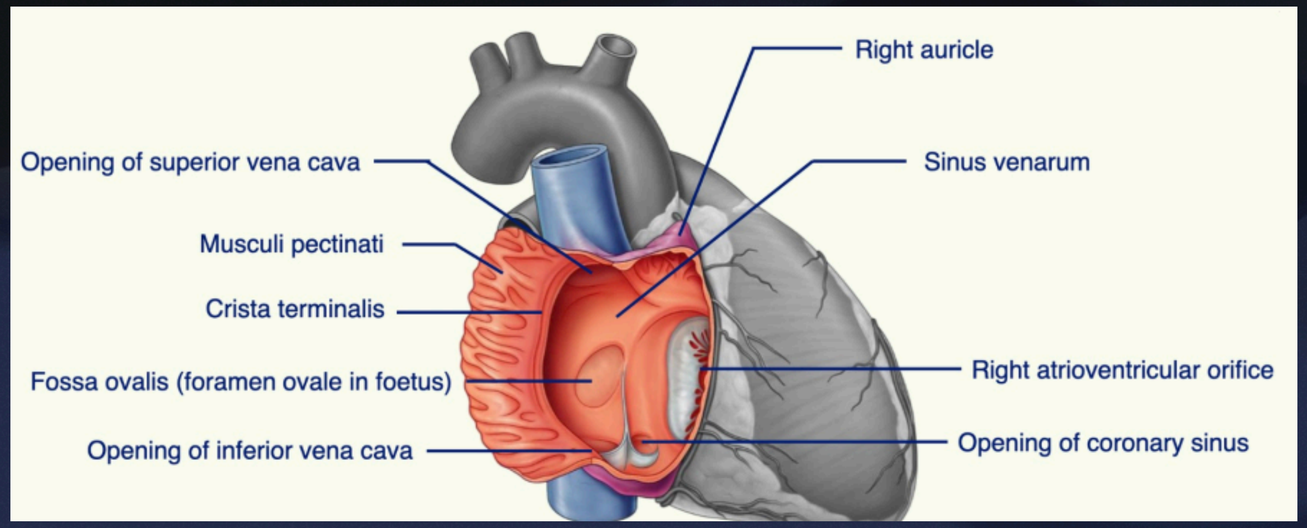


Right Atrium

Receives deoxygenated blood from three vessels: inferior vena cava, superior vena cava, coronary sinus

Anterior wall is rough - it has pectinate muscle.

Posterior wall is smooth - sinus venarum.

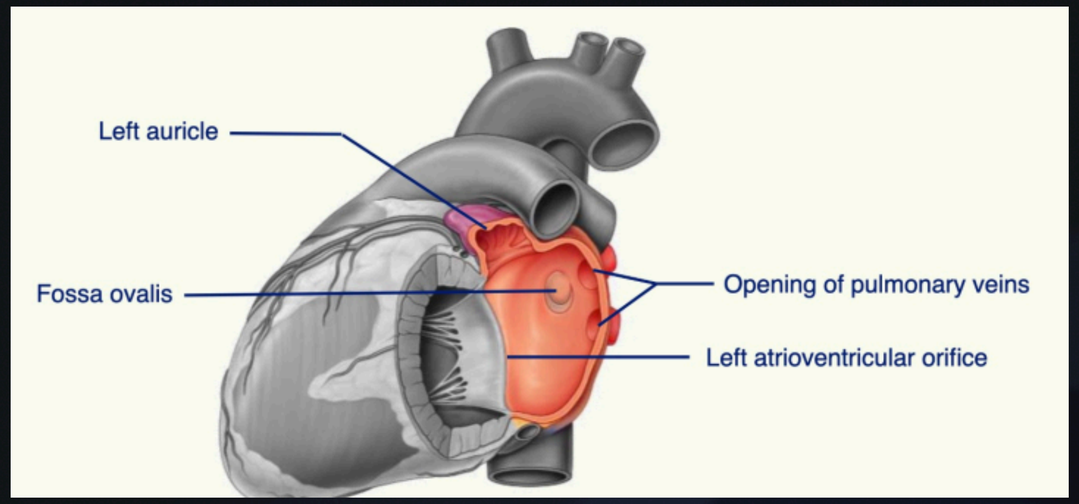


Crista terminalis is the raised border between the smooth and rough walls.

Fossa ovalis is the remnant of the foramen ovale after it has closed.

Blood then goes to the RV via the tricuspid valve.

