

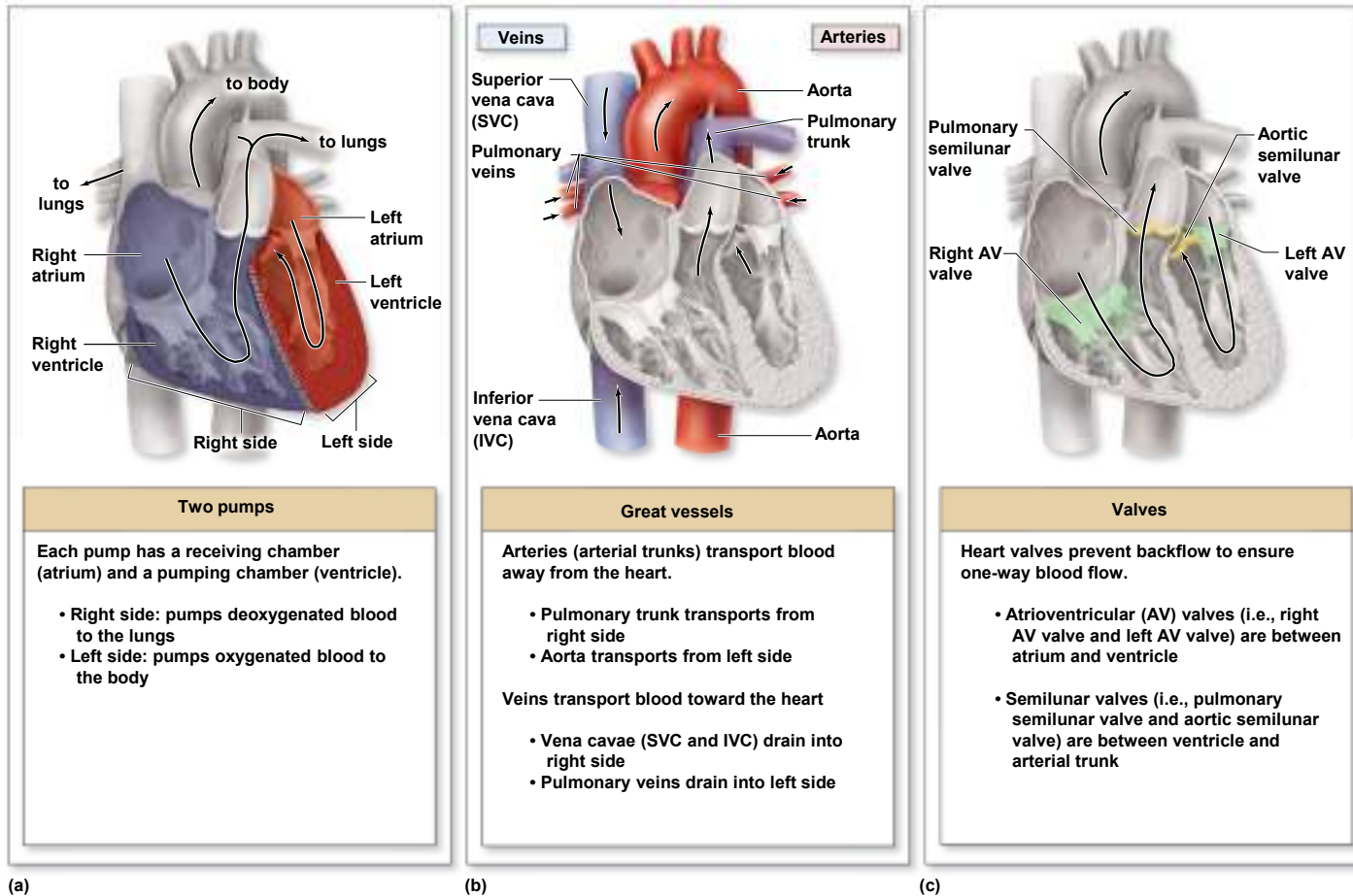


CARDIOVASCULAR SYSTEM

DANIL HAMMOUDI.MD

<https://www.visiblebody.com/learn/circulatory/circulatory-the-heart>



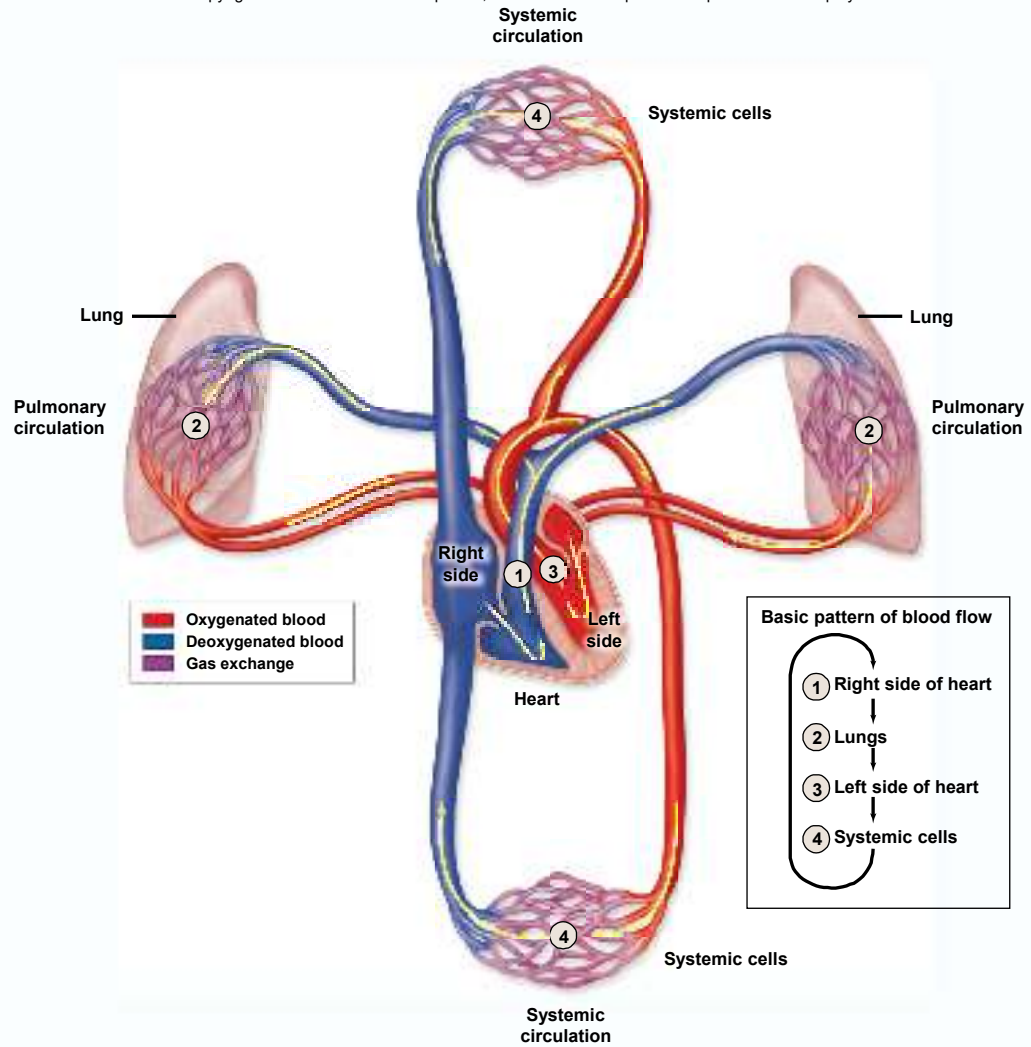


(a)

(b)

(c)

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CARDIOVASCULAR EMBRYOLOGY

Cardiovascular Development

- **3rd gestational week ... heart formed**
[five weeks after the last normal menstrual period (LMP)]
- **8th gestational week... heart functional**

The heart is the first functional organ in a vertebrate embryo

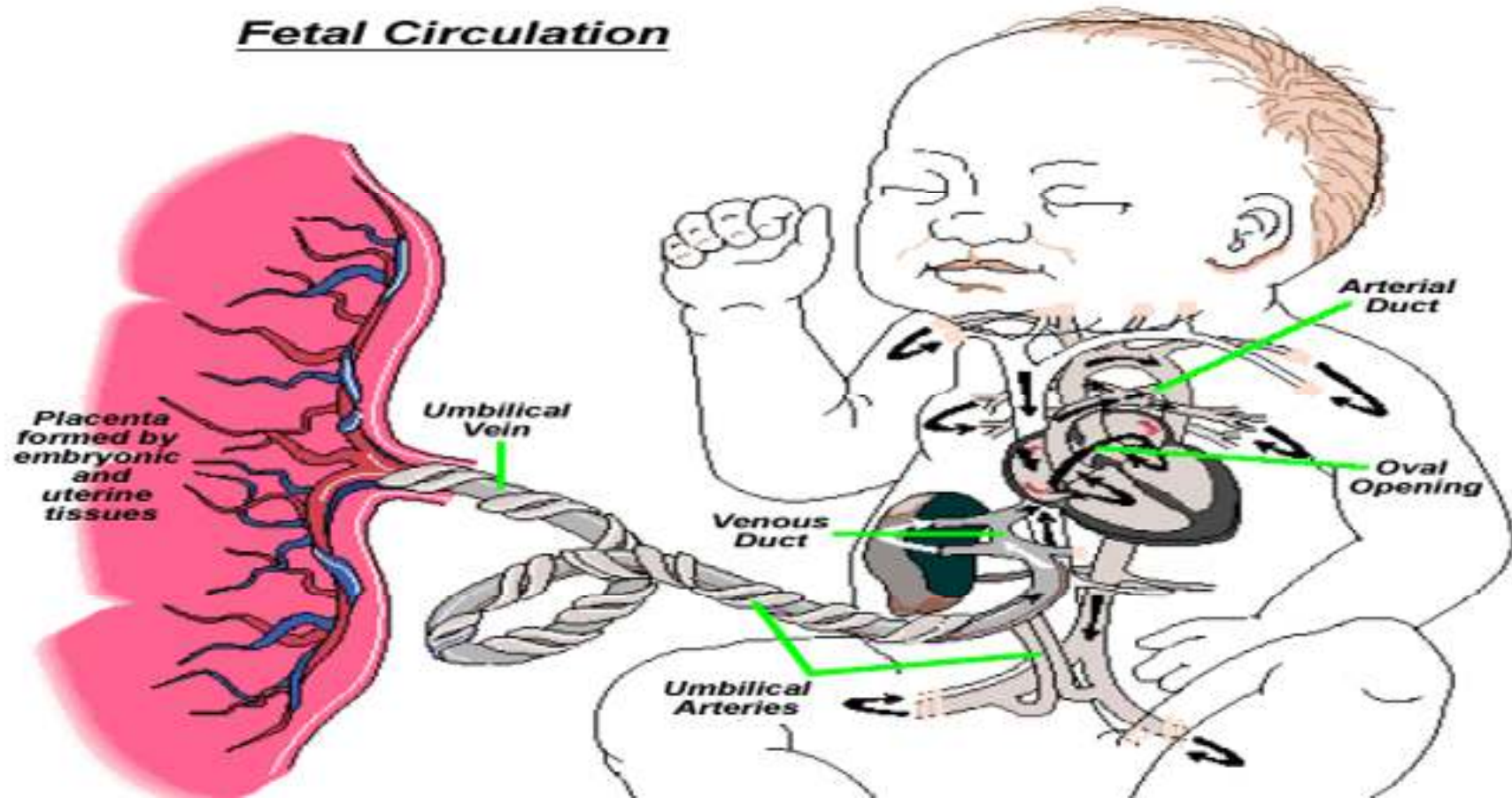


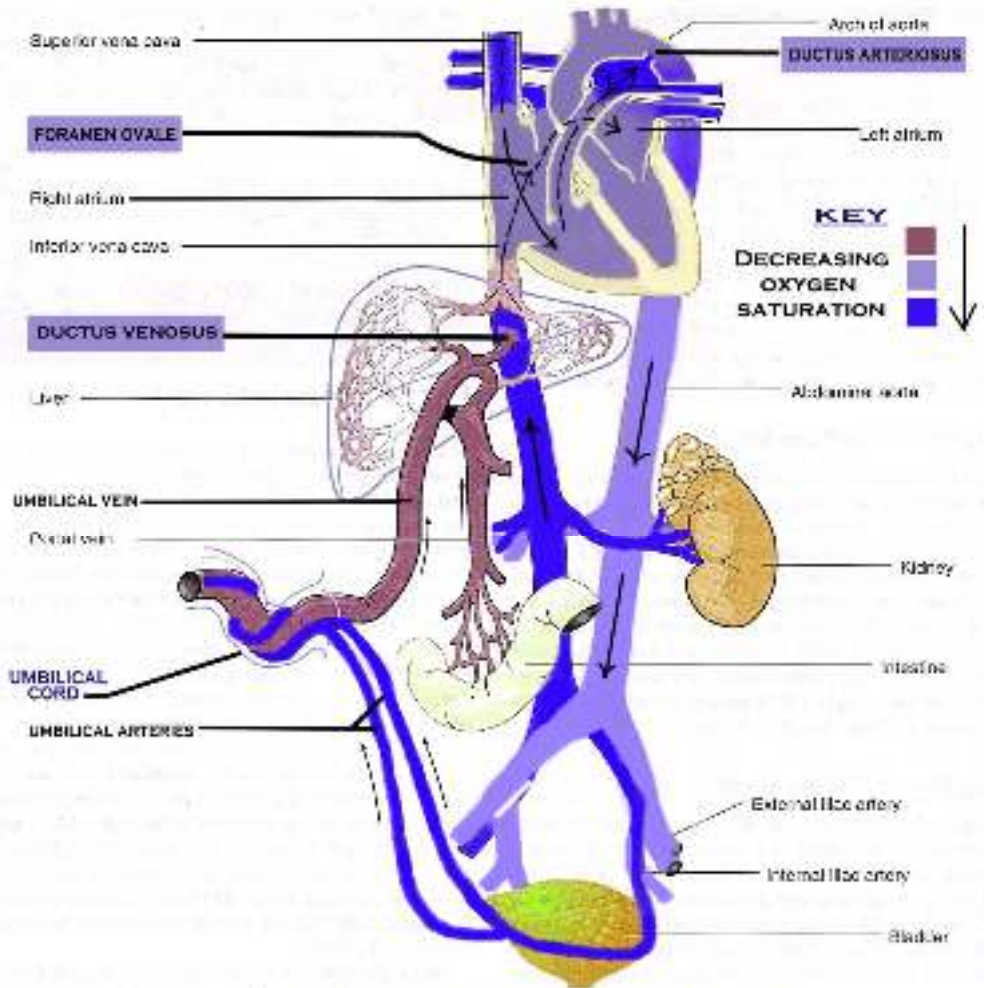
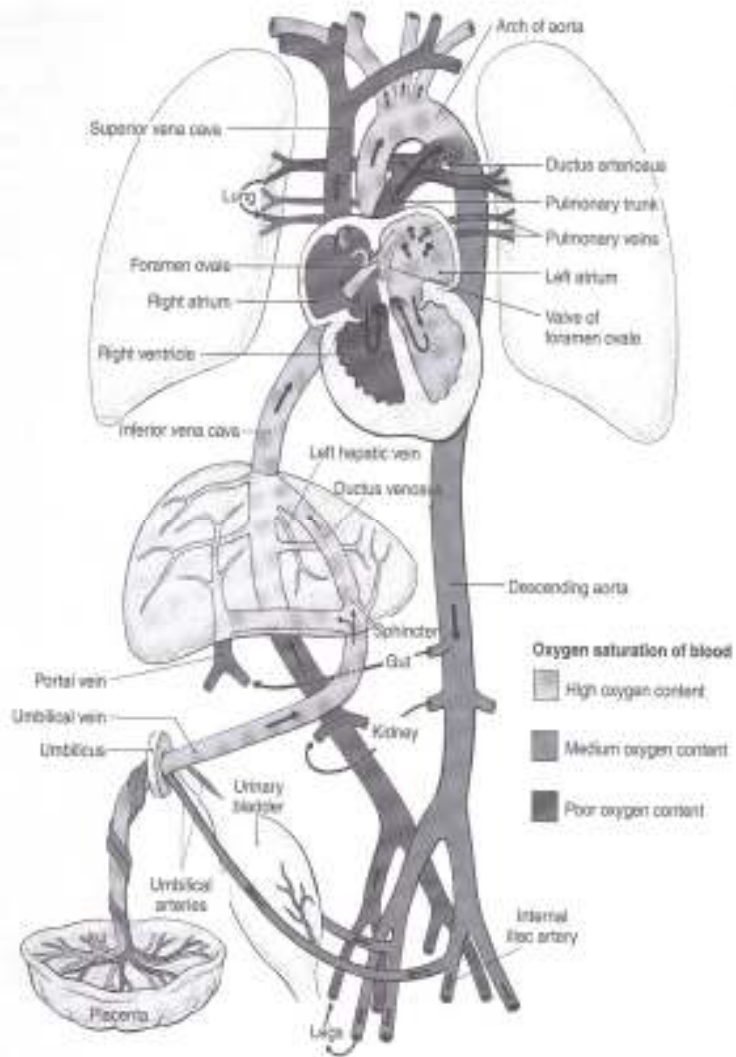
For your information

- Start at the mother rate 70 -80 until the 7th week
- 165-185 BPM during the early 7th week, (early 9th week after the LMP).
- This acceleration is approximately 3.3 BPM per day, or about 10 BPM every three days, an increase of 100 BPM in the first month
- After peaking at about 9.2 weeks after the LMP, it decelerates to about 150 BPM (+/-25 BPM) during the 15th week after the LMP. After the 15th week the deceleration slows reaching an average rate of about 145 (+/-25 BPM) BPM at term. The regression formula which describes this acceleration before the embryo reaches 25 mm in crown-rump length or 9.2 LMP weeks is:

$$\text{Age in days} = \text{EHR}(0.3) + 6$$

Fetal Circulation

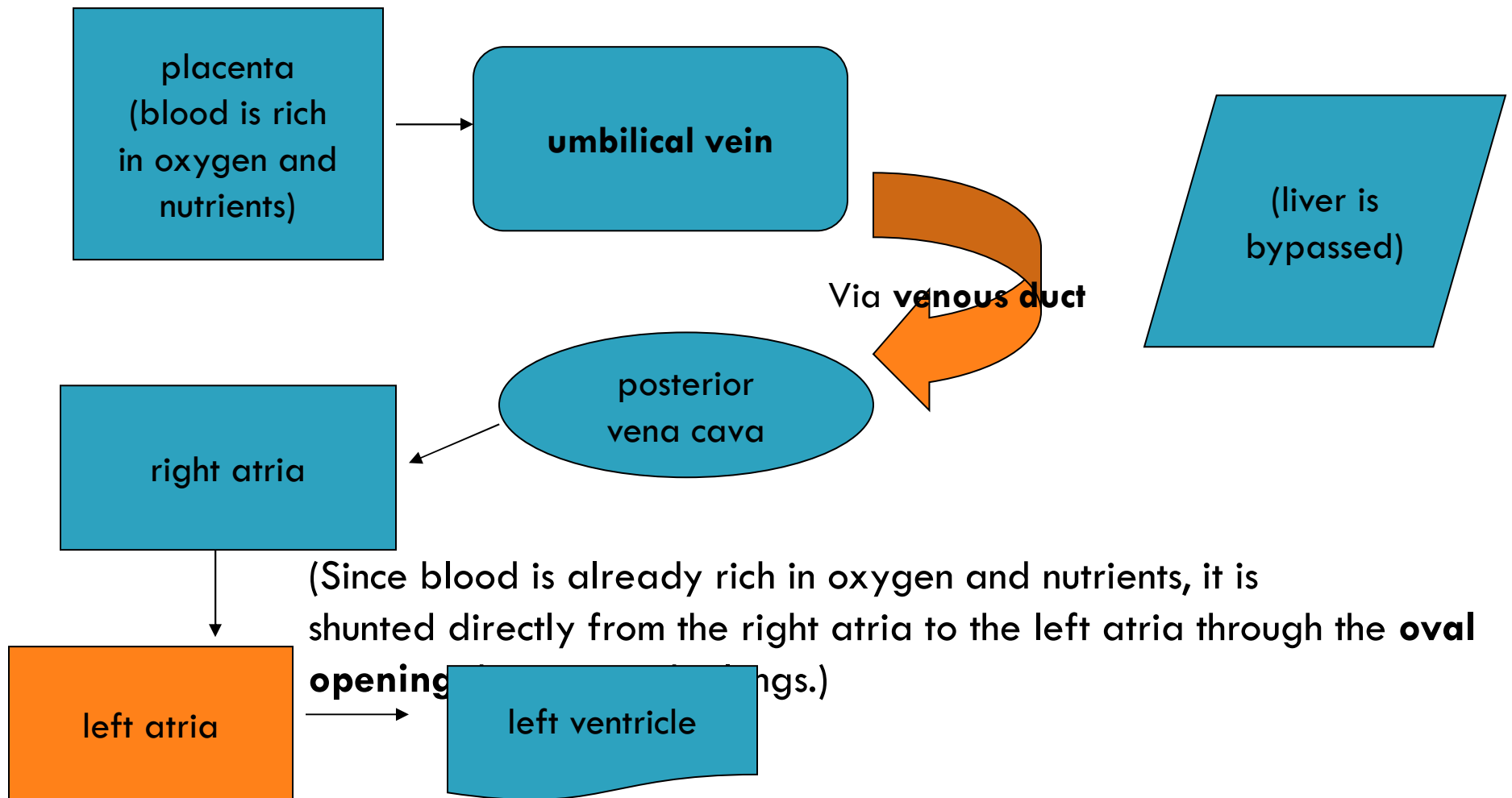




FETAL CIRCULATION JUST BEFORE BIRTH.
NOTE THE COURSE OF BLOOD FLOW INDICATED BY THE ARROWS.

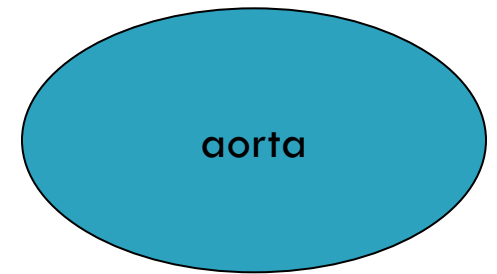
- In the developing fetus, the **ductus arteriosus (DA)**, also called the **ductus Botalli**, is a **shunt connecting the pulmonary artery to the aortic arch**.
 - It **allows most of the blood from the right ventricle to bypass the fetus fluid-filled lungs**,
 - protecting the lungs from being overworked and allowing the right ventricle to strengthen.
- There are two other fetal shunts, the **ductus venosus and the foramen ovale**.

- In the fetus, the **ductus venosus** shunts a significant majority (**80%**) of the blood flow of **the umbilical vein directly to the inferior vena cava**.
- Thus, it **allows oxygenated blood from the placenta to bypass the liver**.
- In conjunction with the other fetal shunts, the foramen ovale and ductus arteriosus, it plays a **critical role in preferentially shunting oxygenated blood to the fetal brain**

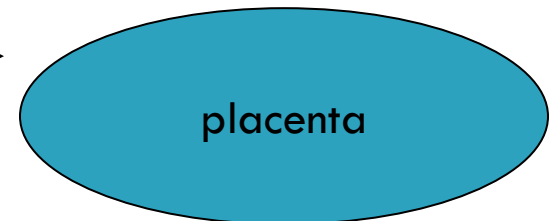




→
Blood is shunted via the **arterial duct** directly from the right atria to the aorta, again bypassing the lungs.



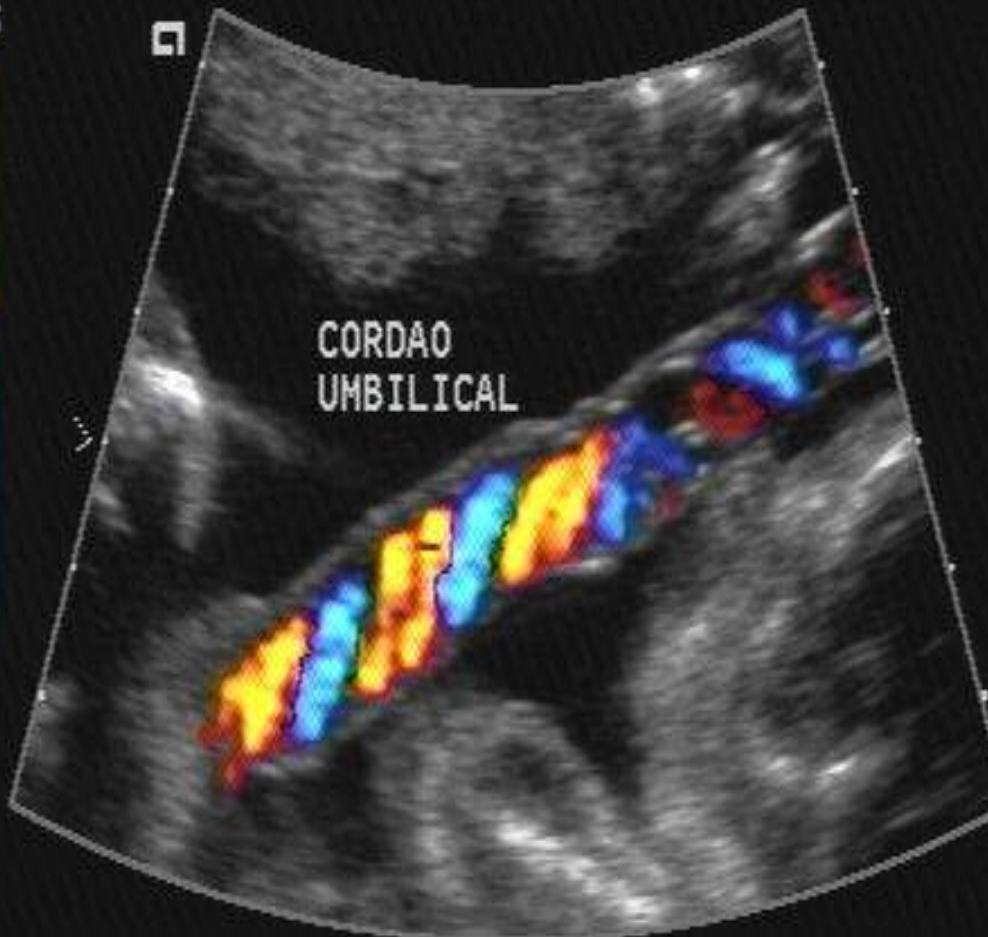
→
blood low in oxygen and nutrients moves from fetus back to mother



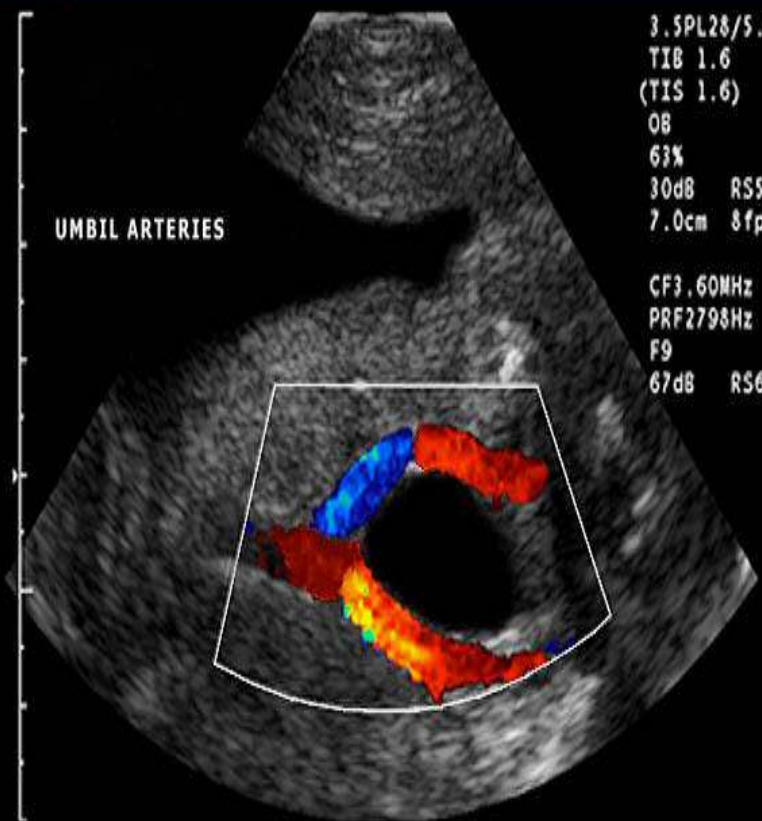
PG. 1

PT:CORDAO UMBILICAL COLOR,b45b2612

1/S



SIEMENS

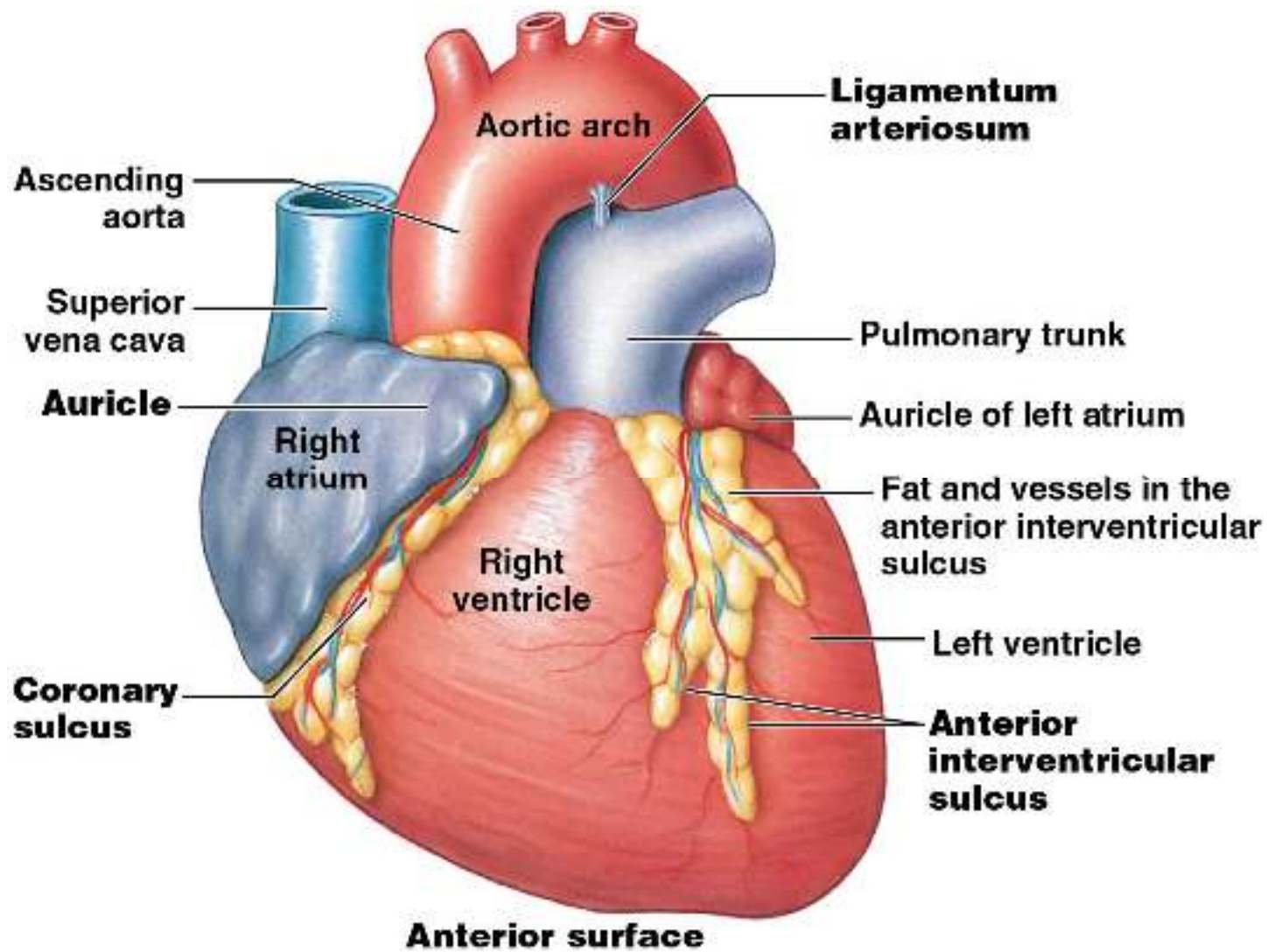


3.5PL28/S.14
TIB 1.6
(TIS 1.6)
OB
63%
30dB RS5
7.0cm 8fps

CF3.60MHz
PRF2798Hz
F9
67dB RS6

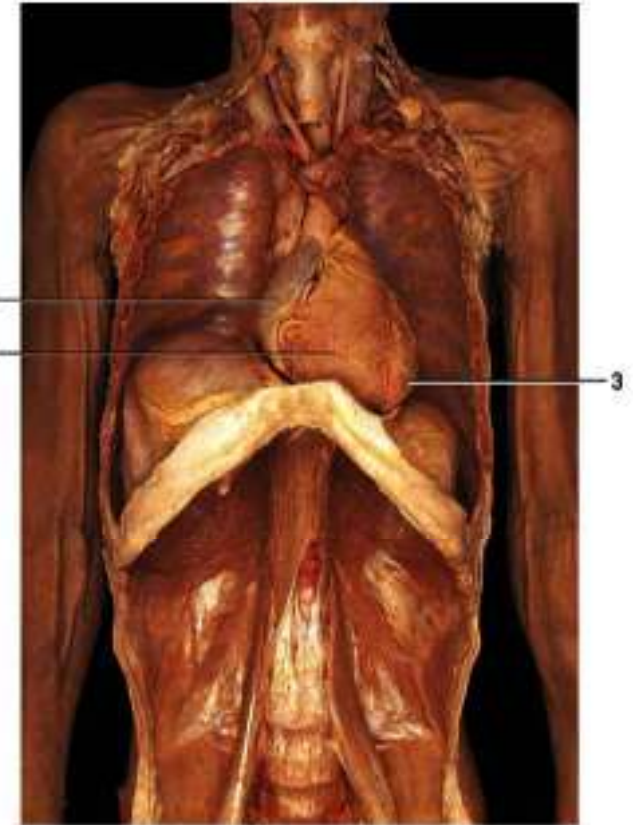
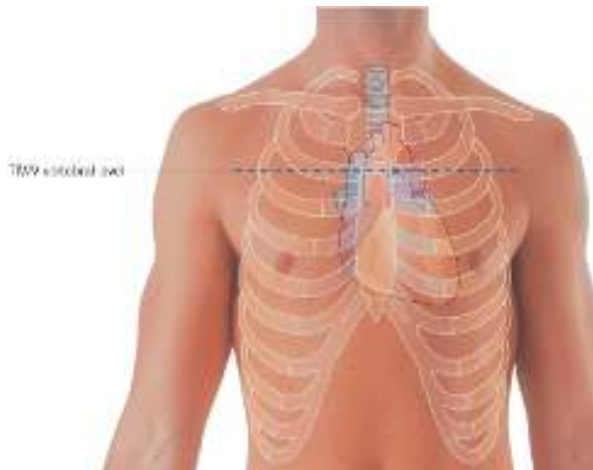
Adult remnants of fetal circulation

Adult	Fetus
Fossa ovale	Foramen ovale
Ligamentum arteriosum	Ductus arteriosus
Medial umbilical ligaments	Umbilical aa.(within fetus)
Round ligament (ligamentum teres) of liver	Umbilical v.(within fetus)
Ligamentum venosum	Ductus venosus
Medial umbilical ligament	Umbilical cord (leaving fetus)



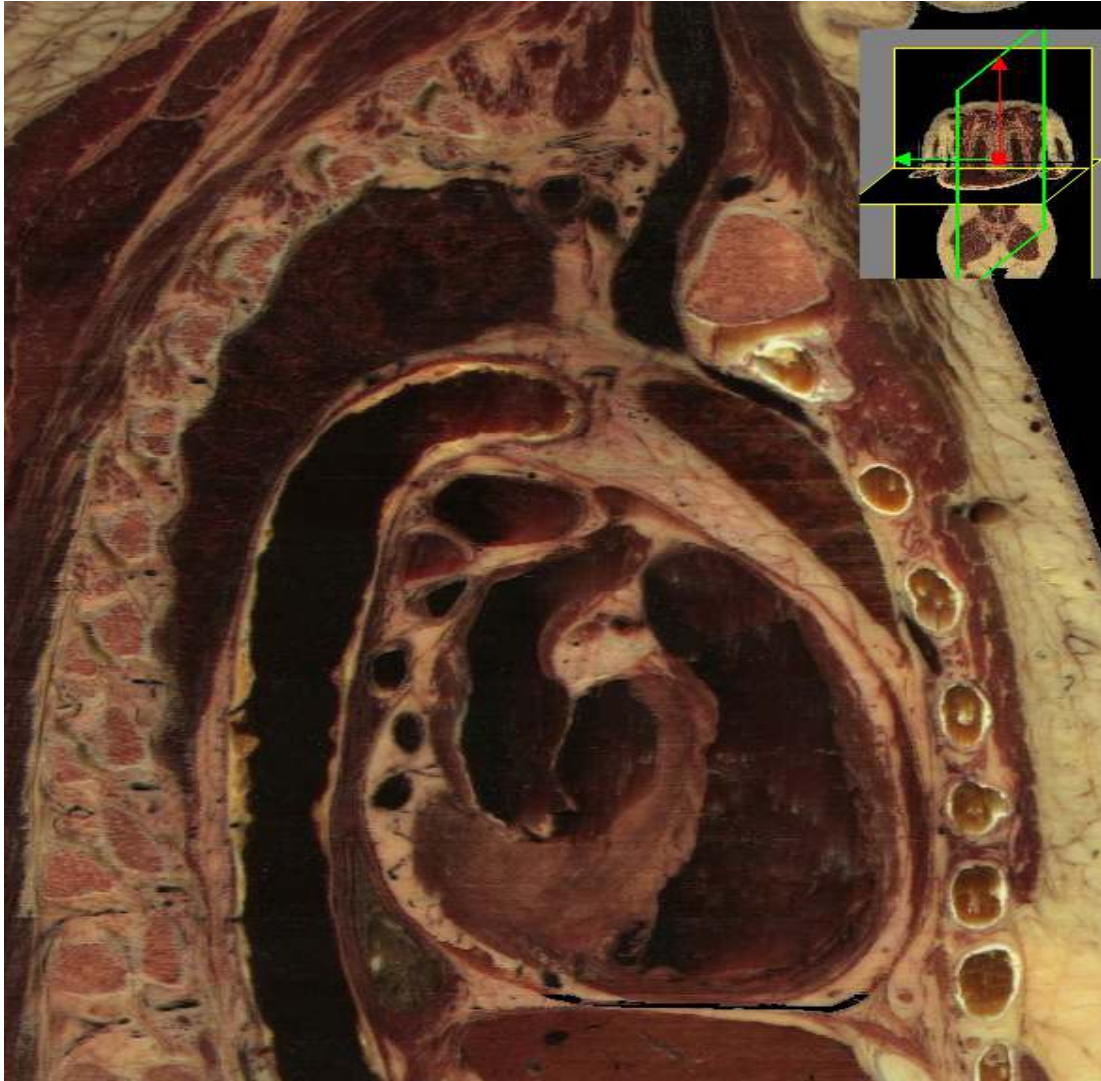
Heart Anatomy

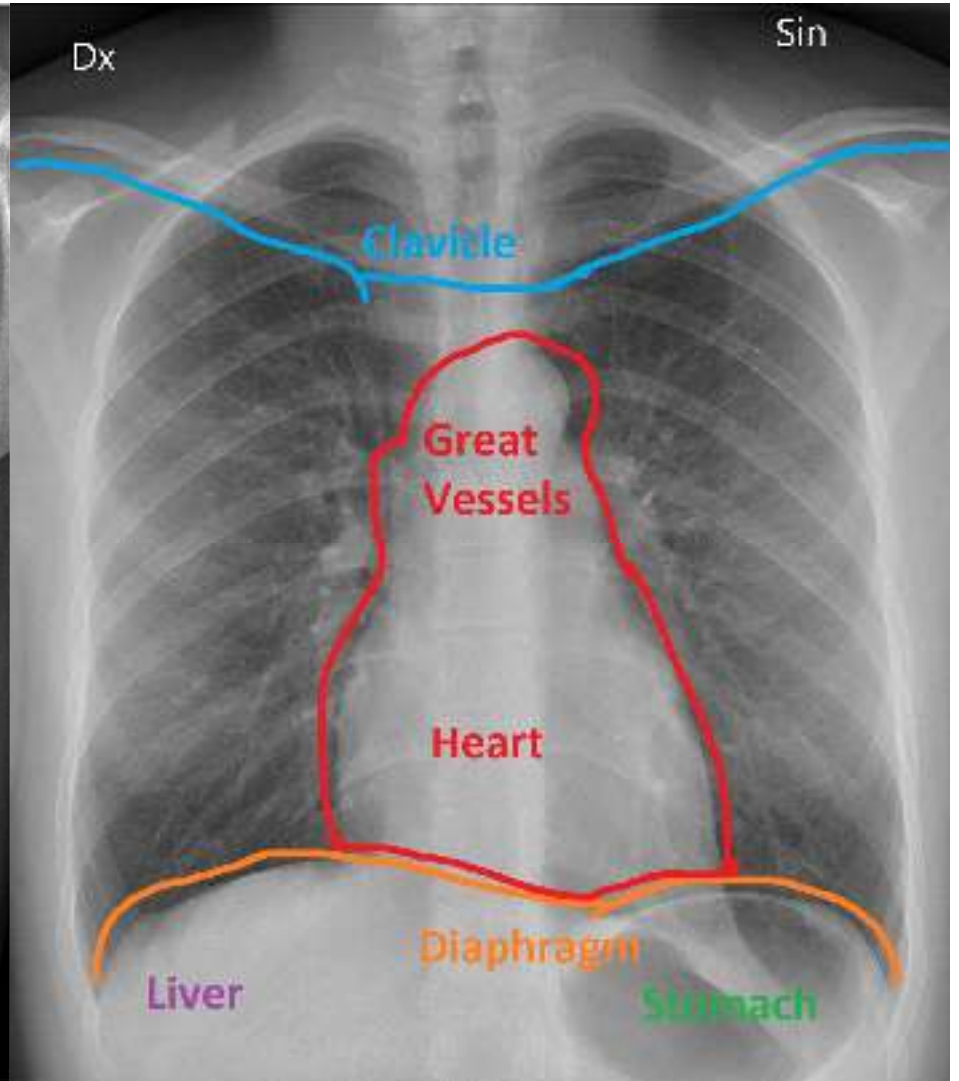
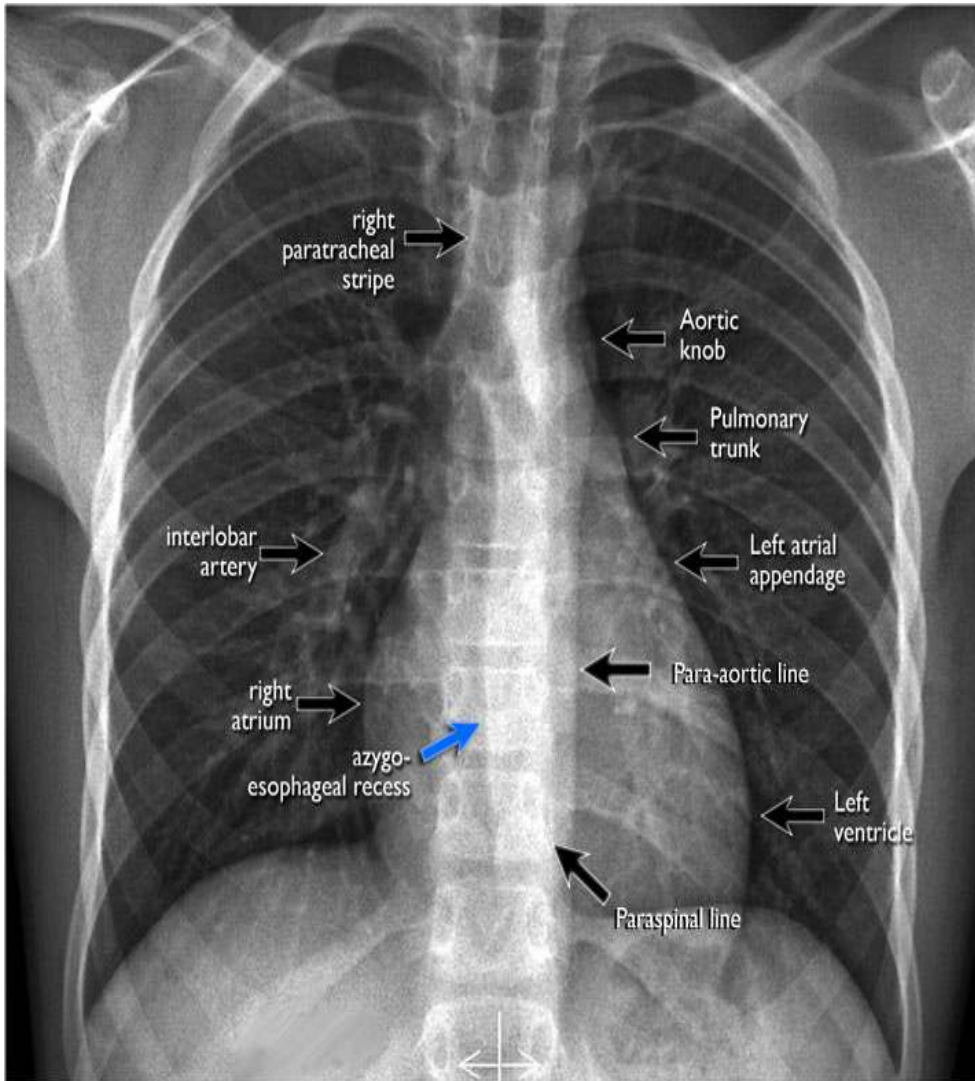
- Approximately the size of your fist
- Location
 - Superior surface of diaphragm
 - Left of the midline
 - Anterior to the vertebral column, posterior to the sternum
- The **heart** is positioned obliquely between the
- lungs in the mediastinum



1.5

1. right atrium; forms right border of heart
2. right ventricle; forms most of sternocostal surface of heart
3. left ventricle; forms most of left border of heart

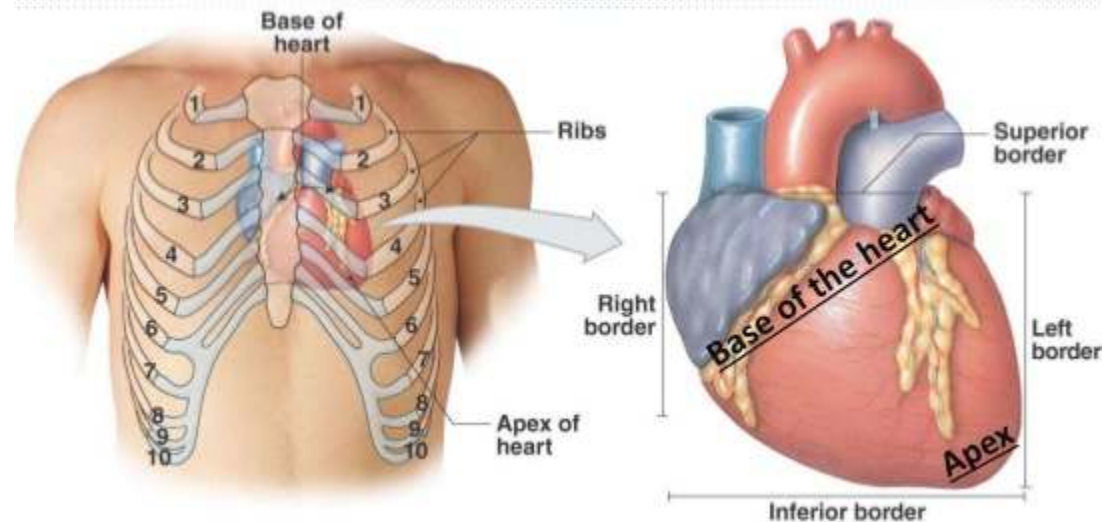




- The heart and roots of the great vessels within the pericardial sac are related anteriorly
 - to the sternum,
 - costal cartilages,
 - and the medial ends of the **3rd** and **5th ribs on the left side.**
- The heart and pericardial sac are situated obliquely, about two thirds to the left and one third to the right of the median plane.
- The heart is shaped like a tipped over, three-sided pyramid with an **apex, base, and four surfaces.**

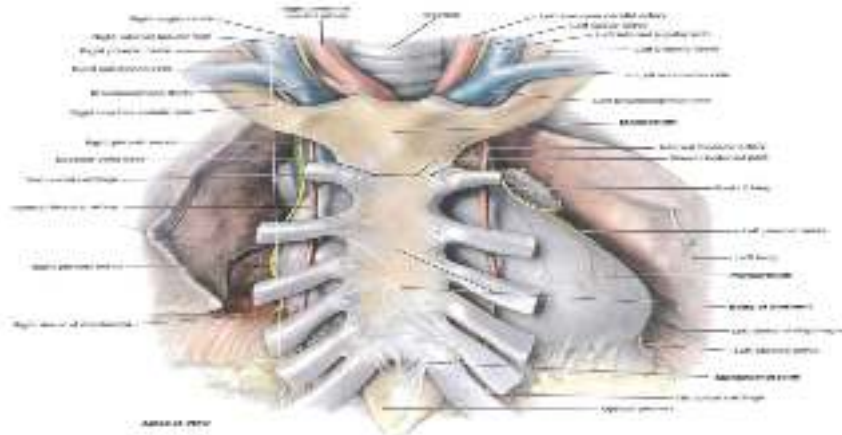
Orientation of the Heart

HEART POSITION IN THE THORAX



The apex of the heart

- Is directed anteriorly and to the left and is formed by the inferolateral part of the **left ventricle**.
- Is located posterior to the left **5th intercostal space in adults, usually 9 cm from the median plane**.
- Is where the sounds of **mitral valve closure are maximal (apex beat)**; the apex underlies the site where the



The base of the heart

- Is the heart's posterior aspect.
- **Is formed mainly by the left atrium, with a lesser contribution by the right atrium.**
- Faces posteriorly toward the bodies of vertebrae T6/T9, and is separated from them by
 - ***the pericardium,***
 - ***oblique pericardial sinus,***
 - ***esophagus, and aorta.***
- Extends superiorly to the bifurcation of the pulmonary trunk and inferiorly to the coronary groove.
- Receives the pulmonary veins on the right and left sides of its left atrial portion and the superior and inferior venae cavae at the superior and inferior ends of its right atrial portion.