Left Atrium

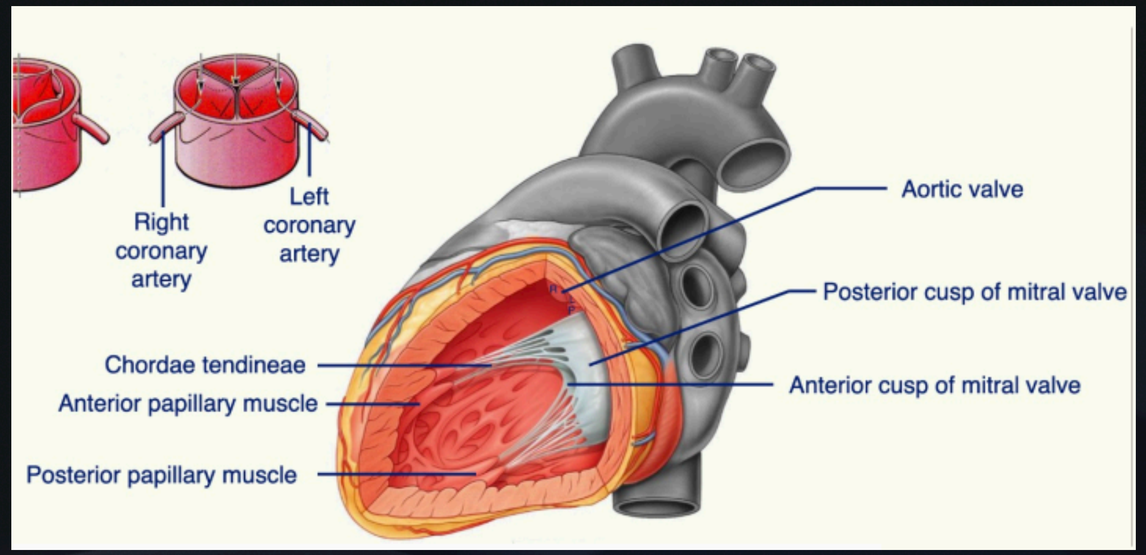


LA receives oxygenated blood from the pulmonary veins.

Both anterior and posterior walls of the LA are smooth, with no rough surfaces (no pectinate muscle). This is limited to the left auricle/appendage.

Blood will move from the LA to LV via the mitral (bicuspid) valve.

Left Ventricle



Has the thickest muscle wall (myocardium) of all 4 chambers.

Like the right ventricle, the LV also has trabeculae carneae, chordae tendineae and papillary muscles.

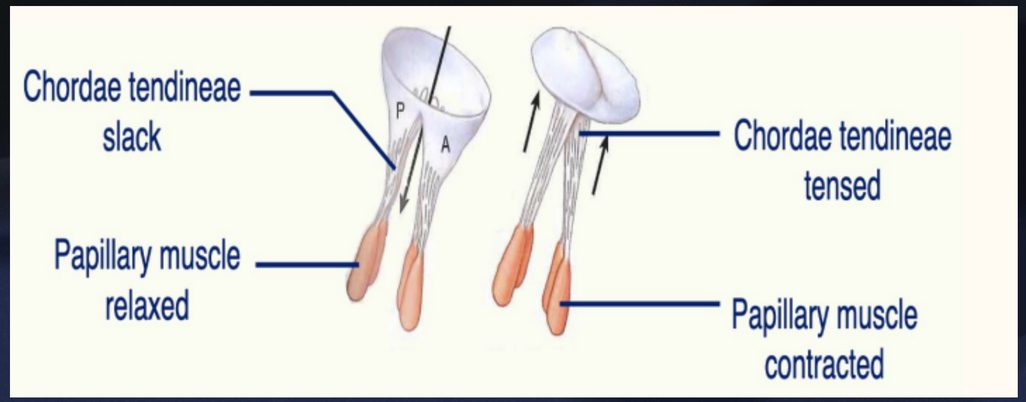
Unlike the RV, the LV only has two papillary muscles and two sets of chordae tendineae since the mitral valve is bicuspid (has two cusps).

Blood goes from the LV into the aorta via the aortic valve.

Atrioventricular valves

Opening of the AV valves is a passive process, as blood moves from atria to ventricles.

They close just before ventricular systole to stop backflow into the atria.



When they are open, chordae tendineae are slack and the papillary muscles are relaxed.

When closed, the chordae tendineae are taut and and the papillary muscles are contracted.

Opening and closing of the valves are passive, it is controlled by pressure differences between the chambers.

The chordae tendineae, stop the cusps of the valves from inverting. As you can probably imagine, it's really bad if chordae rupture or stretch too much.