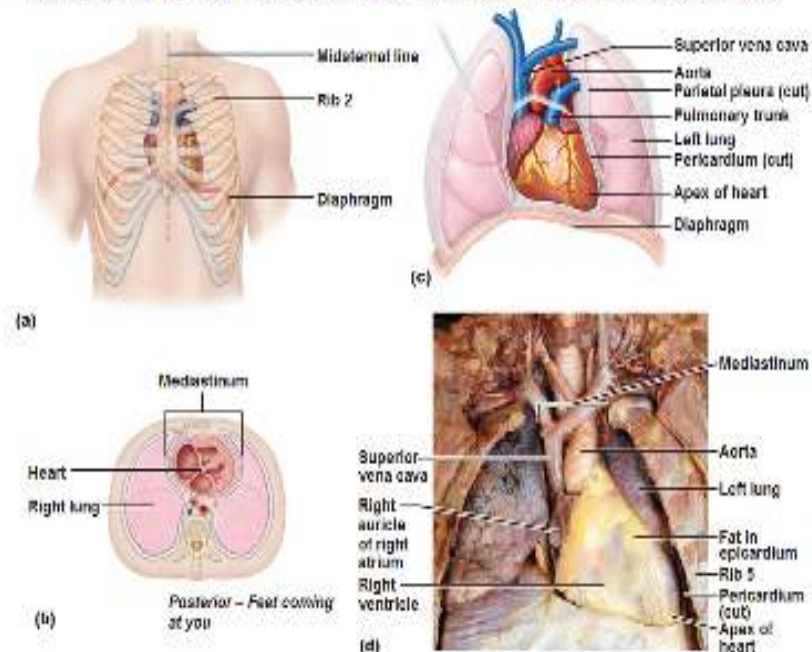
Orientation of the Heart

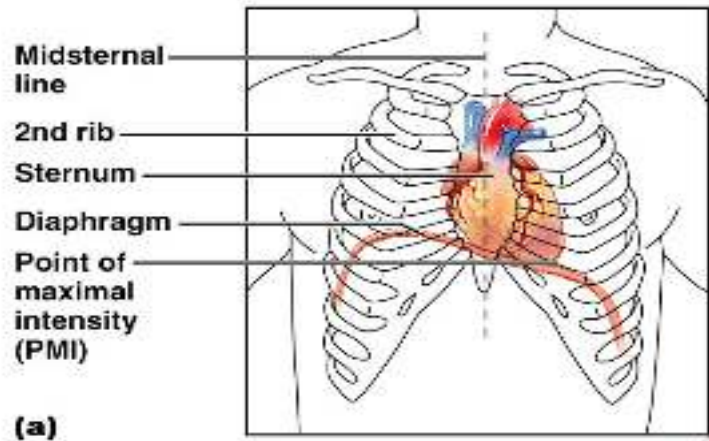
- **Anterior (sternocostal) surface**, formed mainly by the right ventricle.
 - **Diaphragmatic (inferior) surface**, formed mainly by the left ventricle and partly by the right ventricle; it is related to the central tendon of the diaphragm.
 - **Left pulmonary surface**, formed mainly by the left ventricle; it forms the cardiac impression of the left lung.
 - **Right pulmonary surface**, formed mainly by the right atrium.
- The heart appears trapezoidal in both anterior and posterior views.

The four borders of the heart are the

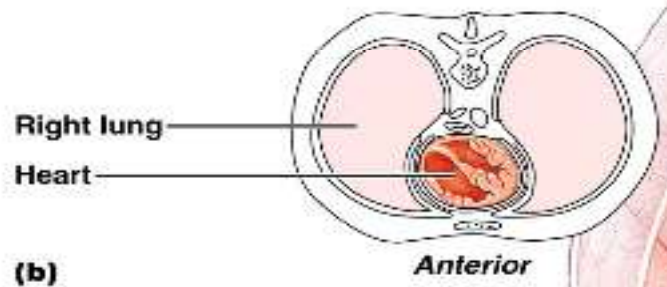
- **Right border** (slightly convex), formed by the right atrium and extending between the SVC and the IVC.
- **Inferior border** (nearly horizontal), formed mainly by the right ventricle and only slightly by the left ventricle.
- **Left border** (oblique), formed mainly by the left ventricle and slightly by the left auricle.
- **Superior border**, formed by the right and left atria and auricles in an anterior view; the ascending aorta and pulmonary trunk emerge from the superior border, and the SVC enters its right side. Posterior to the aorta and pulmonary trunk and anterior to the SVC, the superior border forms the inferior boundary of the transverse pericardial sinus.

Location of the Heart in the Thorax – The Mediastinum

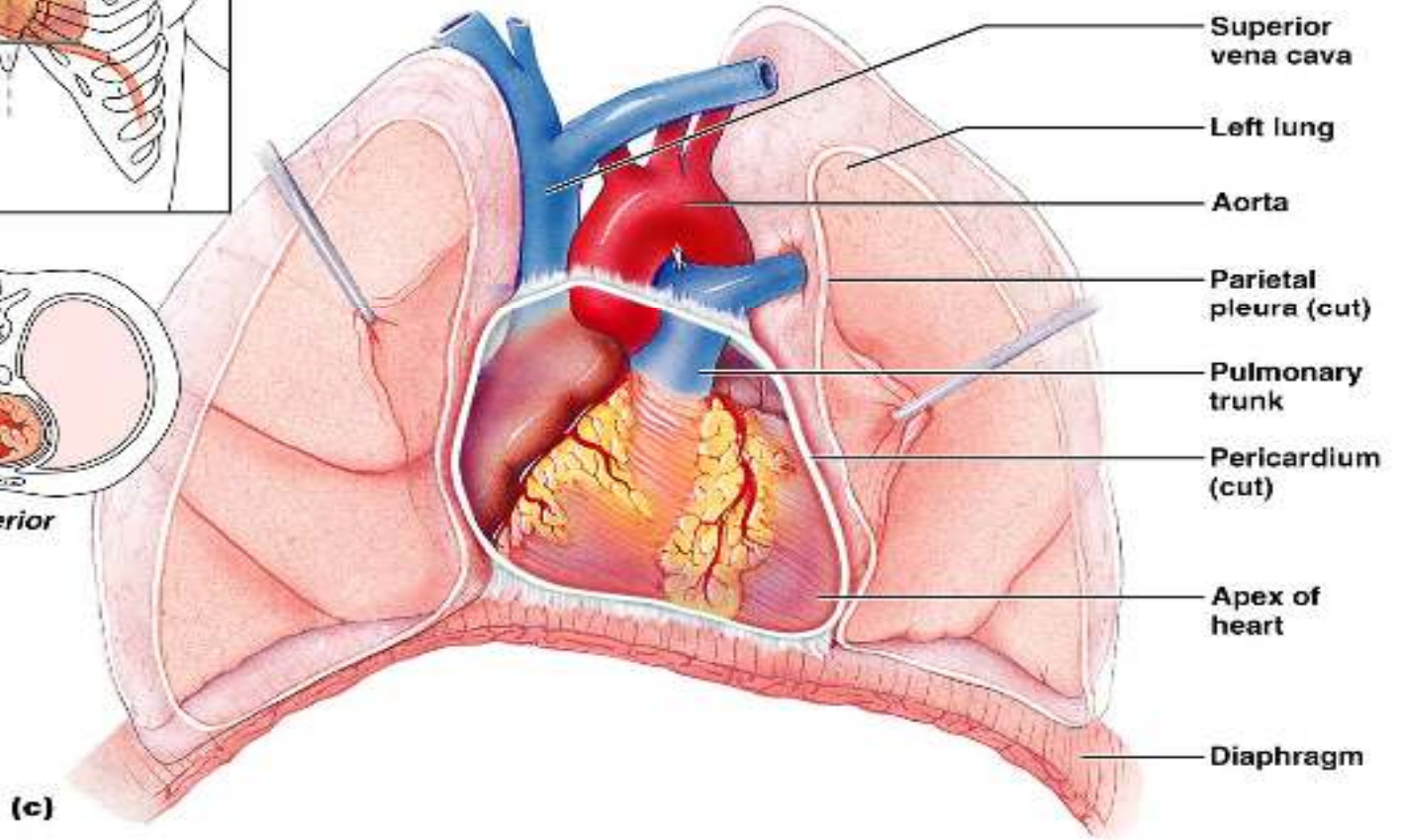




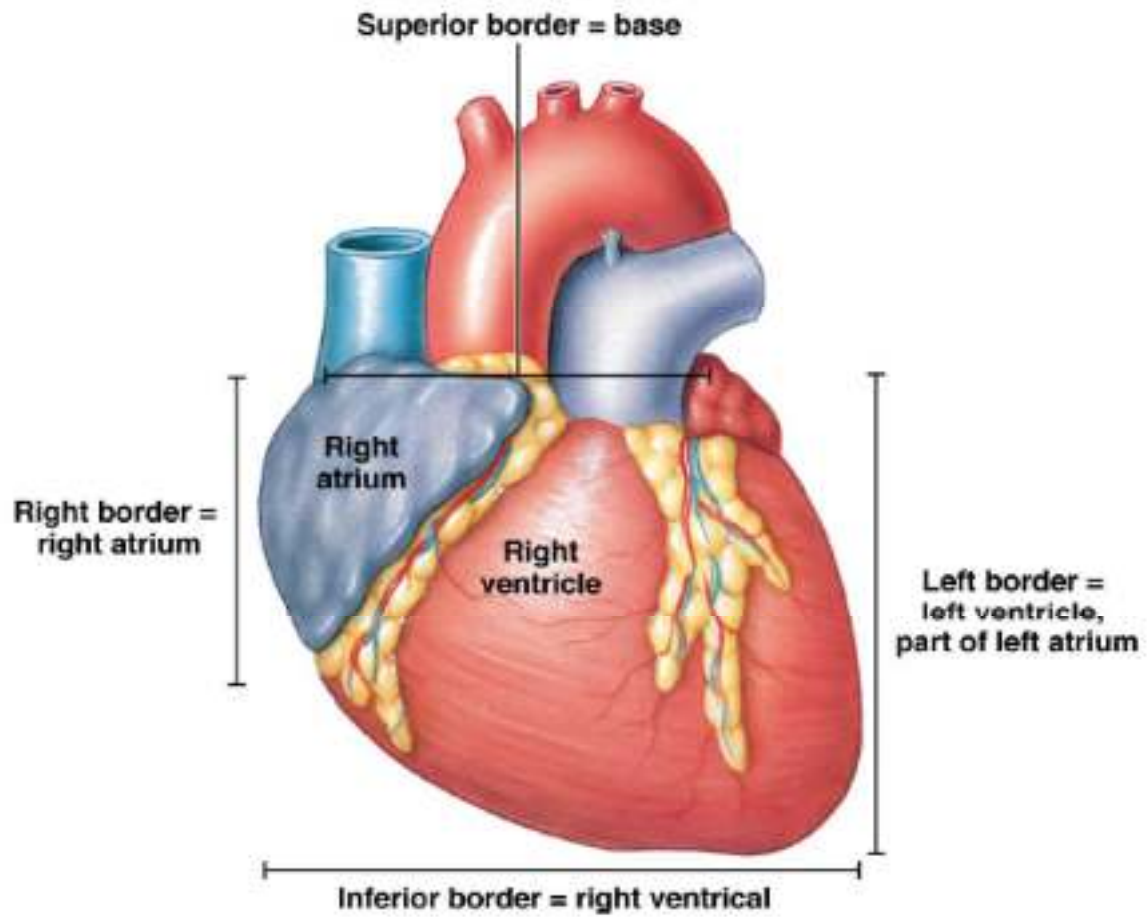
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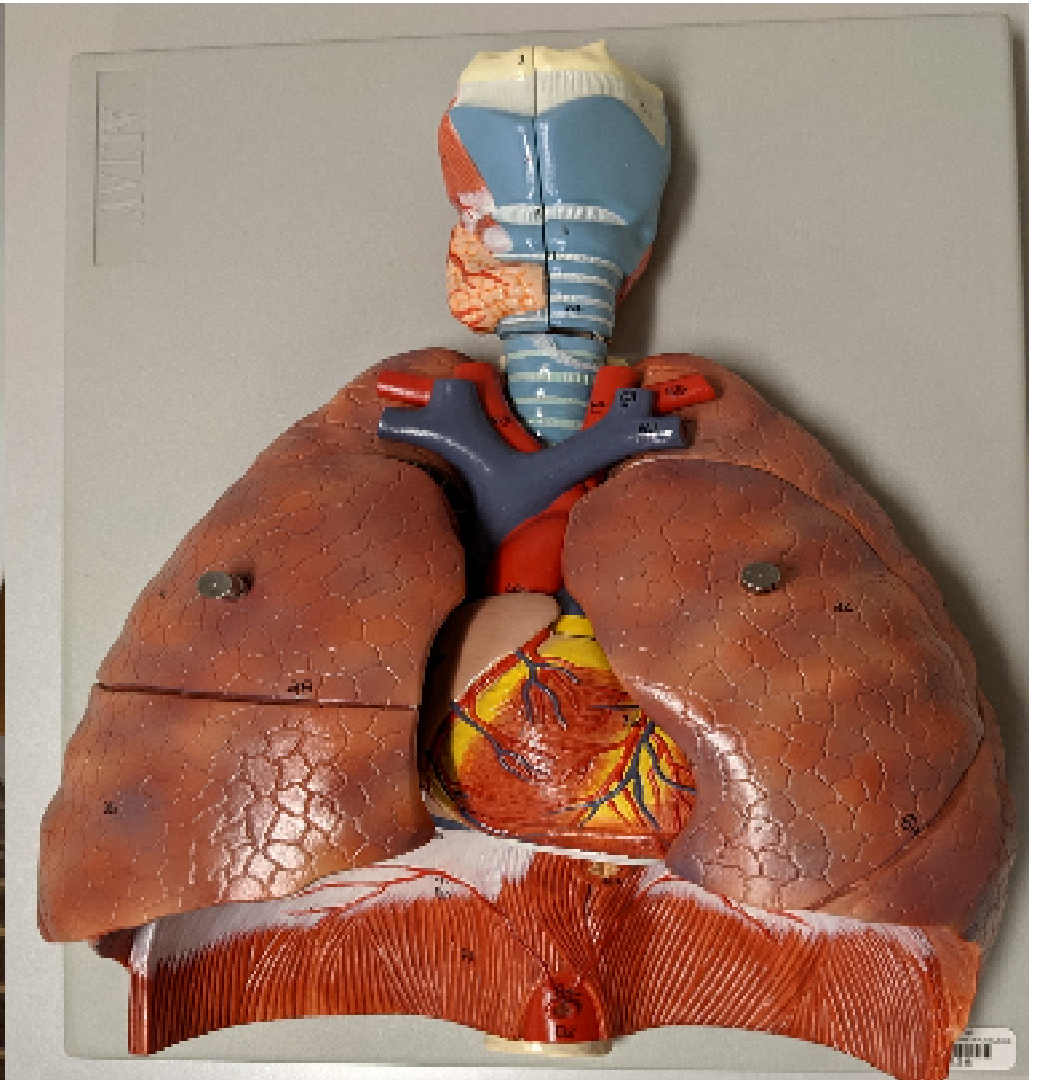


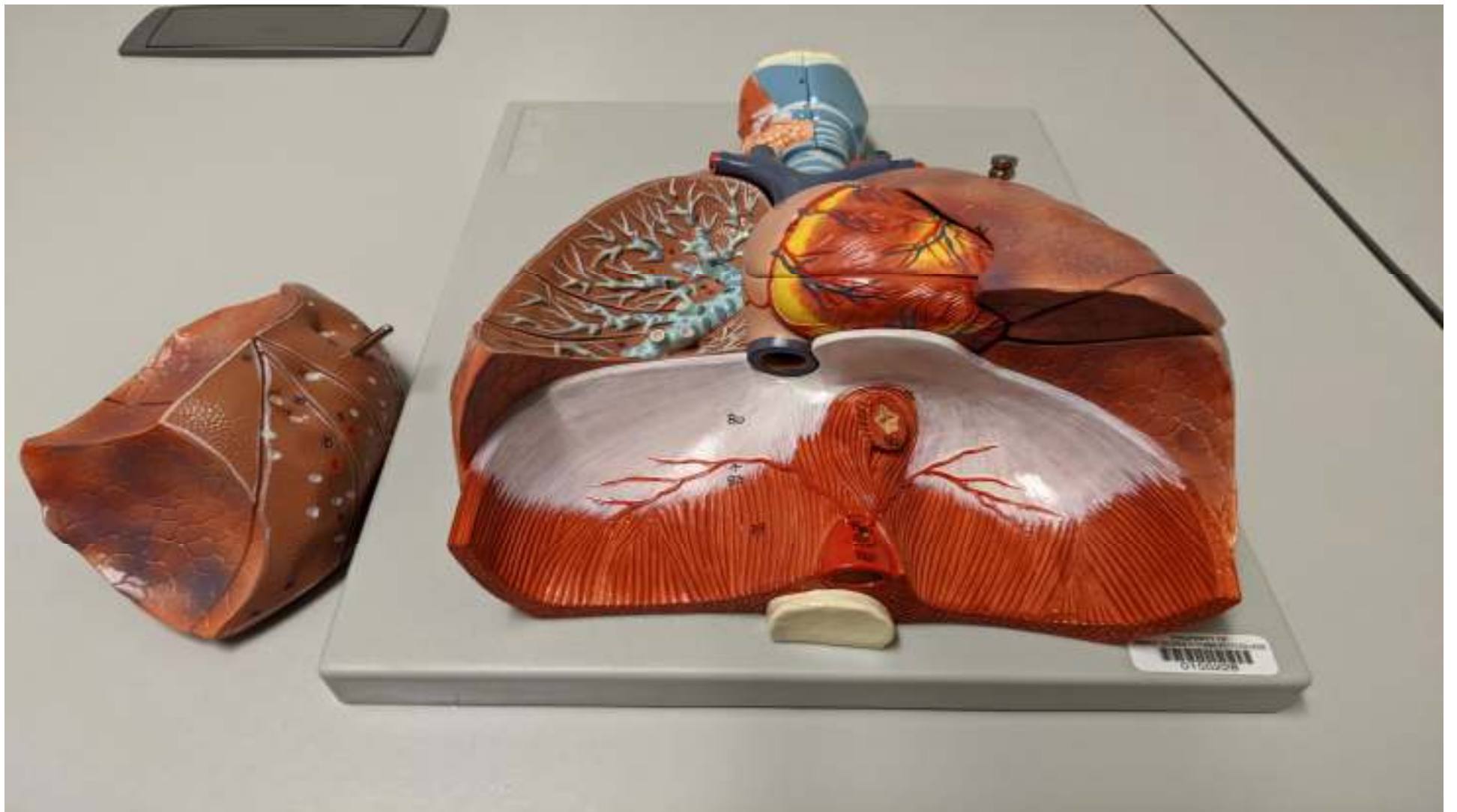
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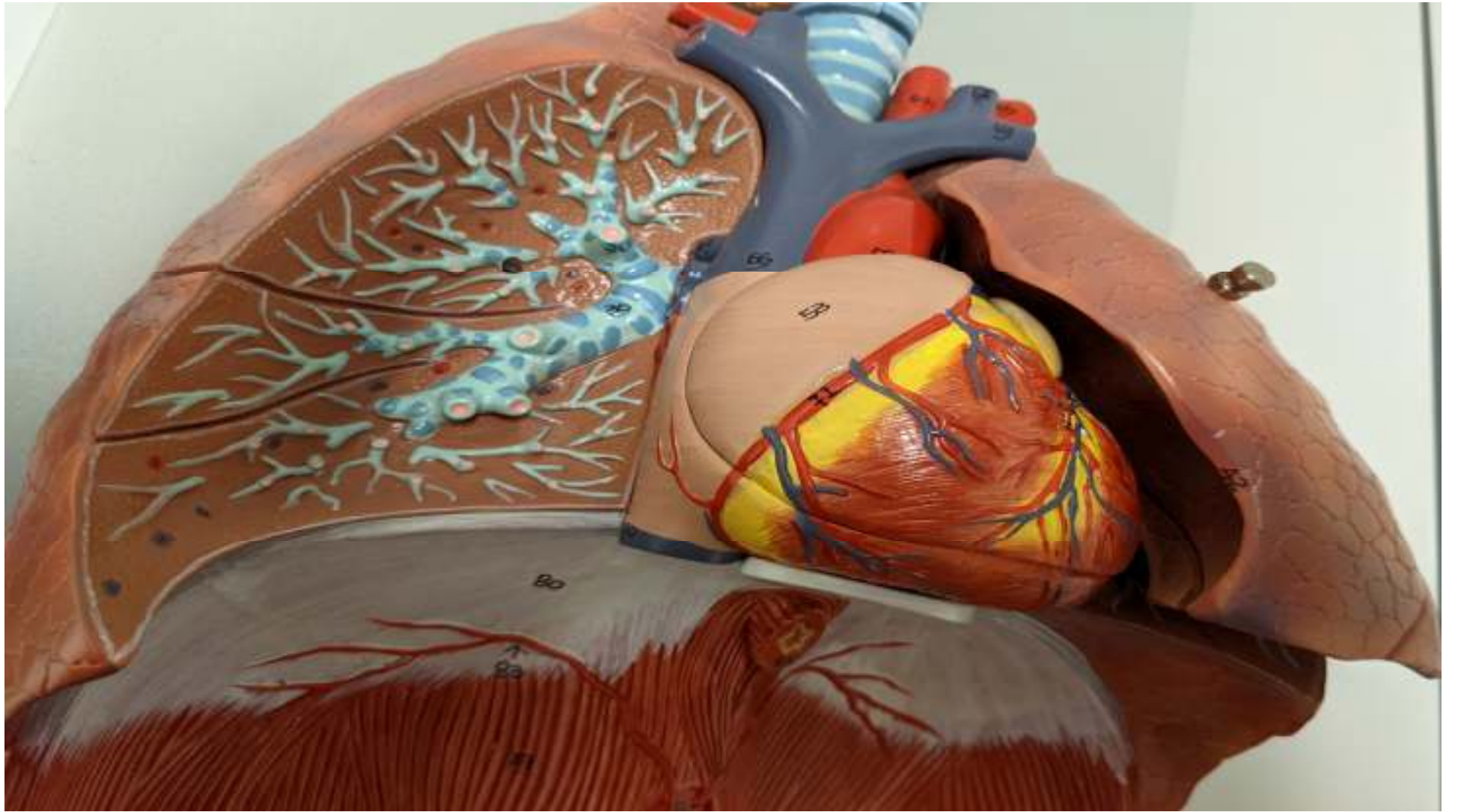


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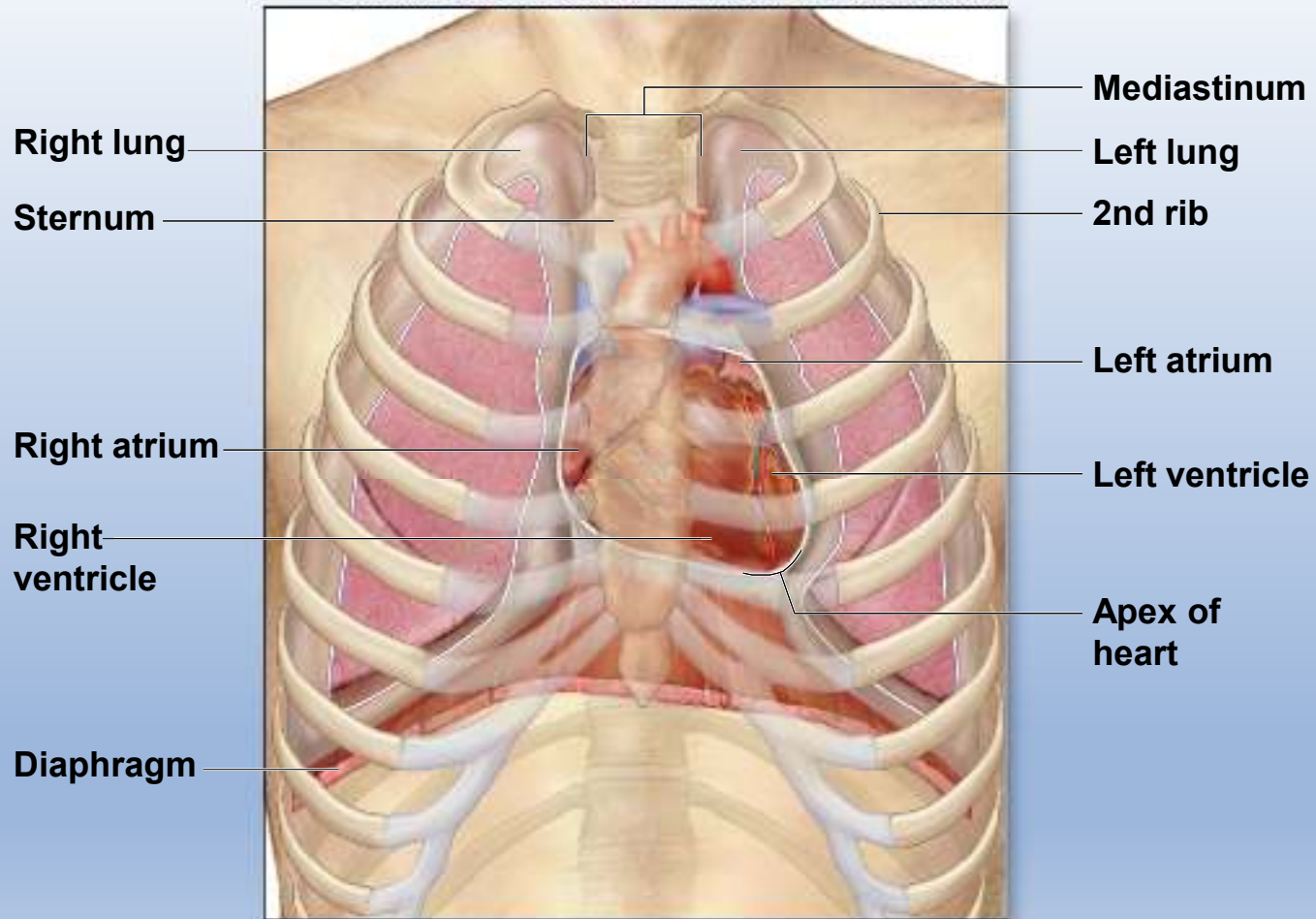




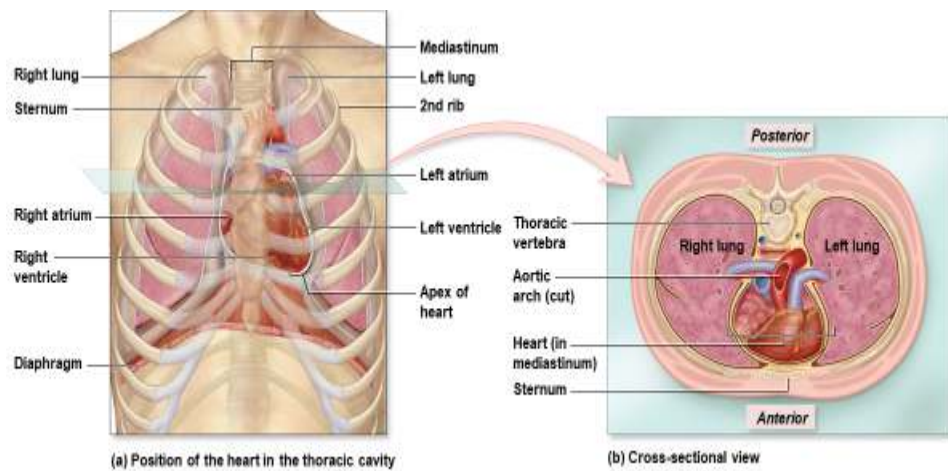




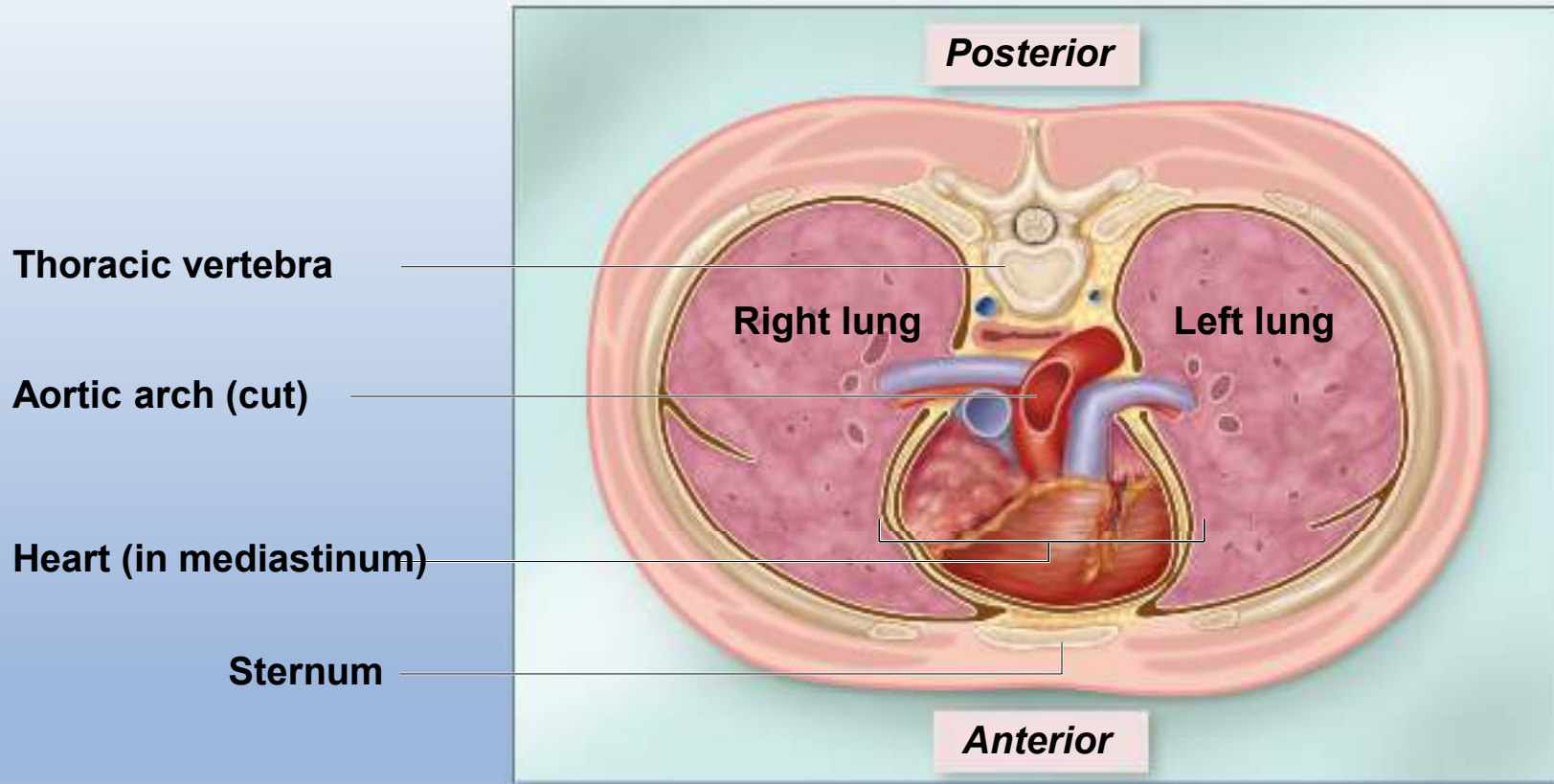
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(a) Position of the heart in the thoracic cavity



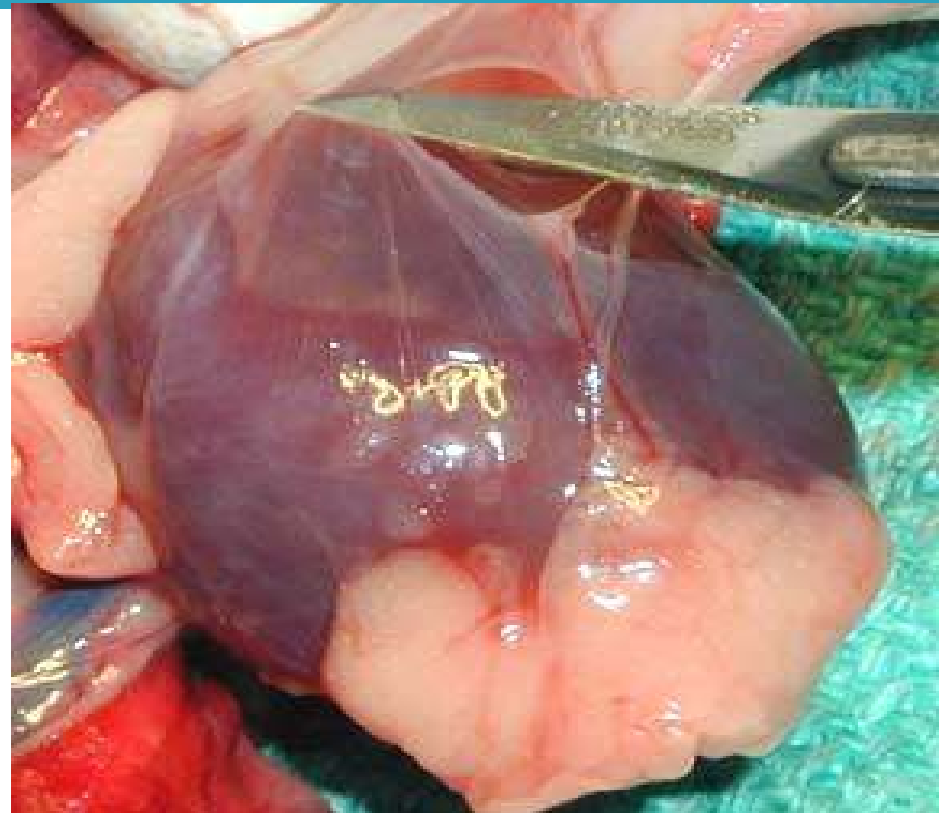
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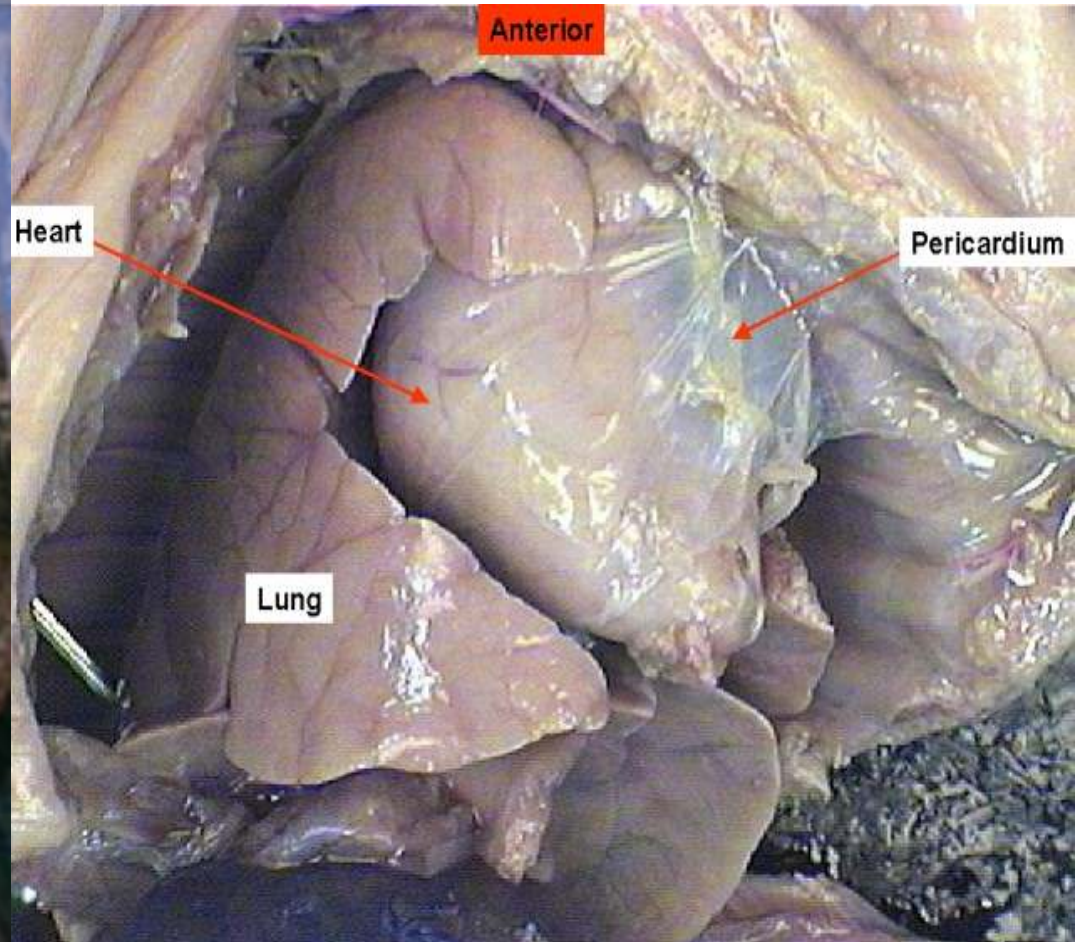
(b) Cross-sectional view

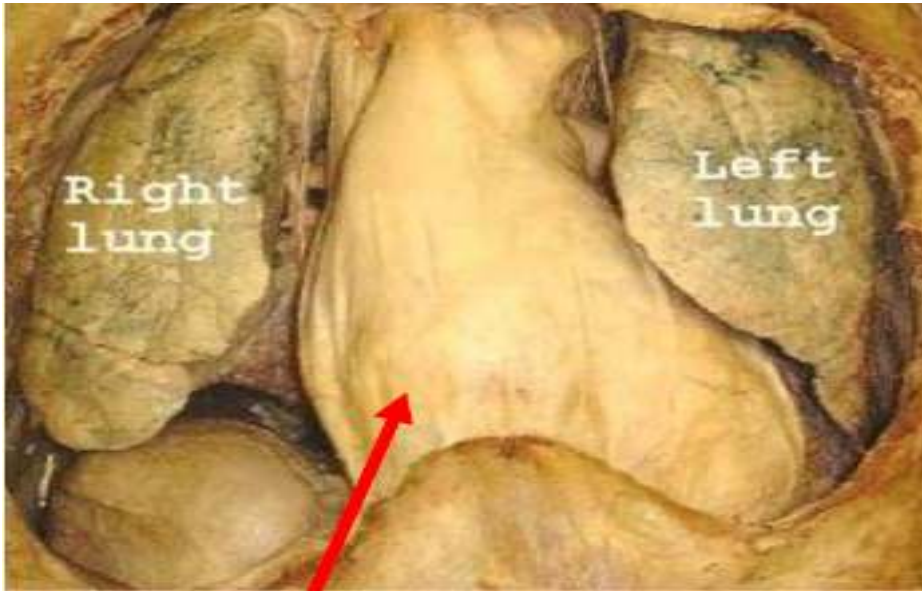
Coverings of the Heart: Anatomy

- **Pericardium** – a double-walled sac around the heart composed of:
 - A superficial fibrous pericardium
 - A deep two-layer serous pericardium
 - The **parietal layer** lines the internal surface of the fibrous pericardium
 - The **visceral layer or epicardium** lines the surface of the heart
 - They are separated by the fluid-filled pericardial cavity

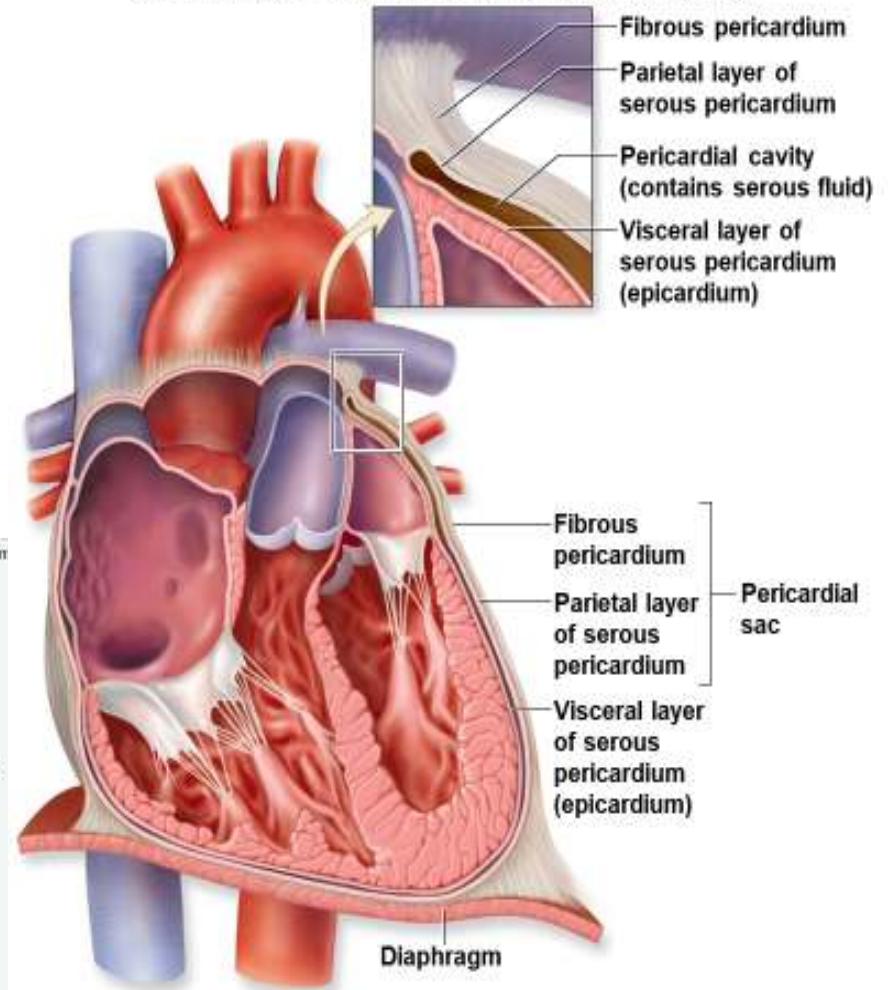


Pericardium



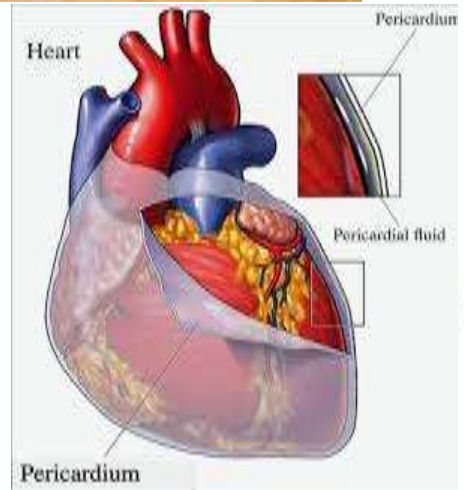


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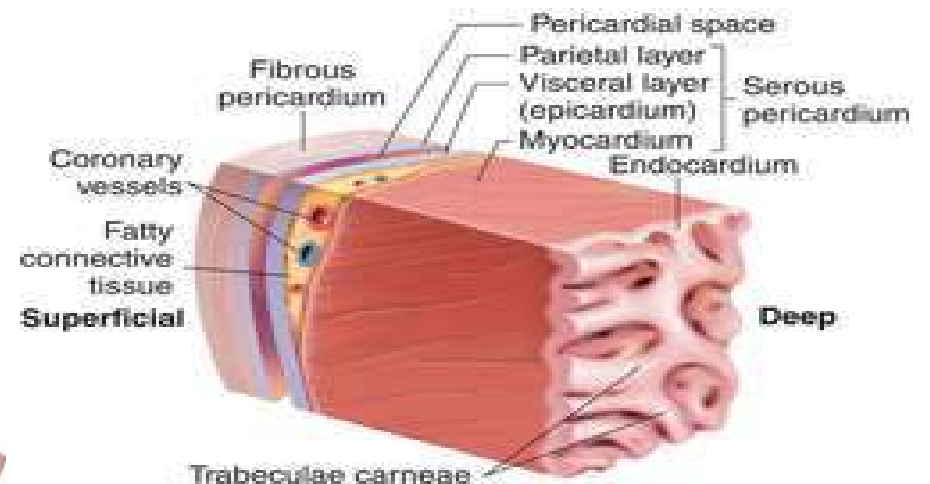
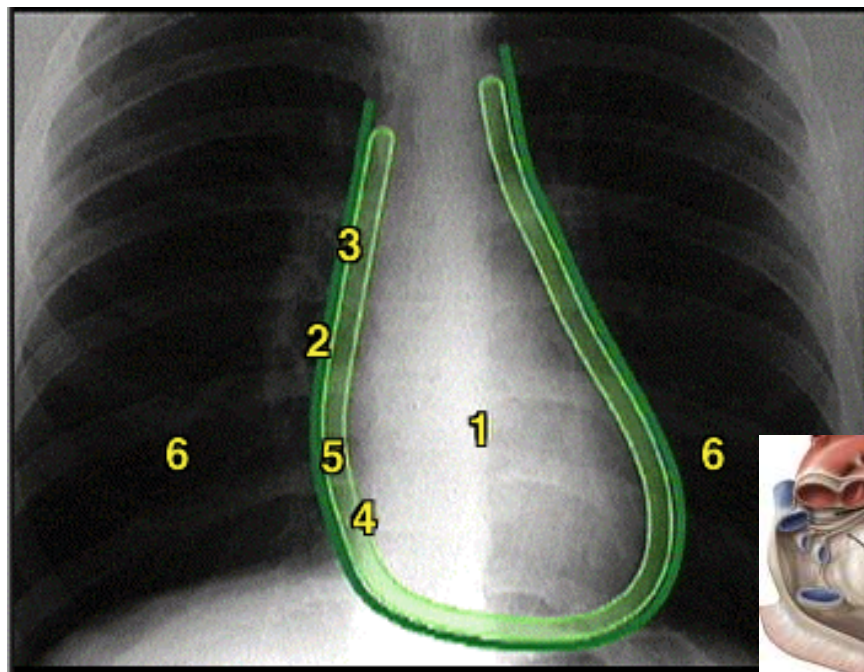
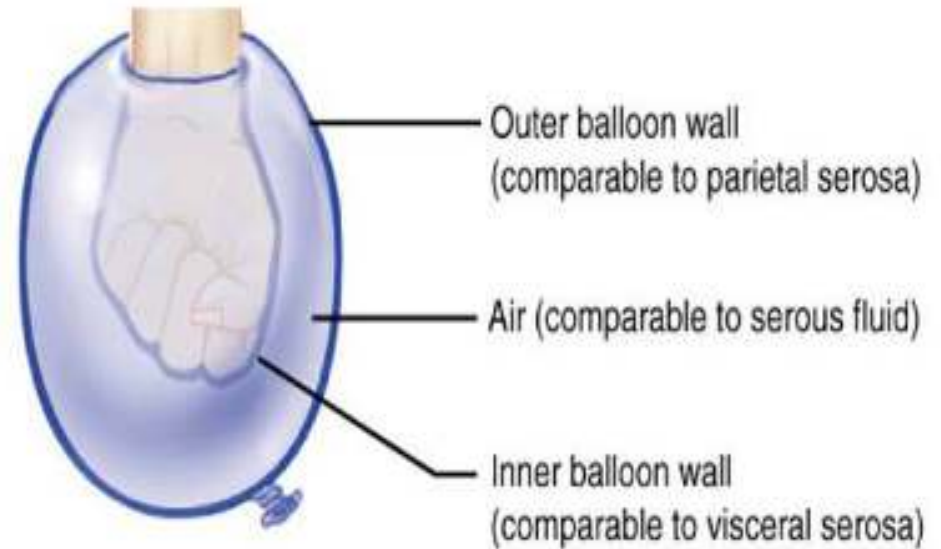
Fibrous Pericardium

- Collagenous sac enclosing the heart.
- Stabilizes heart's position and prevents over distention.



Serous Pericardium

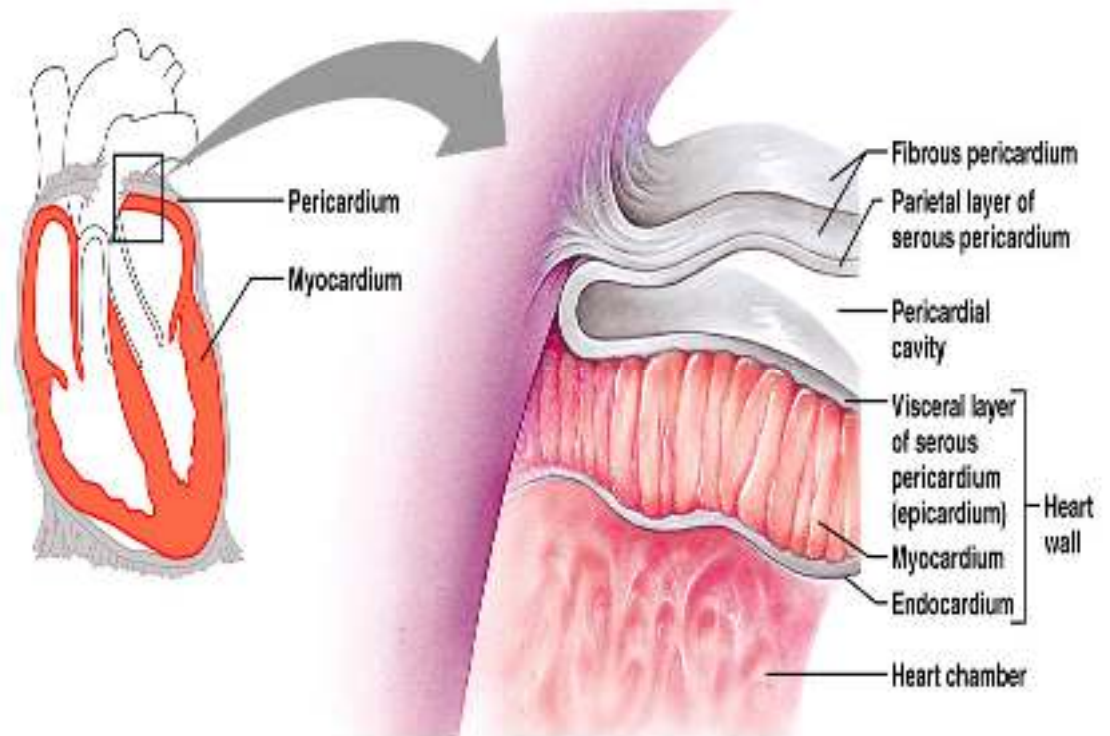
- Deep to the fibrous pericardium.
- 2 layered structure.
- Relationship with the heart is similar to that of a fist punching a balloon.



Coverings of the Heart: Physiology

□ The pericardium function :

- **Protects and anchors the heart**
- **Prevents overfilling of the heart with blood**
- **Allows for the heart to work in a relatively friction-free environment**



Heart layers: Anatomy

Epicardium

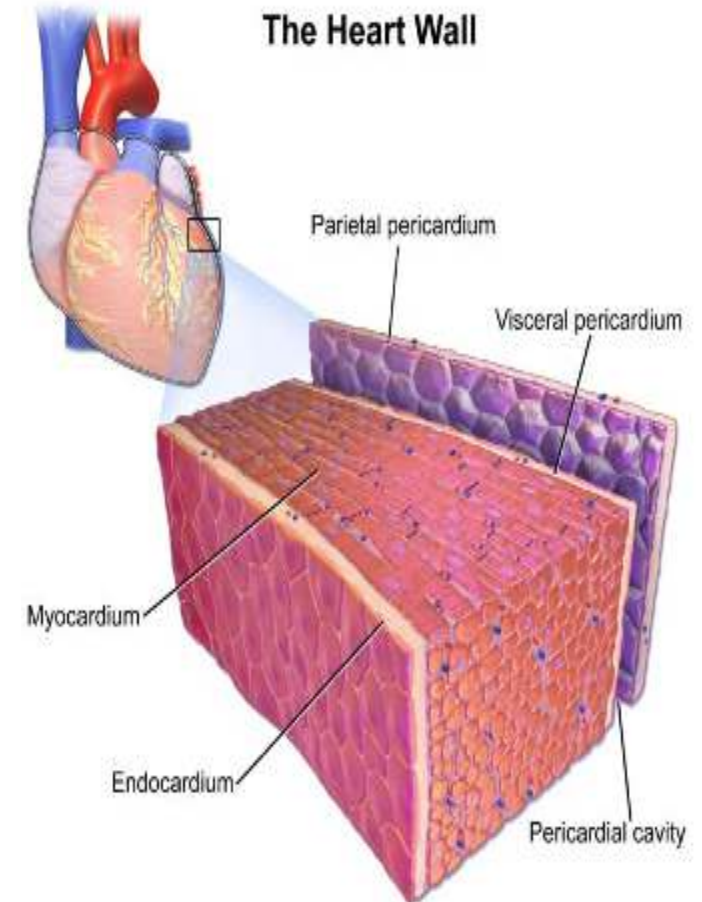
- Corresponds to the visceral pericardium.
- Functions as an outer protective layer.
- Serous membrane that consists of connective tissue covered by epithelium.
- **Includes blood capillaries, lymph capillaries, and nerve fibers.**

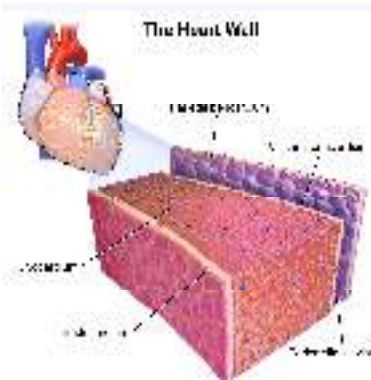
Myocardium

- Relatively thick.
- Consists largely of cardiac muscle tissue **responsible for forcing blood out of the heart chambers.**
- Muscle fibers are arranged in planes, separated by connective tissues that are richly supplied with blood capillaries, and nerve fibers.

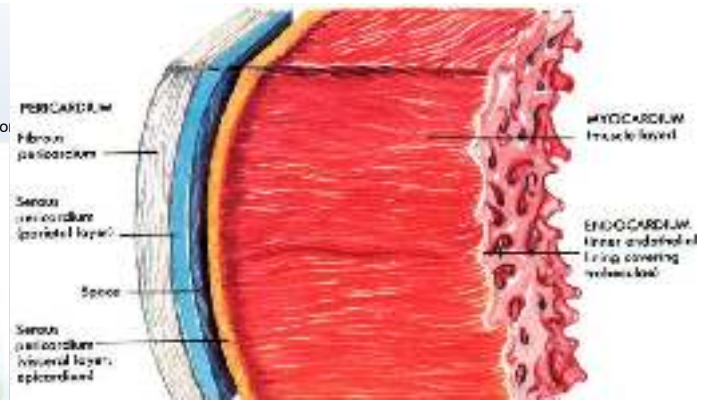
Endocardium

- Consists of epithelial and connective tissue that contains many elastic and collagenous fibers.
- Connective tissue also contains blood vessels and some **specialized cardiac muscle fibers called Purkinje fibers.**
- Lines all of the heart chambers and covers heart valves.
- Is continuous with the inner lining of blood vessels--**endothelium.**





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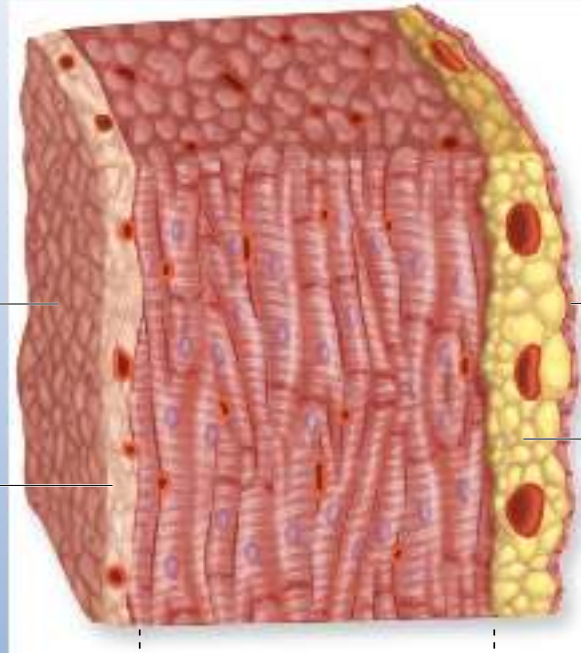


Simple squamous epithelium (endothelium)

Areolar connective tissue

Simple squamous epithelium

Areolar connective tissue and adipose connective tissue

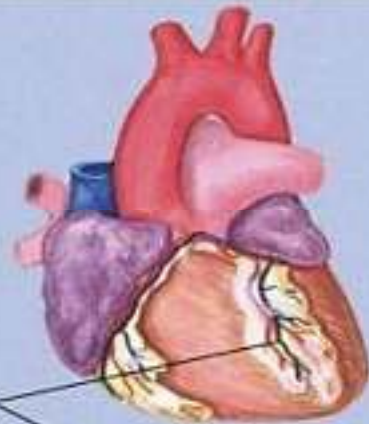


Endocardium

Myocardium (cardiac muscle)

Epicardium (visceral layer of serous pericardium)

(b)



Layer	Characteristics	Function
Epicardium (visceral pericardium)	Serous membrane including blood capillaries, lymph capillaries, and nerve fibers	Serves as lubricative outer covering
Myocardium	Cardiac muscle tissue separated by connective tissues and including blood capillaries, lymph capillaries, and nerve fibers	Provides muscular contractions that eject blood from the heart chambers
Endocardium	Endothelial tissue and a thick subendothelial layer of elastic and collagenous fibers	Serves as protective inner lining of the chambers and valves





Connective tissues
Pericardial cavity (contains pericardial fluid)

Myocardium

Endocardium

Endothelium
Areolar tissue

Heart wall

The Pericardium

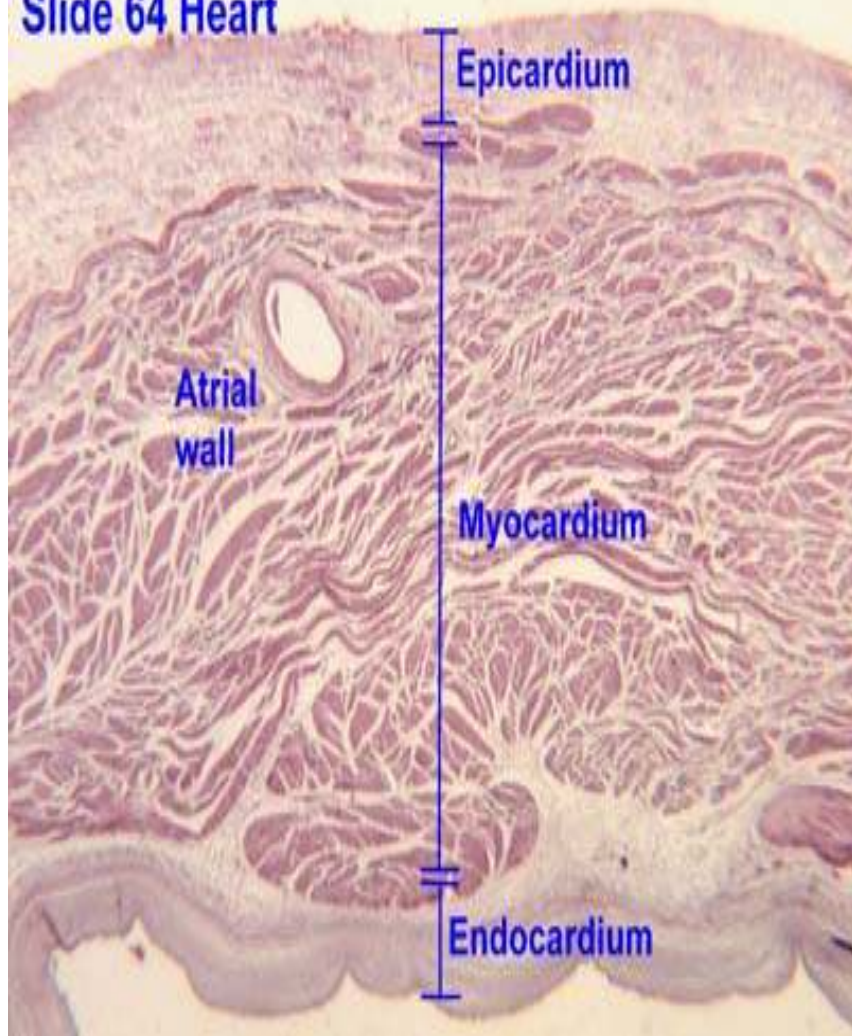
Parietal Layer of Serous Pericardium

Dense fibrous tissue
Areolar tissue } Parietal layer
Mesothelium }

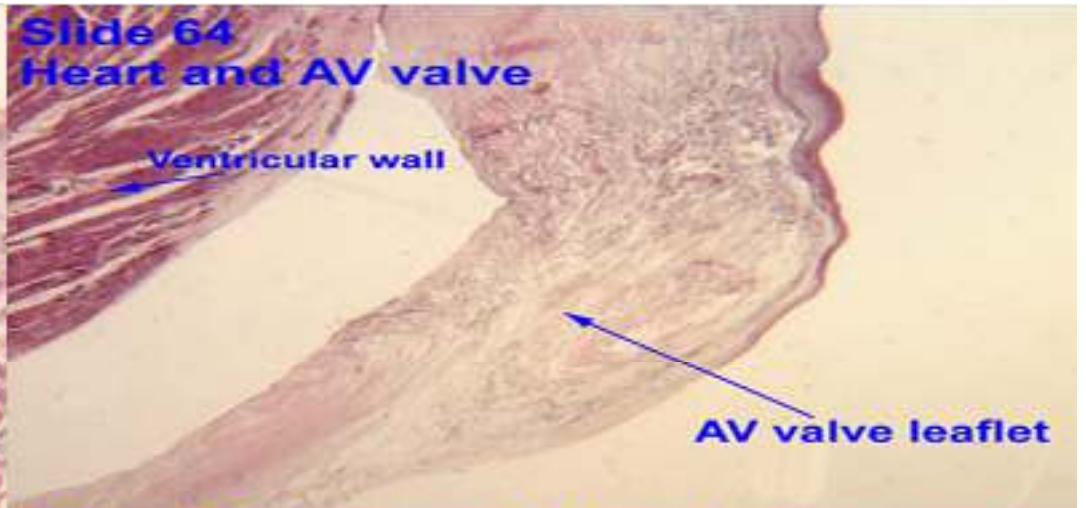
Visceral Layer of Serous Pericardium

Mesothelium } Visceral layer
Areolar tissue }

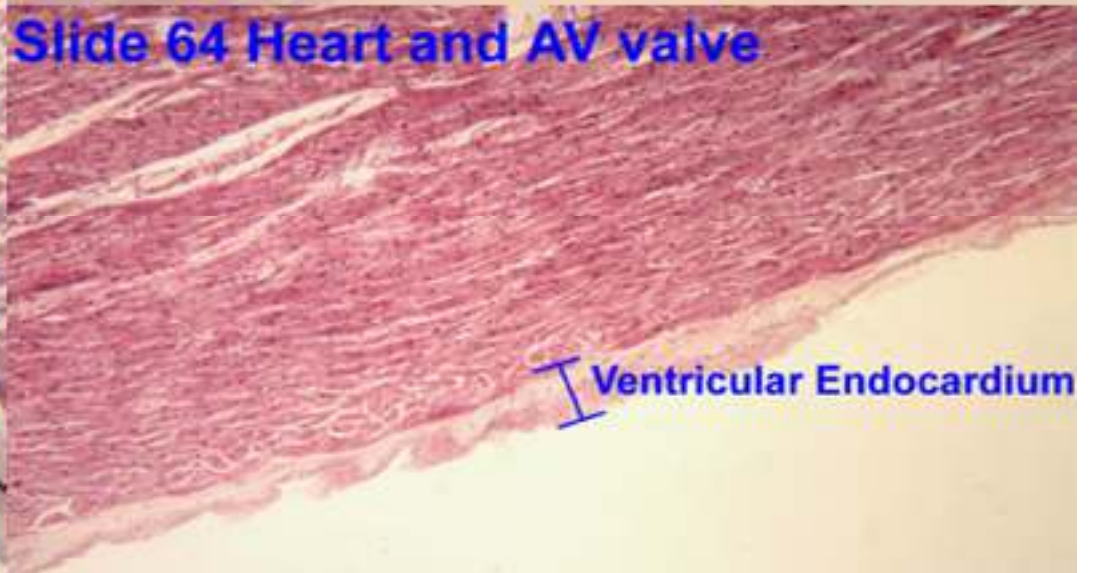
Slide 64 Heart

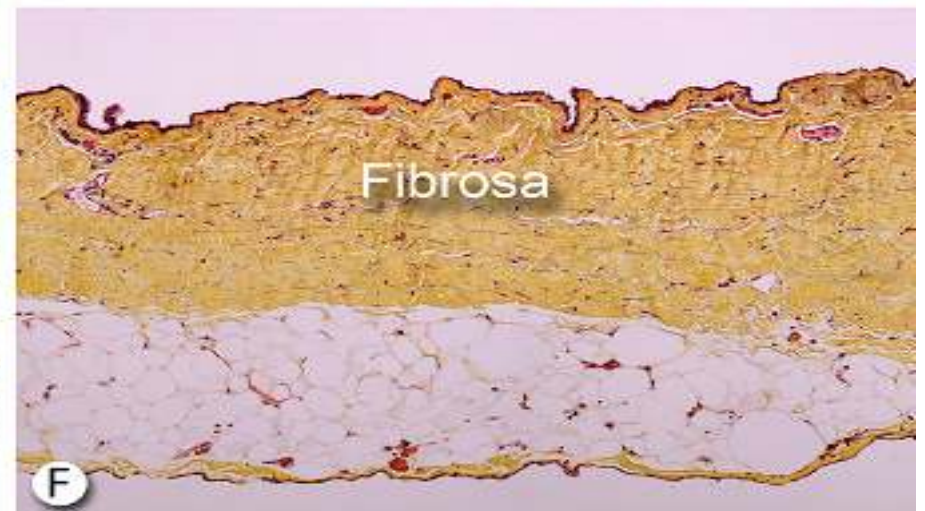
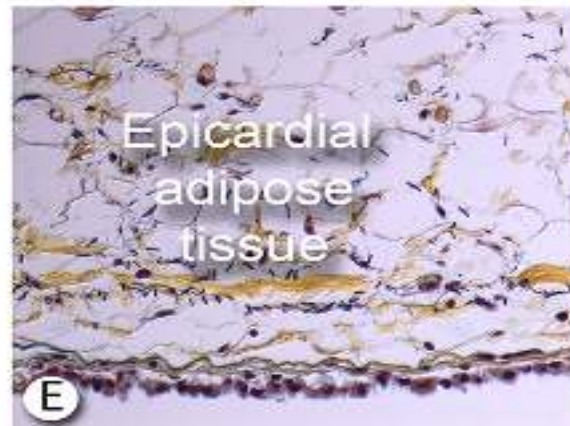
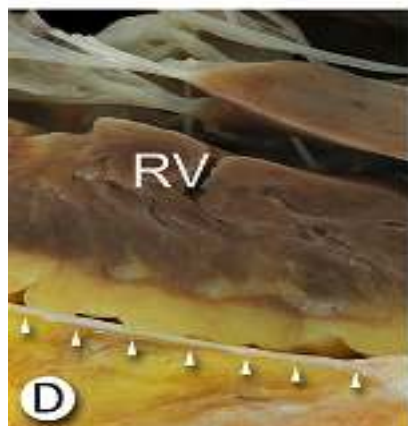
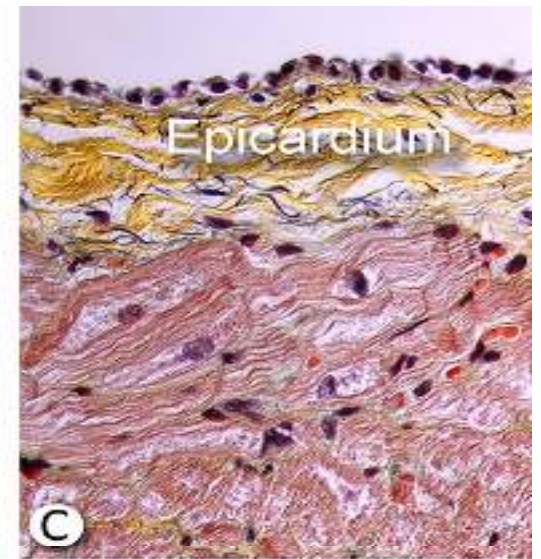
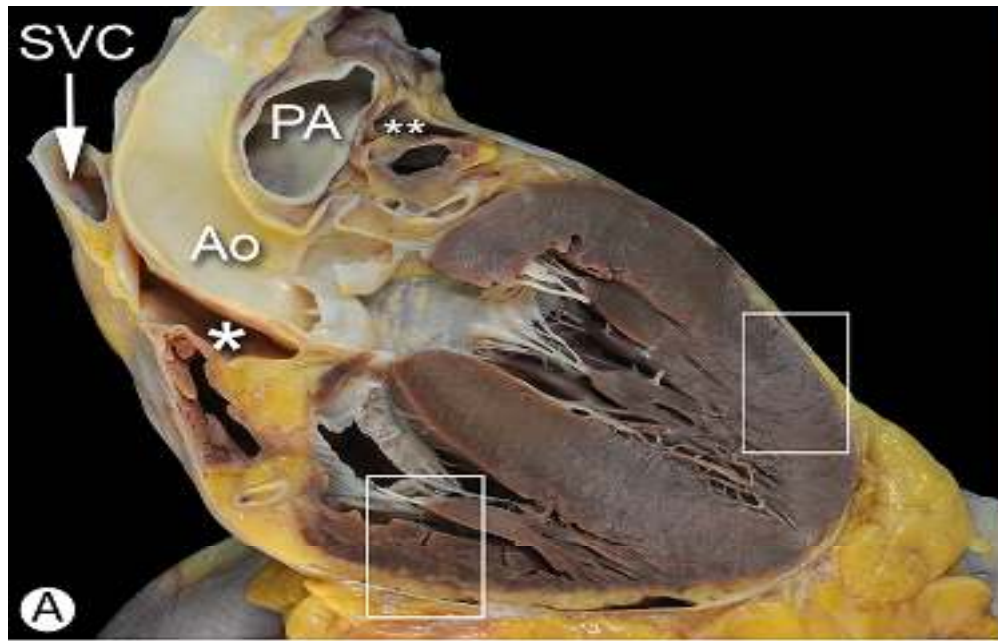


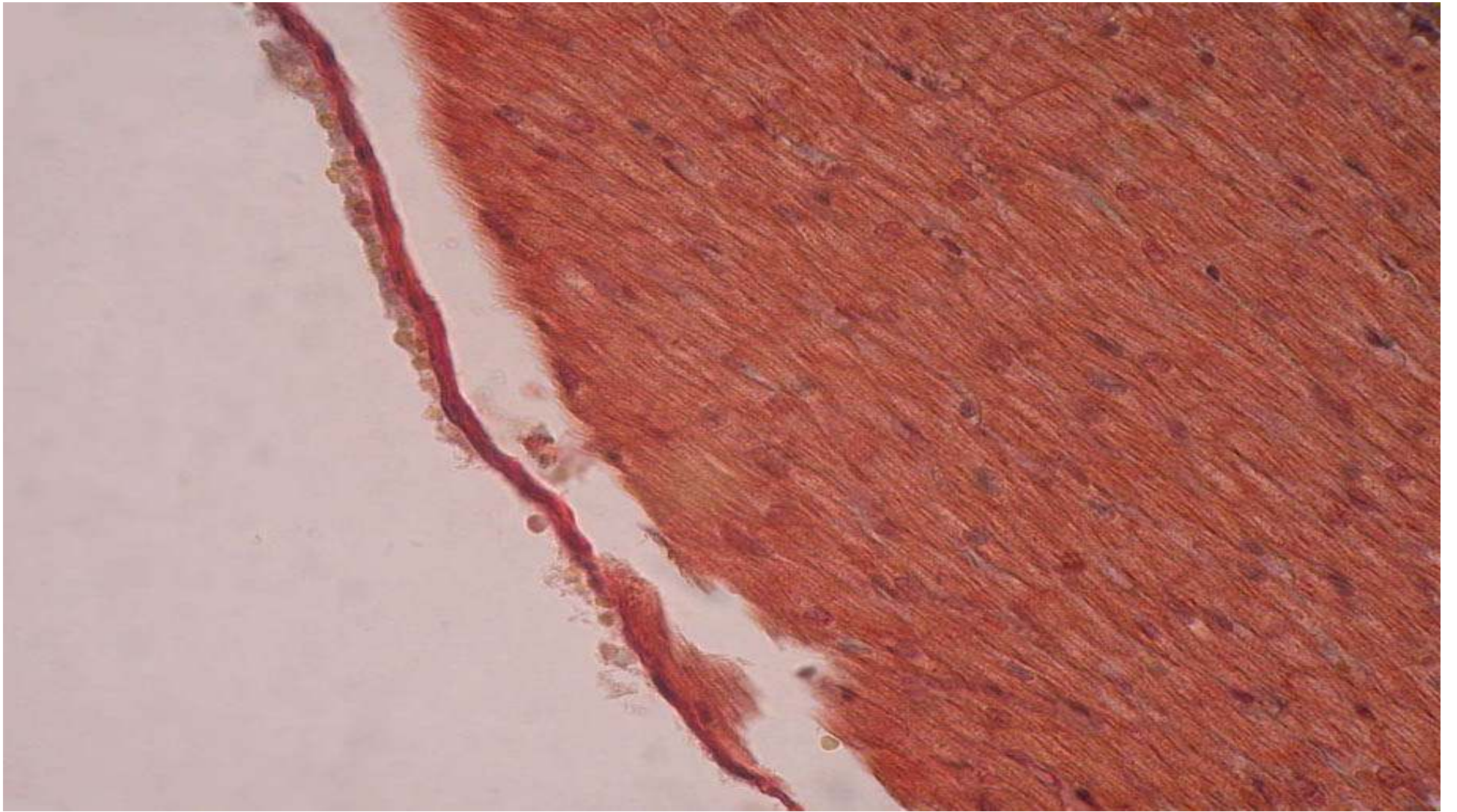
Slide 64 Heart and AV valve



Slide 64 Heart and AV valve

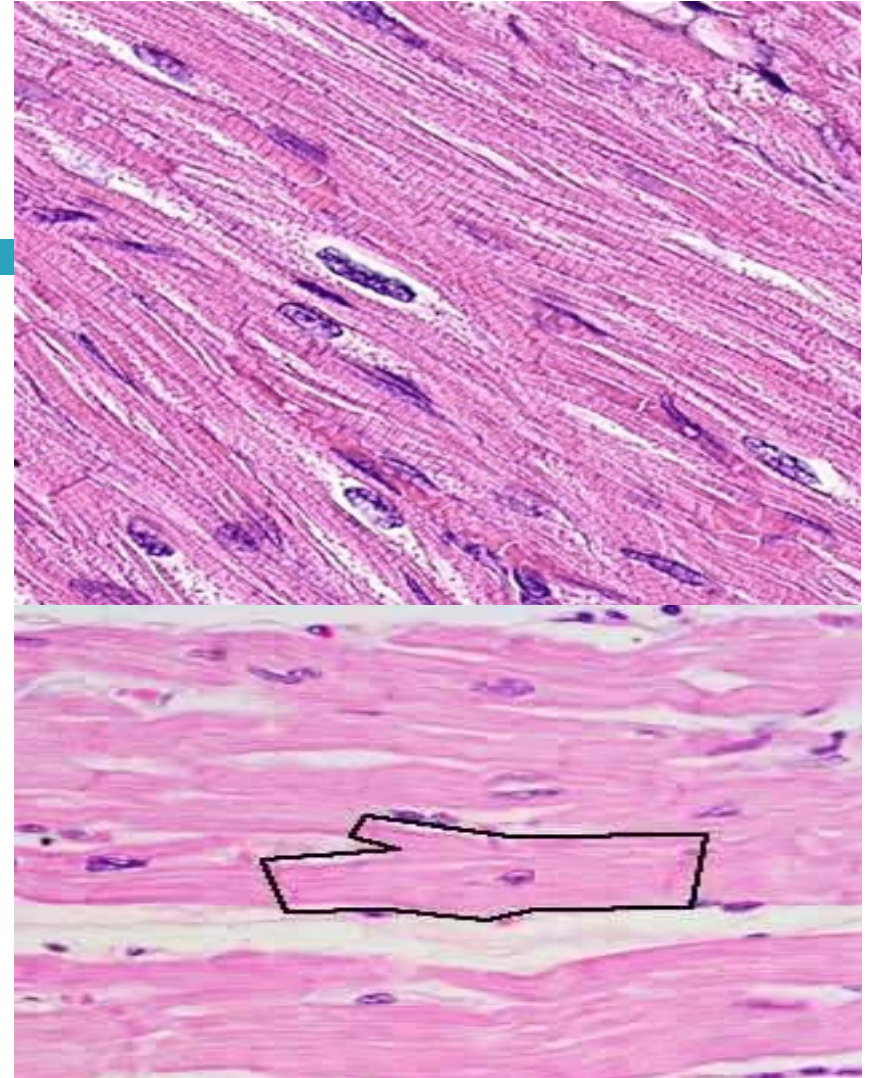






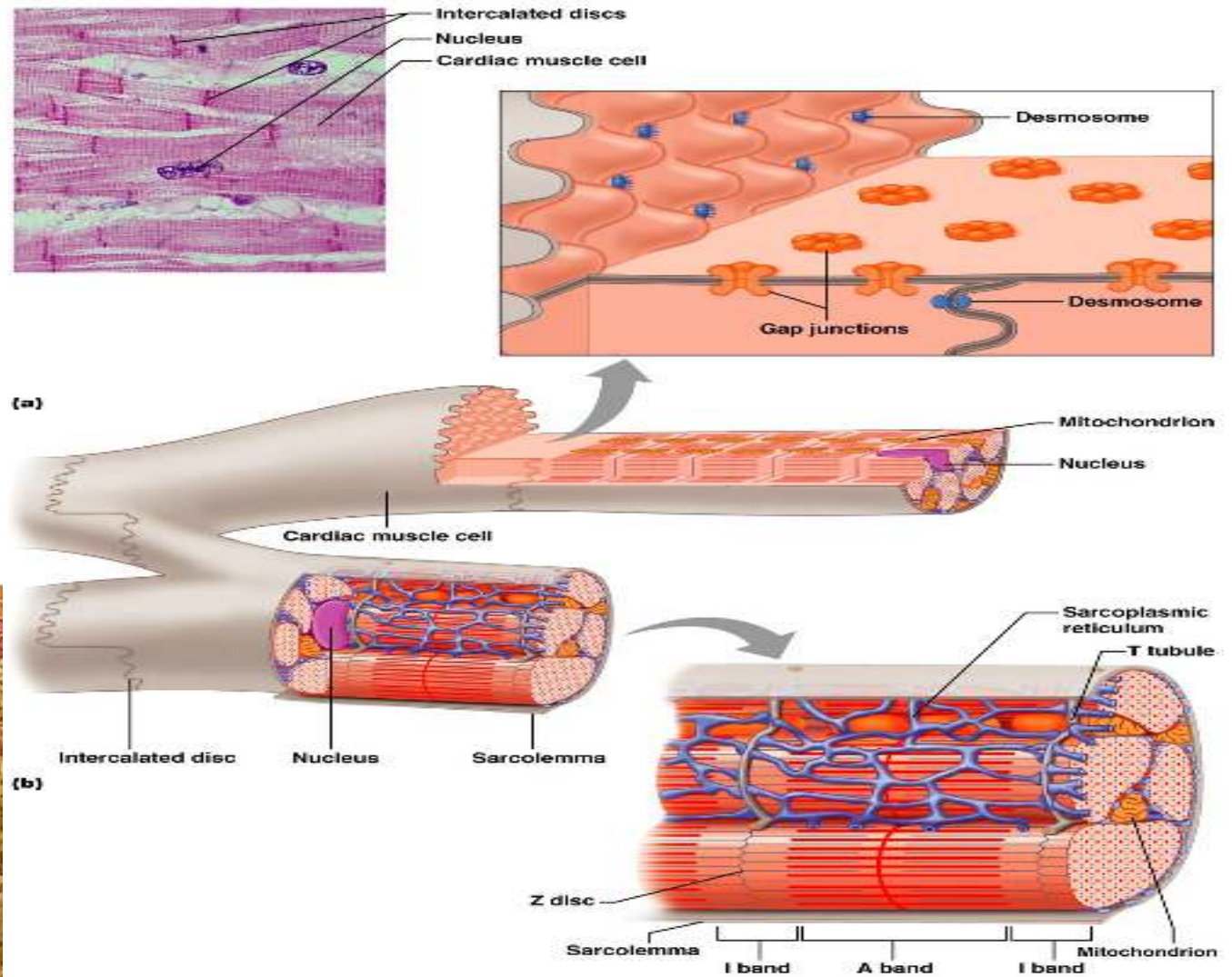
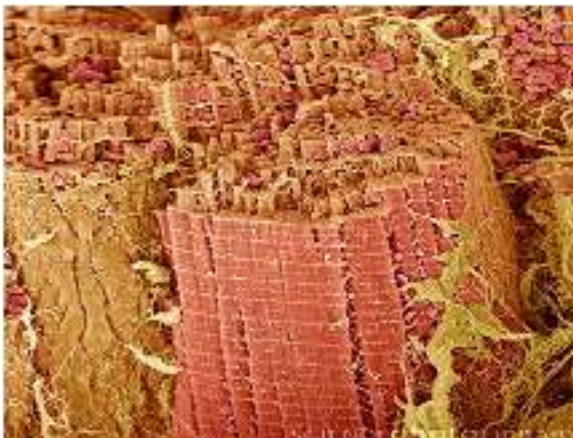
Microscopic Anatomy of Heart Muscle

- Cardiac muscle is striated, short, fat, branched, and interconnected
- The connective tissue endomysium acts as both tendon and insertion
- Intercalated discs anchor cardiac cells together and allow free passage of ions
- Heart muscle behaves as a functional syncytium

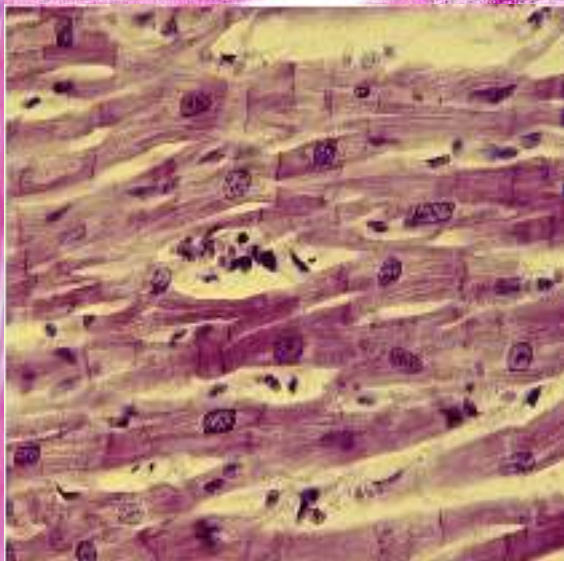
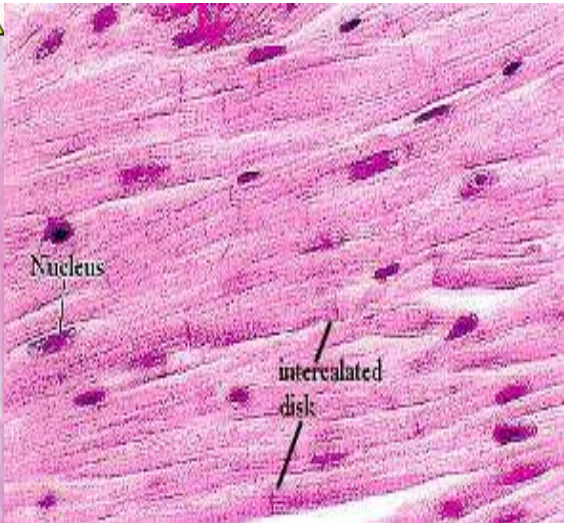
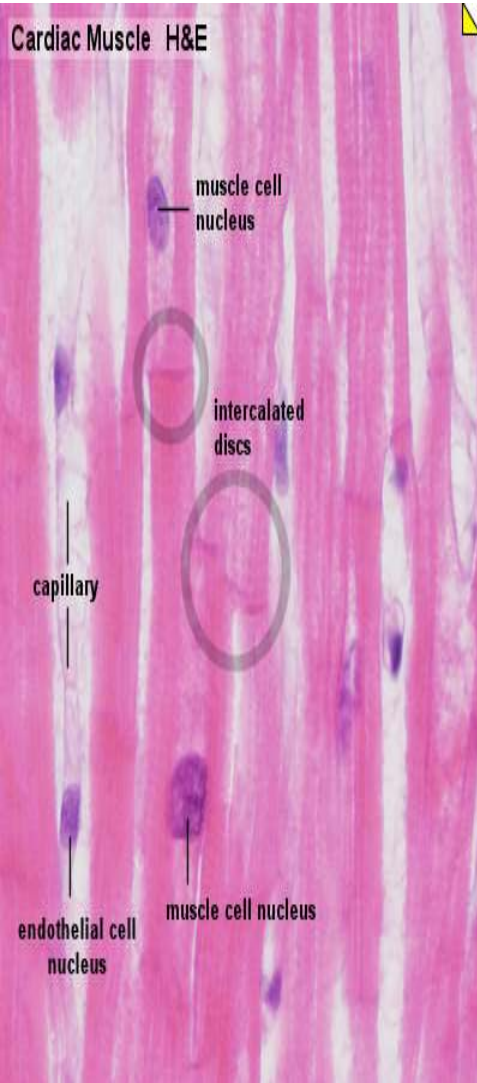


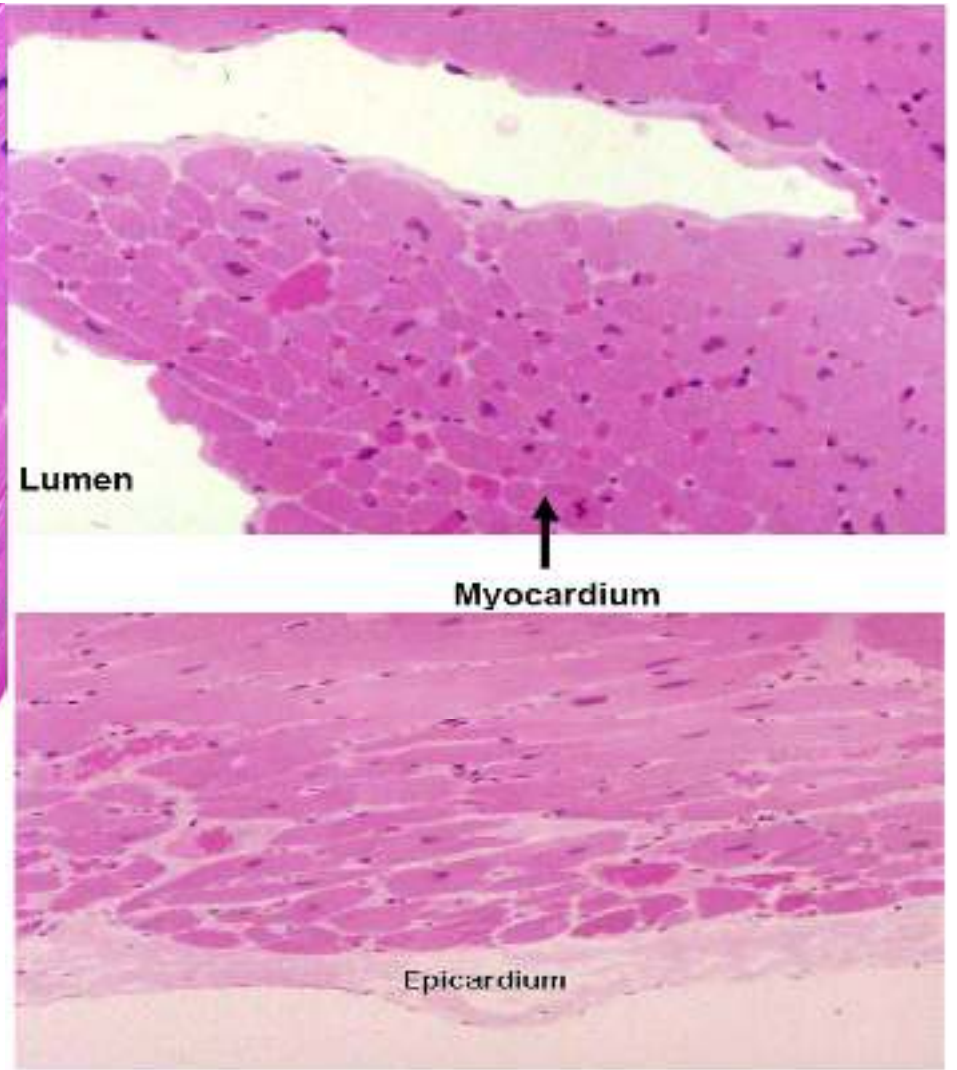
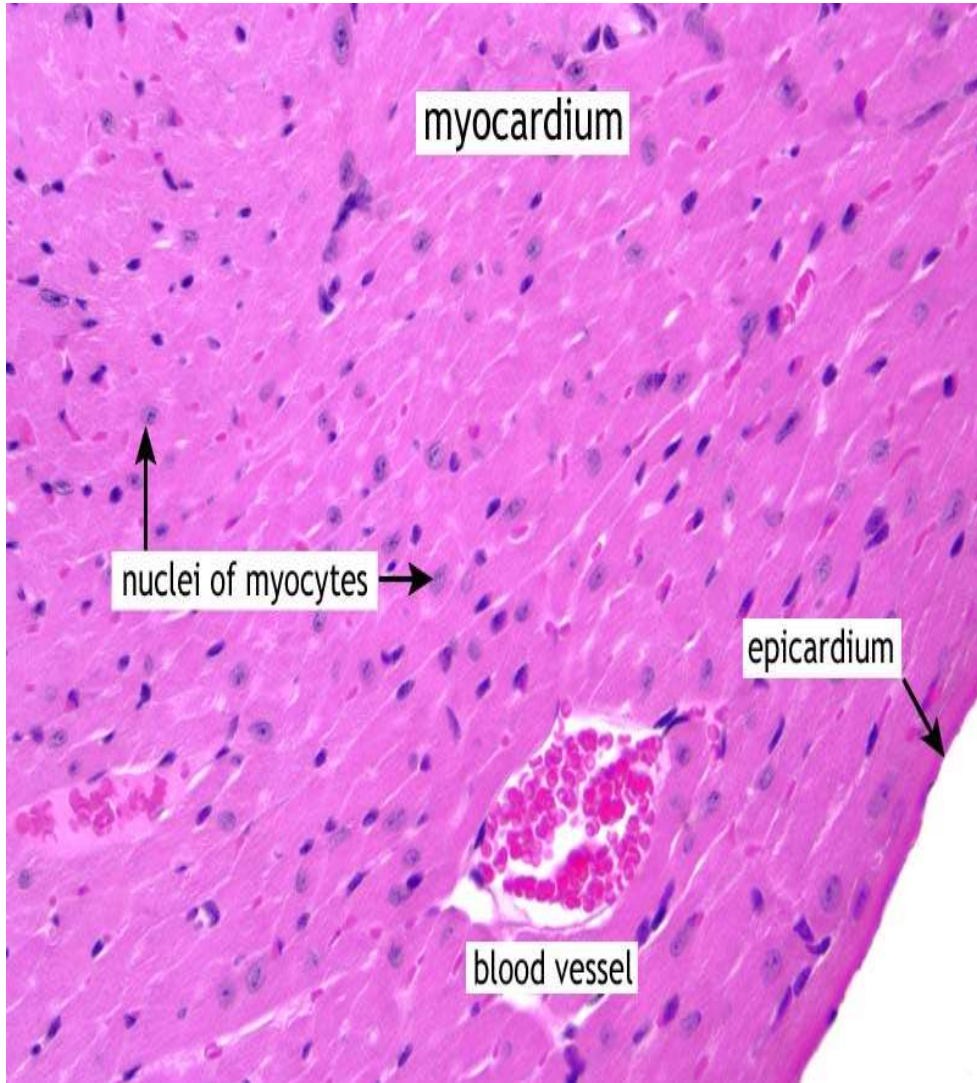
Microscopic Anatomy of Cardiac Muscle

- Striated muscle but fibres divide and recombine.
- Though each cell is distinct with its own nucleus, the cells are joined end to end by specialised cell junctions called intercalated discs.
- These junctions offer a very weak resistance to electrical flow and thus the heart muscle acts as a syncytium.
- In contrast with skeletal muscle, the heart muscle tissue can contract without a nervous stimulation.