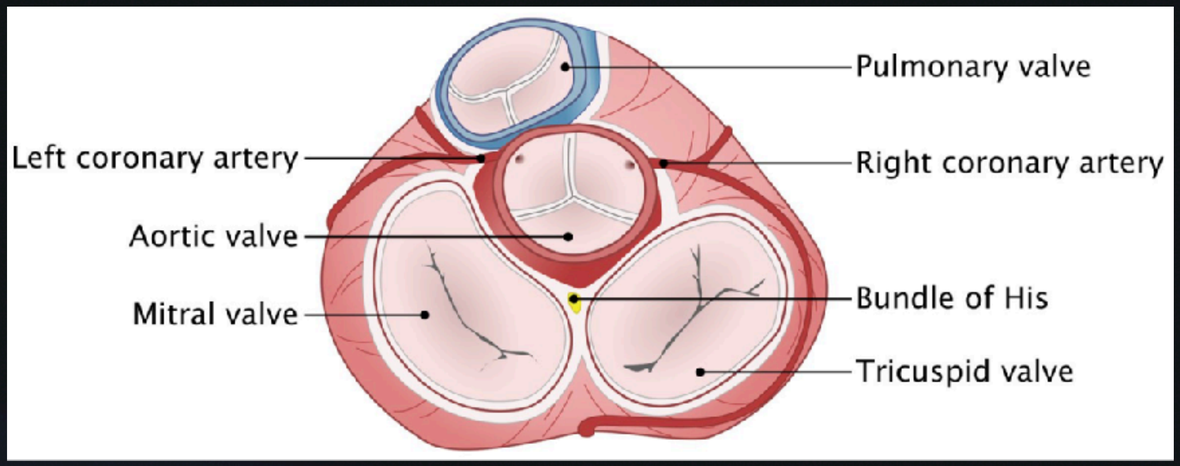
Pulmonary and Aortic valves

Also called the semilunar valves.

The pulmonary and aortic valves control the blood flow from the ventricles into their respective arteries.

Unlike the AV valves, they do not have chordae tendineae and papillary muscles to keep them closed.

They are open in systole and closed in diastole to stop backflow into the ventricles.



Remember that with all heart valves, their opening is a passive process. As the pressure in a chamber becomes greater than the subsequent chamber/artery, the valve opens.

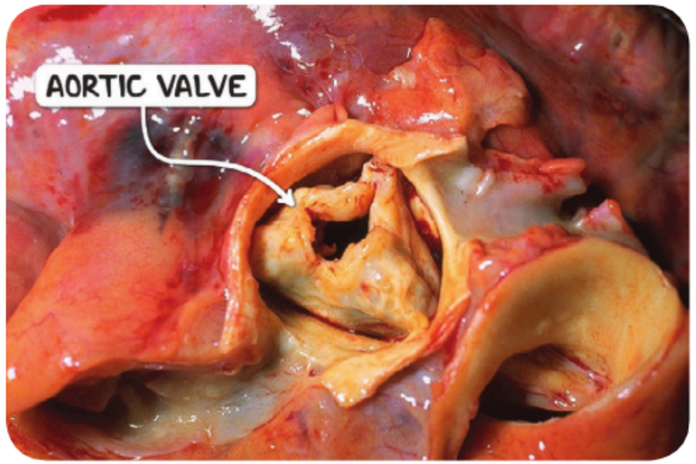


Figure 10.2 Gross pathology of severe aortic stenosis as a consequence of previous rheumatic heart disease. The valve leaflets are stiffened and fused resulting in a narrowed lumen.

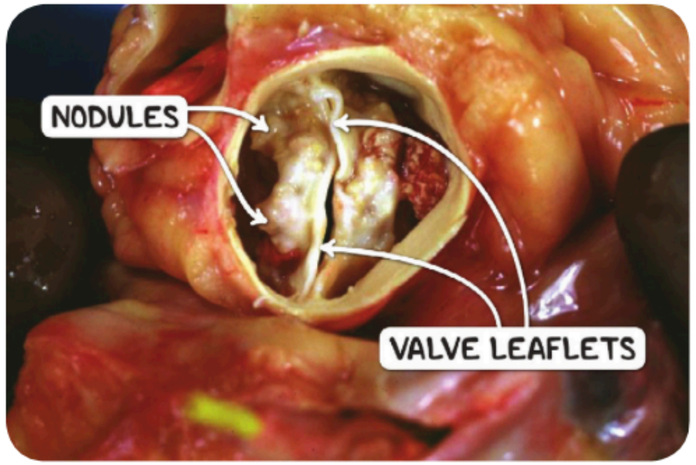


Figure 10.3 Gross pathology of a nodular bicuspid aortic valve.