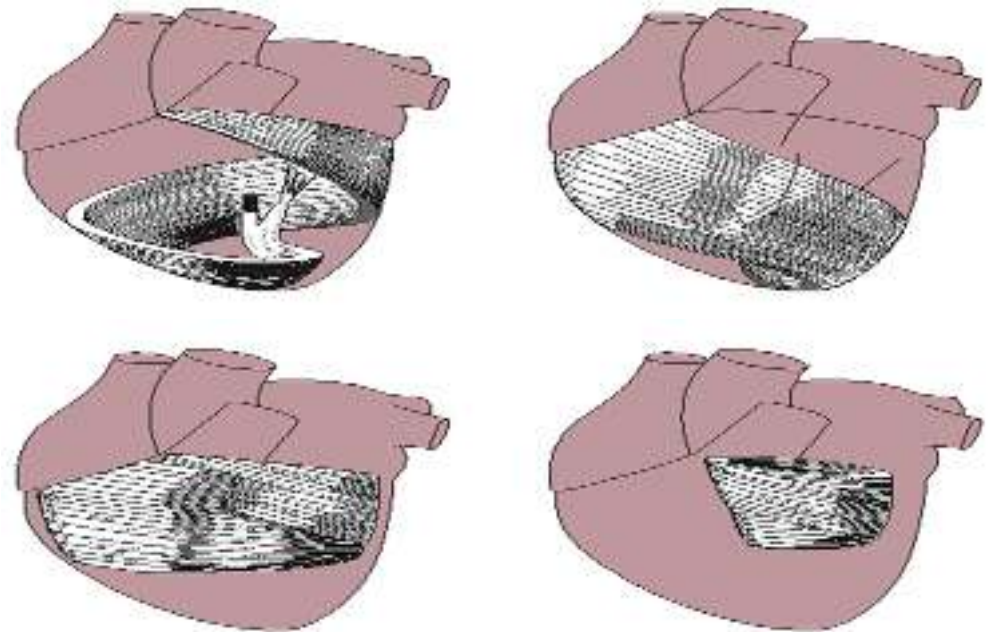
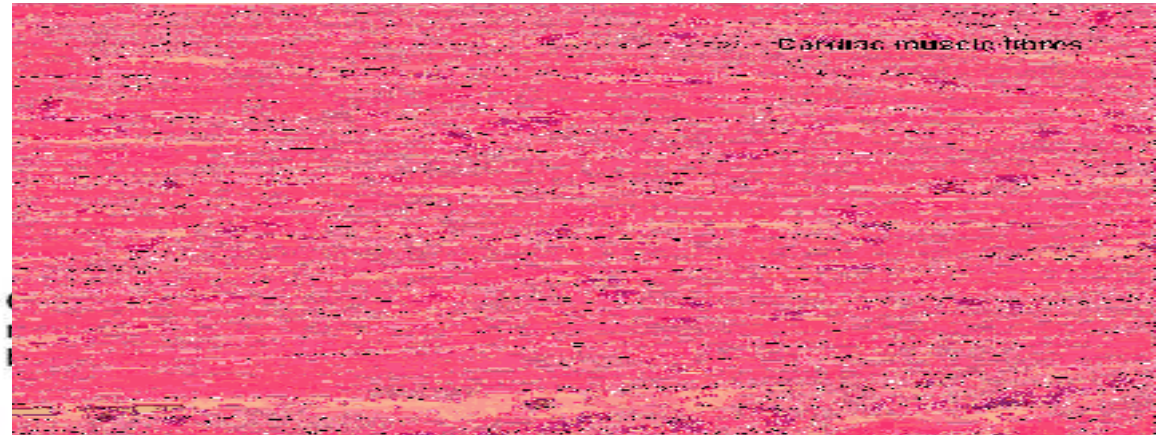
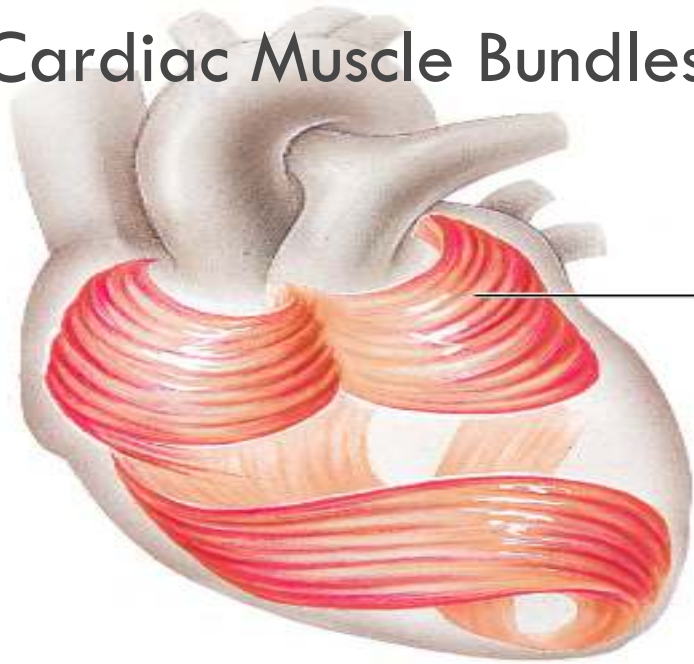


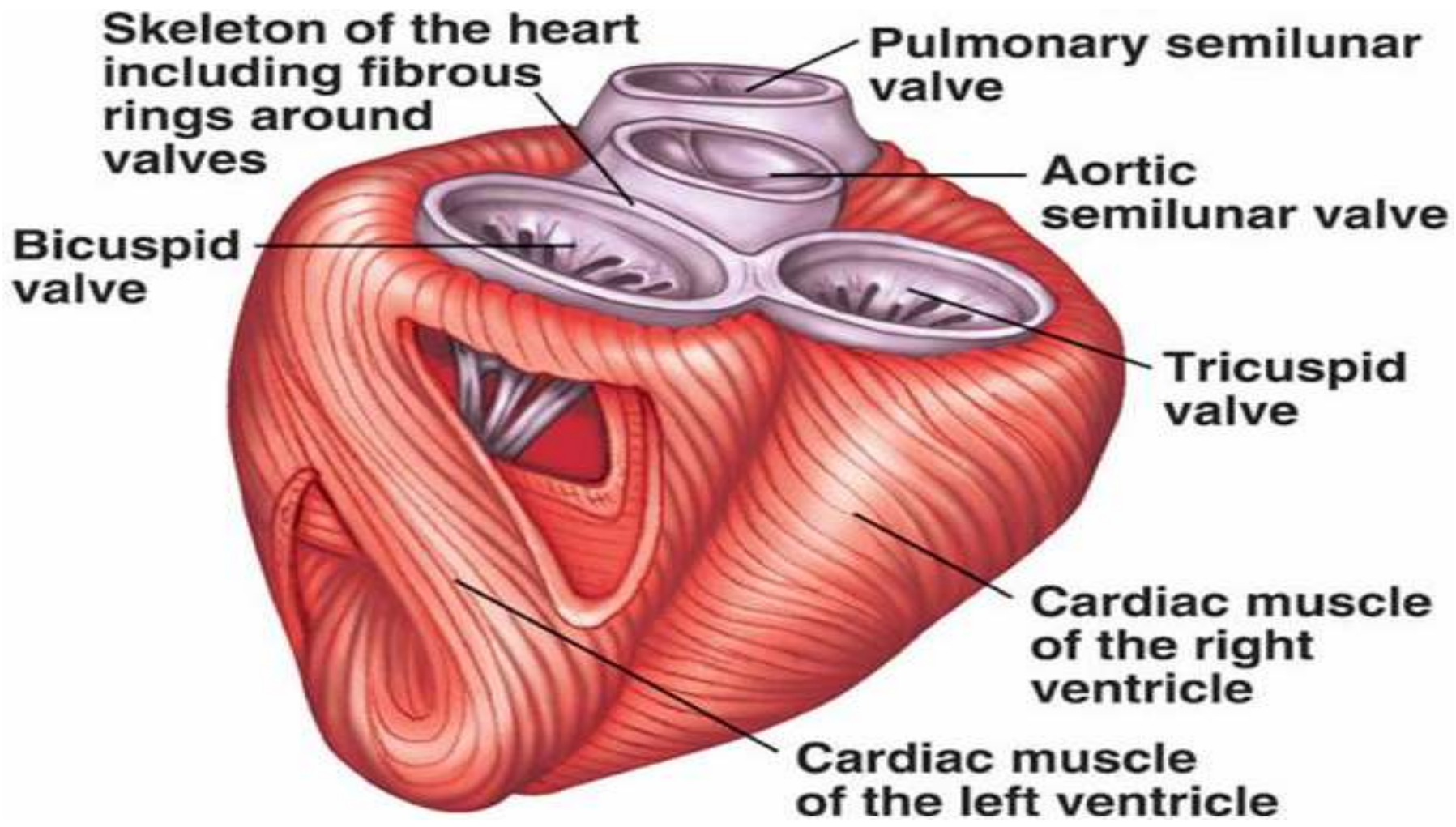
Cardiac Muscle H&E

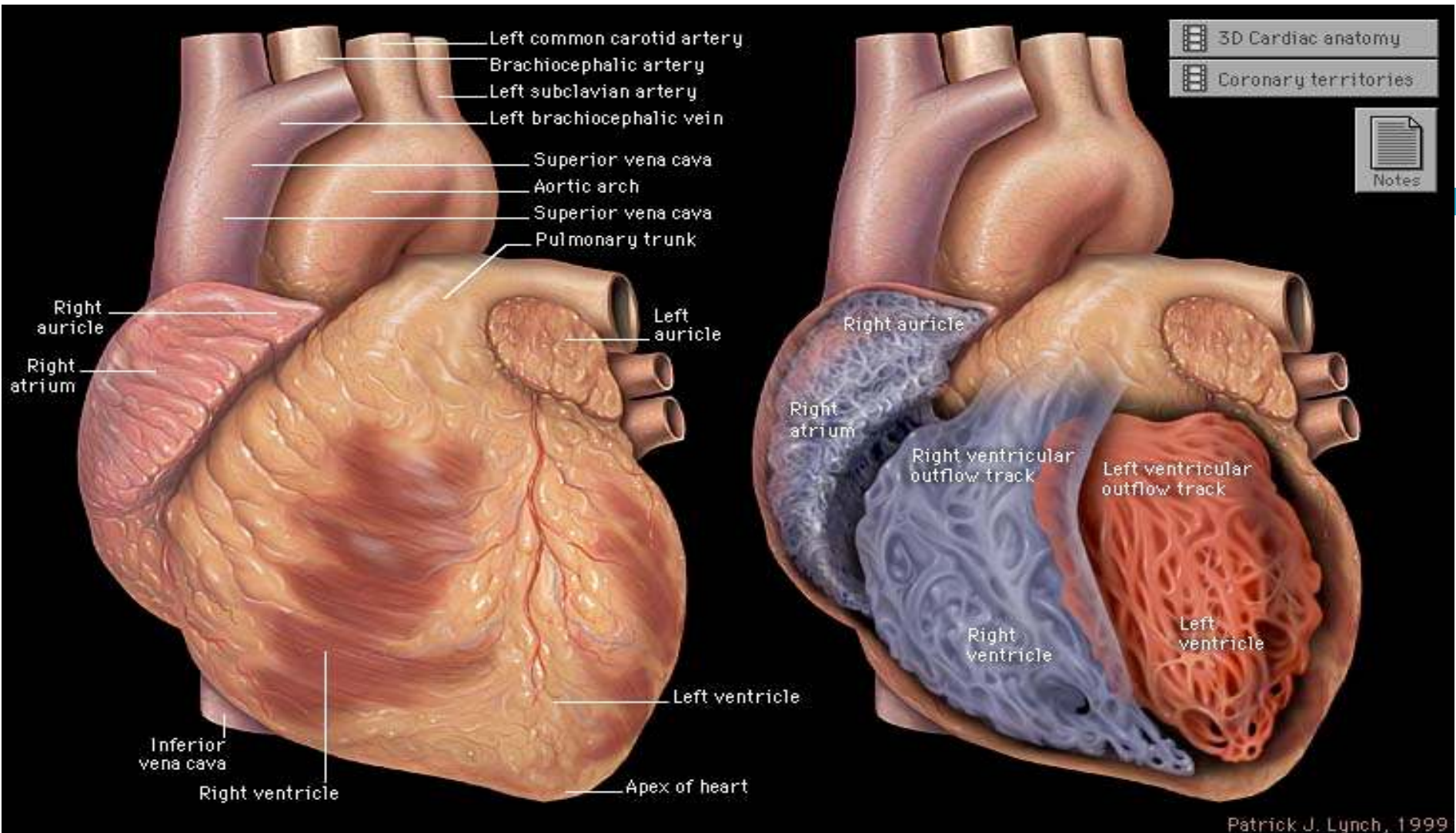




Cardiac Muscle Bundles





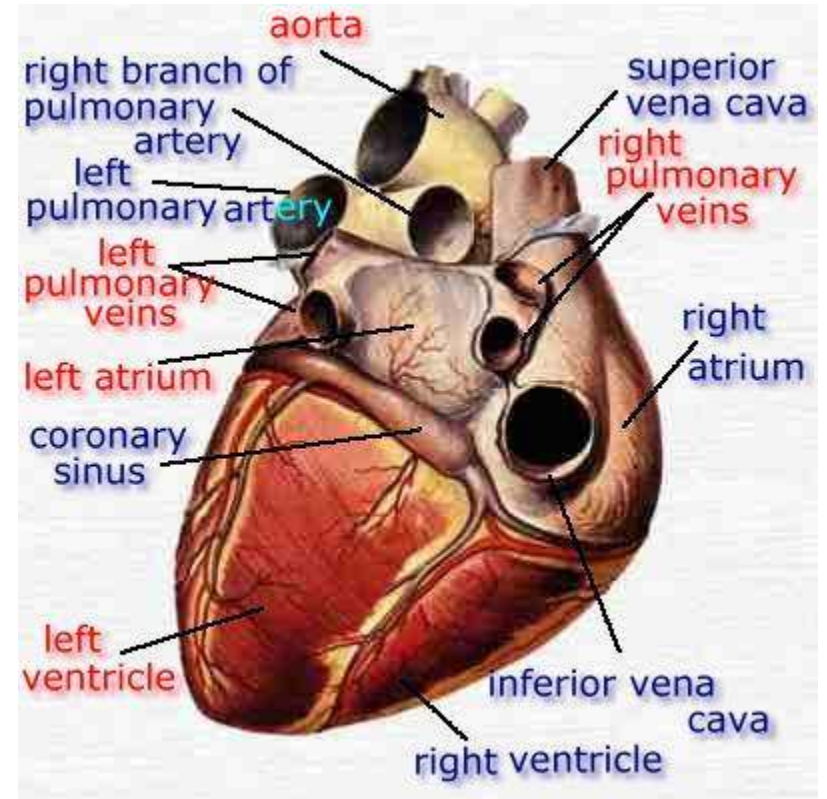


Other differences between cardiac and skeletal muscle tissue

- **Sarcoplasmic Reticulum** is less extensive in cardiac muscle.
- **Calcium sensitivity** of intact cardiac muscle is greater than skeletal muscle.
 - Because of this increased sensitivity, cardiac muscle contraction is longer than skeletal muscle.
- **Cardiac muscle cannot undergo tetanisation.**
 - This occurs as the **absolute refractory period in the cardiac muscle cell is longer than for skeletal muscle.**
 - In fact absolute refractory period is almost as long as the contraction period - 200 msec.
- **Cardiac muscle resists wear and tear** better than skeletal muscle.
 - This is important as cardiac muscle contracts some 100,000 times/day (in 70 years this totals to 2.5 billion times).
- Cardiac muscle is **very susceptible to oxygen lack** - can withstand not more than 30secs without oxygen before they stop working.
- The cardiac muscle as a whole, and not only the single muscle fibre, obeys the all or none rule i.e.
 - **if one muscle cell in the syncytium contracts, the rest contract at the same time.**

External Heart: Major Vessels of the Heart (Anterior View)

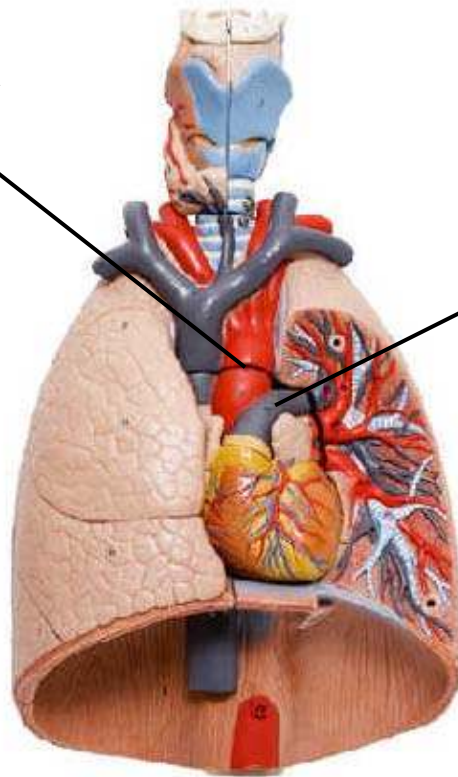
- **Vessels returning blood** to the heart include:
 - ▣ Superior and inferior venae cavae
 - ▣ Right and left pulmonary veins
- **Vessels conveying blood away from the heart:**
 - ▣ Pulmonary trunk, which splits into right and left pulmonary arteries
 - ▣ Ascending aorta (three branches) – brachiocephalic, left common carotid, and subclavian arteries



Thorax

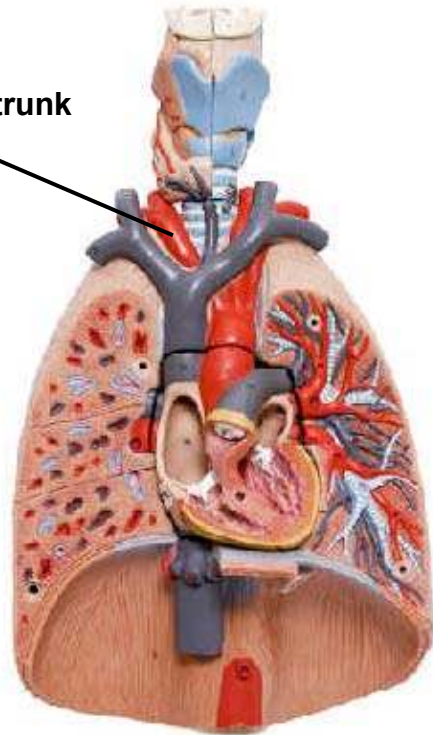
Ascending aorta

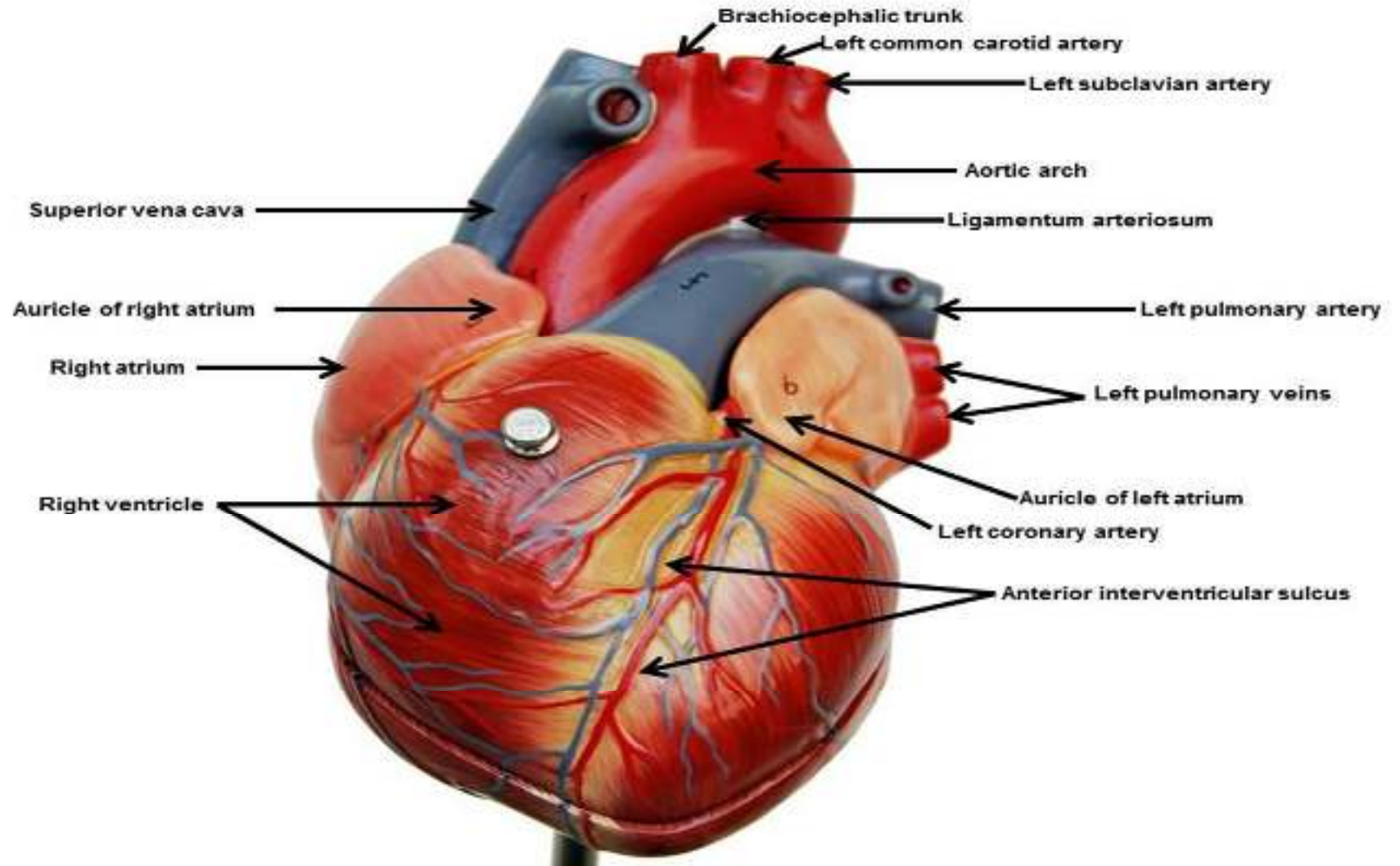
Pulmonary trunk



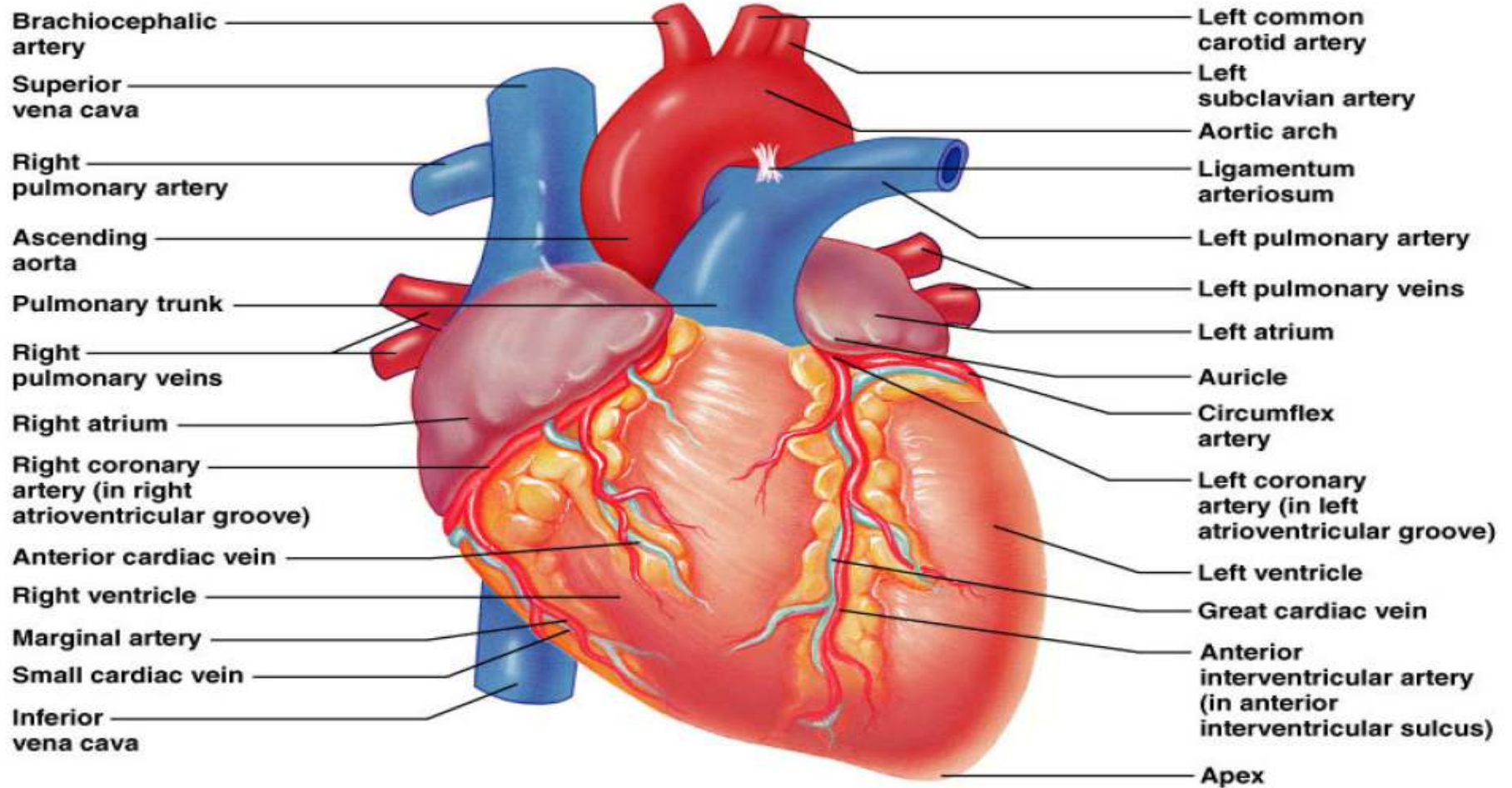
Thorax

Brachiocephalic trunk

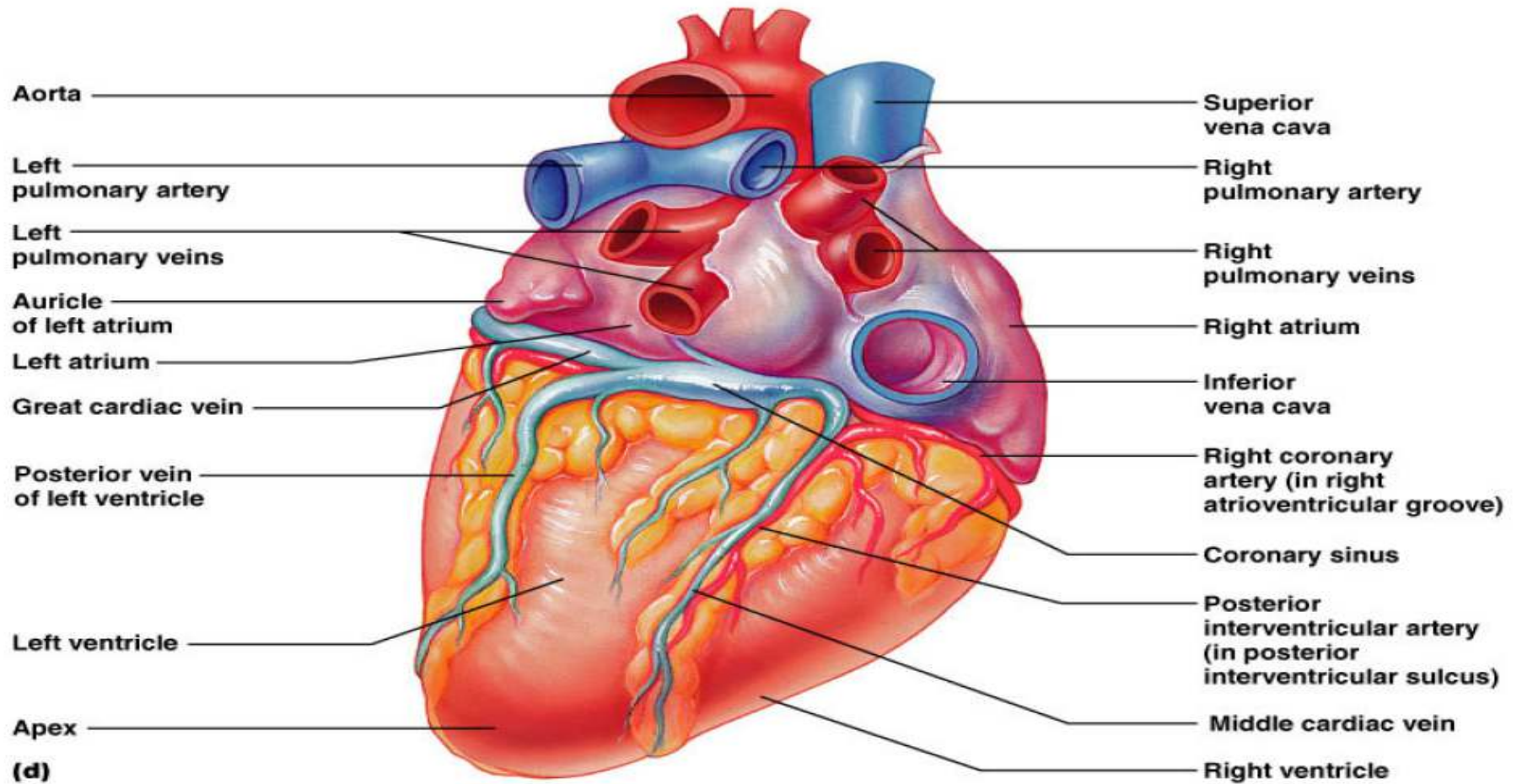




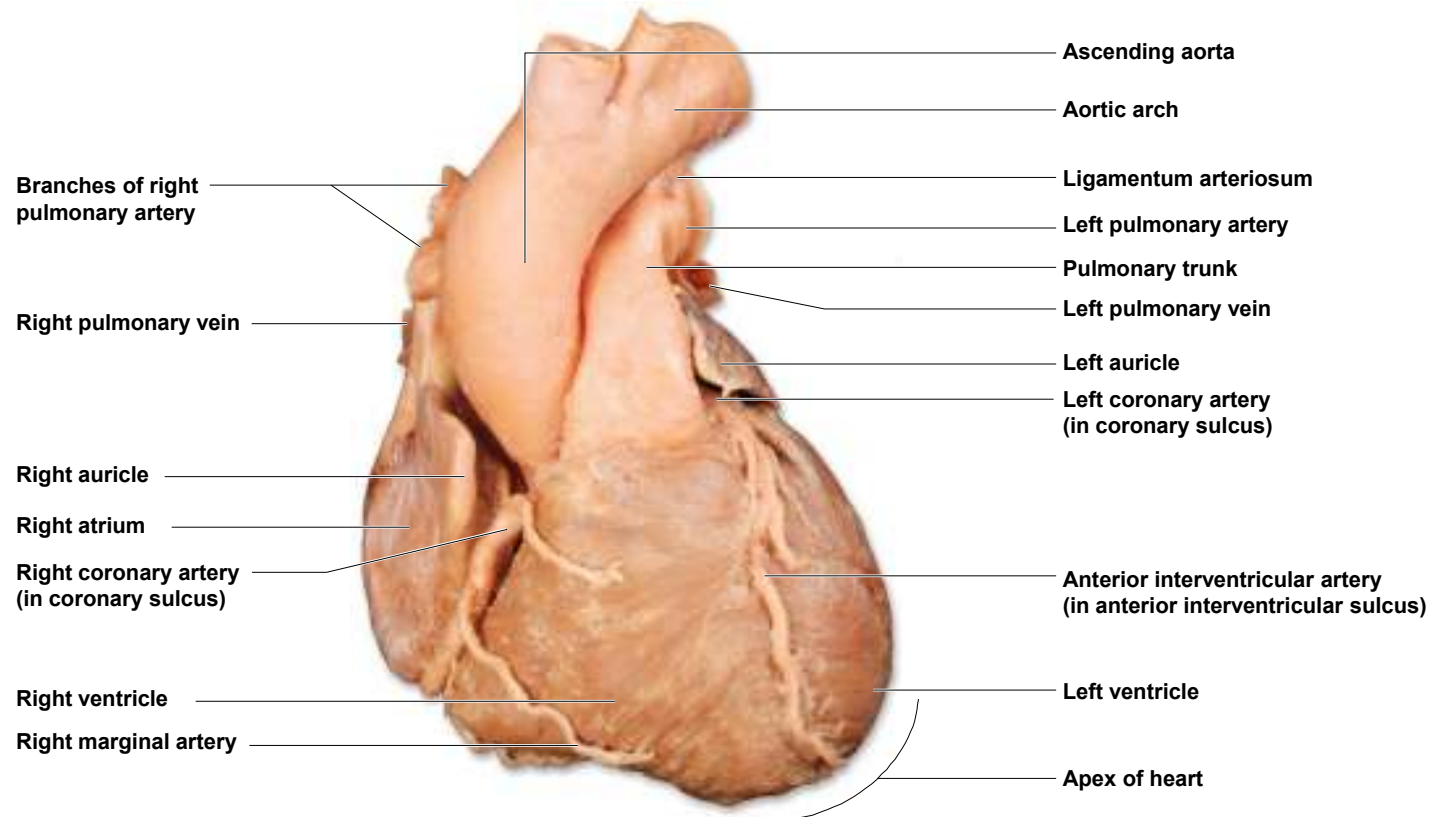
Heart



Heart



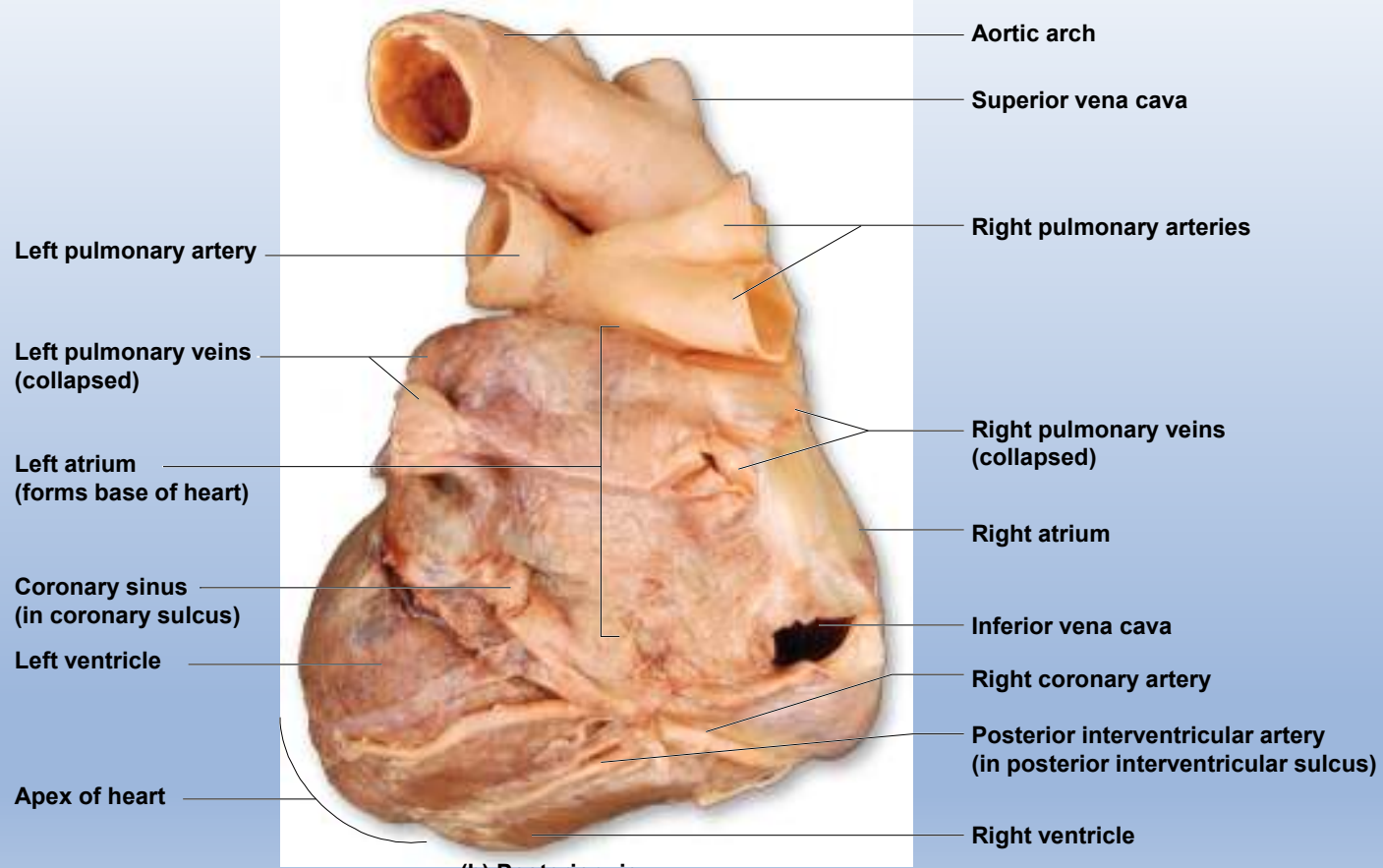
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(a) Anterior view

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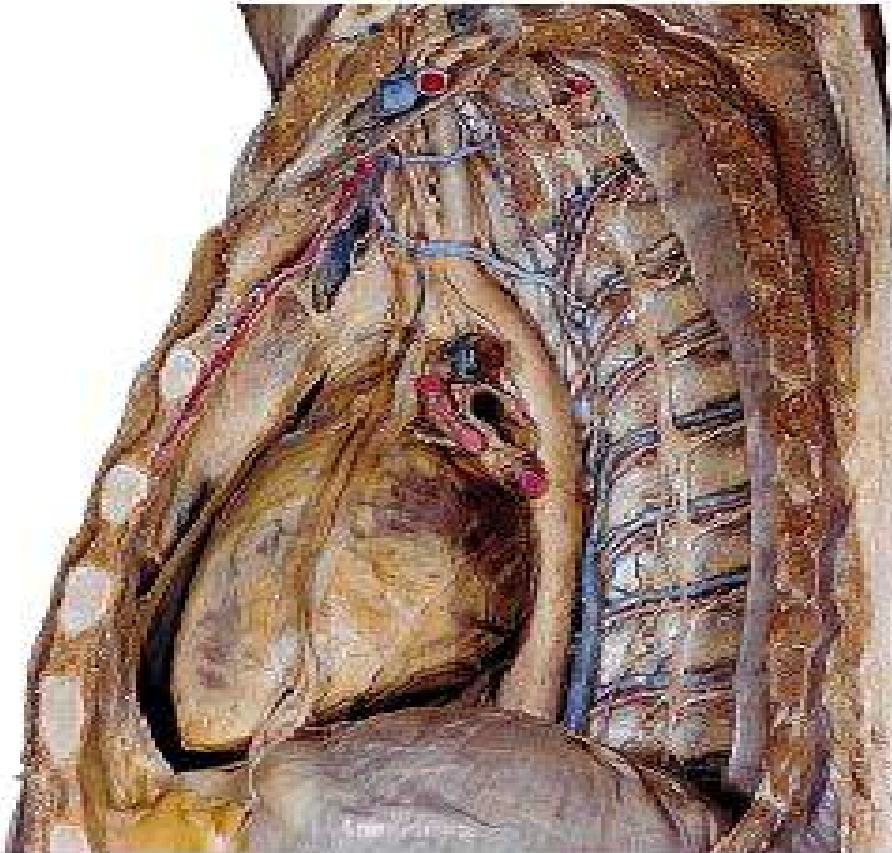
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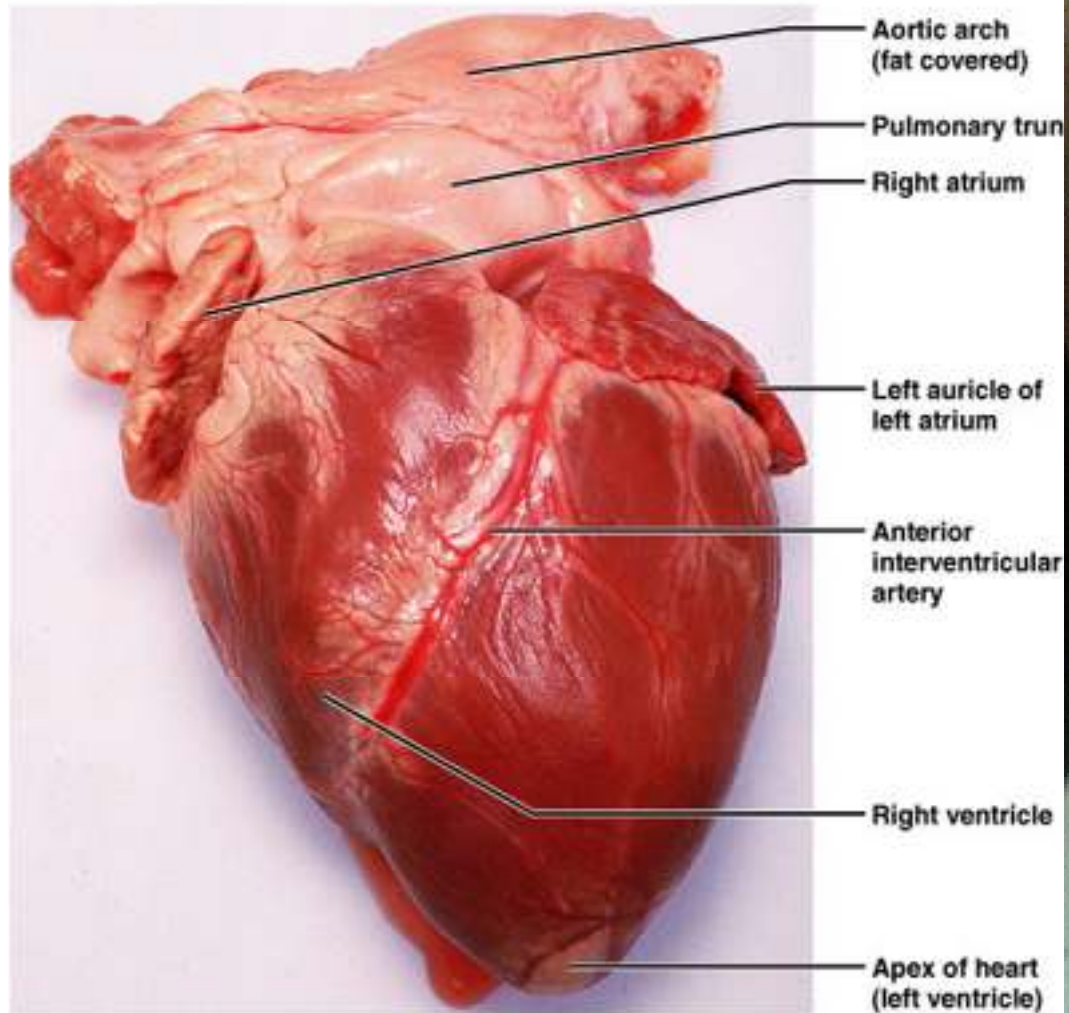
(b) Posterior view

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LEFT MEDIASTINAL VIEW OF THE HEART

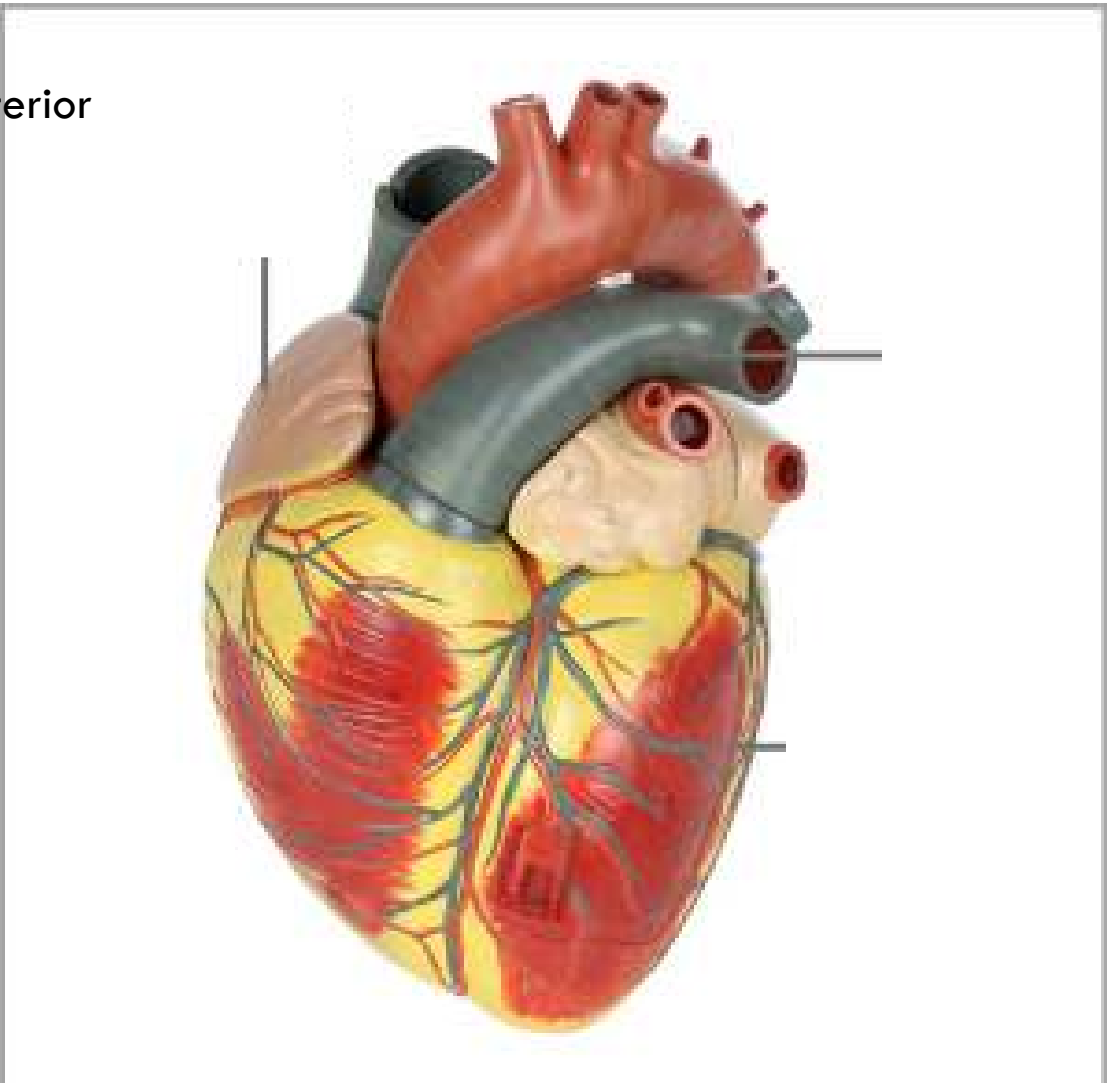


The heart is tipped to the left, resting obliquely in the chest immediately above the diaphragm. In the adult, the muscular tip or apex is located between the 5th and 6th ribs approximately 3 1/2 inches from the mid sternum.