Great vessels and vascular anatomy

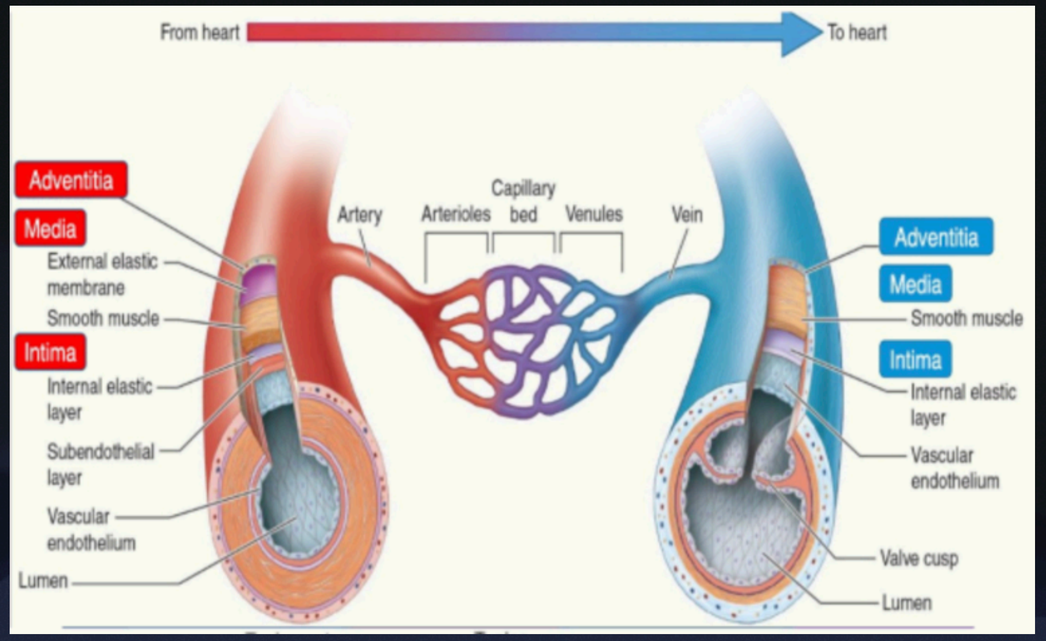
Anatomy of blood vessels

There are three layers that make up blood vessel walls:

Tunica intima: the innermost layer of the vessel wall. It is a single layer of flattened squamous endothelial cells, but also has a basement membrane and an elastic lamina. It allows for diffusion to deeper tissue.

Tunica media: the smooth muscle layer of the vessel along with elastic fibres. Allow for vasoconstriction and vasodilation.

Tunica adventitia: Outermost layer. Consists of collagen fibres + elastic tissue.

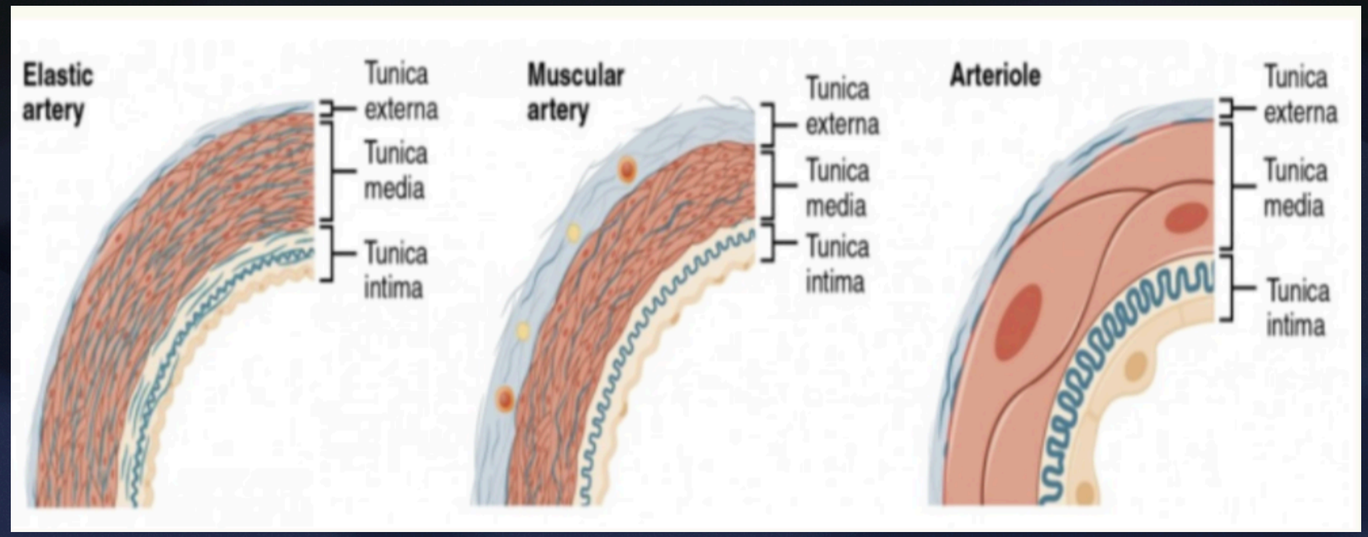


The types of arteries

Elastic (conducting) arteries - have a high elastic fibre content in tunica media; they are able to cope with high pressures and maintain pressures too. Relatively large lumen; conducts blood flow from heart to distributing arteries. Examples include aorta, pulmonary artery and aortic branches.
Autonomic nervous system controls the contraction and relaxation of smooth muscle, which allows vasodilation and vasoconstriction.