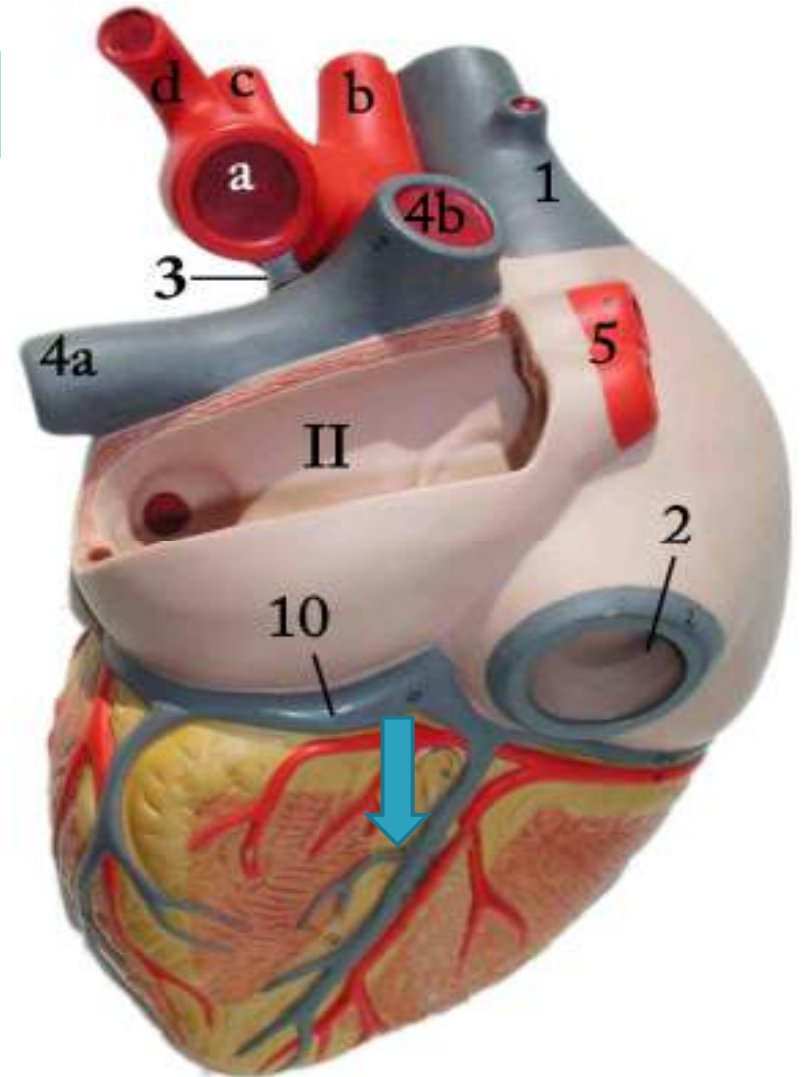
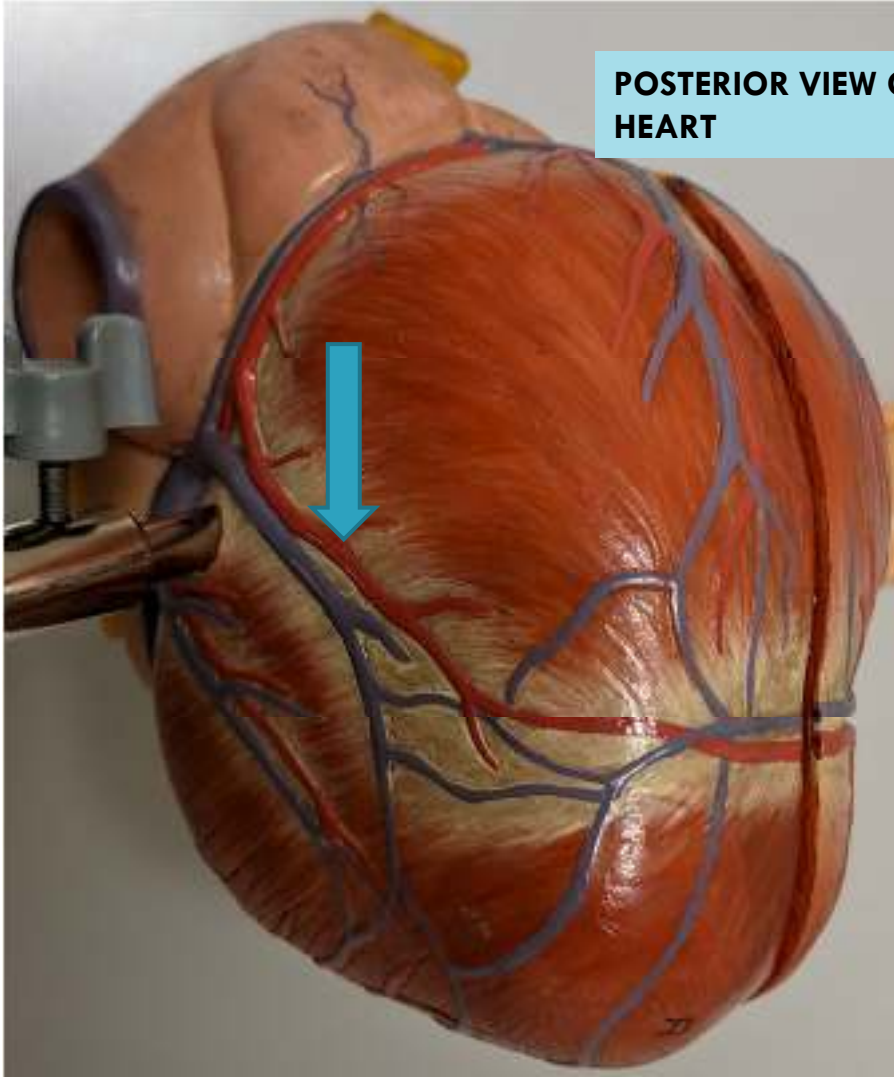


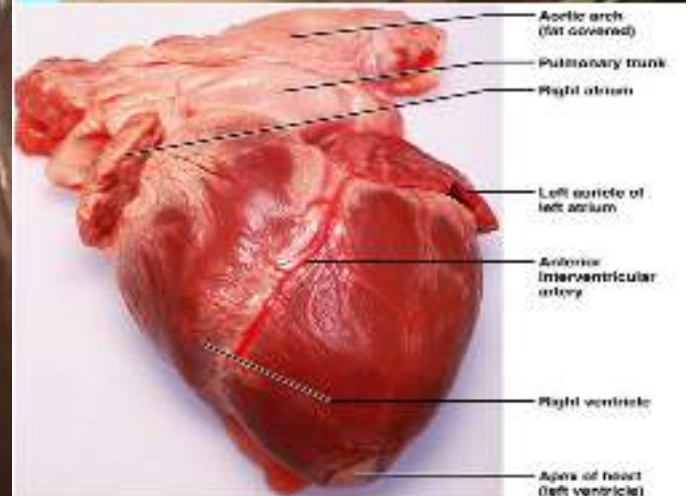
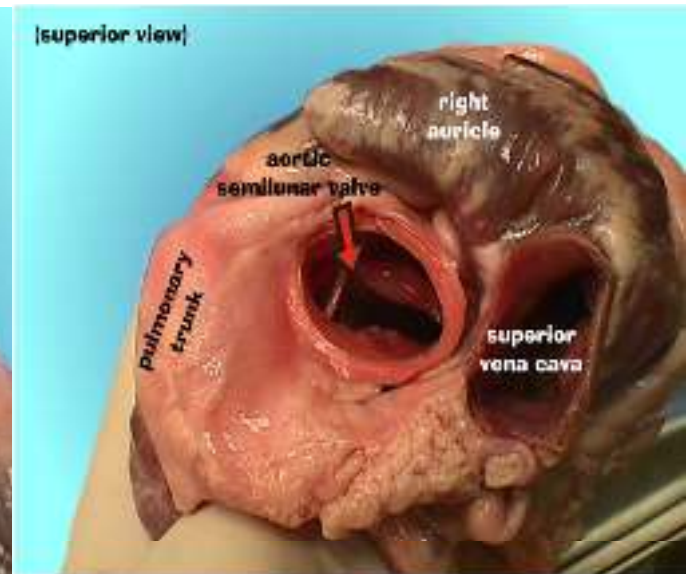
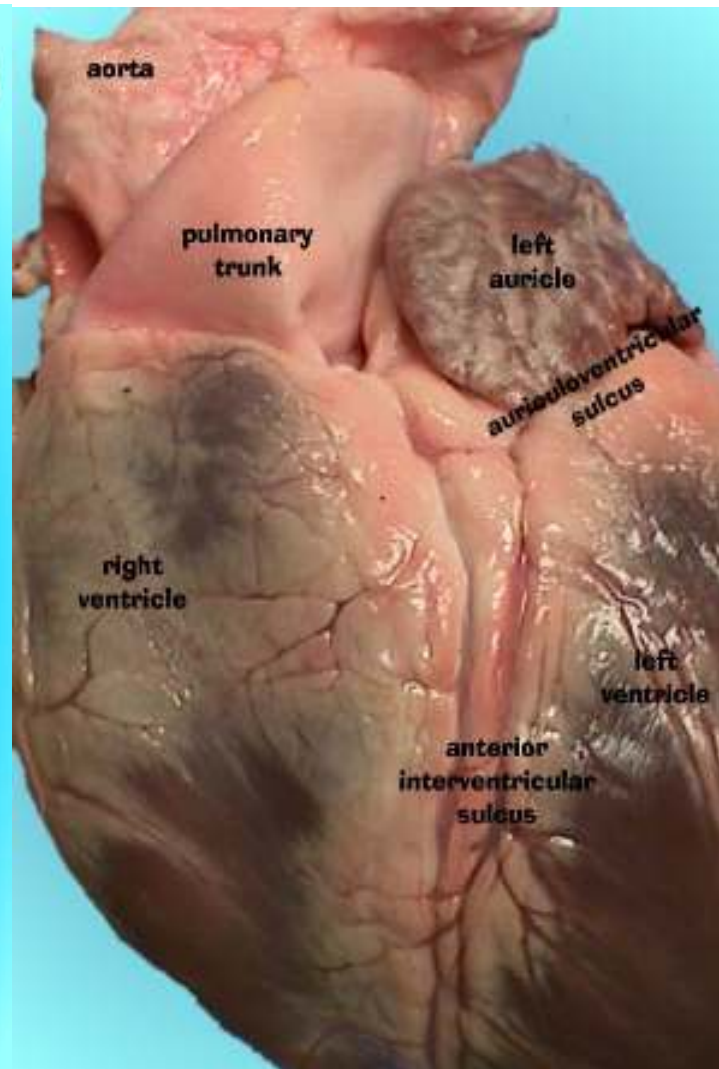
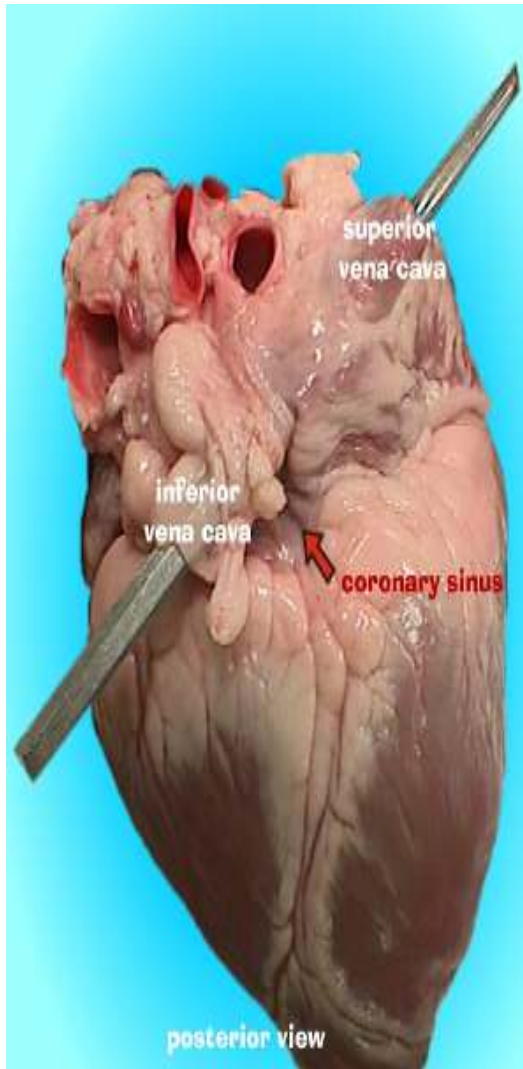


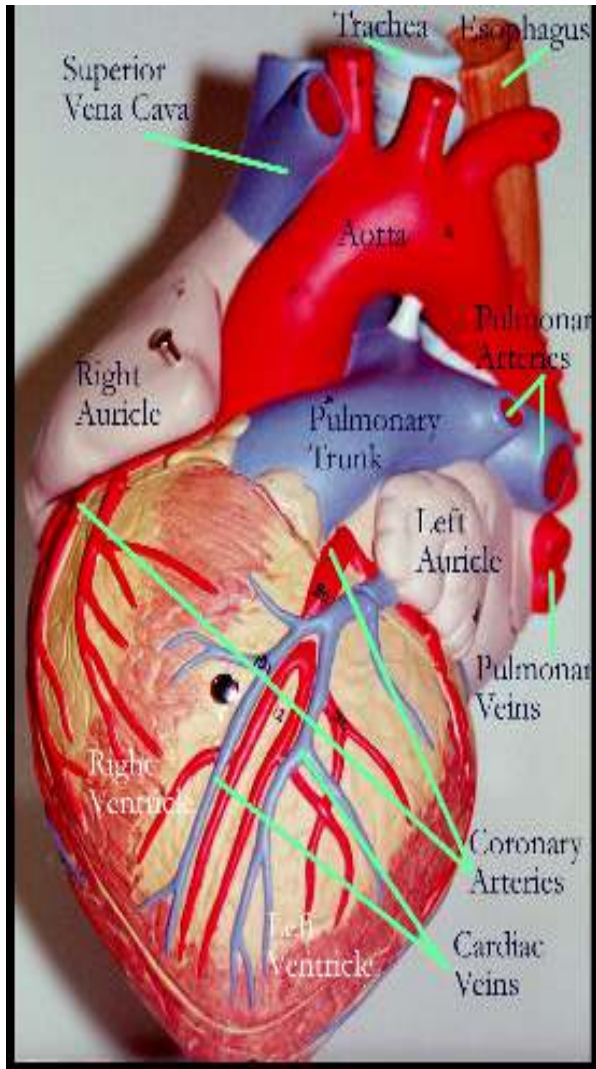
Posterior



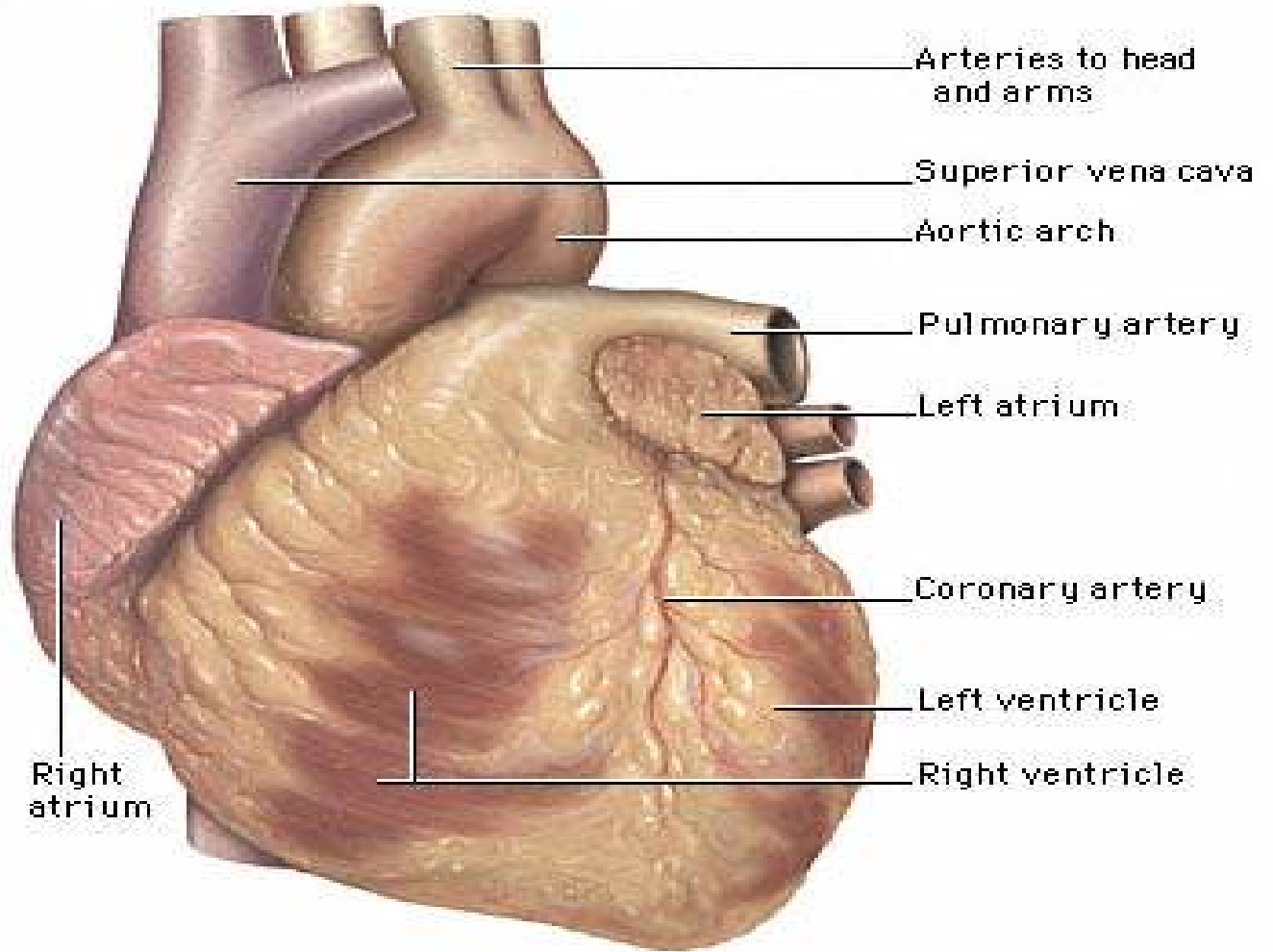
POSTERIOR VIEW OF THE HEART

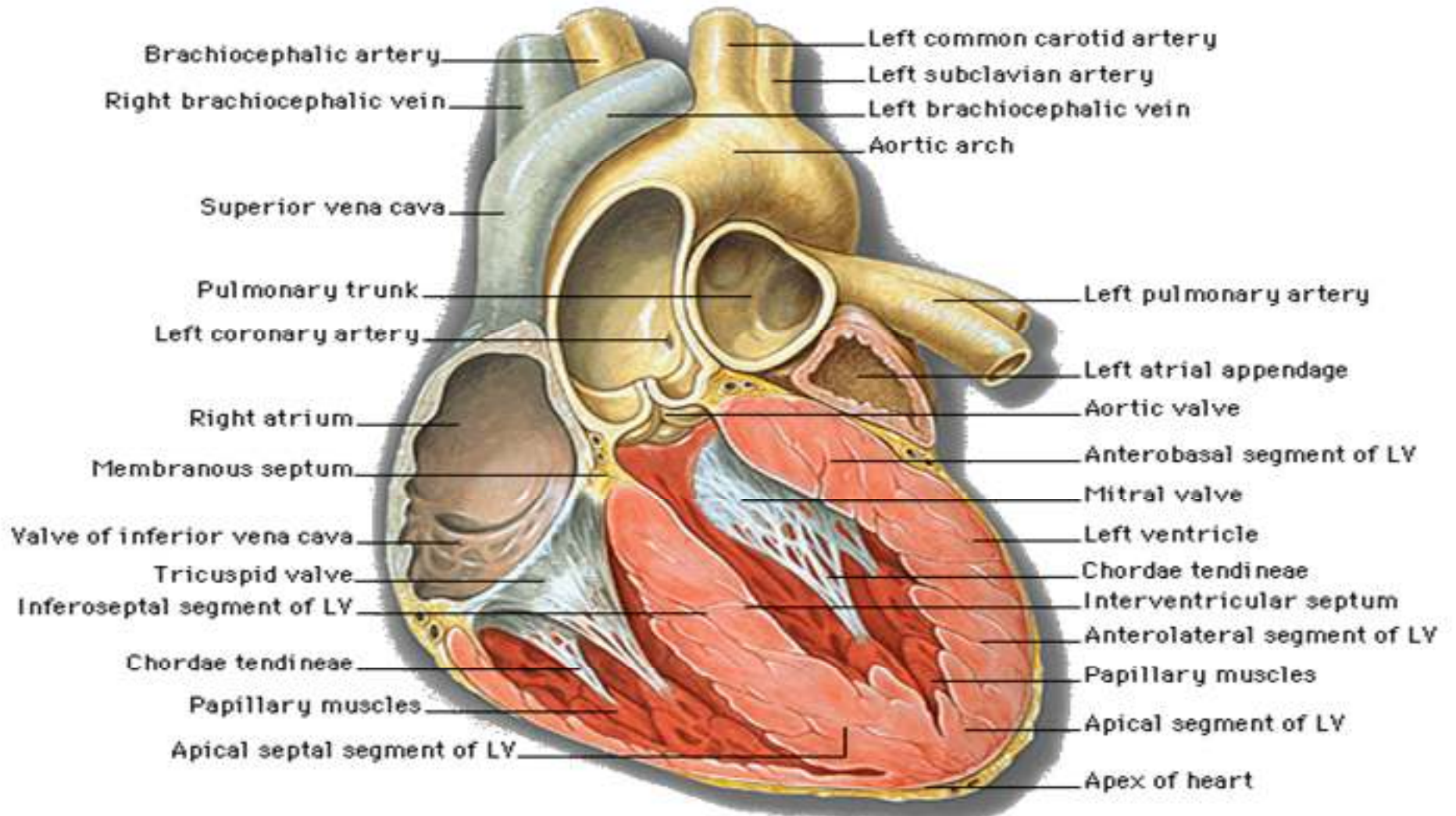






Exterior structures of the heart





Internal Heart – Right Side

Superior Vena Cava

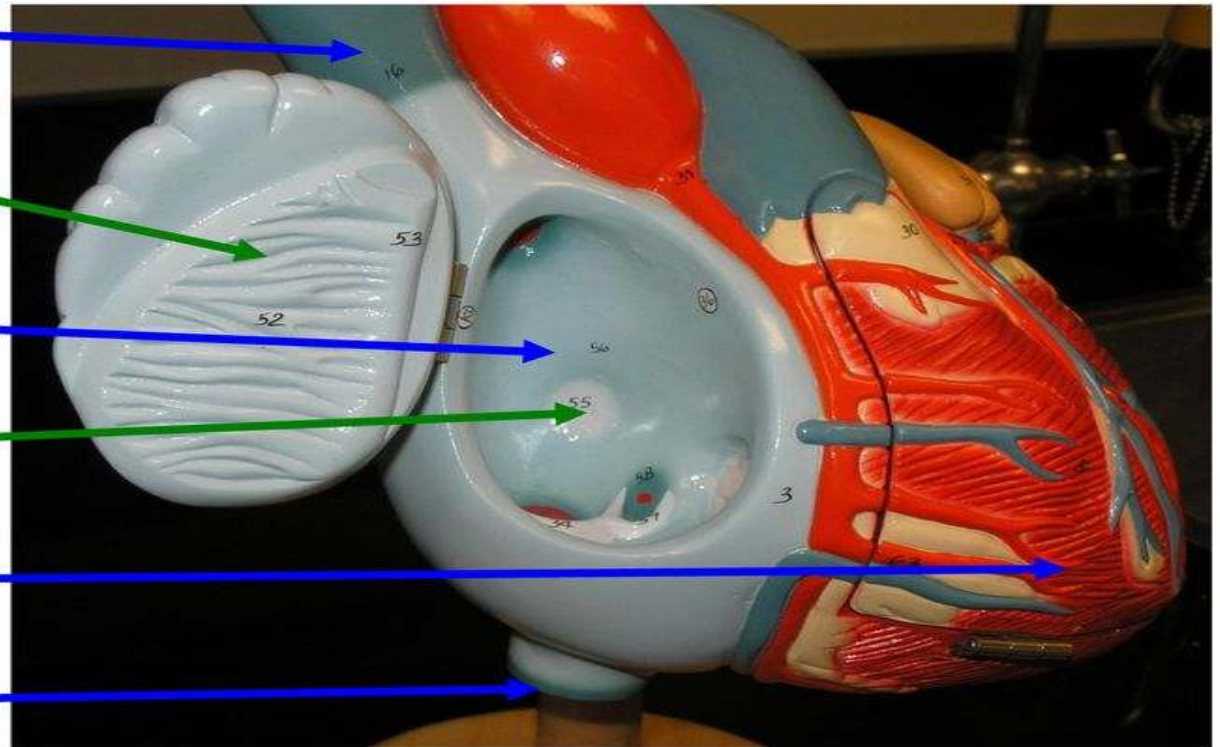
Pectinate muscles
Ridges of muscles on the wall of
the ANTERIOR Atria

Right Atrium

Fossa Ovalis

Right Ventricle

Inferior Vena Cava



Right Auricle

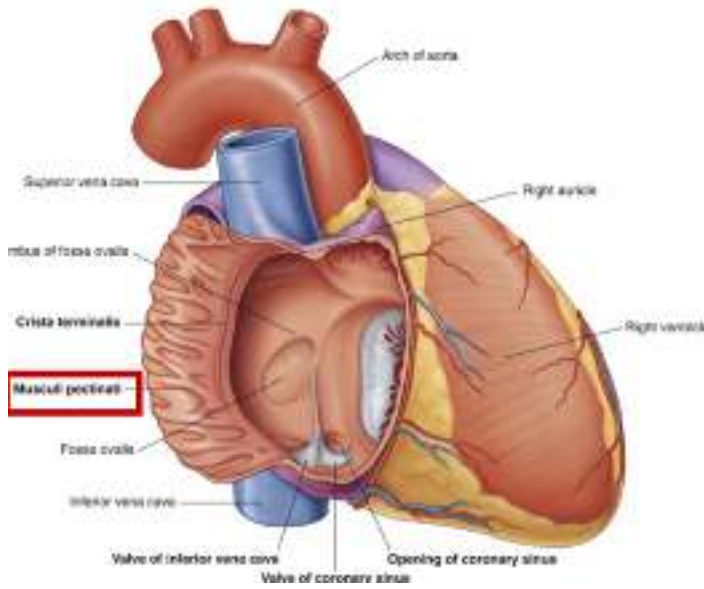
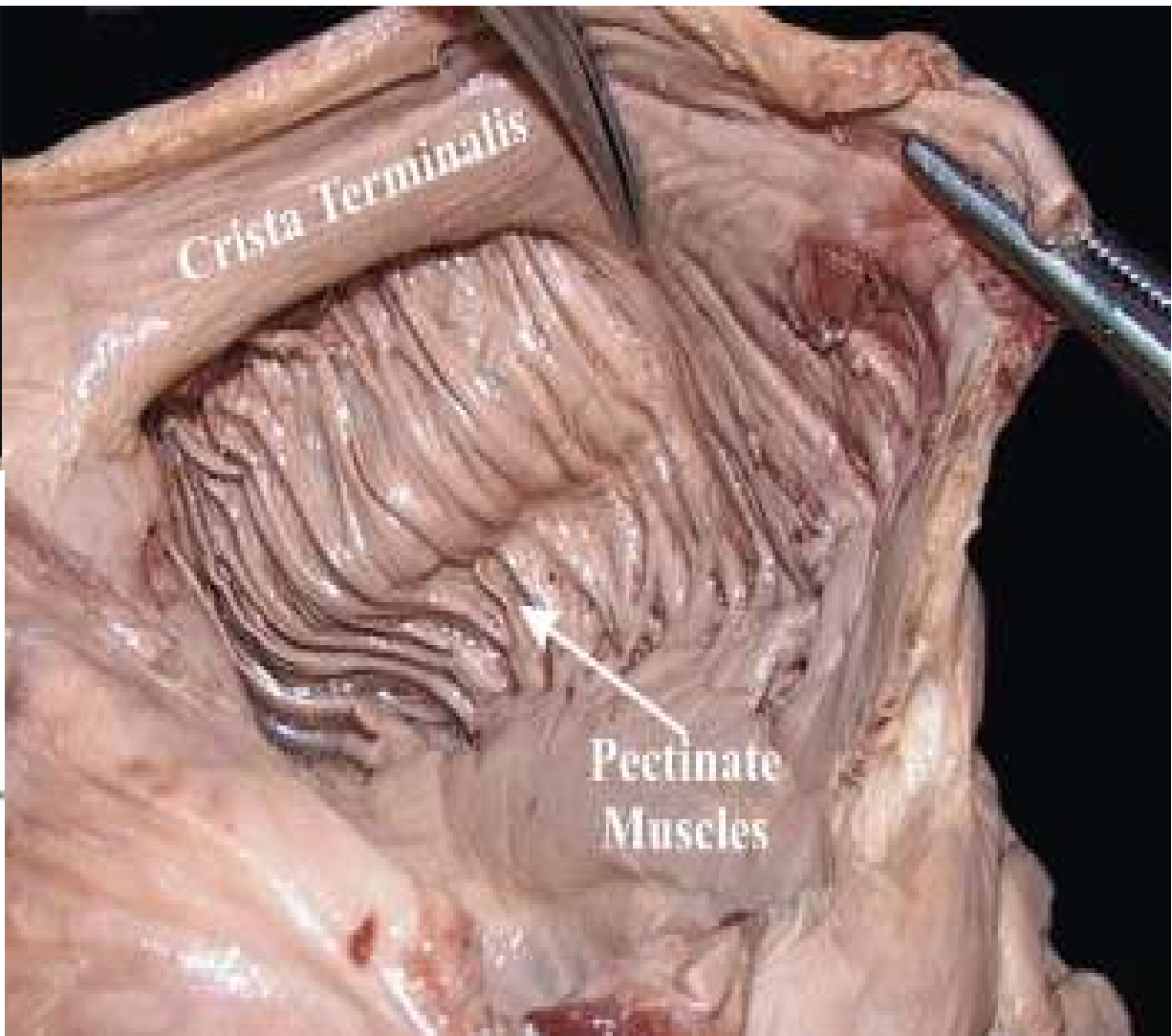
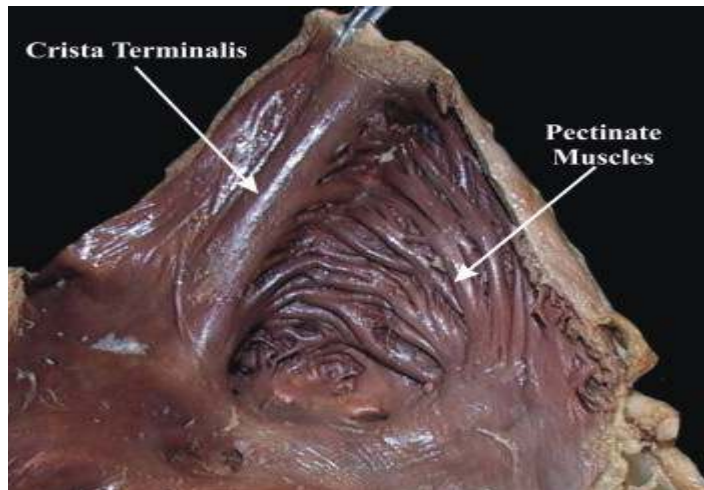


The right appendage is generally triangular in shape in the human heart and may be larger or smaller than the left auricle appendage

left Auricle

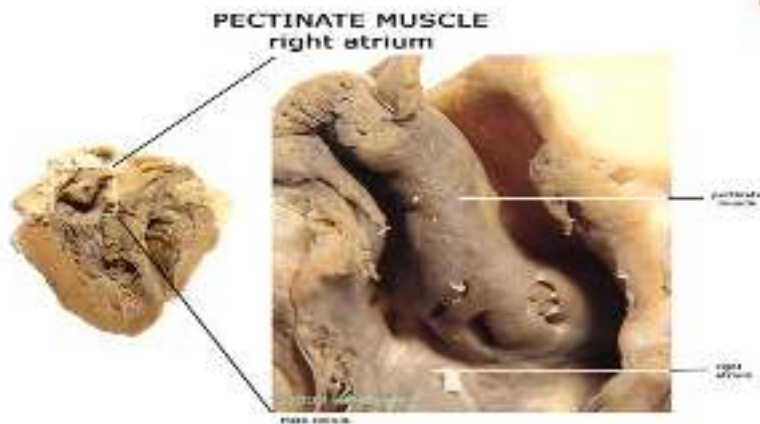


The left appendage is generally tubular in shape in the human heart and may be larger or smaller than the right atrial appendage

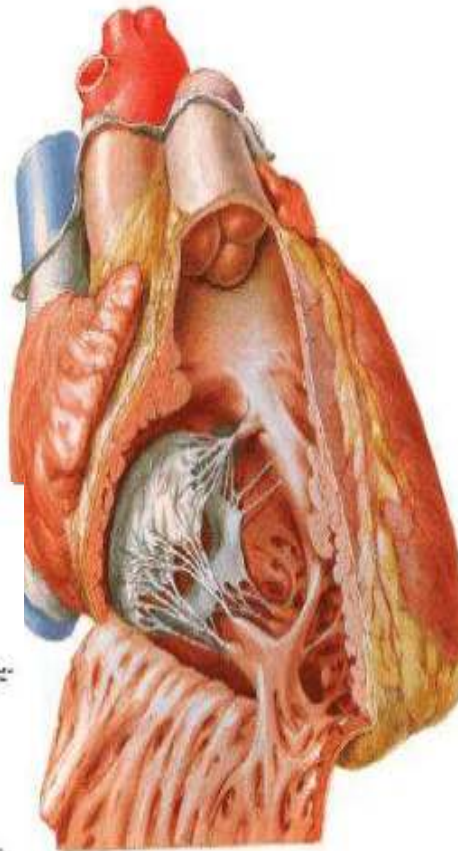


Atria of the Heart

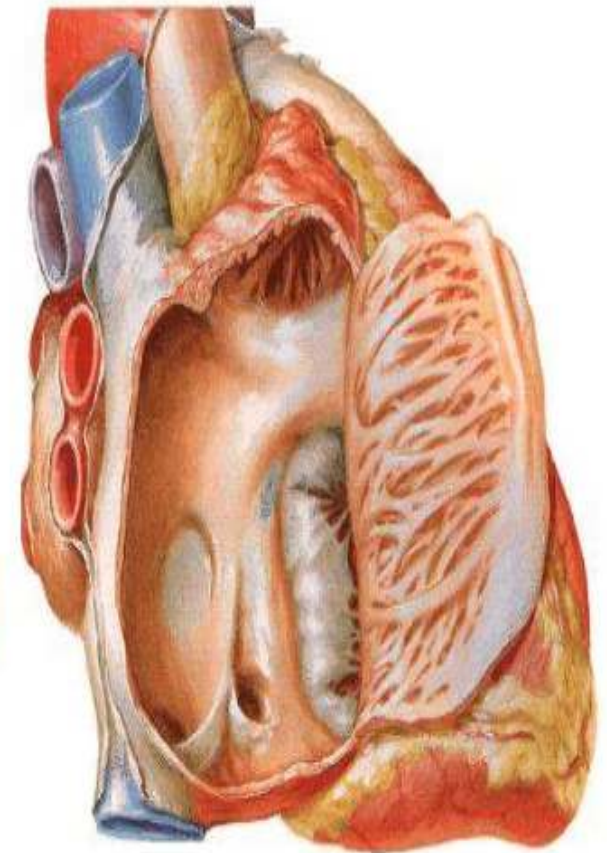
- Atria are the **receiving** chambers of the heart
- Each atrium has a protruding auricle
- **Pectinate muscles** mark atrial walls
- **Blood enters right atria from superior and inferior venae cavae and coronary sinus**
- **Blood enters left atria from pulmonary veins**



Opened Right Ventricle
Anterior View

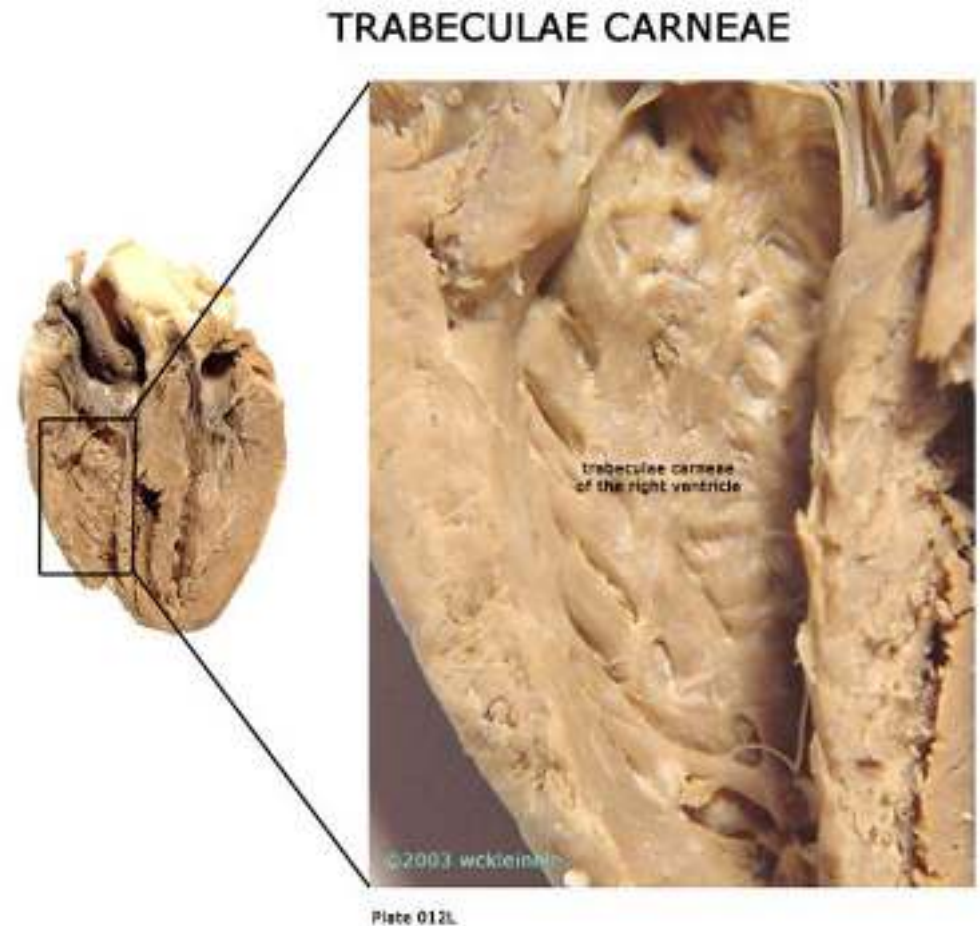


Opened Right Atrium
Right Lateral View



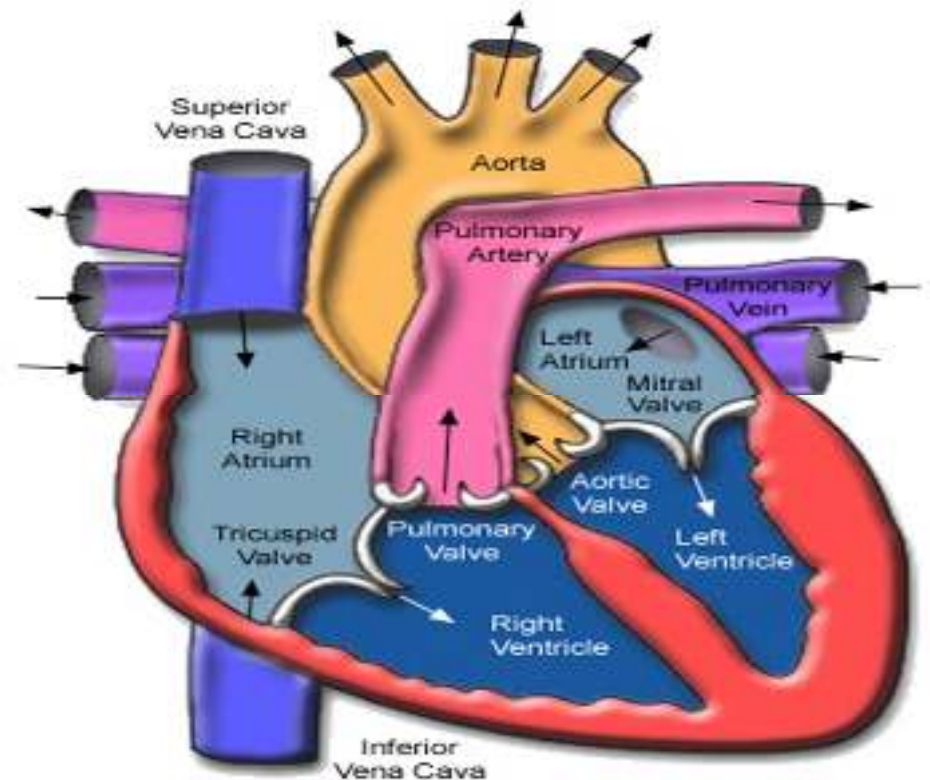
- Ventricles are the discharging chambers of the heart
- **Papillary muscles and trabeculae carnae muscles mark ventricular walls**
- **Right ventricle pumps blood into the pulmonary trunk**
- **Left ventricle pumps blood into the aorta**

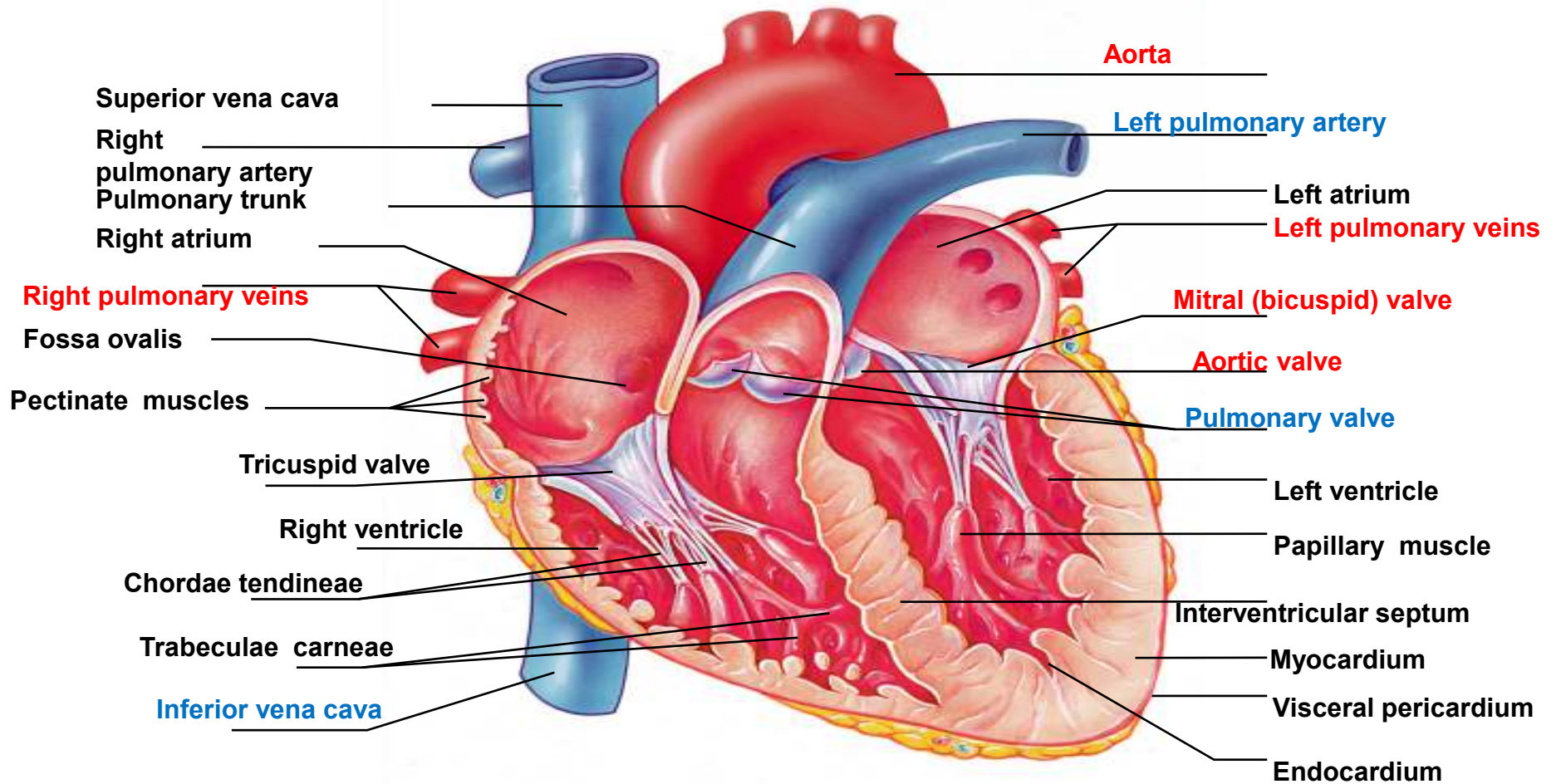
Ventricles of the Heart



External Heart: Major Vessels of the Heart (Posterior View)

- ❑ **Vessels returning blood to the heart include:**
 - ❑ Right and left pulmonary veins
 - ❑ Superior and inferior vena cavae
- ❑ **Vessels conveying blood away from the heart include:**
 - ❑ Aorta
 - ❑ Right and left pulmonary arteries





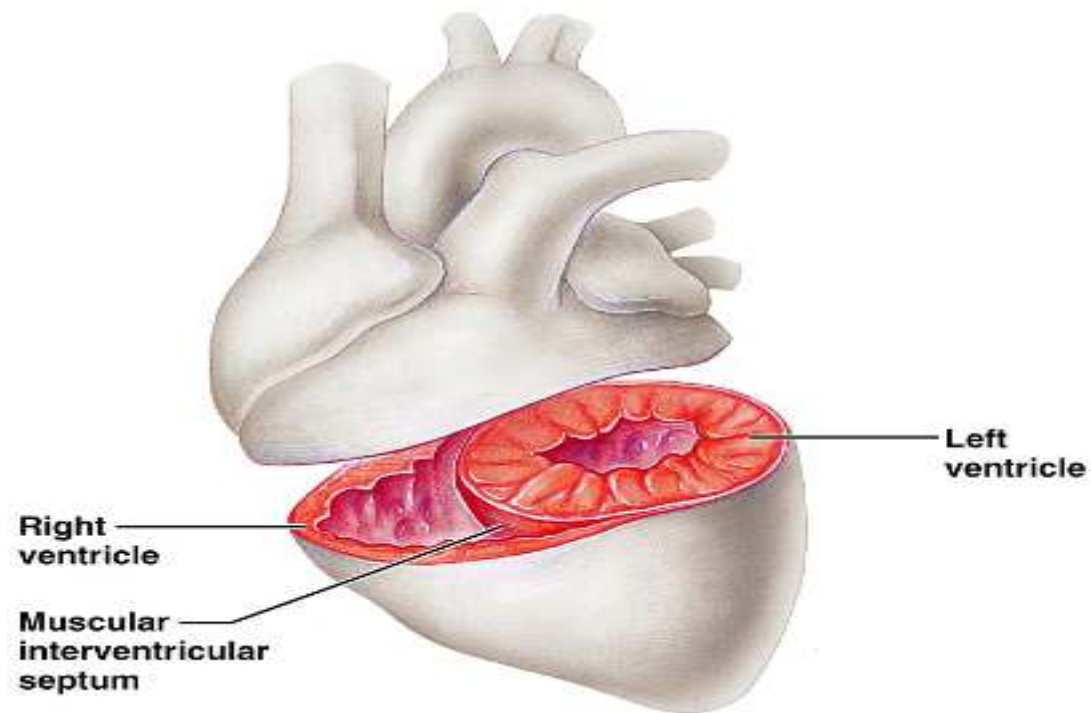
(e)