Muscular (distribution) arteries - high muscle content in tunica media, lumen is smaller than that of a conducting artery. Regulate blood flow to organs and parts of the body. Examples include splenic arteries, ulnar artery.

Resistance arteries (arterioles) - poorly defined tunica adventitia and small amount of smooth muscle. Walls are thick relative to their lumen and they are good at regulating systemic blood pressure by vasoconstriction and vasodilation in response to neural and non-neural stimuli



Veins

Generally, veins have a thinner vascular wall than their arterial counterparts. Intraluminal pressure is usually low, especially deep veins in lower limbs, need valves in order to prevent backflow when blood is returned to the heart.

Respiratory pump - negative intrathoracic pressure and positive abdominal pressure during inspiration assists blood flow back to the RA.

Skeletal muscle pump - when surrounding skeletal muscles contract, the blood in veins is squeezed through the valves.

Vein walls have more collagen, allowing for high tensile strength.
Exchange vessels such as capillaries and sinusoids are only one cell thick - an often fenestrated tunica intima.

THREE great vessels

1.

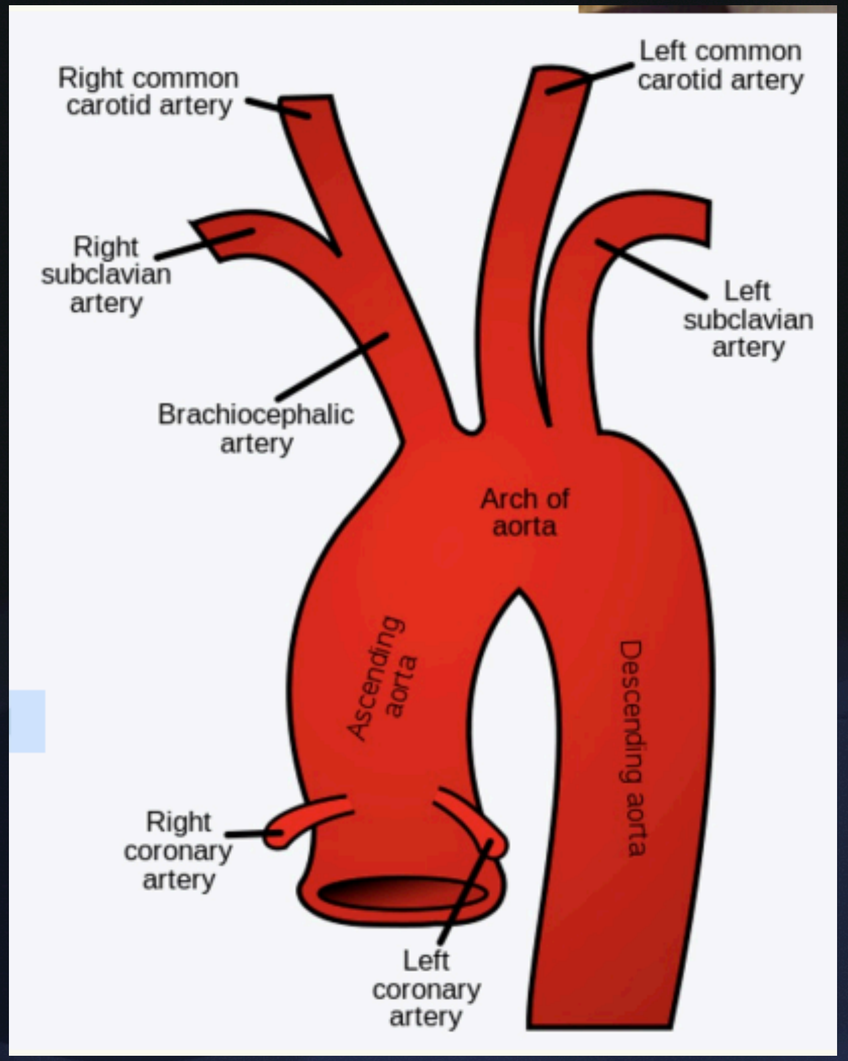
Ascending aorta - Takes oxygenated blood from the left ventricle to the aortic arch. Wrapped in a layer of serous pericardium along with the pulmonary trunk. Lies within the fibrous pericardium.

2.

Aortic arch - moves posteriorly and diagonally to the left, over the pulmonary trunk. It is in the superior mediastinum. It gives off three branches, from left to right: the brachiocephalic trunk, left common carotid artery and left subclavian (the right carotid and subclavian are branches of the brachiocephalic trunk). Attached to the pulmonary trunk via the ligamentum arteriosus.

3.

Descending aorta - begins at T4 and it is located in the posterior mediastinum, so it passes behind the lung hilum. It passes through the diaphragm at T12. After that, it is called the abdominal aorta.


Right common carotid artery
Left common carotid artery
Right subclavian artery
Left subclavian artery
Brachiocephalic artery
Arch of aorta
Ascending aorta
Descending aorta
Right coronary artery
Left coronary artery

Some other (less) great vessels

Pulmonary trunk - conveys deoxygenated blood from the RV to the lungs. Bifurcates at T5 into the L + R pulmonary arteries. Anterior to aorta initially, but then moves posteriorly.

Superior vena cava (SVC) - receives deoxygenated blood from veins above the diaphragm and drains that into the RA. It is formed by the right and left brachiocephalic veins joining. It then begins descending vertically behind the 1st and 2nd intercostal spaces. It also does not have any valves.

Inferior vena cava (IVC) - receives deoxygenated blood from vessels below the diaphragm, and drains into the inferoposterior part of the RA. It has a valve at this point; the eustachian valve. Passes through the diaphragm at T8 and is very short after that as it passes through the pericardium.

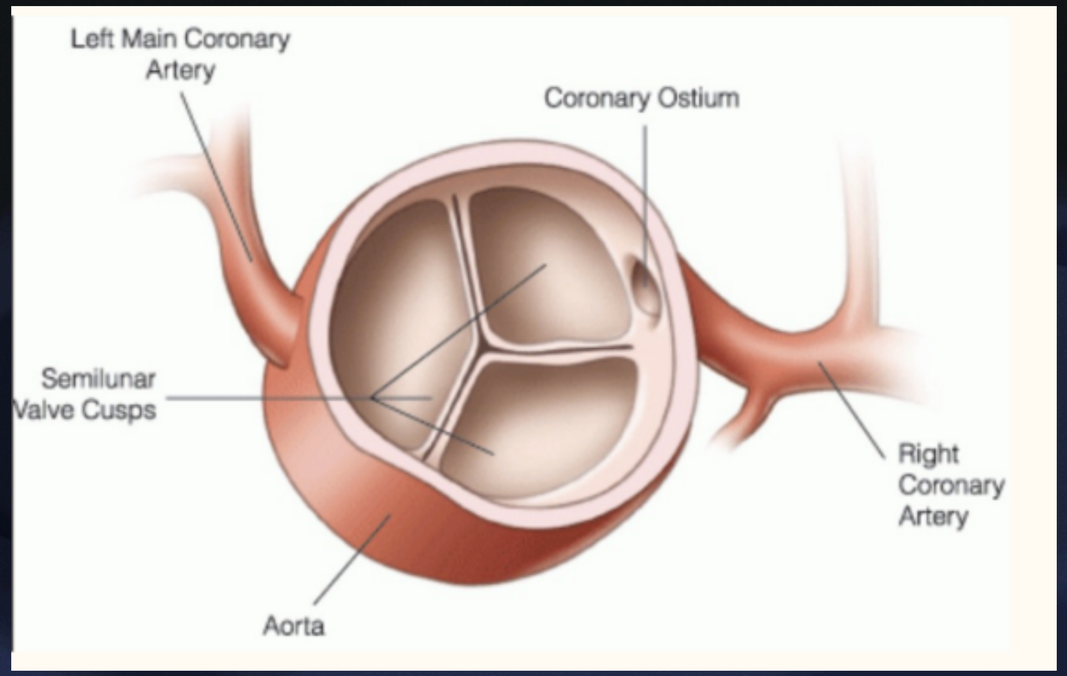
Blood supply and innervation of the heart

The Coronary Arteries

The coronary arteries supply the heart itself, and are the first branches of the aorta. The coronary arteries open just above the aortic valve. These openings are called the coronary ostia.

The coronary arteries are supplied during diastole, not systole, as the blood pools back towards the aortic valve.

There are two main ones: the right and left coronary arteries.



The coronary arteries are supplied during diastole. This is because of the positioning of the coronary artery openings in the ascending aorta; just above the aortic valve, so the aortic valve cusps will cover the opening (ostia). When the blood in the aorta pools back onto the aortic valve during diastole, the ostia will be uncovered and blood will go into the coronary arteries.