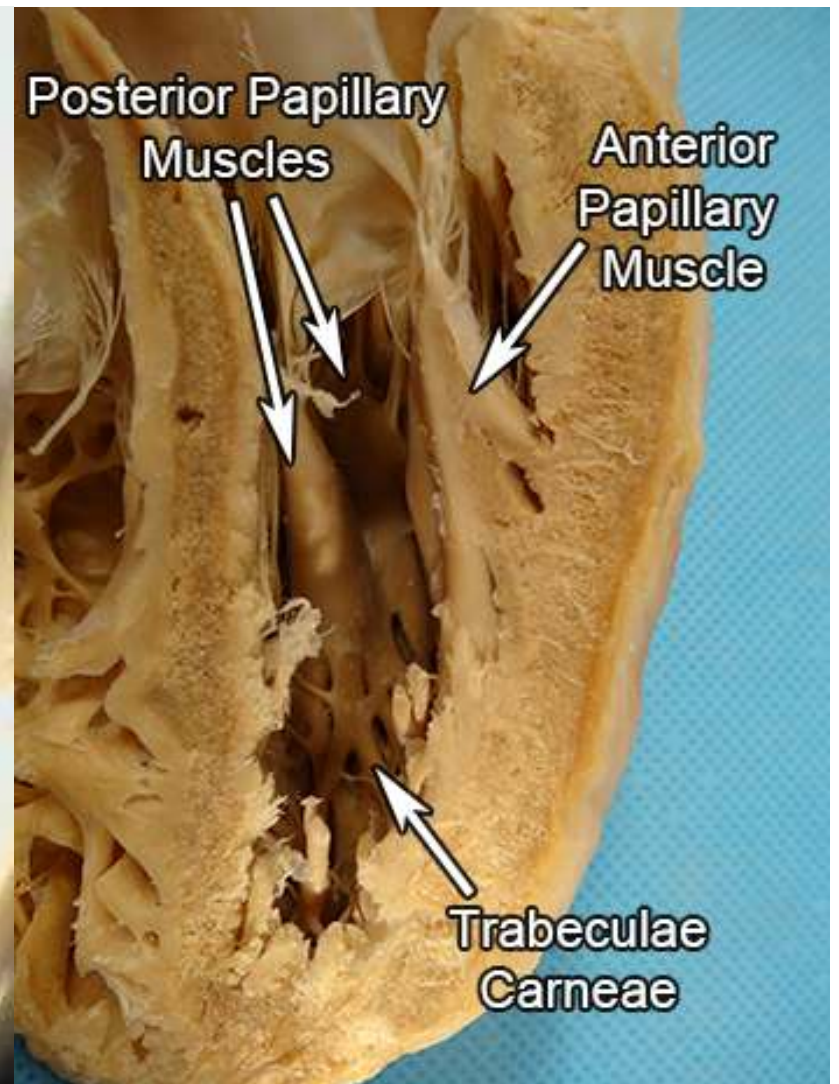
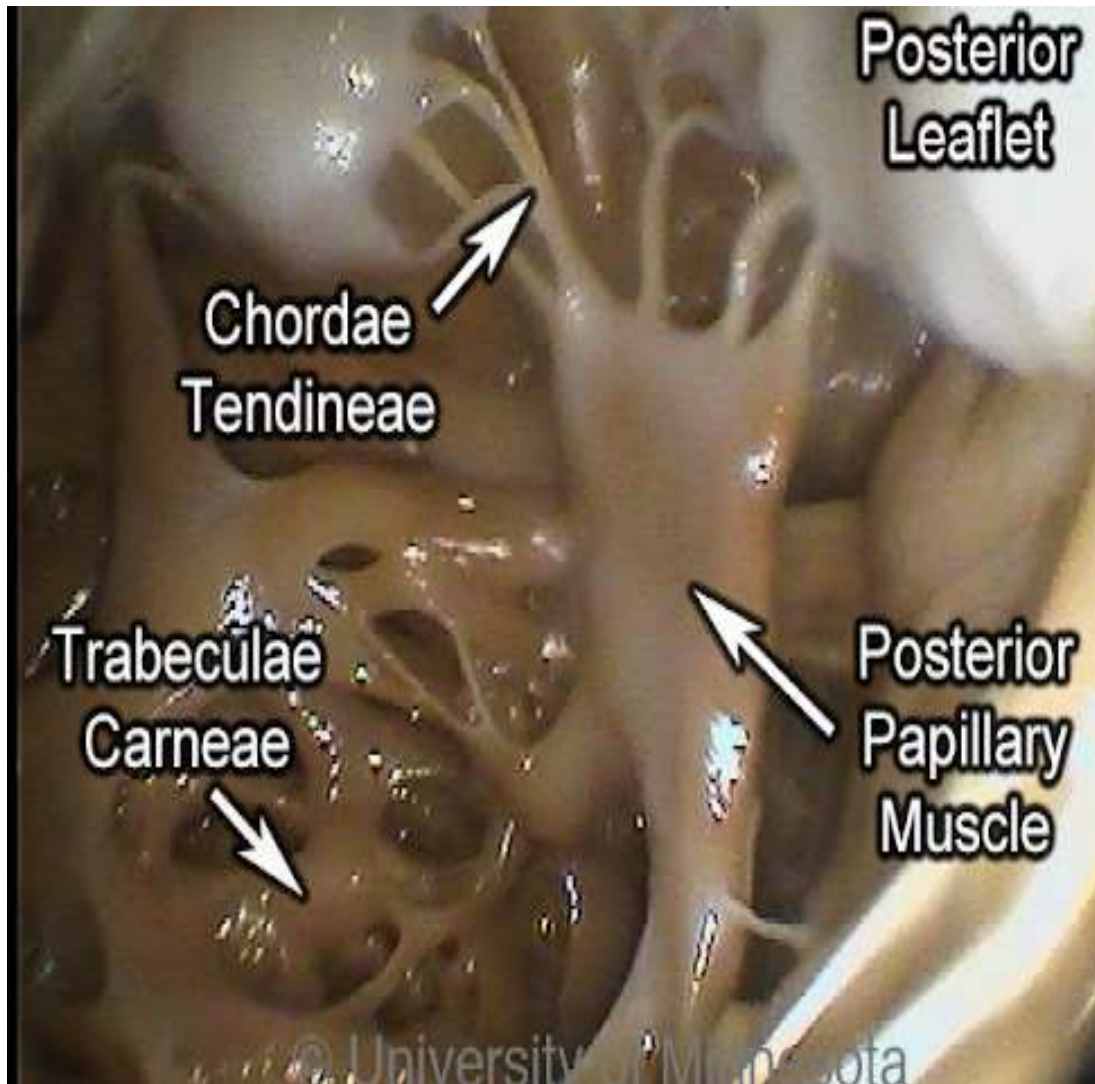
Blood Flow Through the Heart

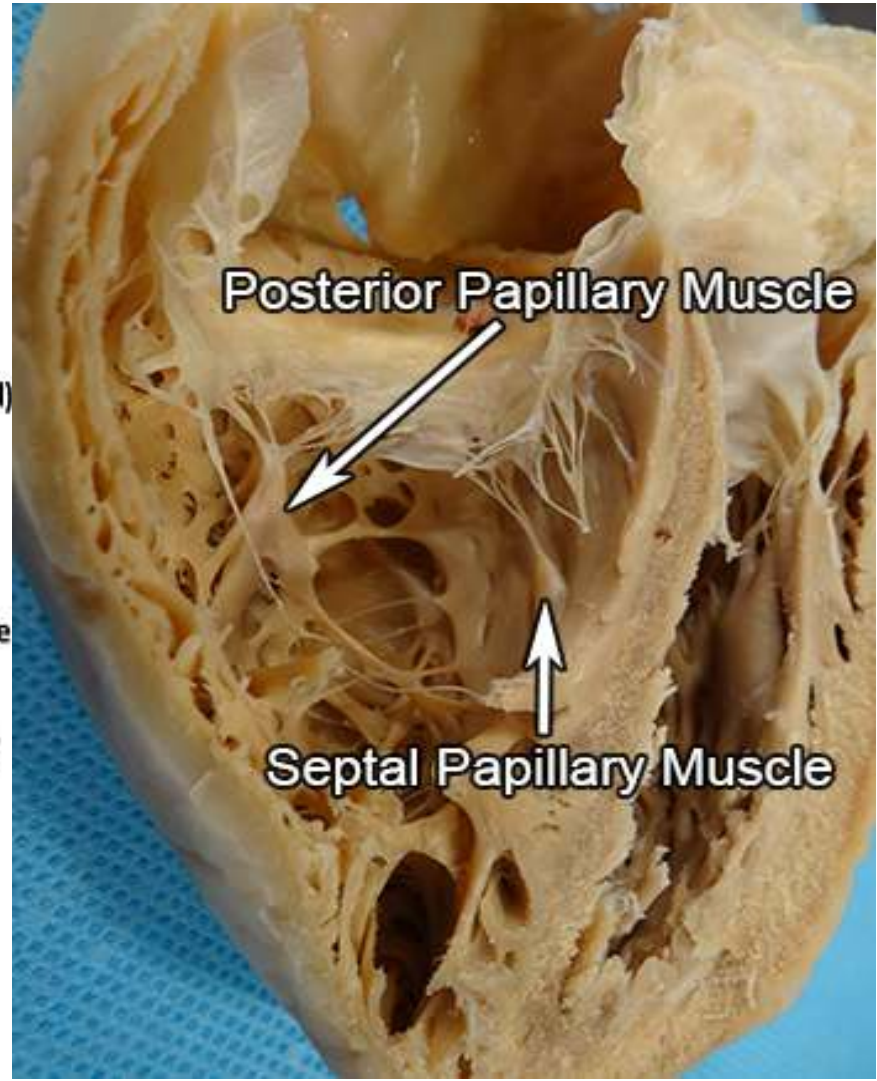
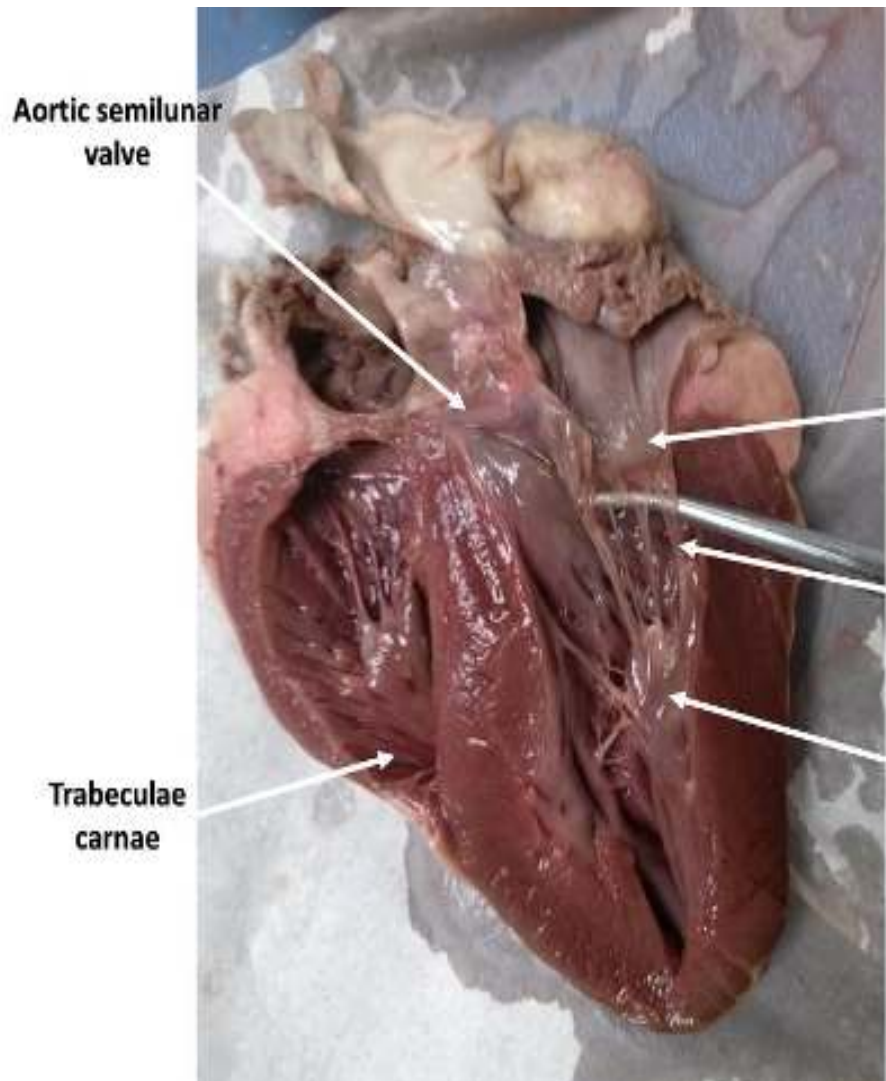
Heart Chamber	Receives Blood From	Sends Blood To	Valve Through Which Blood Flows
Right atrium	Superior vena cava Inferior vena cava Coronary sinus ¹	Right ventricle	Right atrioventricular (AV) valve
Right ventricle	Right atrium	Pulmonary trunk	Pulmonary semilunar valve
Left atrium	Pulmonary veins	Left ventricle	Left AV valve
Left ventricle	Left atrium	Aorta	Aortic semilunar valve

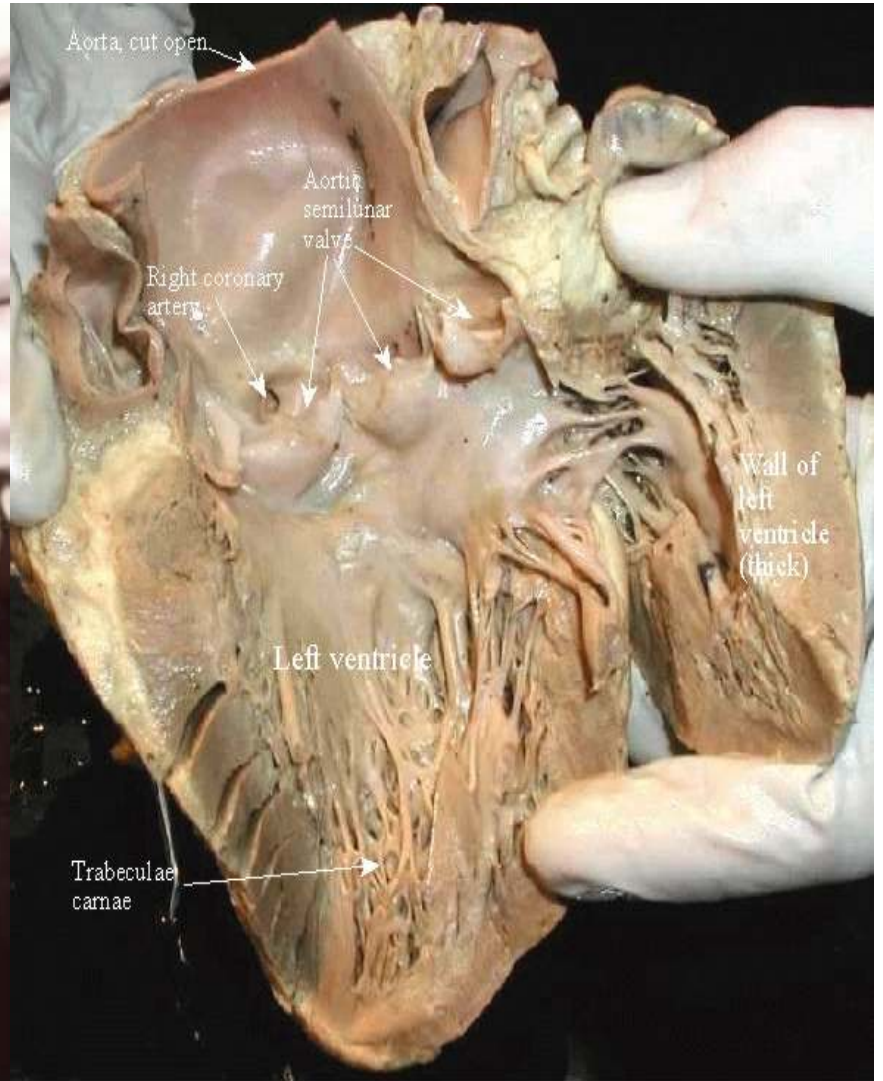
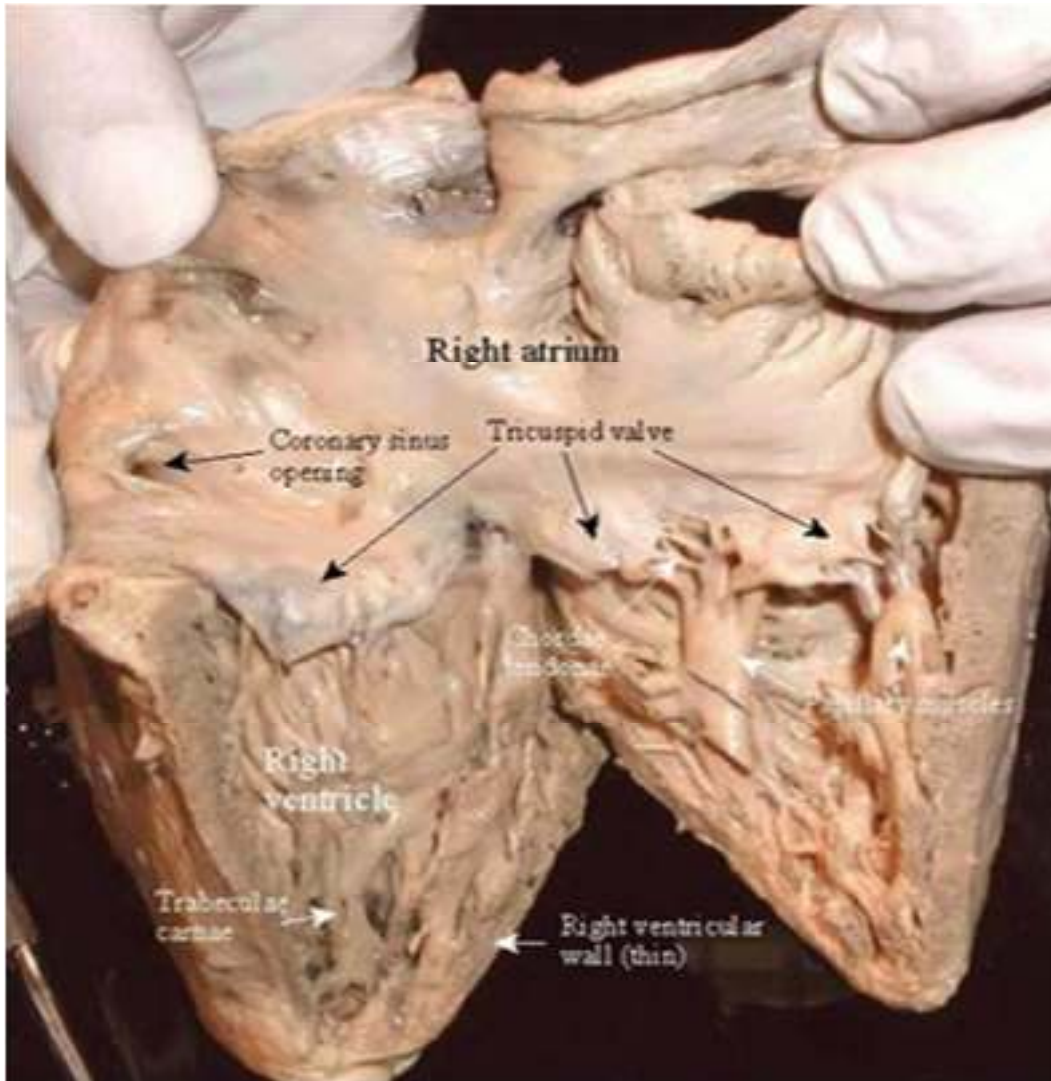
1. Drains deoxygenated blood from the heart wall.

Right and Left Ventricles

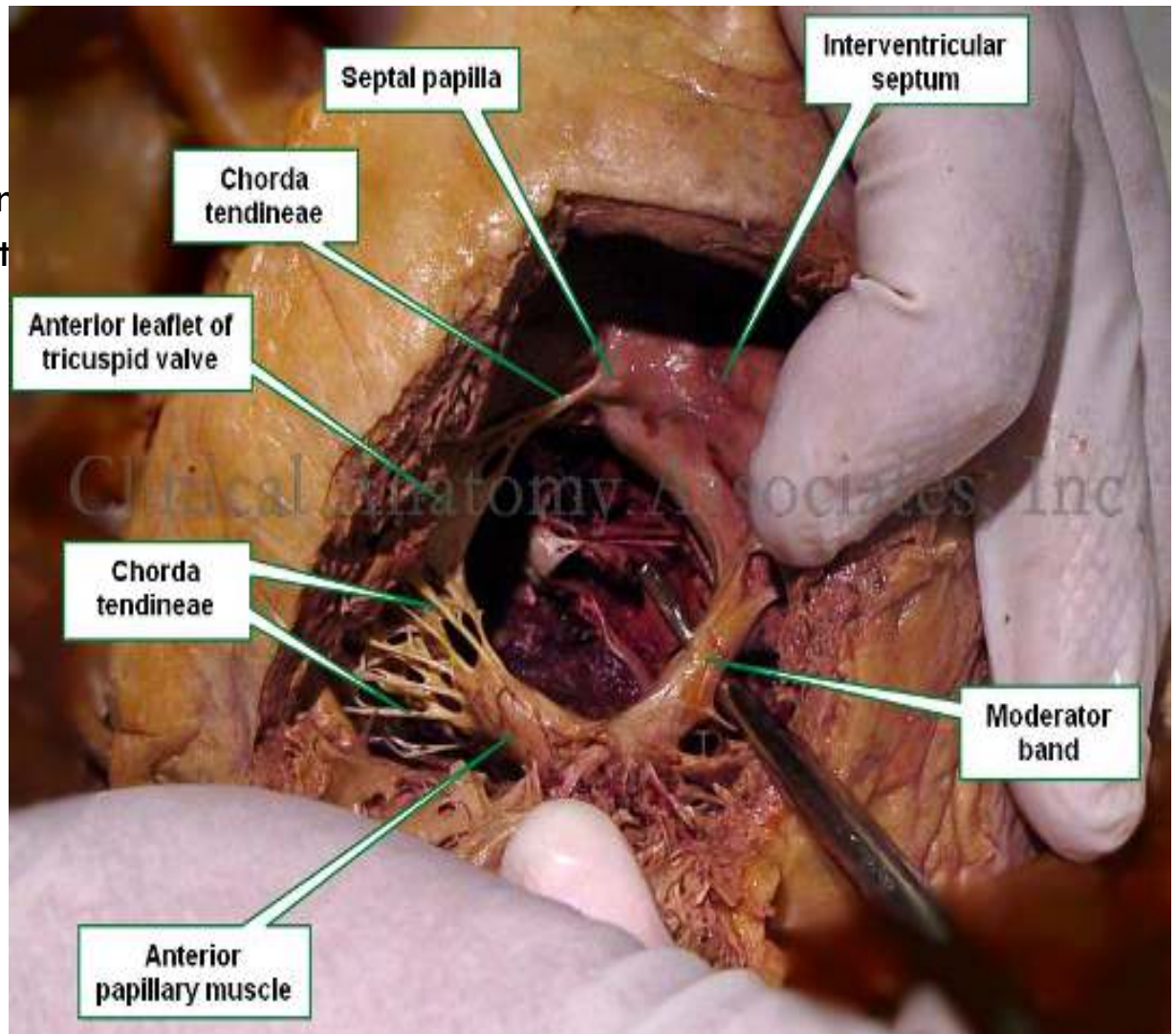
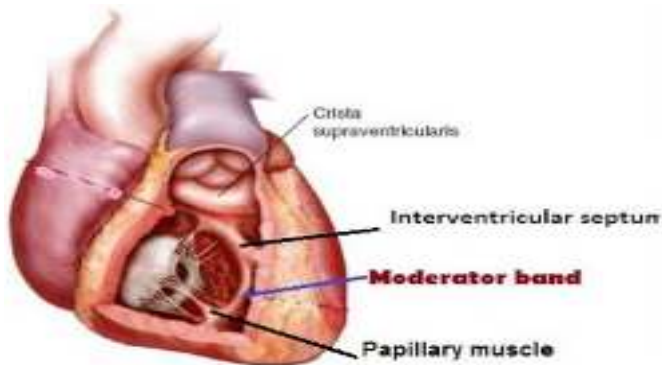


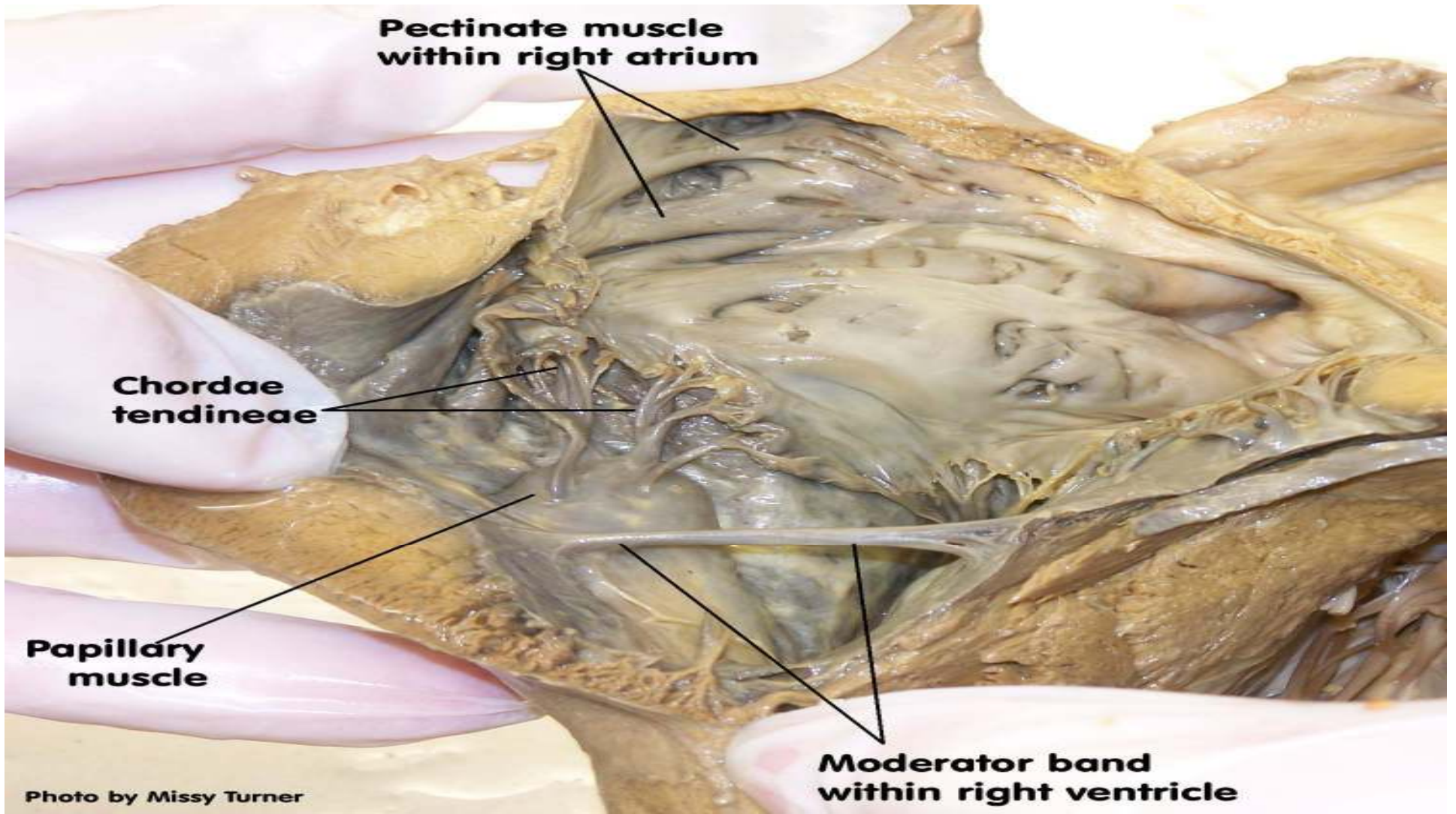






In the human heart, **the moderator band, or trabecula septomarginalis**, is a muscle column that courses inferiorly from the right portion of the interventricular septum to the base of the anterior papillary muscle of the right ventricle .
play a key role in collateral circulation following obstruction of the epicardium coronary arteries.





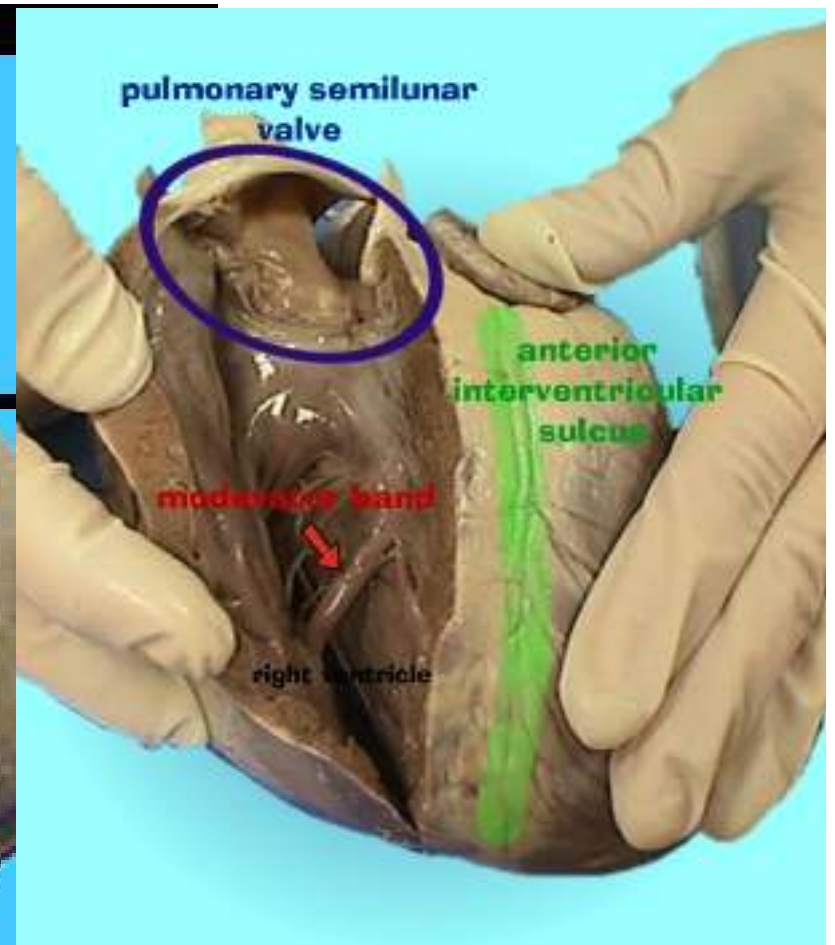
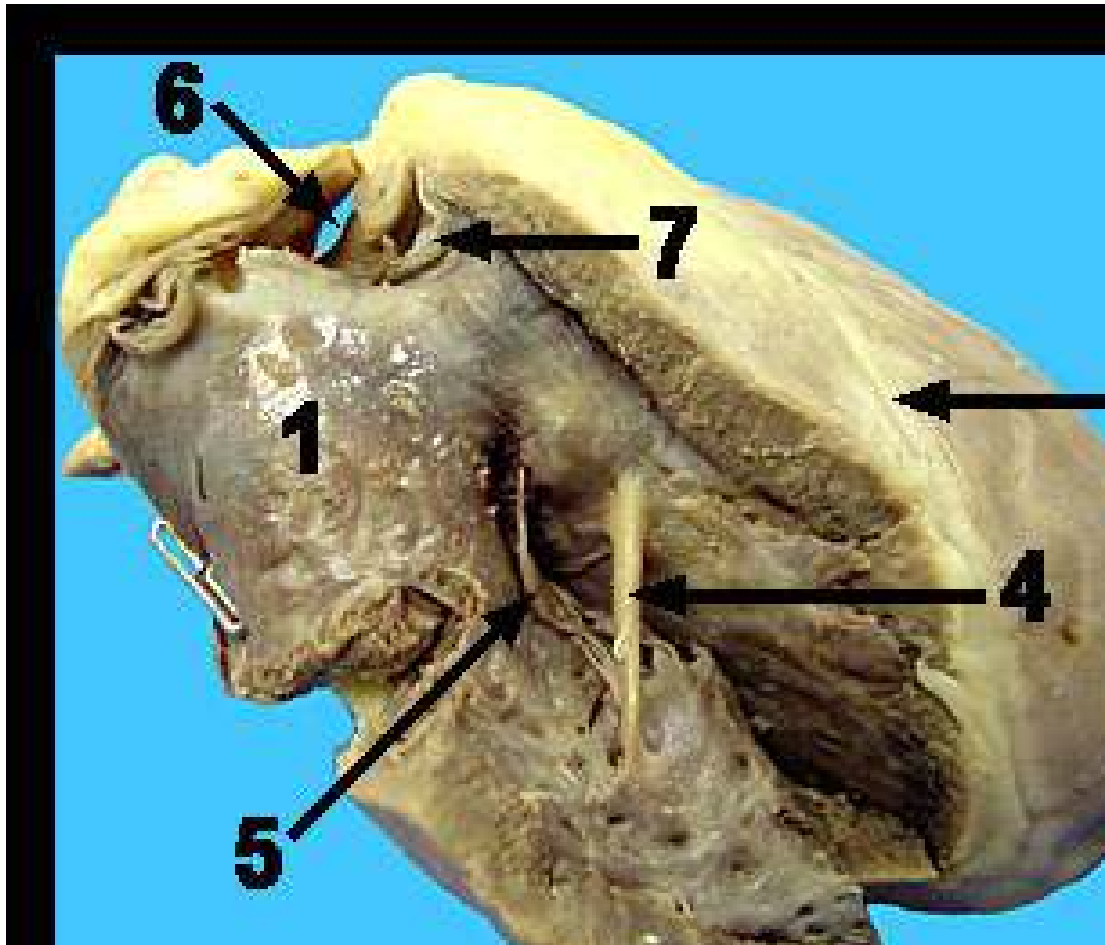
**Pectinate muscle
within right atrium**

**Chordae
tendineae**

**Papillary
muscle**

**Moderator band
within right ventricle**

Photo by Missy Turner



Moderator band thickened muscle ridge providing rapid conduction path; tenses papillary muscles just before ventricular contraction; prevents slamming or inversion of AV valve

LEFT ATRIUM & VENTRICLE DETAIL

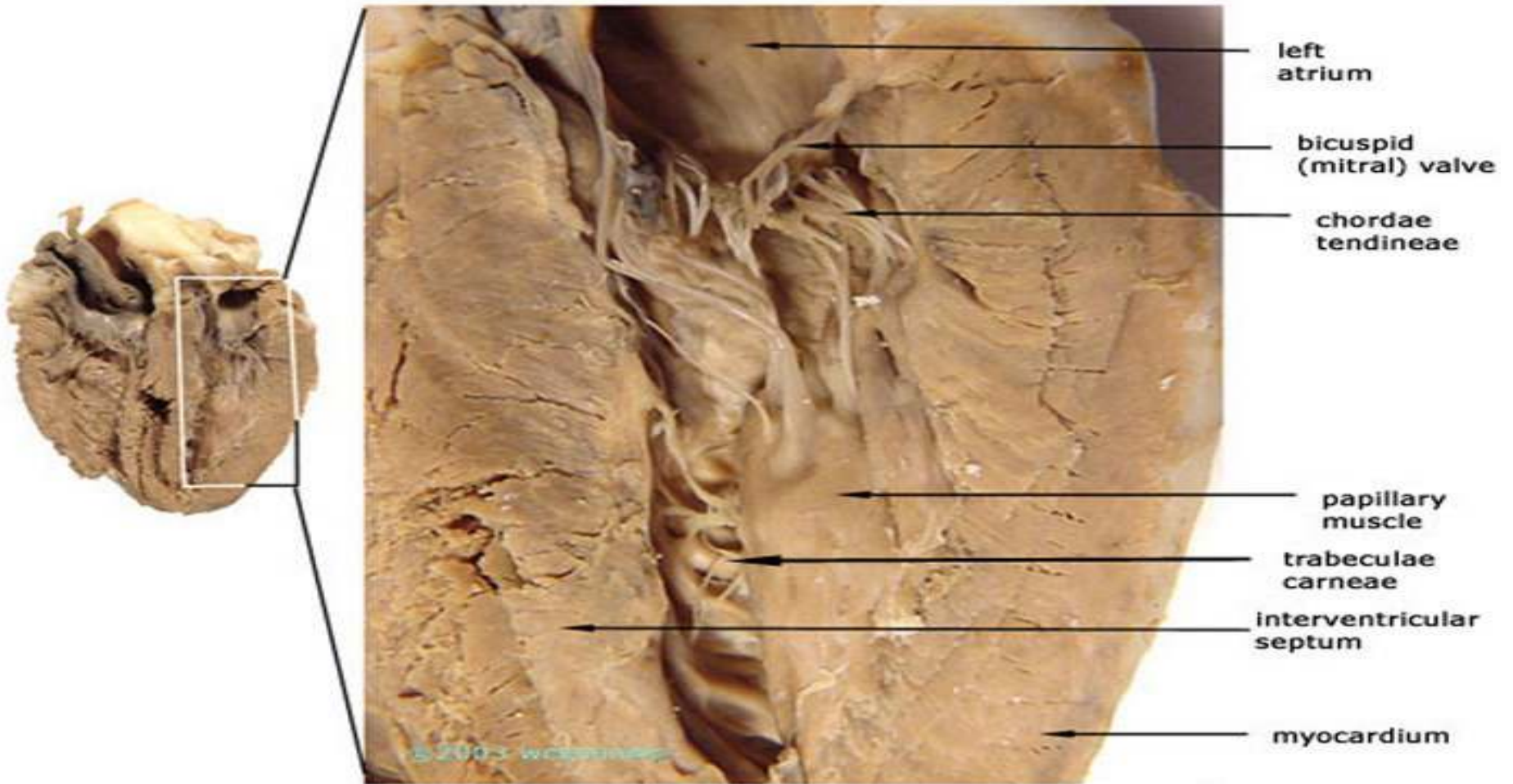
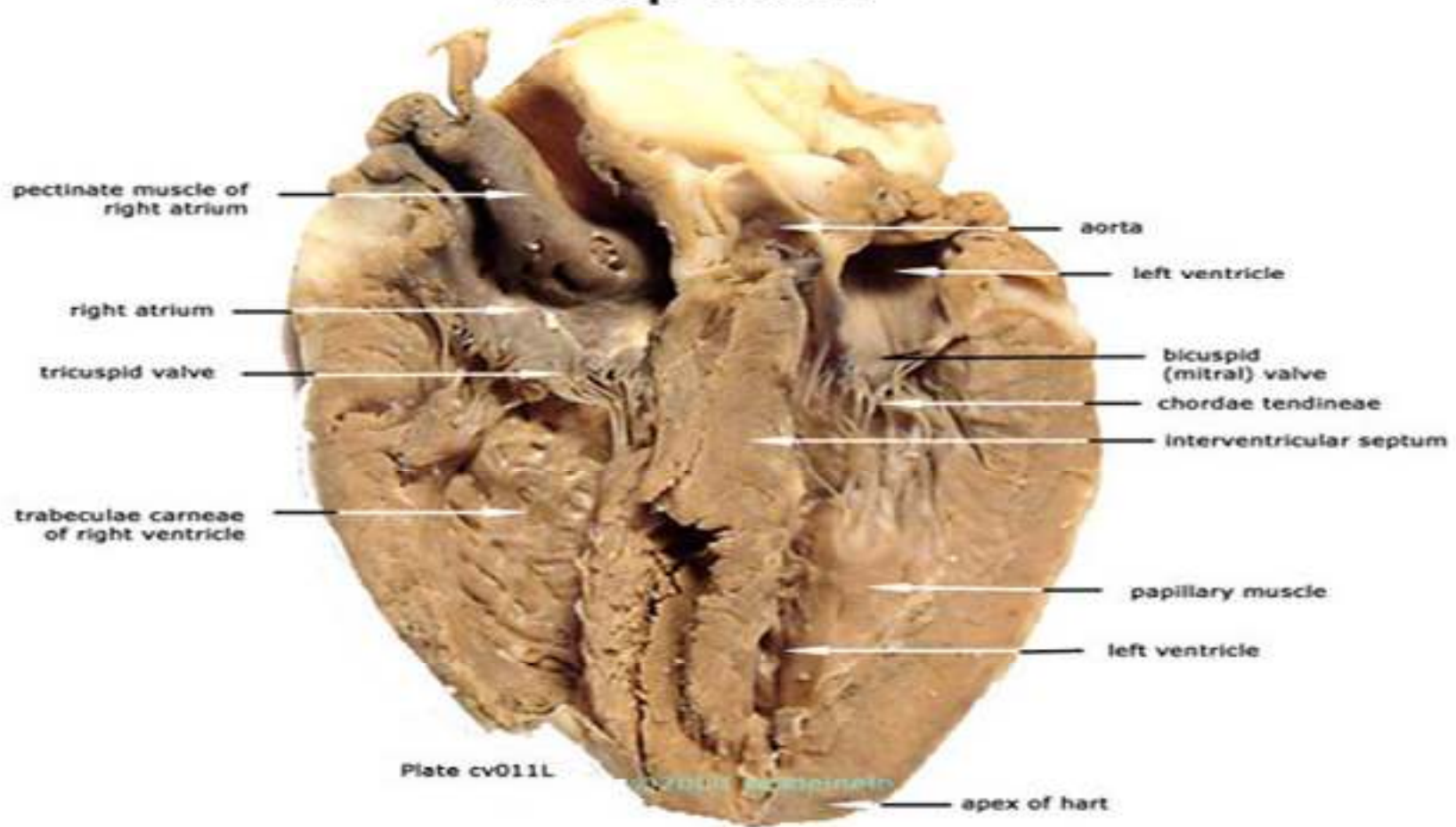


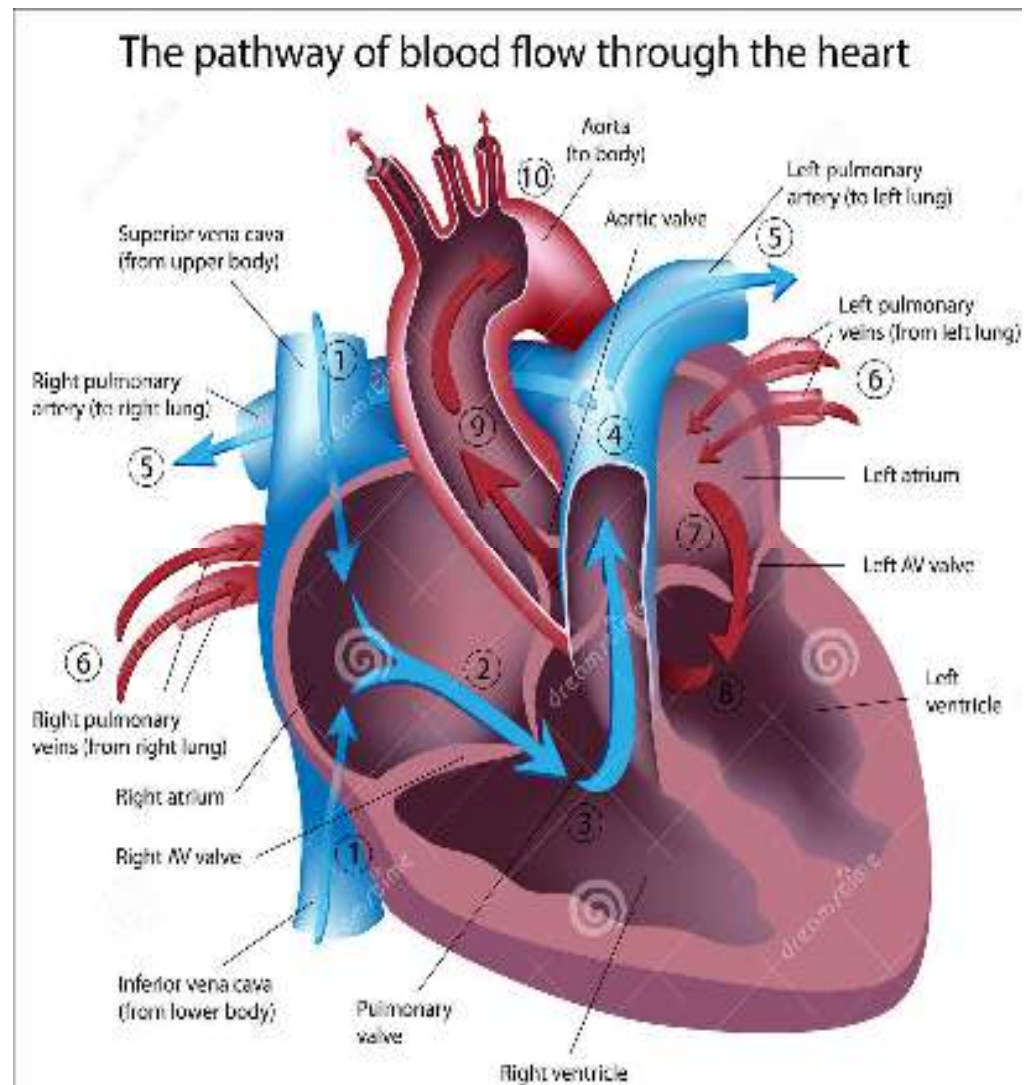
Plate cv013L

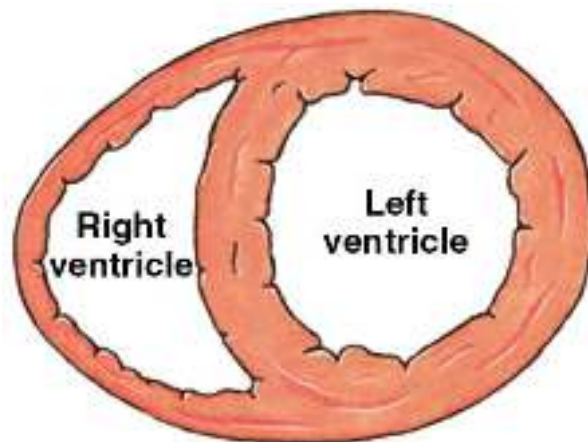
POSTERIOR SAGITTAL SECTION sheep heart



Pathway of Blood Through the Heart and Lungs

- ❑ **Right atrium → tricuspid valve → right ventricle**
- ❑ **Right ventricle → pulmonary semilunar valve → pulmonary arteries → lungs**
- ❑ **Lungs → pulmonary veins → left atrium**
- ❑ **Left atrium → bicuspid valve → left ventricle**
- ❑ **Left ventricle → aortic semilunar valve → aorta**
- ❑ **Aorta → systemic circulation**

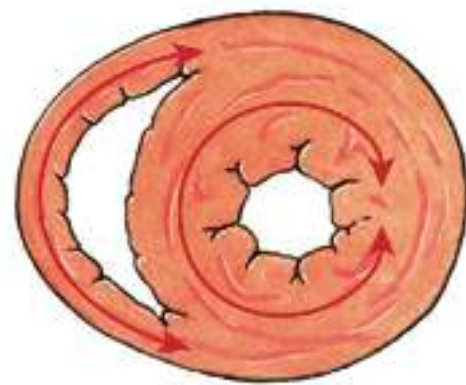
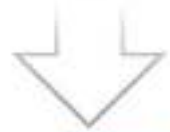