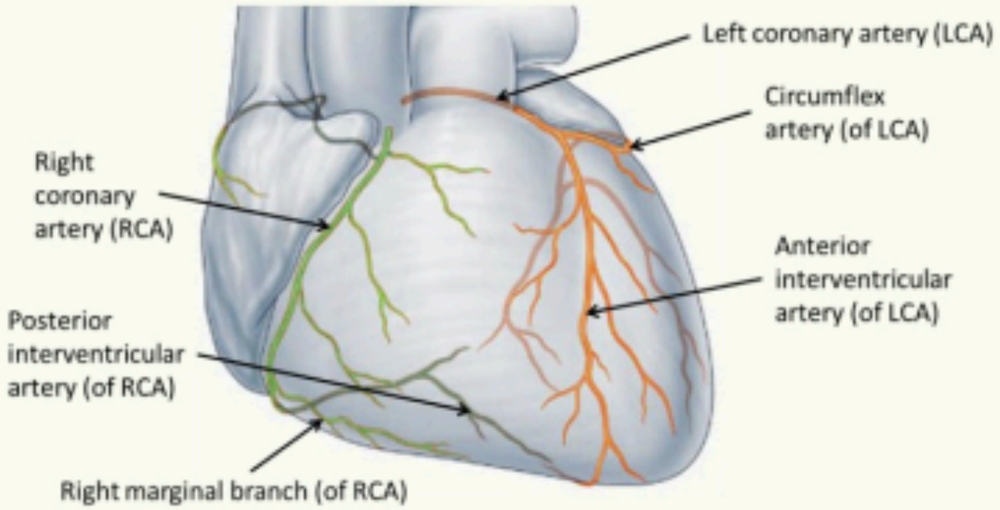
There are three grooves on the surface of the heart: the anterior and posterior atrioventricular grooves (between the L and R ventricles) and the coronary sulcus (between the atria and ventricles).

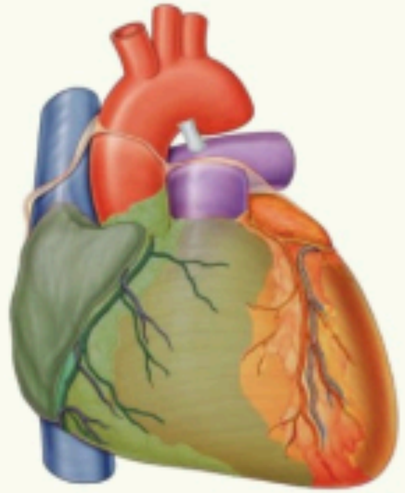
In these grooves sit the coronary arteries.

The left coronary artery first gives off the left anterior descending artery (LAD aka the widowmaker) also called the left interventricular artery. It then forms the left circumflex artery, which first gives off the left marginal artery, then wraps around the left side of the heart and moving to the posterior side.

The right coronary artery branches off to give the right marginal artery and then moves round to the back and forms the posterior interventricular artery

Right Coronary Artery (RCA)	Left Coronary Artery (LCA)
Right atrium	Left atrium
Right ventricle (most)	Left ventricle (most)
Left ventricle (diaphragmatic part)	Right ventricle (partially)
Interventricular septum (posterior 1/3)	Interventricular septum (anterior 2/3)
SA node (60%)	SA node (40%)
	AV node and bundle





Cardiac Veins

All cardiac veins, EXCEPT ANTERIOR CARDIAC VEINS, will drain into the coronary sinus.

Anterior Cardiac veins drain into the RA.

There are 5 main tributary veins that drain into the coronary sinus:

- Great cardiac vein - starts at the apex, moves up the anterior interventricular groove, curves to the left and around the heart -> forms the coronary sinus.
- Middle cardiac vein - begins at the apex, moves up the posterior interventricular groove and drains into the coronary sinus.
- Small cardiac vein - located on the anterior side, travels along the right atrioventricular groove, joins the right side of the coronary sinus.
- Left marginal vein - on the posterior surface, joins the great cardiac vein but can drain directly into the coronary sinus in some people.
- Left posterior ventricular vein - on the posterior surface, drains into the coronary sinus.

Nervous innervation of the heart

Activity of the heart is controlled by the autonomic nervous system. You don't decide whether to raise or lower your heart rate. - it is not somatic.

Sympathetic control of the heart - raising the heart rate and force of contraction, by stimulating the SAN to increase its rate of firing, is done by the cardiac nerves.

Parasympathetic control of the heart is controlled by the vagus nerve. It lowers the heart rate, decreases force of contraction, by decreasing the firing rate of SAN. It also constricts the coronary arteries.

Sensory visceral afferent return to the CNS via the sympathetic trunk and vagal cardiac branches.

Sympathetic trunk returns to either the thoracic or cervical regions associated with pain. This will register as pain associated with the T-T3 dermatomes

Vagus nerve senses alterations in blood pressure and chemical changes, so it is primarily involved in cardiac reflexes.

Baroreceptors detect changes in blood pressure, there are two: carotid sinus baroreceptors and aortic arch baroreceptors.

- Carotid sinus baroreceptors in the internal carotid arteries detect increases and decreases in blood pressure.
- Aortic arch baroreceptors can only detect increases in blood pressure.

The conduction pathway begins at the sinoatrial node (SAN) aka the pacemaker, located at the junction between the SVC and the RA, at the superior end of the crista terminalis.

The atria are depolarized as the SAN passes the impulse onto the Bachmann's bundle.

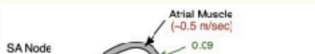
This impulse moves down to the AV node, located in the triangle of Koch (formed between the Tendon of Todoro, the opening of the coronary sinus and the septal leaflet of the tricuspid valve.

There is then a delay as the impulse moves from the AV node to the Bundle of His.

The impulse then splits into the left and right bundle branches, down the interventricular septum.

The left bundle branch gives off further branches, i.e the anterior and posterior fascicles. These then become continuous with the Purkinje fibres.

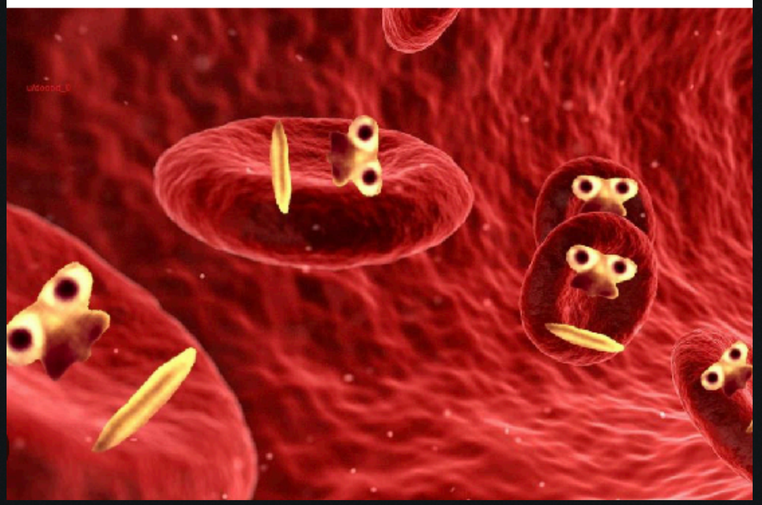
The right bundle branch first gives off the moderator band (septomarginal trabecula), which supply the papillary muscles. The bundle branch then terminates are Purkinje fibres, supplying
The ventricles.



Platelets: *spends hours to clot my injury*

8 y/o me: *scratches the clot because its itchy*

Platelets:



Which spinal level is the division between the superior and inferior mediastinum ?

T4-T5. Remember this is the same as the Angle of Louis.

This is a commonly used

landmark as it marks the point

of the second costal cartilage.

Which statement best describes what happens when the tricuspid valve is open ?

A. Chordae tendineae will be slack, papillary muscles will be relaxed, pressure in the RA will be greater than the RV

B. Chordae tendineae will be taut, papillary muscles will be contracted, pressure in the RA will be less than the RV

C. Chordae tendineae will be slack, papillary muscles will be contracted, pressure in the RA will be greater than the RV

D. Chordae tendineae will be taut, papillary muscles will be relaxed, pressure in the RA will be greater than the RV.

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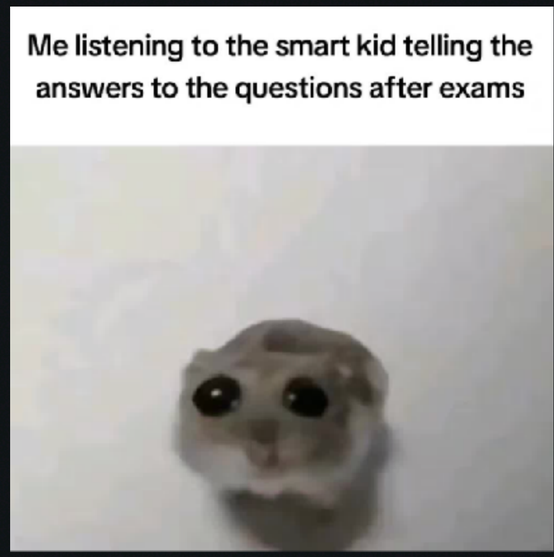

Do papillary muscles contract before or after ventricular systole (contraction) ?

Papillary muscles will contract just before ventricular systole. This is so that the tricuspid/mitral valve is closed before the ventricle contracts and pushes blood into the pulmonary trunk/aorta. Remember that the papillary muscles are contracted and the chordae tendineae are taut when the tricuspid/mitral valve is closed.

Which cardiac veins do not drain into the coronary sinus ?

A. Small cardiac vein

B. Great cardiac vein

C. Right marginal vein

D. Middle cardiac vein

E. Anterior cardiac veins

Between which structure in the conduction pathway of the heart is there a physiological delay ?

A. SAN

B. AVN

C. Left bundle branch

D. Moderator band

The interatrial septum is primarily formed by which anatomical structure during fetal development?

A) Foramen ovale

B) Ductus arteriosus

C) Aorticopulmonary septum

D) Interatrial ridge

Which of the following vessels supplies blood to the anterior surface of the heart?

A) Left anterior descending artery (LAD)

B) Right coronary artery (RCA)

C) Circumflex artery

D) Posterior descending artery

Which of the following structures is NOT part of the cardiac conduction system?

A) Atrioventricular node (AV node)

B) Bundle of His

C) Purkinje fibers

D) Chordae tendineae

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