Right
ventricle

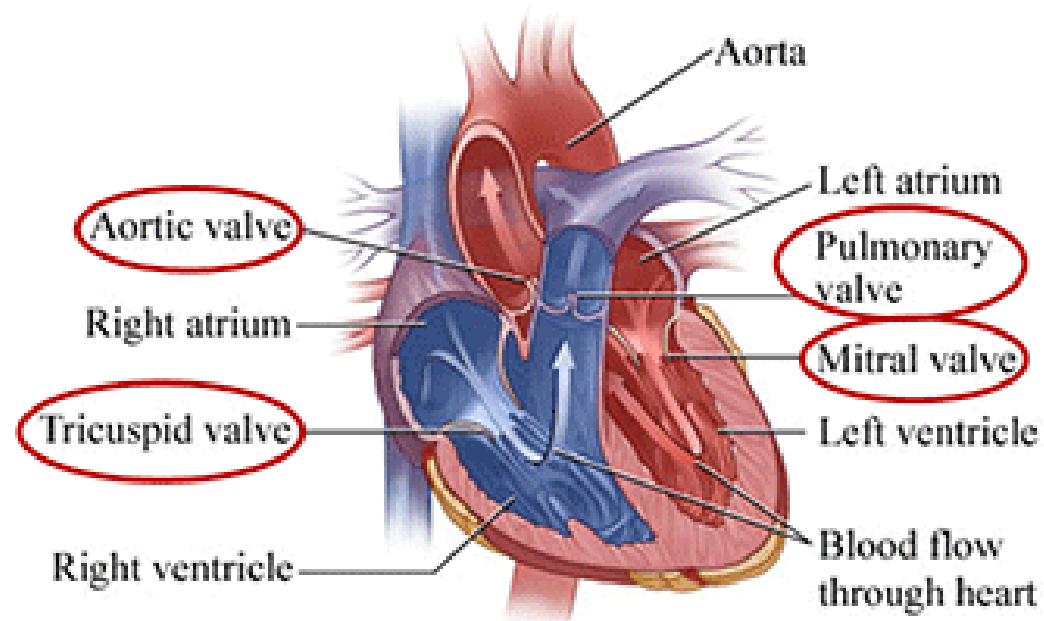
Left
ventricle

Dilated (relaxed)



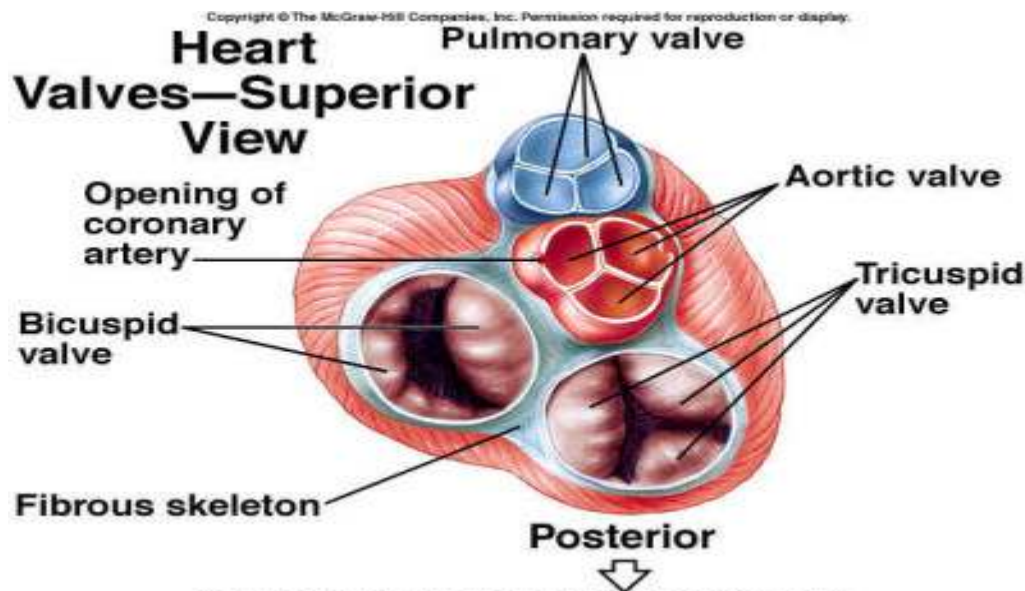
Contracted

Cardiac valves

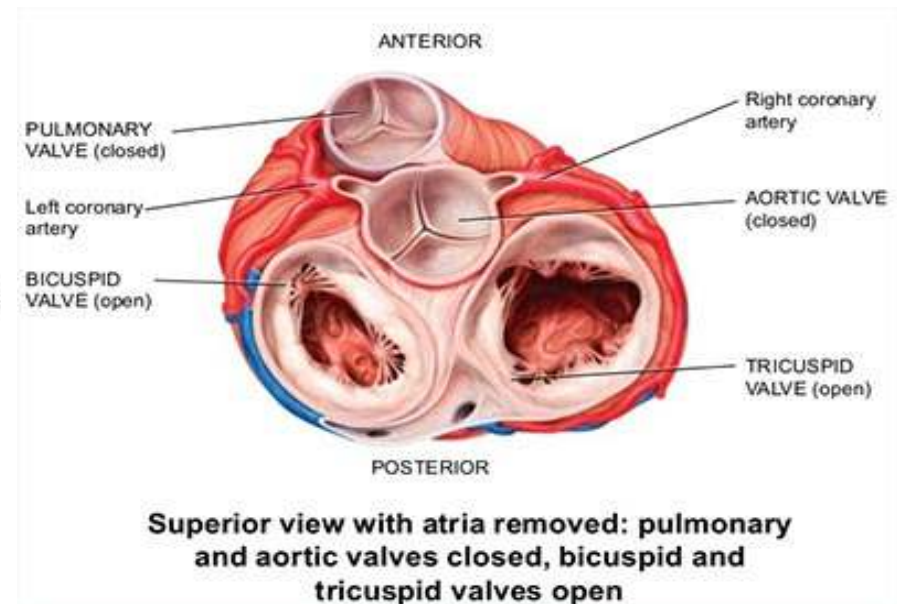


Heart Valves

- ❑ Heart valves ensure unidirectional blood flow through the heart
- ❑ Atrioventricular (AV) valves lie between the atria and the ventricles
- ❑ AV valves prevent backflow into the atria when ventricles contract
- ❑ Chordae tendineae anchor AV valves to papillary muscles



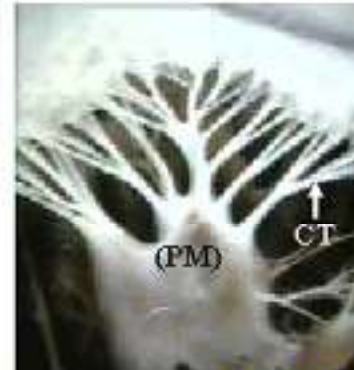
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Valves

- AV atrioventricular valves
 - Tricuspid
 - Mitral or bicuspid
- Semilunar valves
 - Aortic
 - Pulmonic

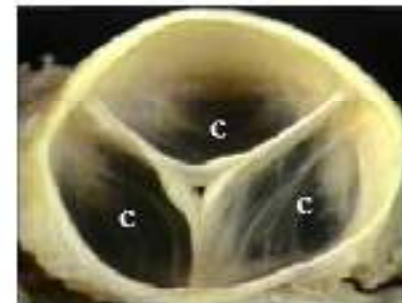
CHORDAE TENDINEAE



The papillary muscles (PM) anchoring the cords to the heart wall will contract to counter any stretch in the cordae tendineae (CT) during vigorous pumping of the heart.

SEMILUNAR VALVES

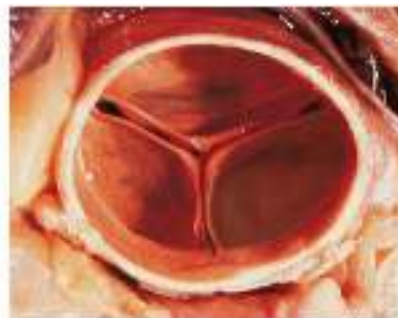
The semilunar valves are found lining the walls of the pulmonary trunk (pulmonary valve) and the aorta (aortic valve). Each valve consists of three pocket-like endocardial cusps (c). During contraction of the ventricles (ventricular systole), the pockets are flattened against the walls of the ejecting vessels. As the ventricles begin to relax (diastole), the blood in the large arteries begins to fall back down into the ventricles. This causes the cusps to fill with blood and billow out closing the vessel and preventing a backflow.



PAMT

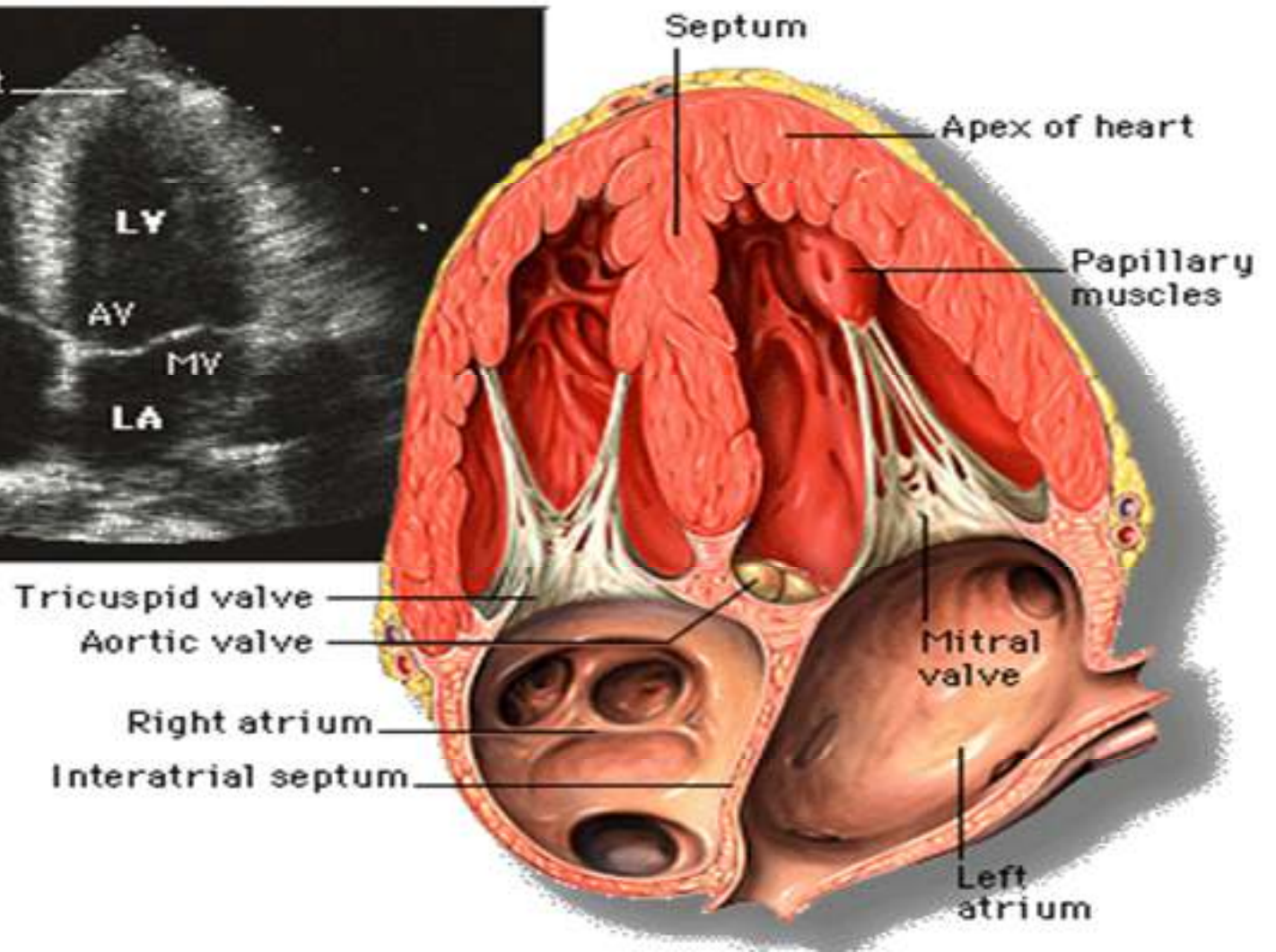
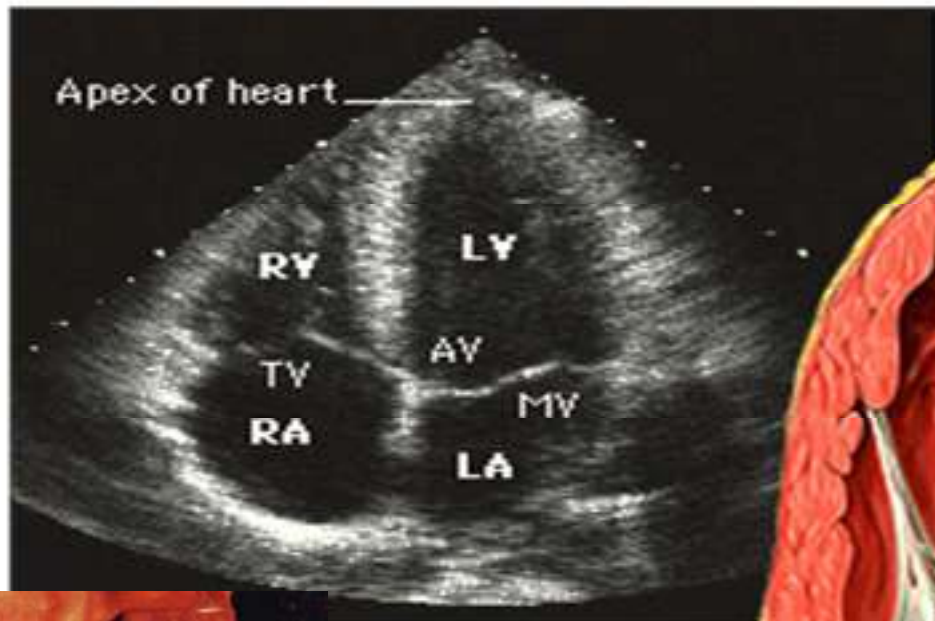


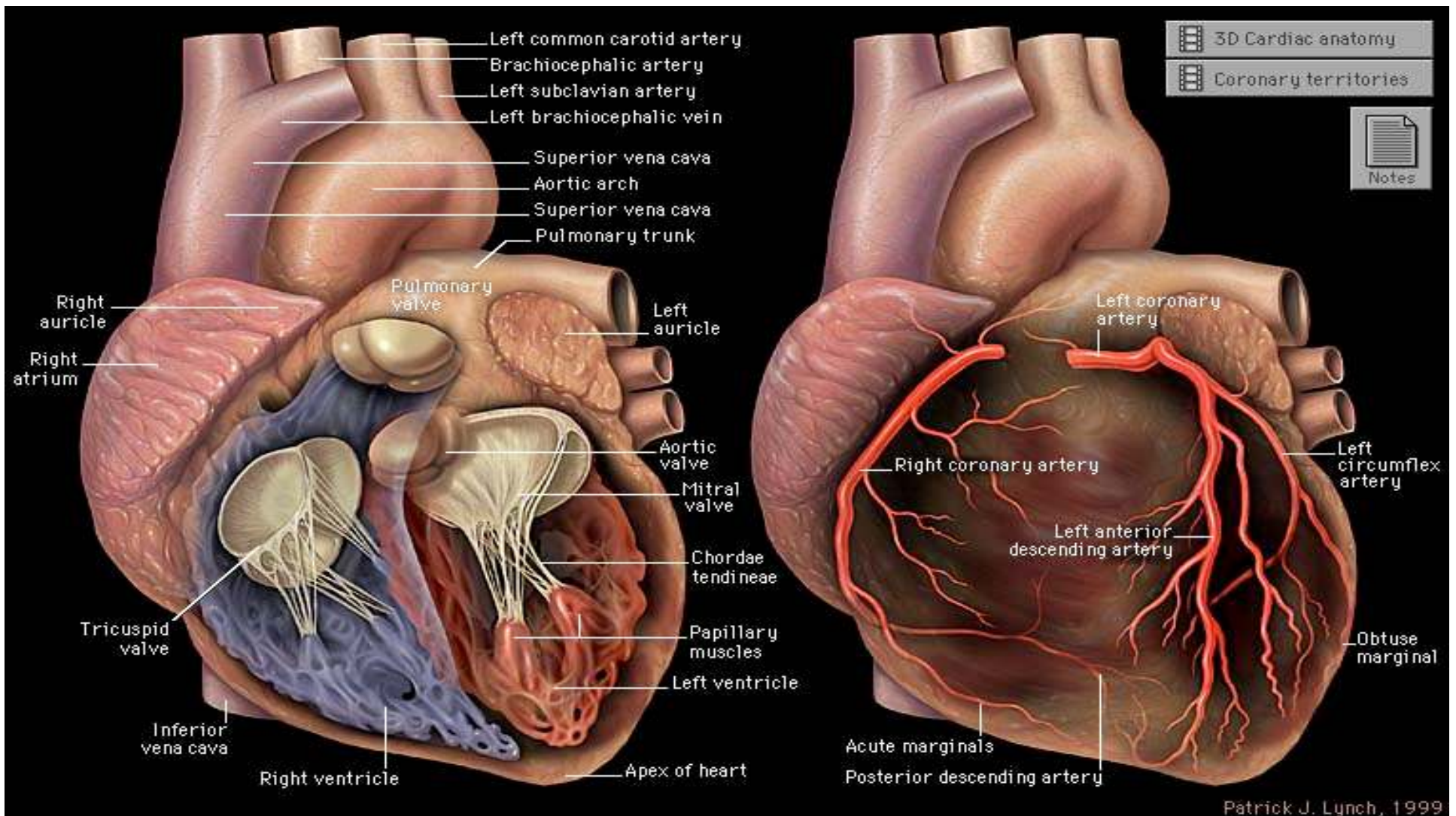
Open



Closed

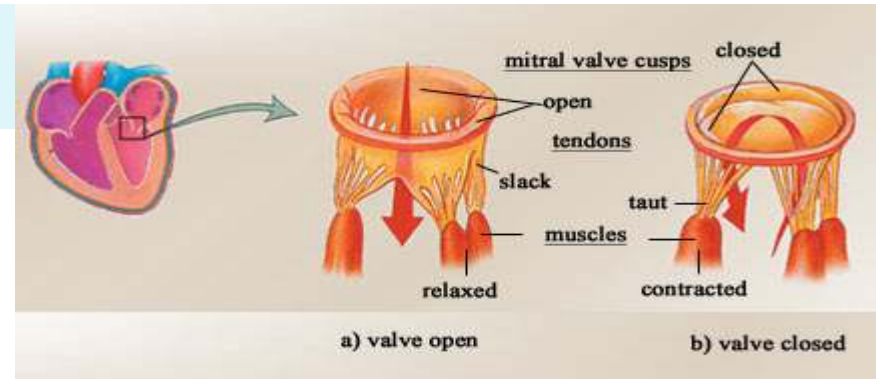
Superior views Pulmonary and aortic (semilunar) valves



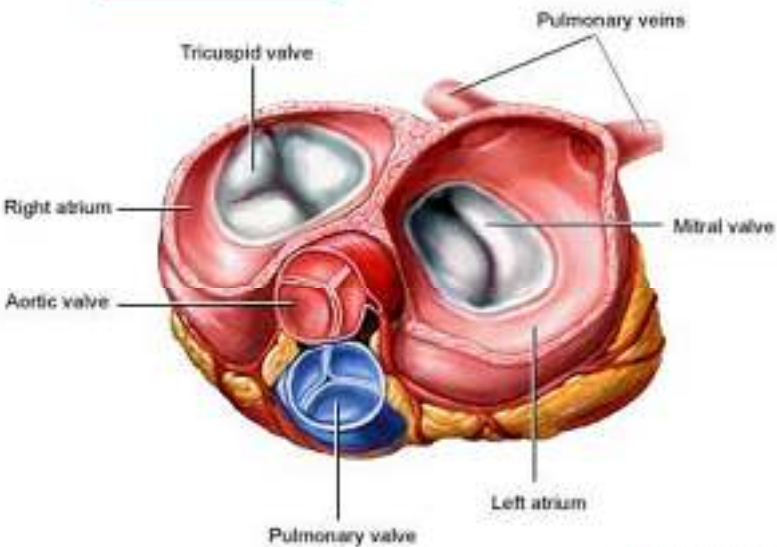


Heart Valves

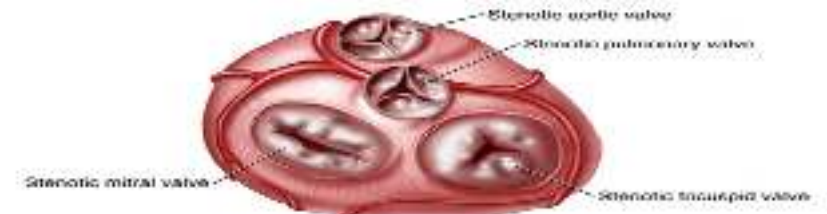
- **Aortic semilunar valve** lies between the left ventricle and the aorta
- **Pulmonary semilunar valve** lies between the right ventricle and pulmonary trunk
- **Semilunar valves prevent backflow of blood into the ventricles**



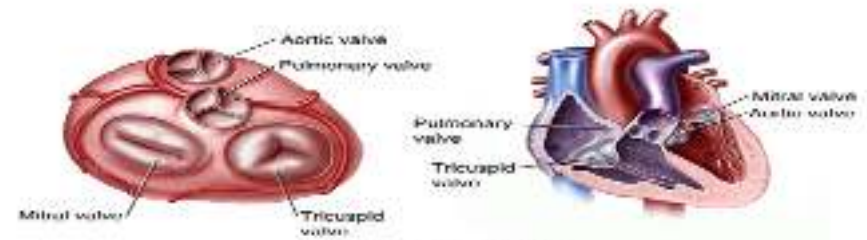
Normal and Diseased Heart Valves



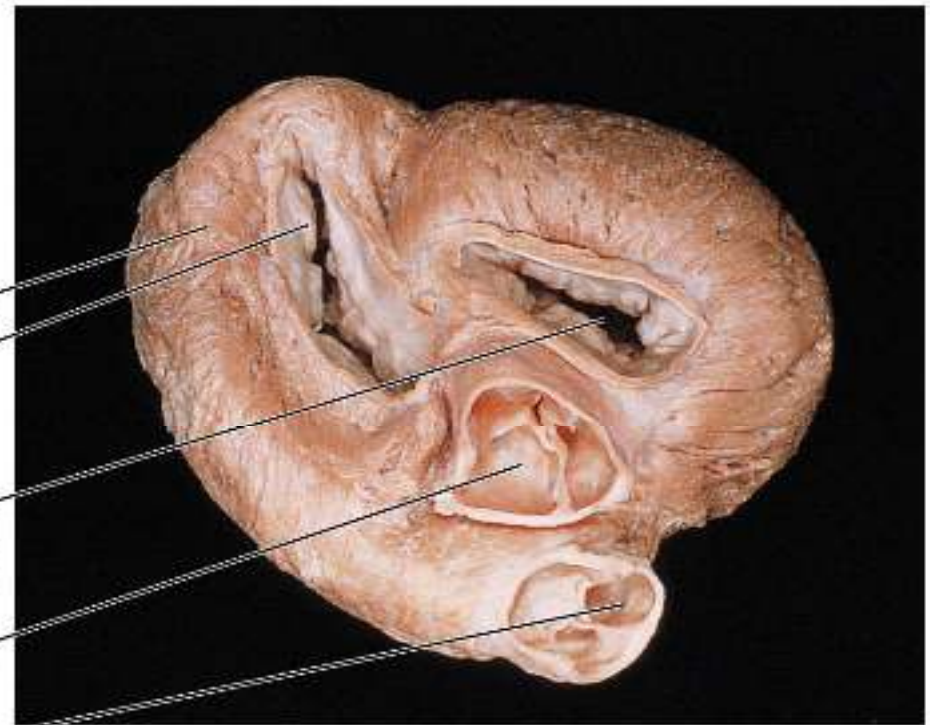
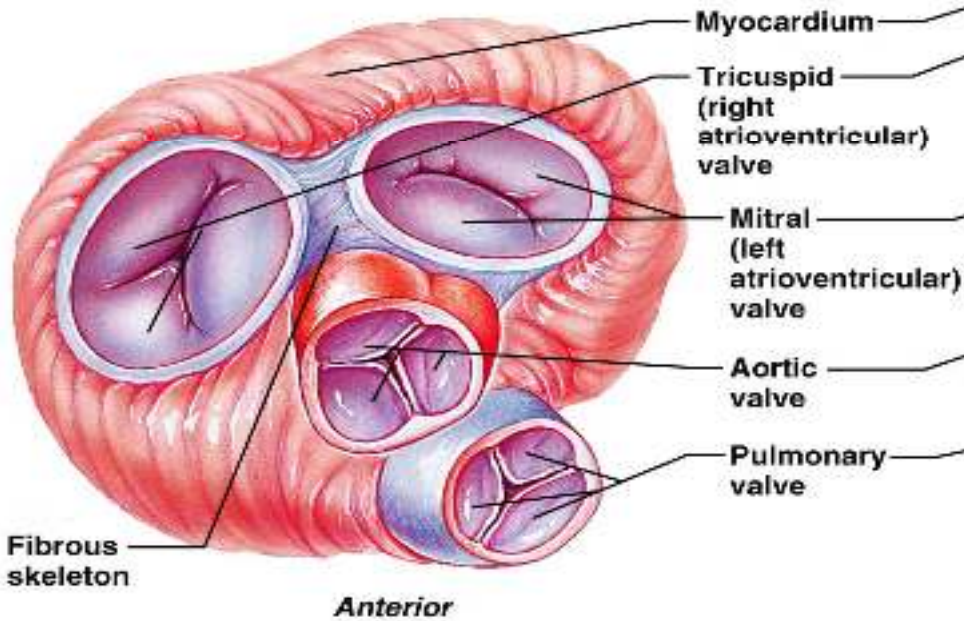
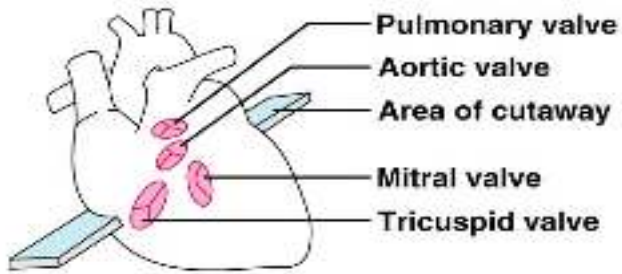
ADAM.



Diseased Heart Valves



Normal Heart Valves

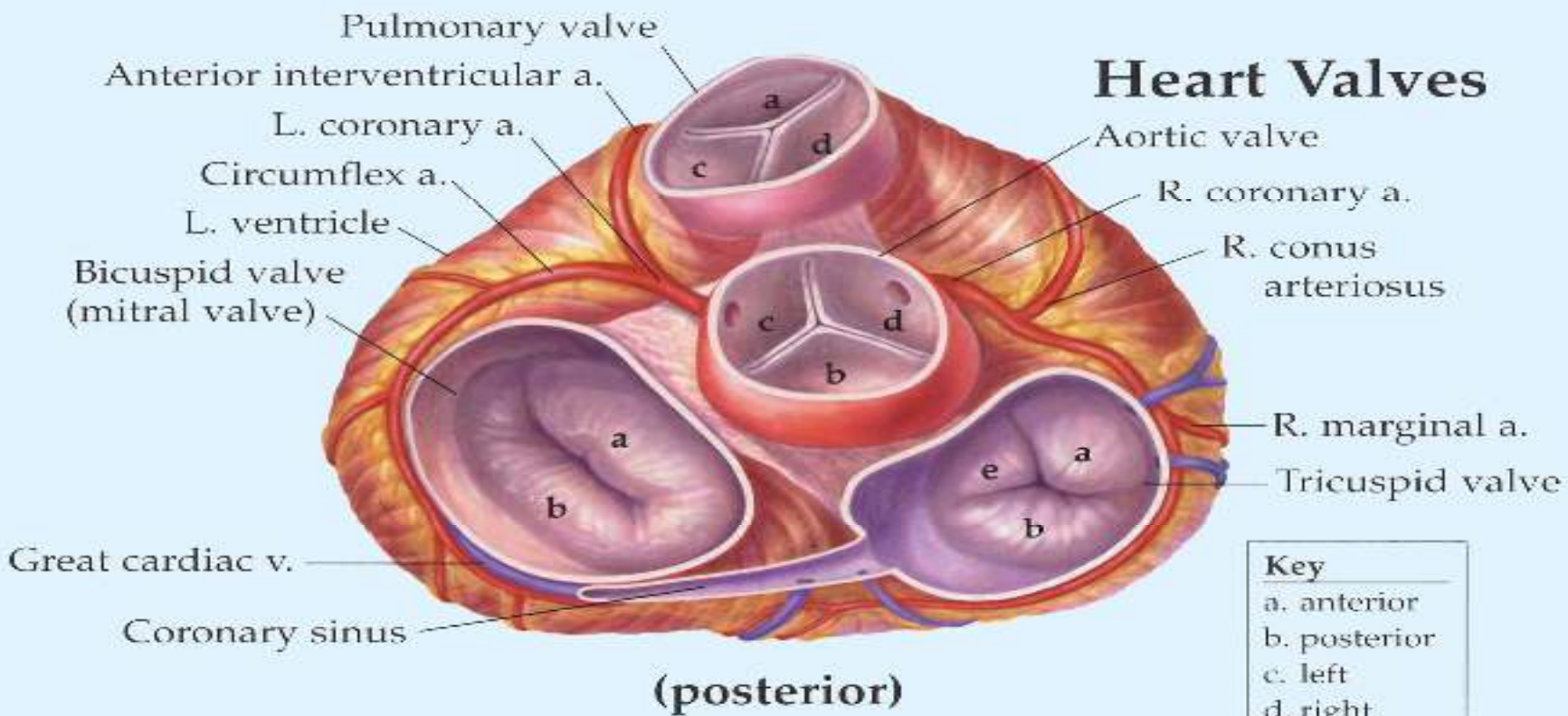


(b)

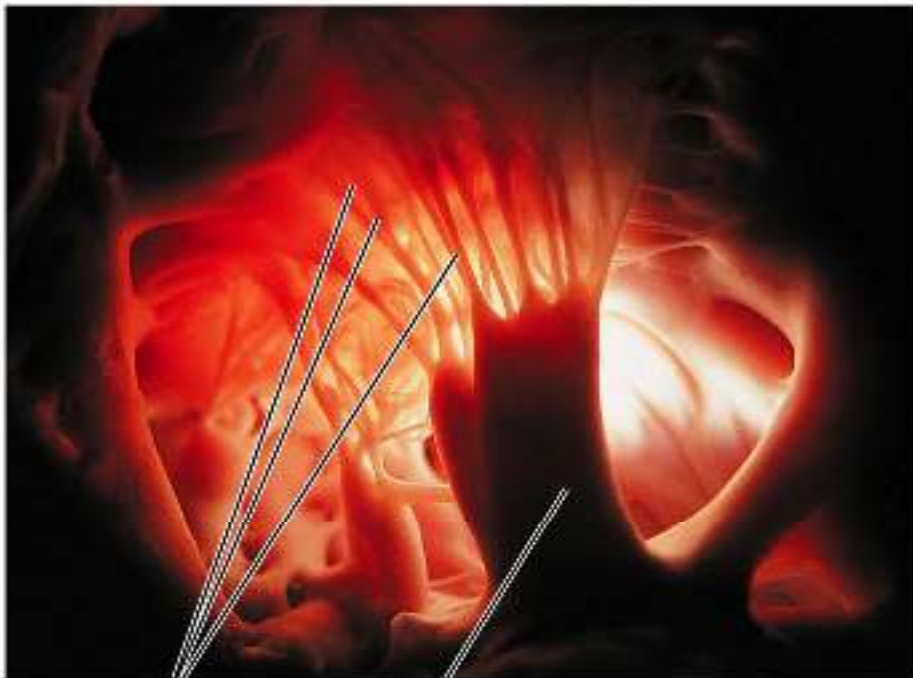
(a)

(anterior)

Heart Valves



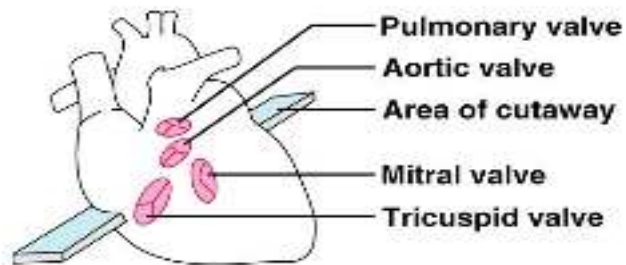
Key	
a.	anterior
b.	posterior
c.	left
d.	right
e.	septal



Chordae tendineae attached to tricuspid valve flap

Papillary muscle

(c)



Pulmonary valve

Aortic valve

Area of cutaway

Mitral valve

Tricuspid valve

Opening of superior vena cava

Tricuspid valve

Myocardium of right ventricle

Papillary muscles

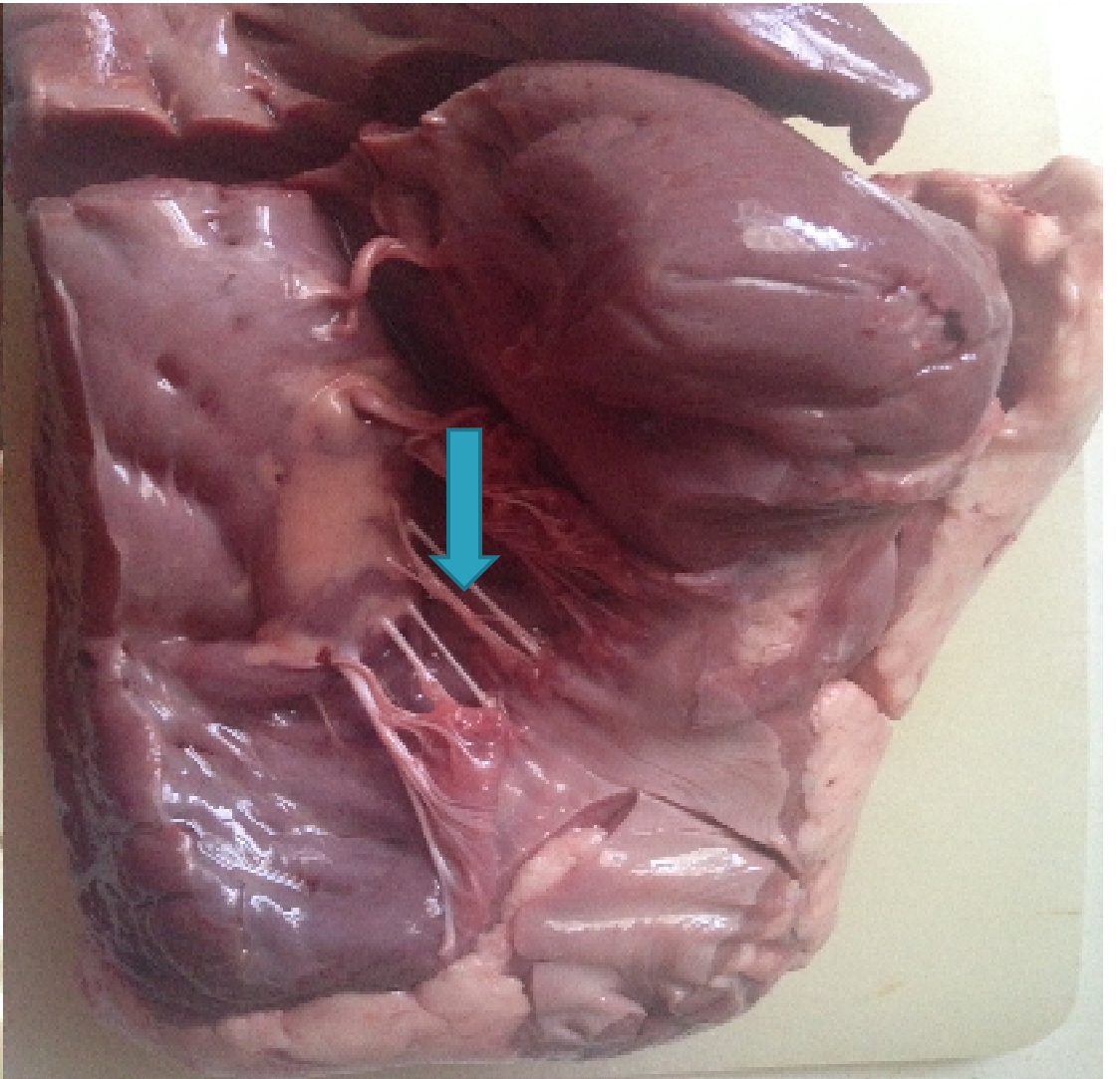
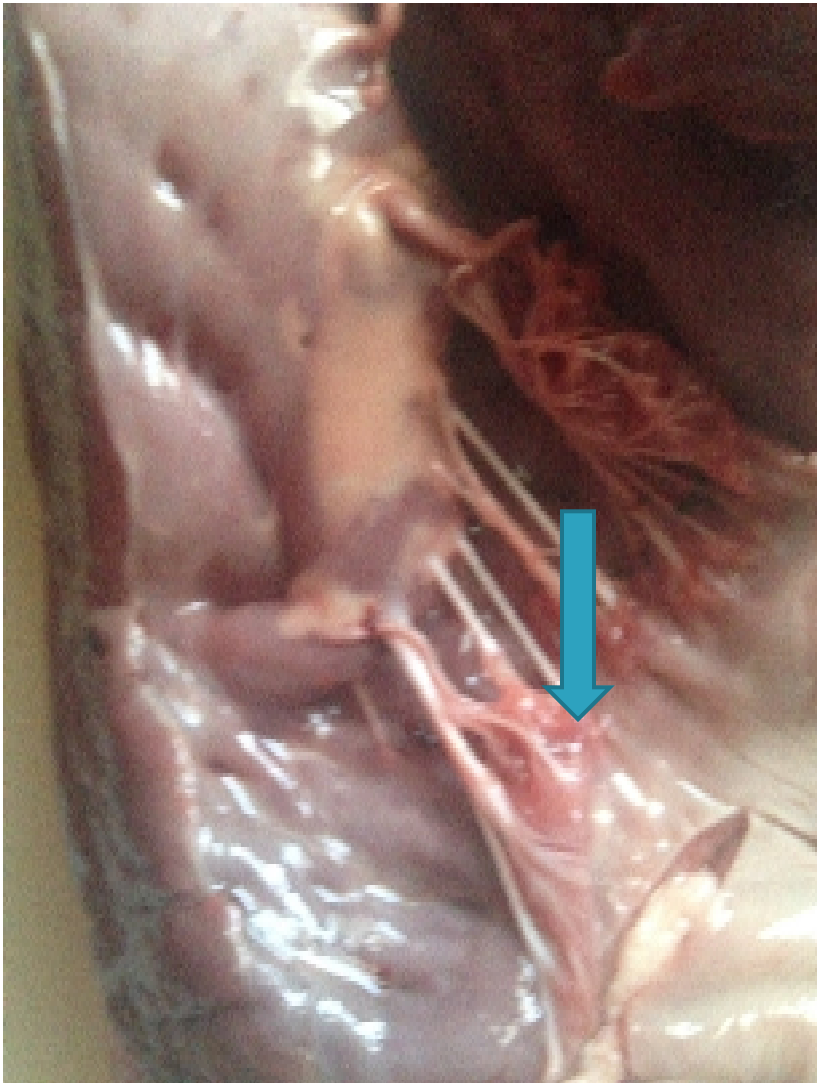
(d)

Mitral valve

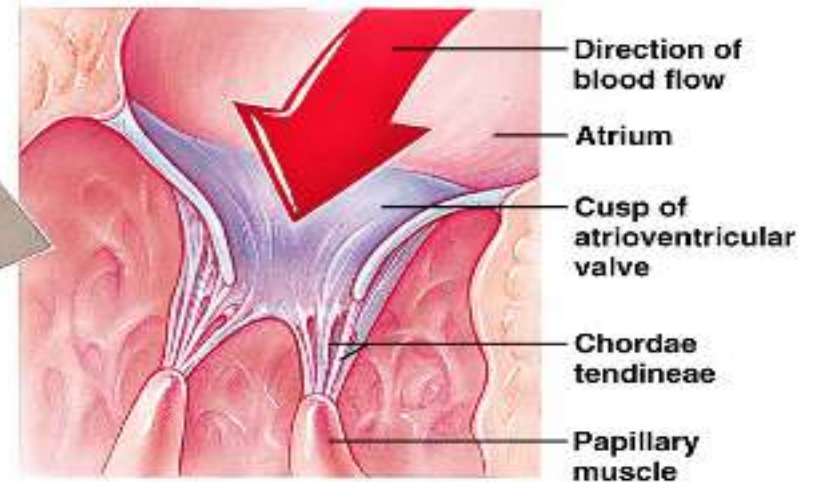
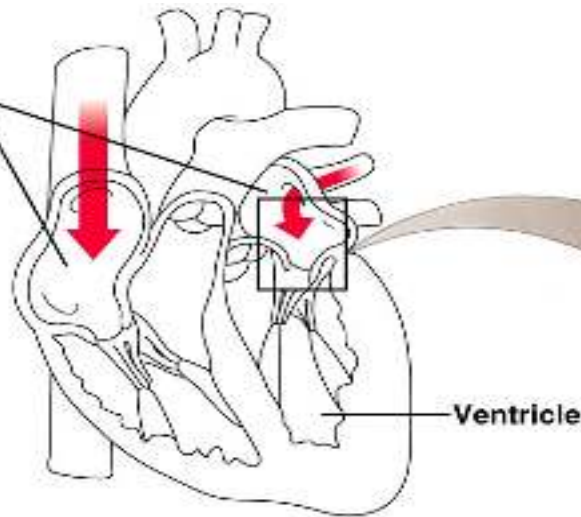
Chordae tendineae

Interventricular septum

Myocardium of left ventricle



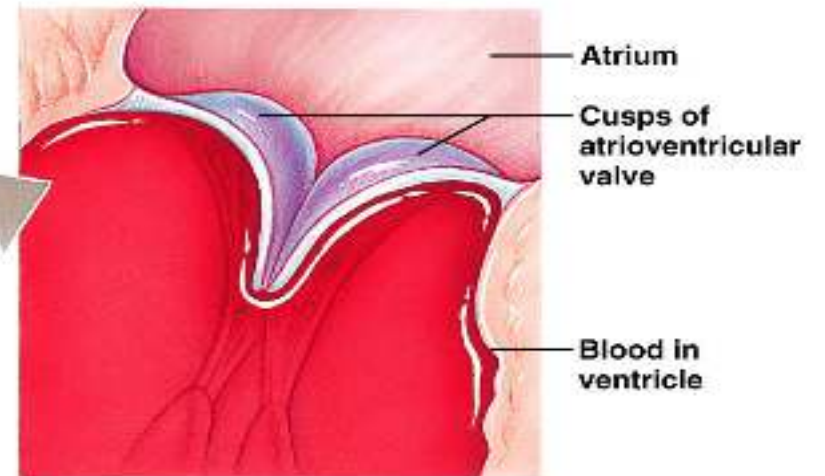
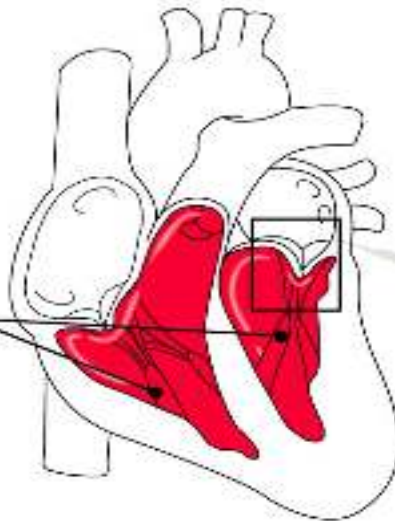
- ① Blood returning to the heart fills atria, putting pressure against atrioventricular valves; atrioventricular valves are forced open.
- ② As ventricles fill, atrioventricular valve flaps hang limply into ventricles.
- ③ Atria contract, forcing additional blood into ventricles.



Atrioventricular valve open

(a)

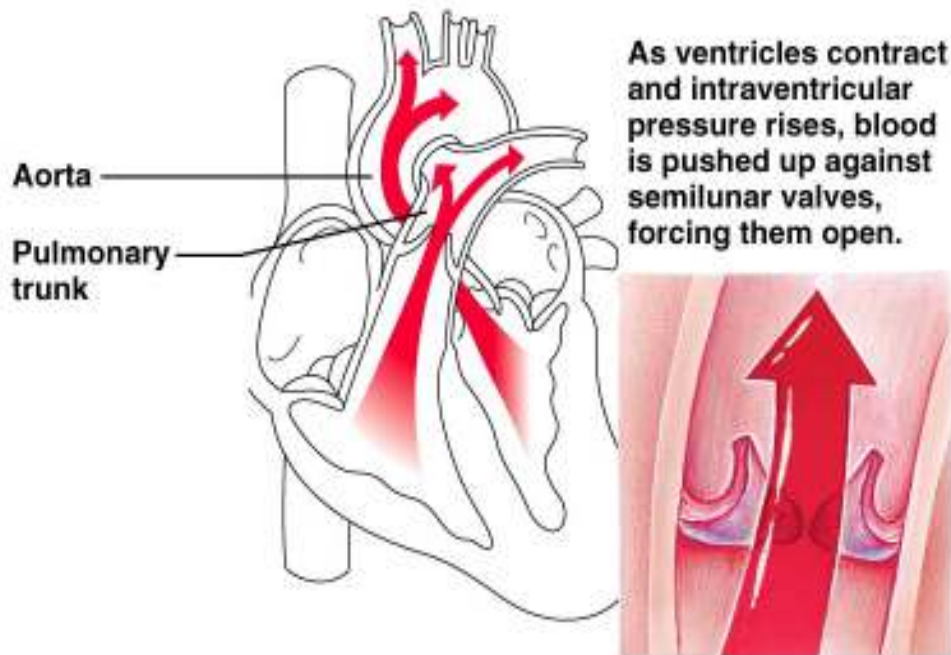
- ① Ventricles contract, forcing blood against atrioventricular valve cusps.
- ② Atrioventricular valves close.
- ③ Papillary muscles contract and chordae tendineae tighten, preventing valve flaps from everting into atria.



Atrioventricular valve closed

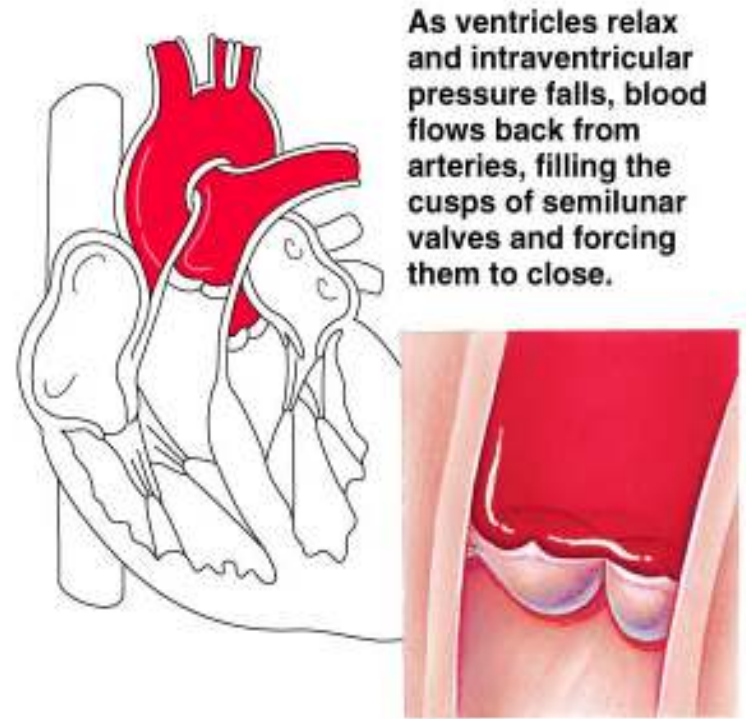
(b)

Semilunar Valve Function



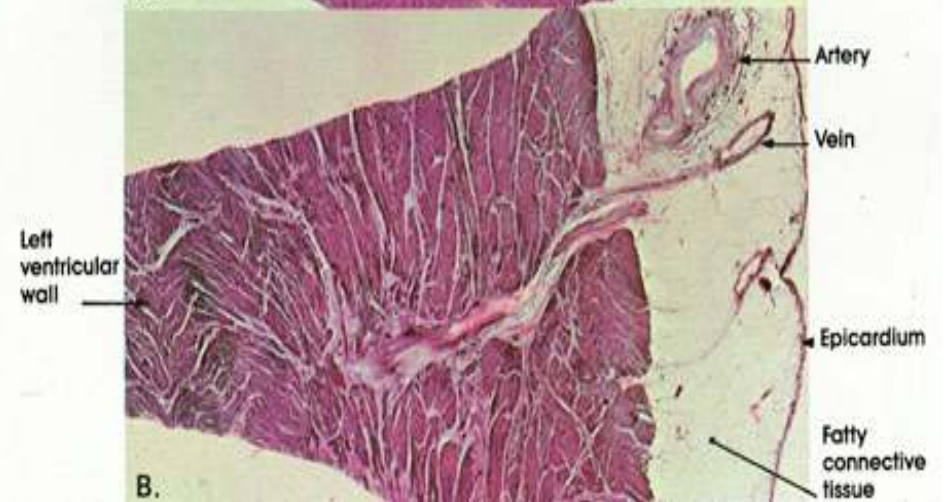
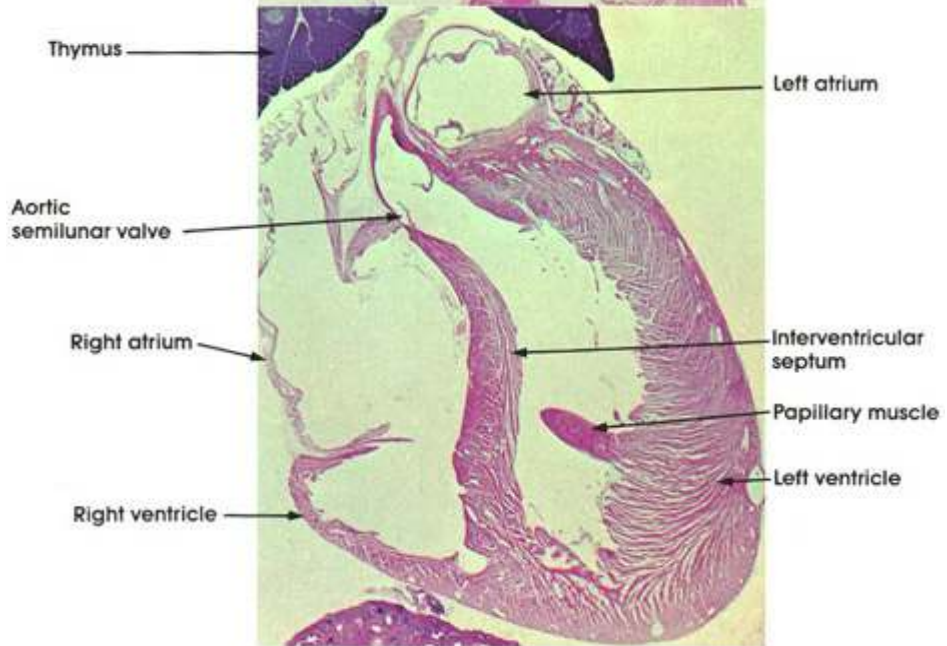
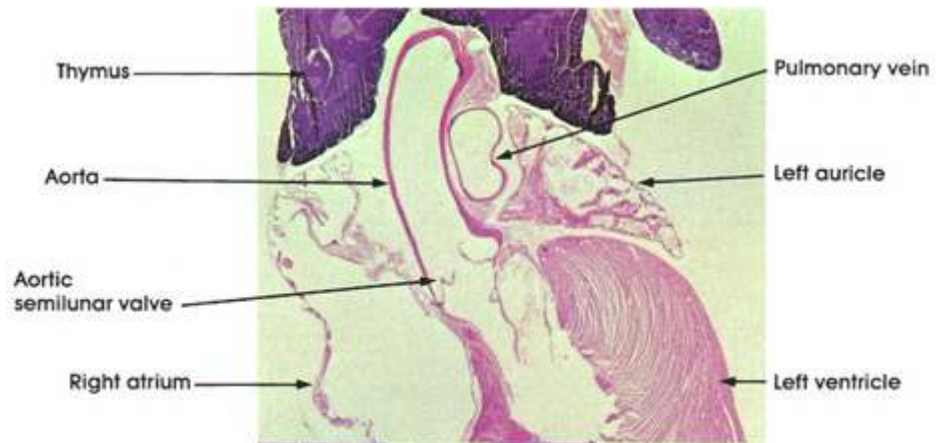
Semilunar valve open

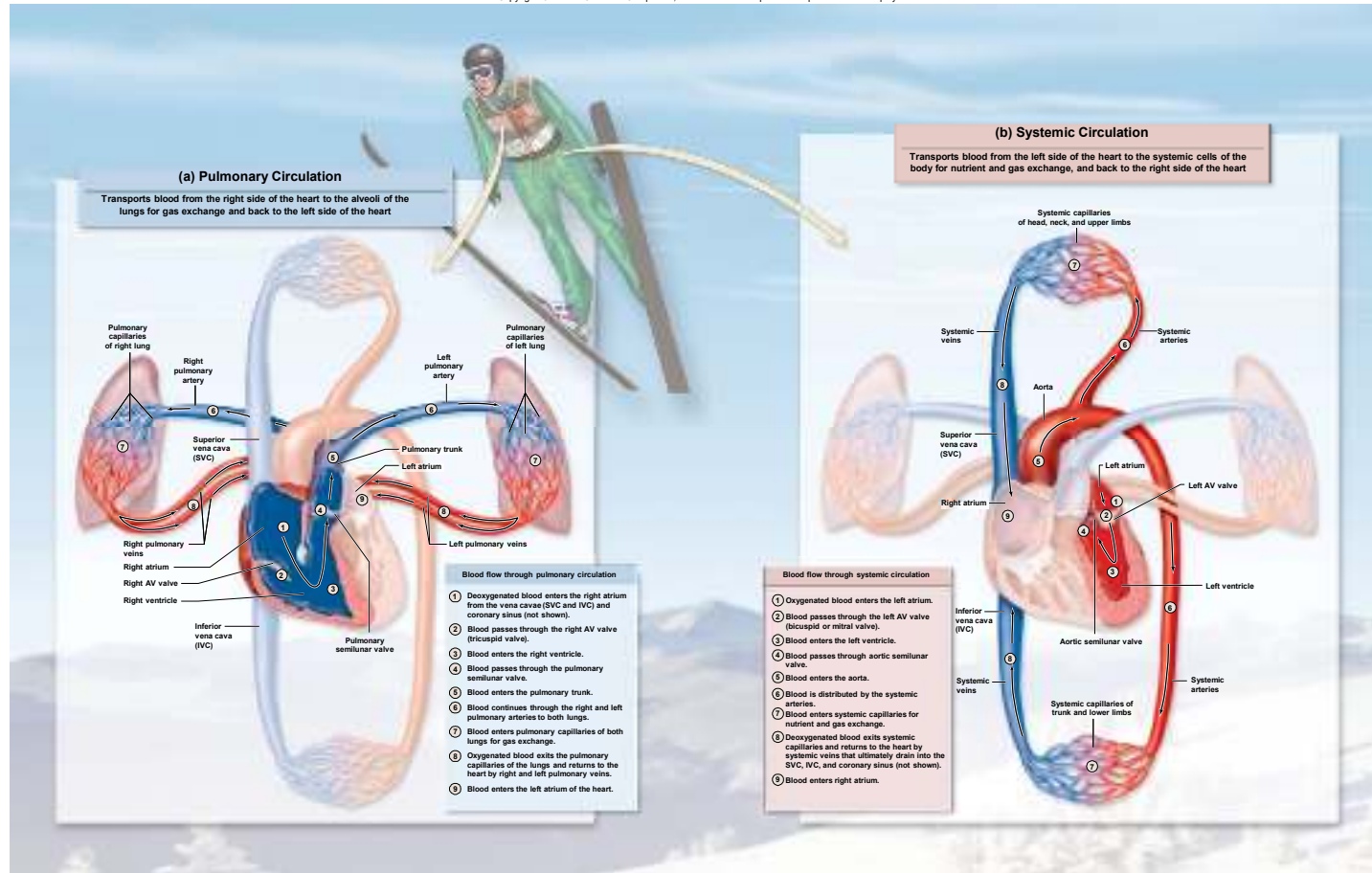
(a)



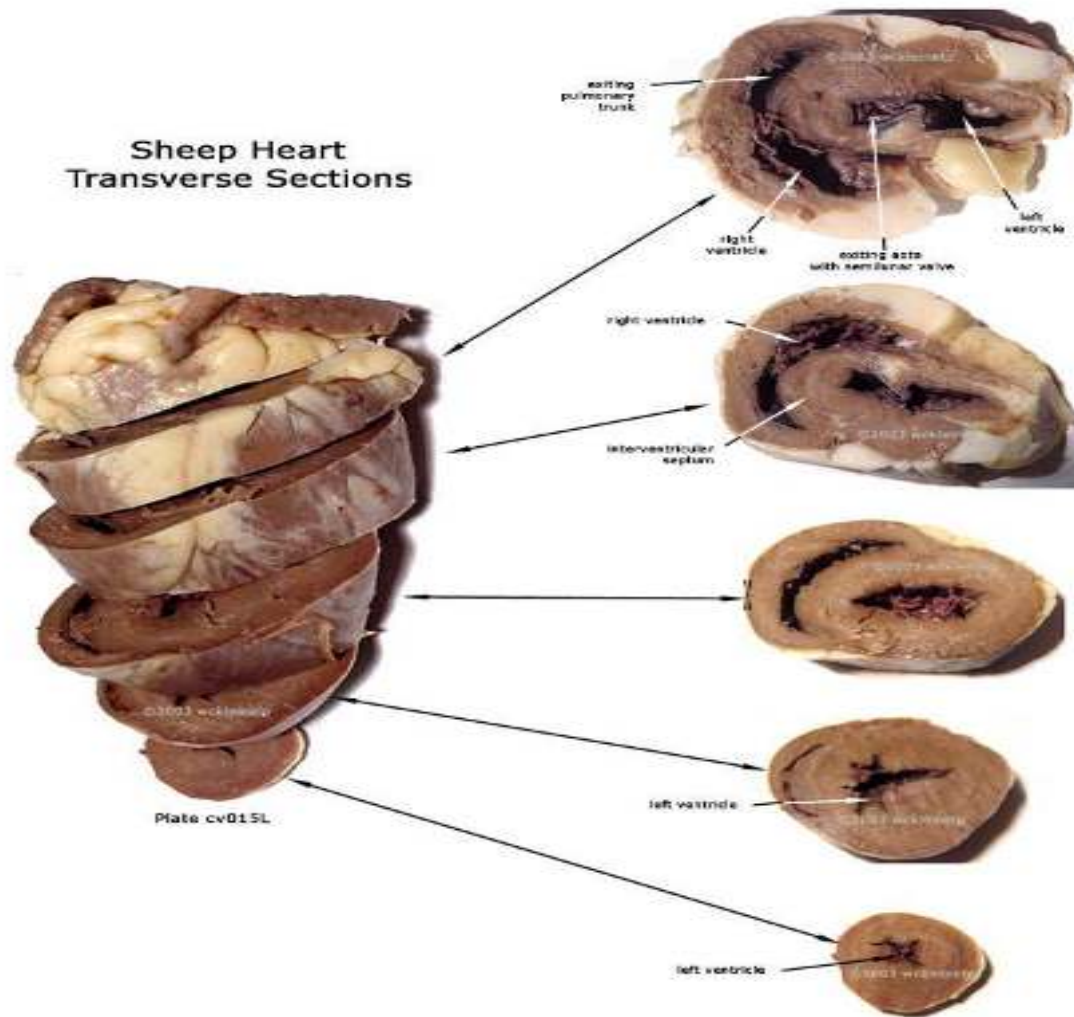
Semilunar valve closed

(b)



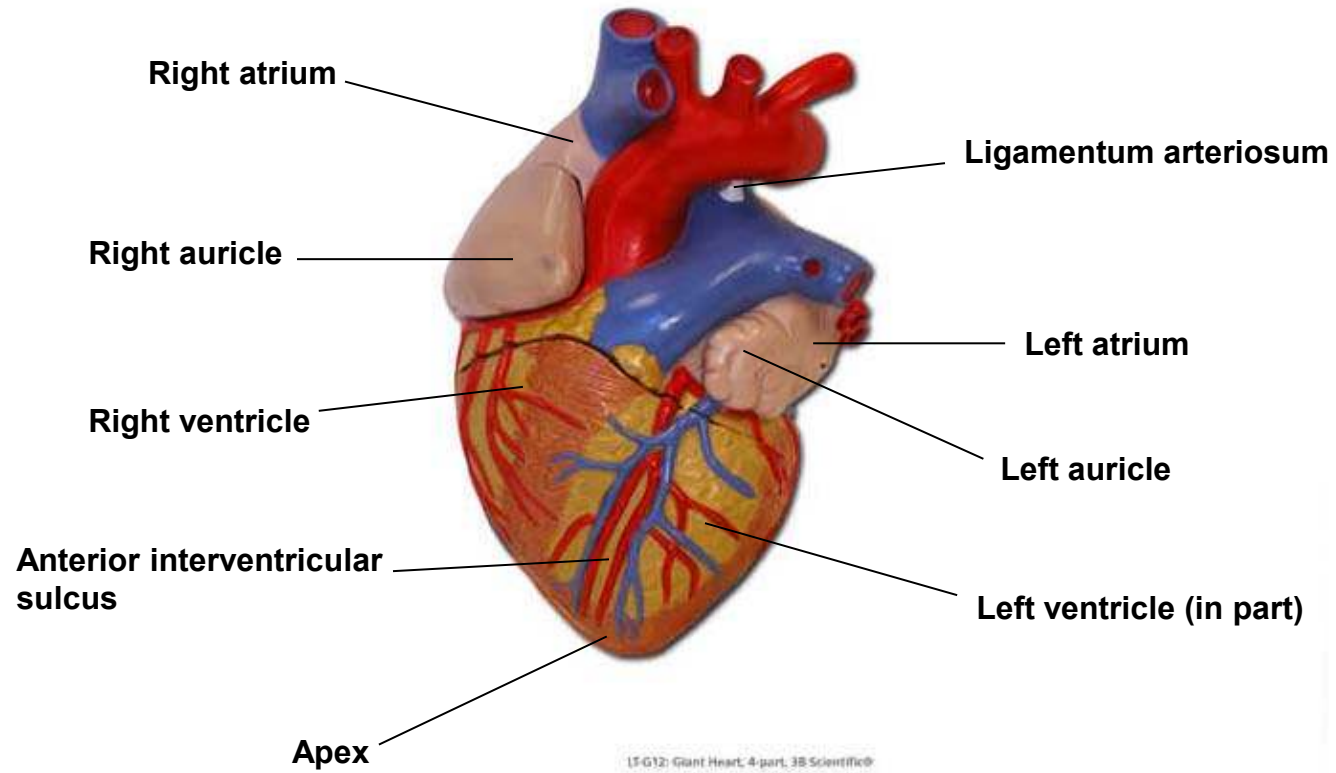


Sheep Heart Transverse Sections

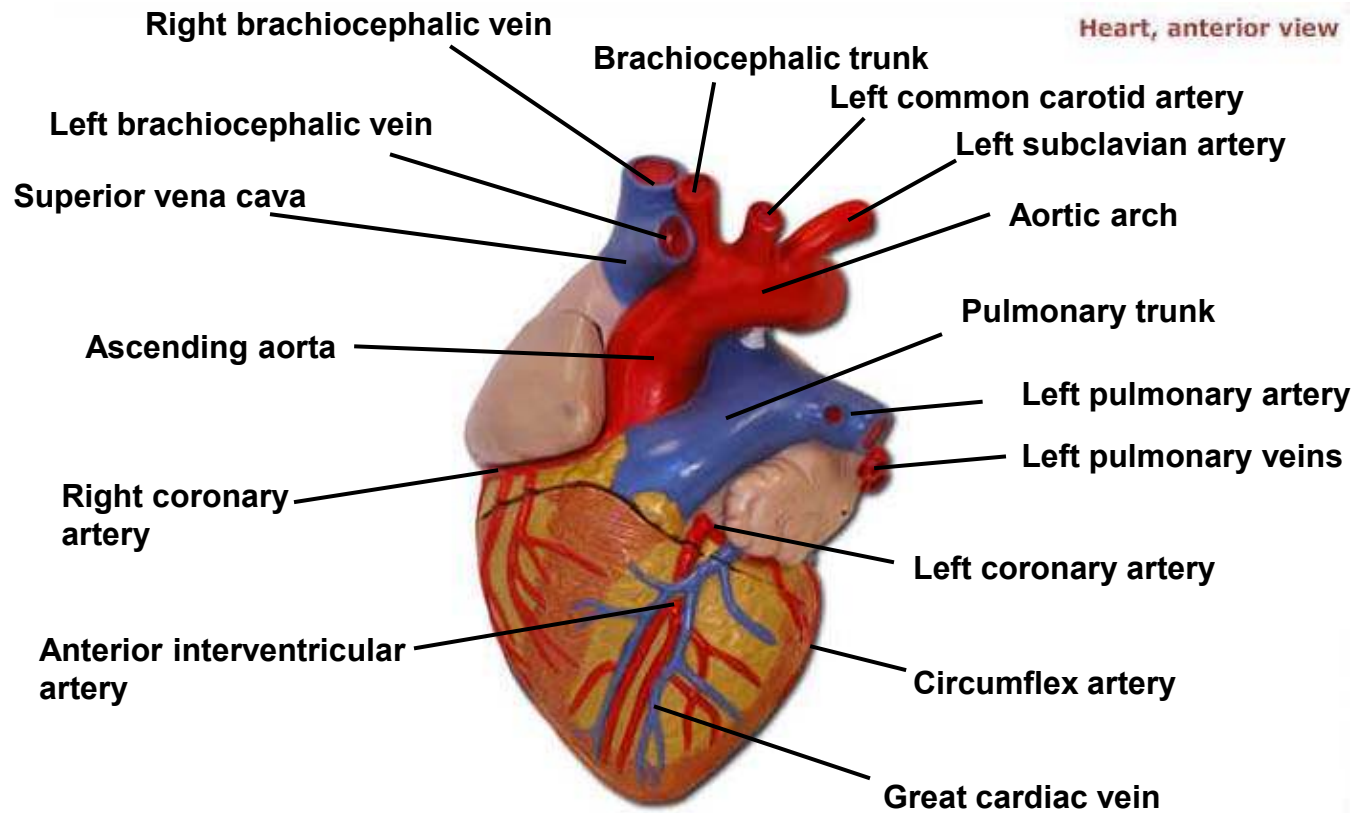


MODELS

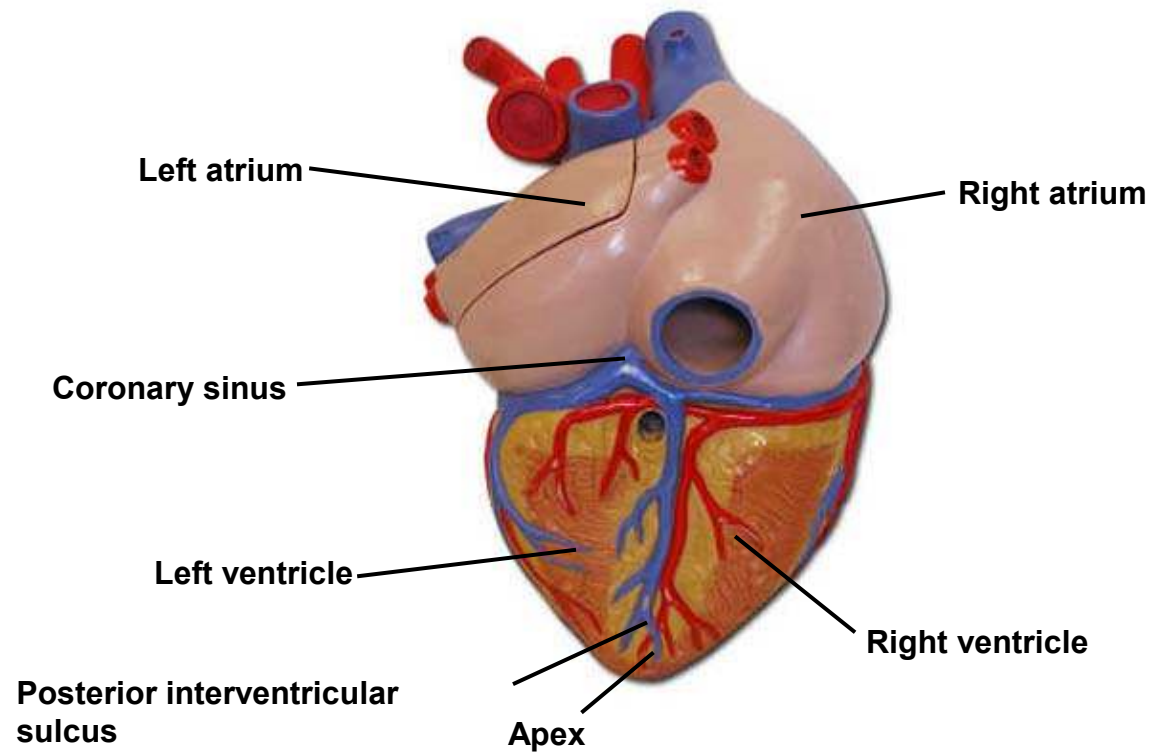
Heart, anterior view

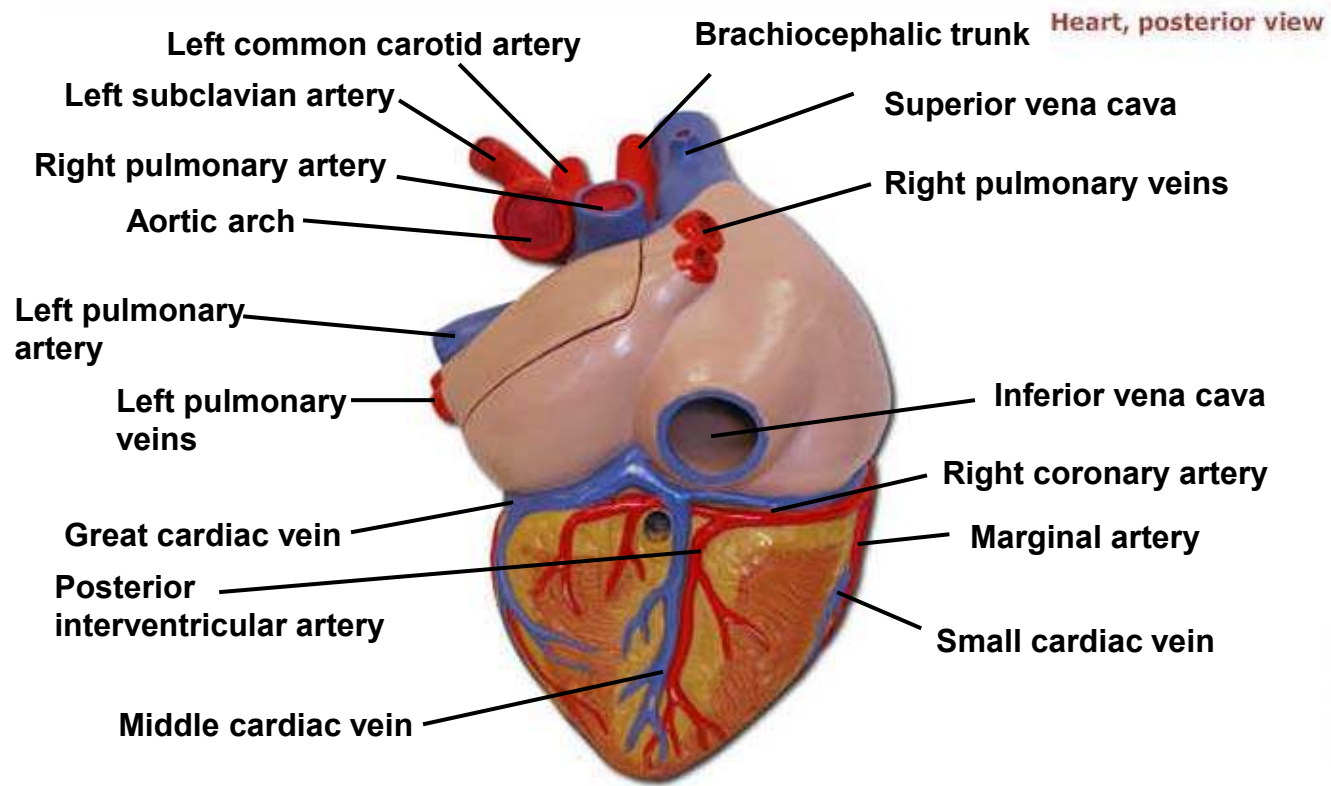


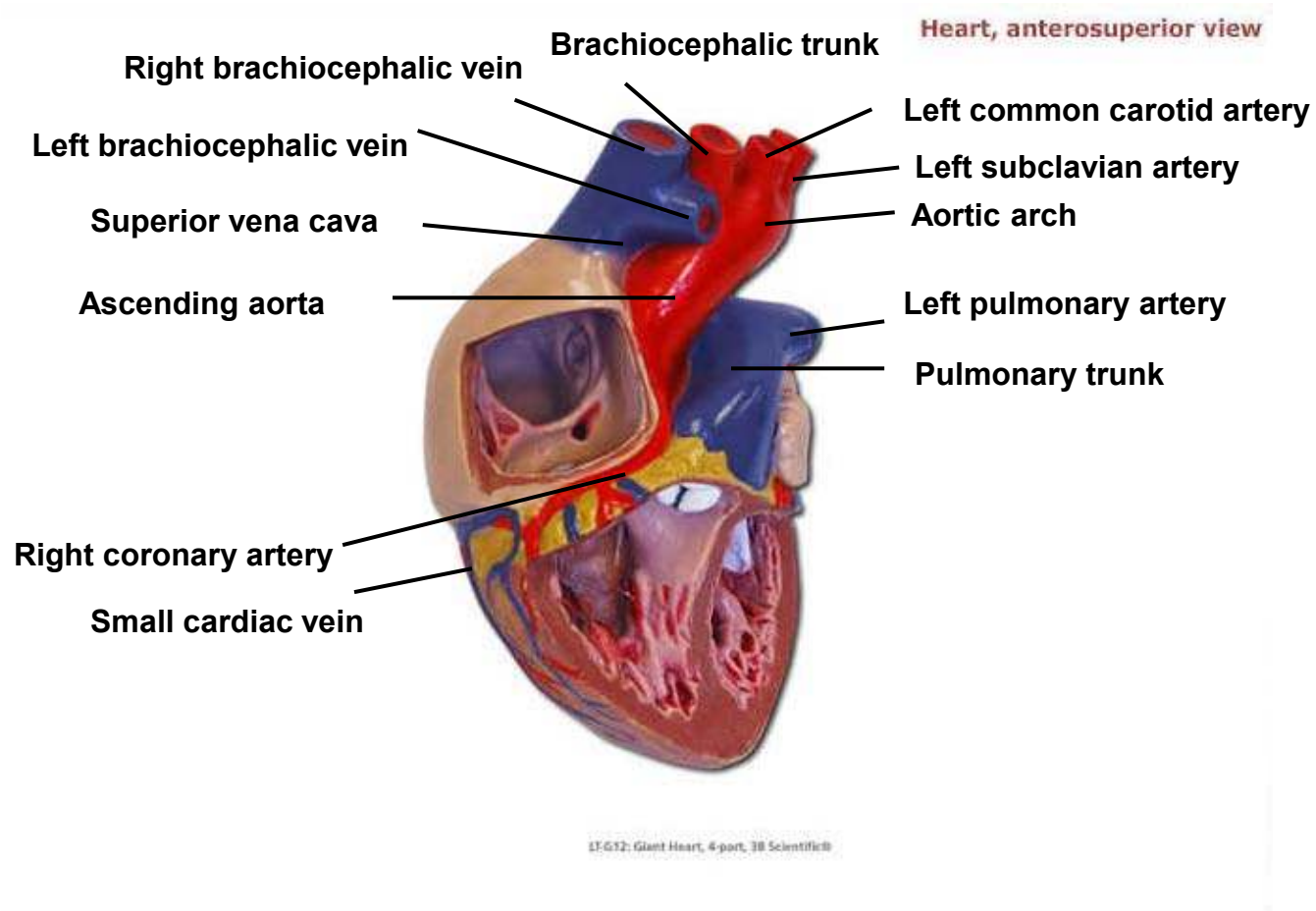
Heart, anterior view



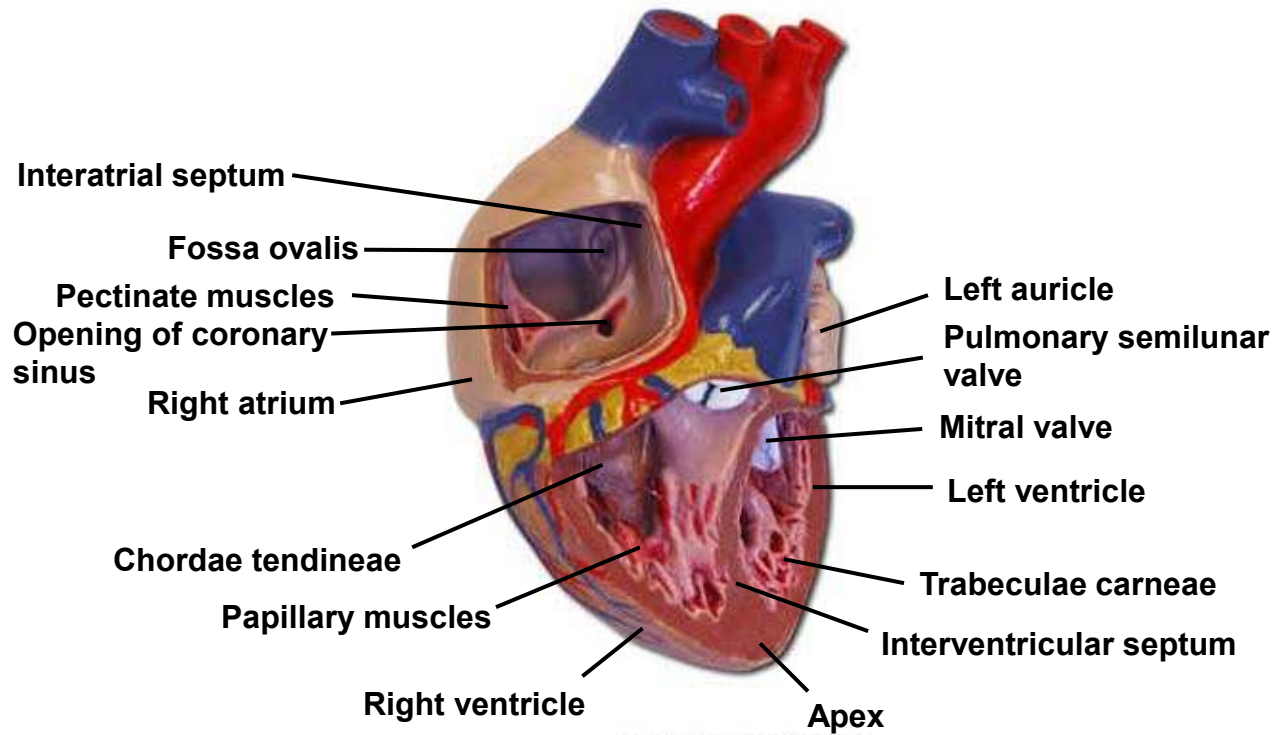
Heart, posterior view





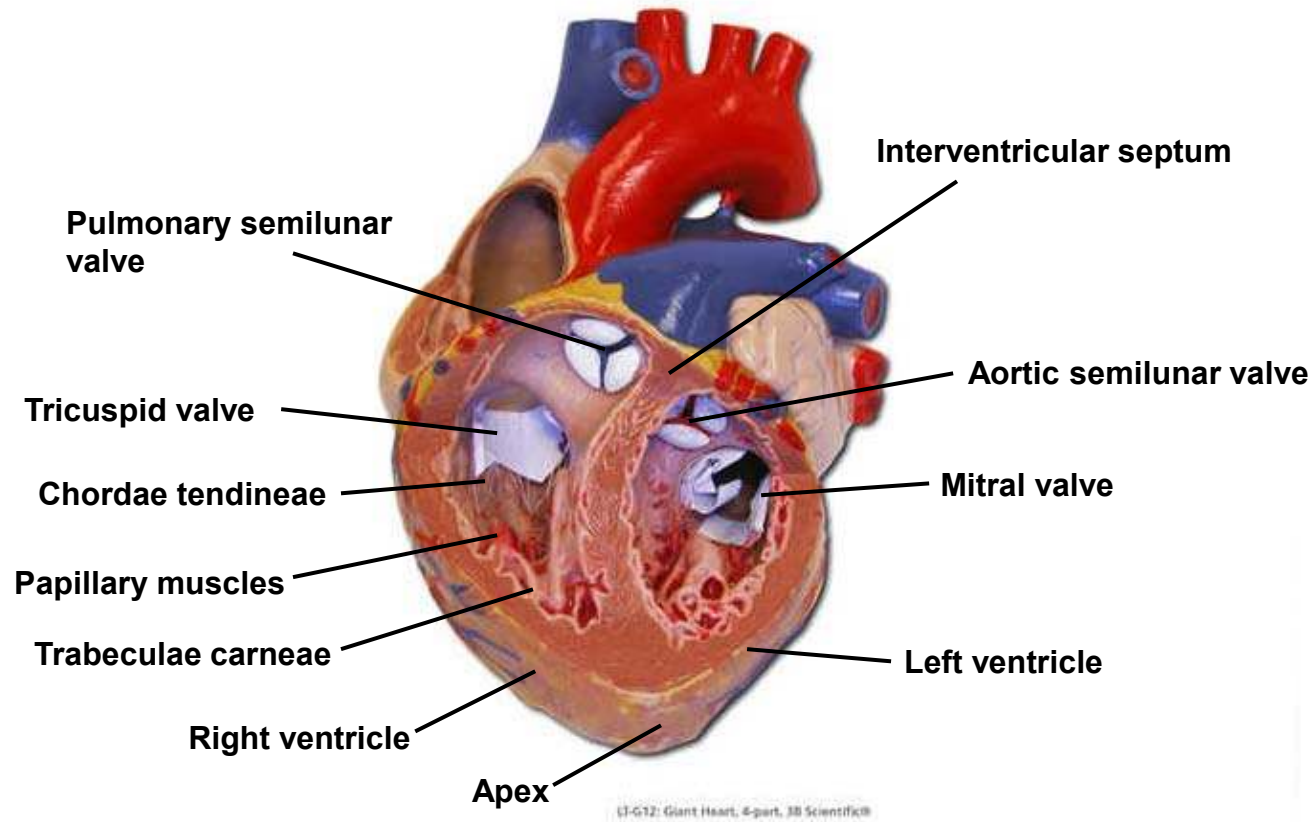


Heart, anterosuperior view



1F-612: Giant Heart, 4-part, 30 Scientific®

Heart, anteroinferior view



Coronary circulation



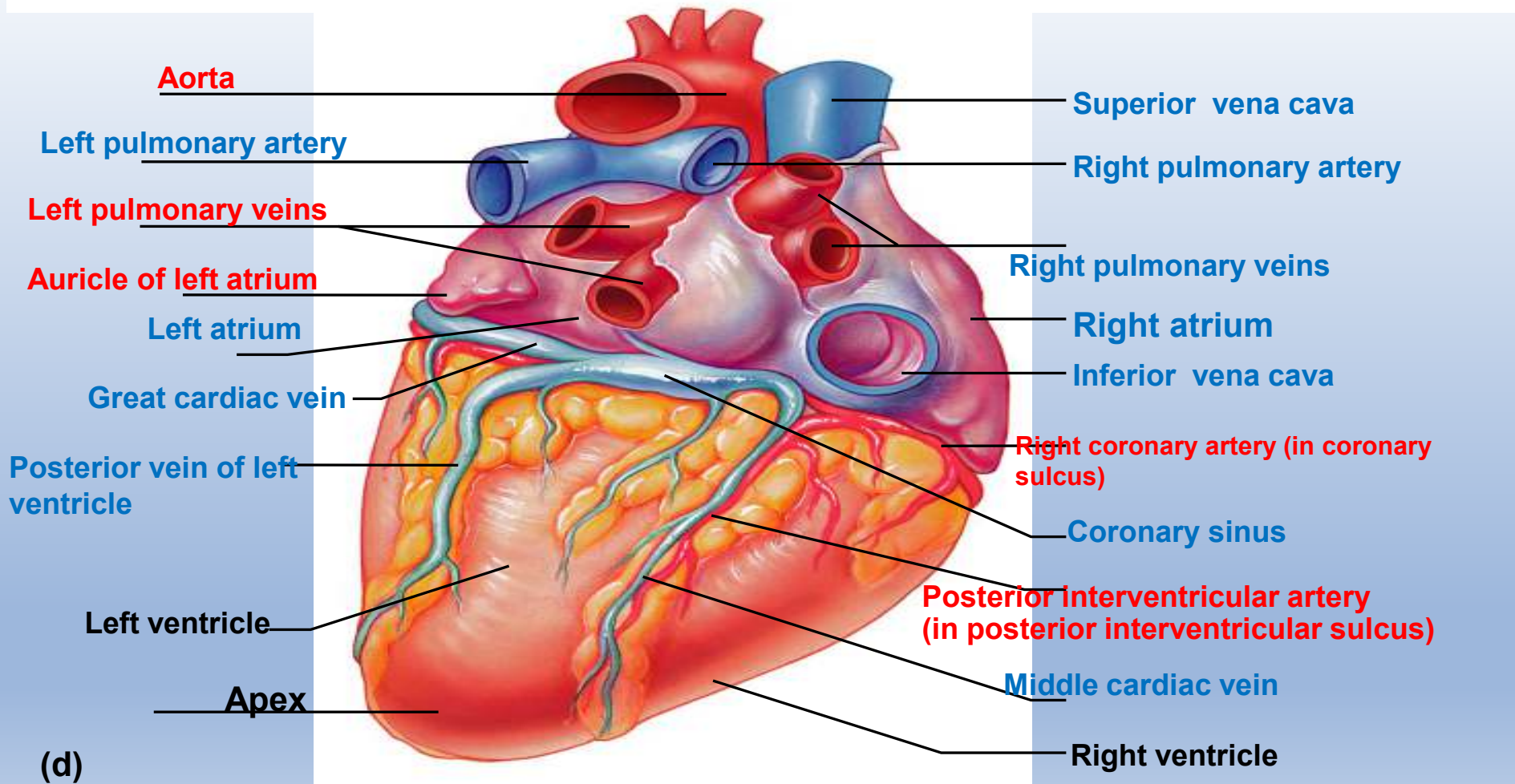
External Heart: Vessels that Supply/Drain the Heart (Posterior View)

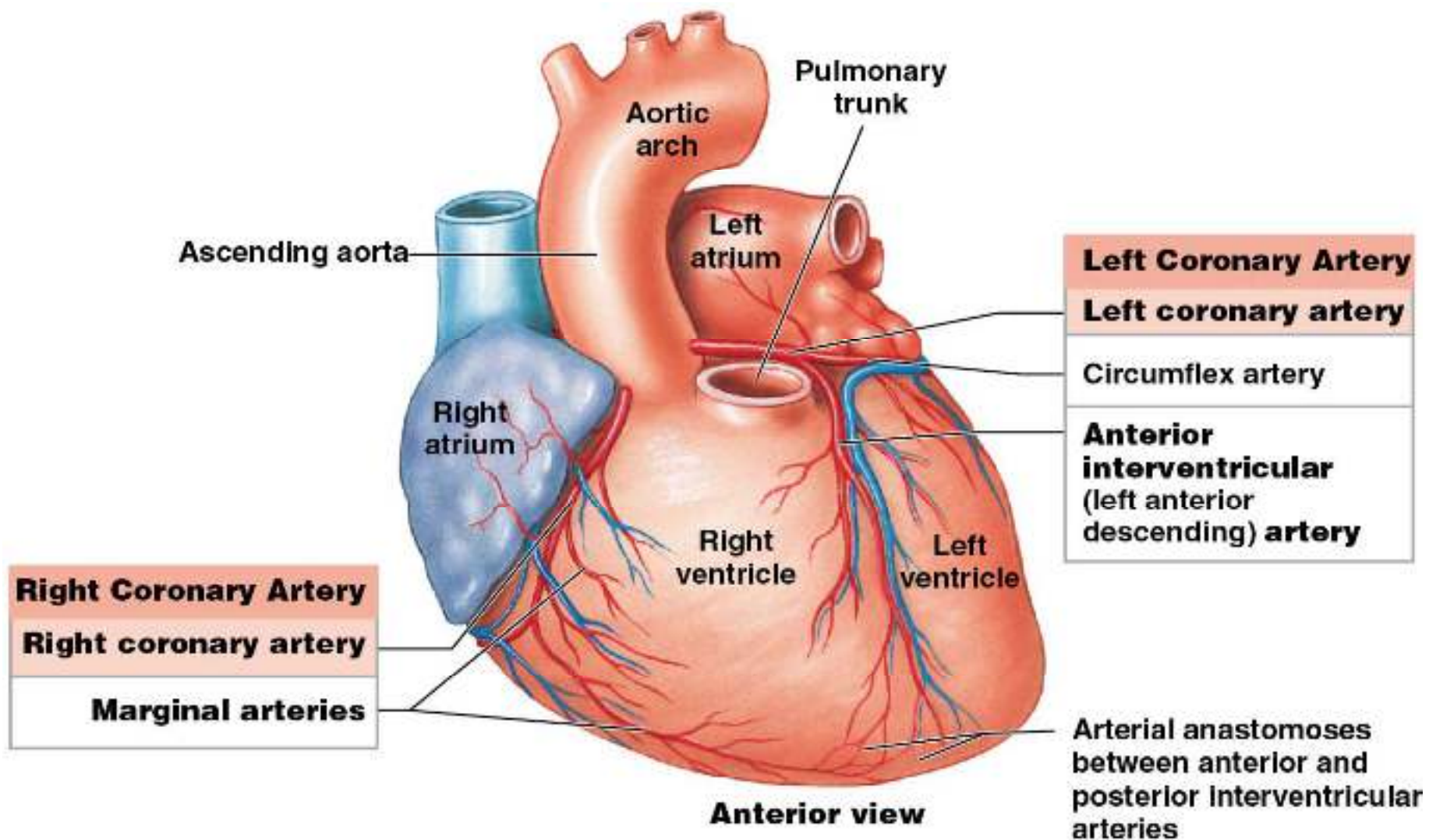
□ Arteries –

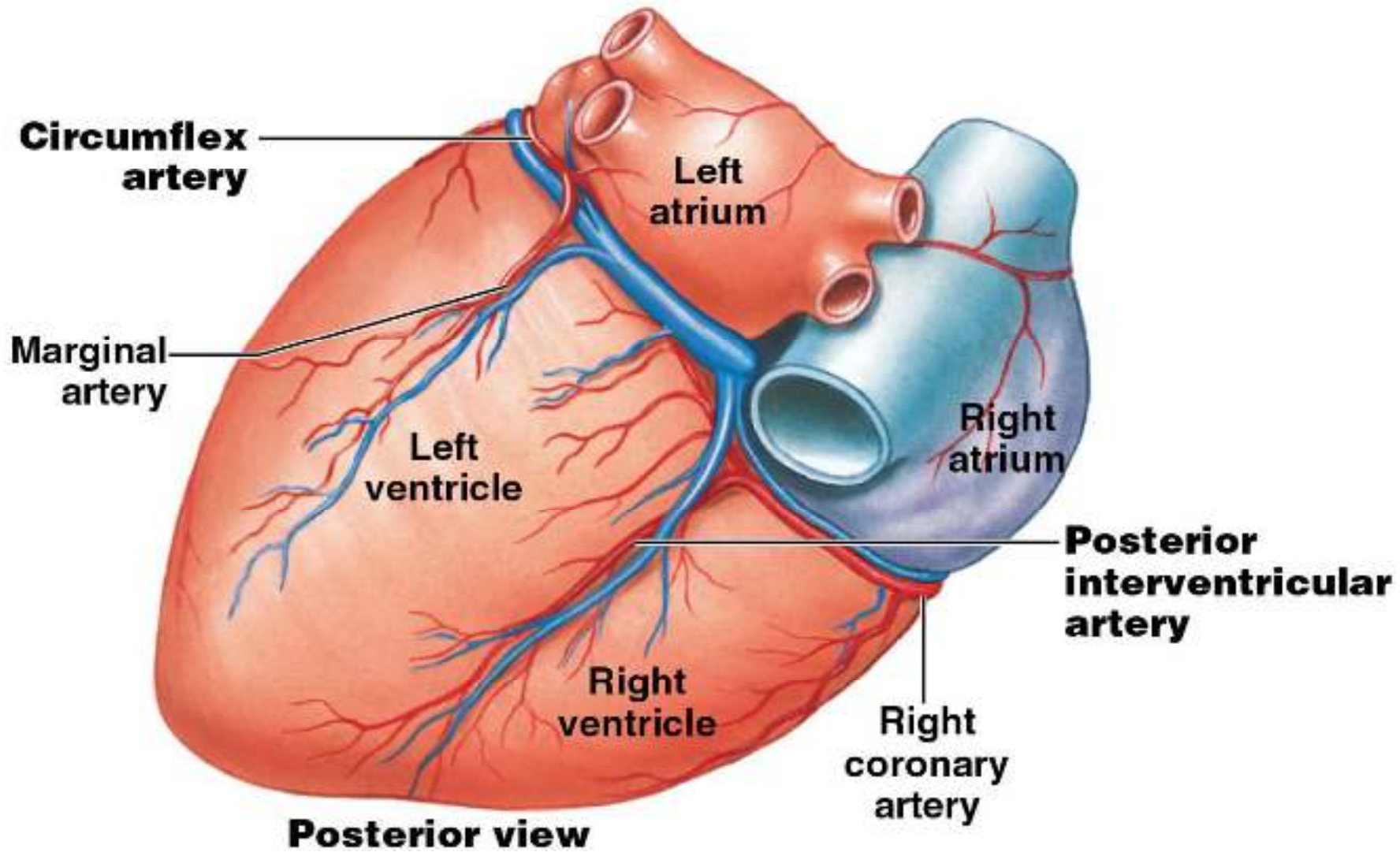
- right coronary artery (in atrioventricular groove)
- the posterior interventricular artery (in interventricular groove)

□ Veins –

- great cardiac vein,
- posterior vein to left ventricle,
- coronary sinus,
- middle cardiac vein

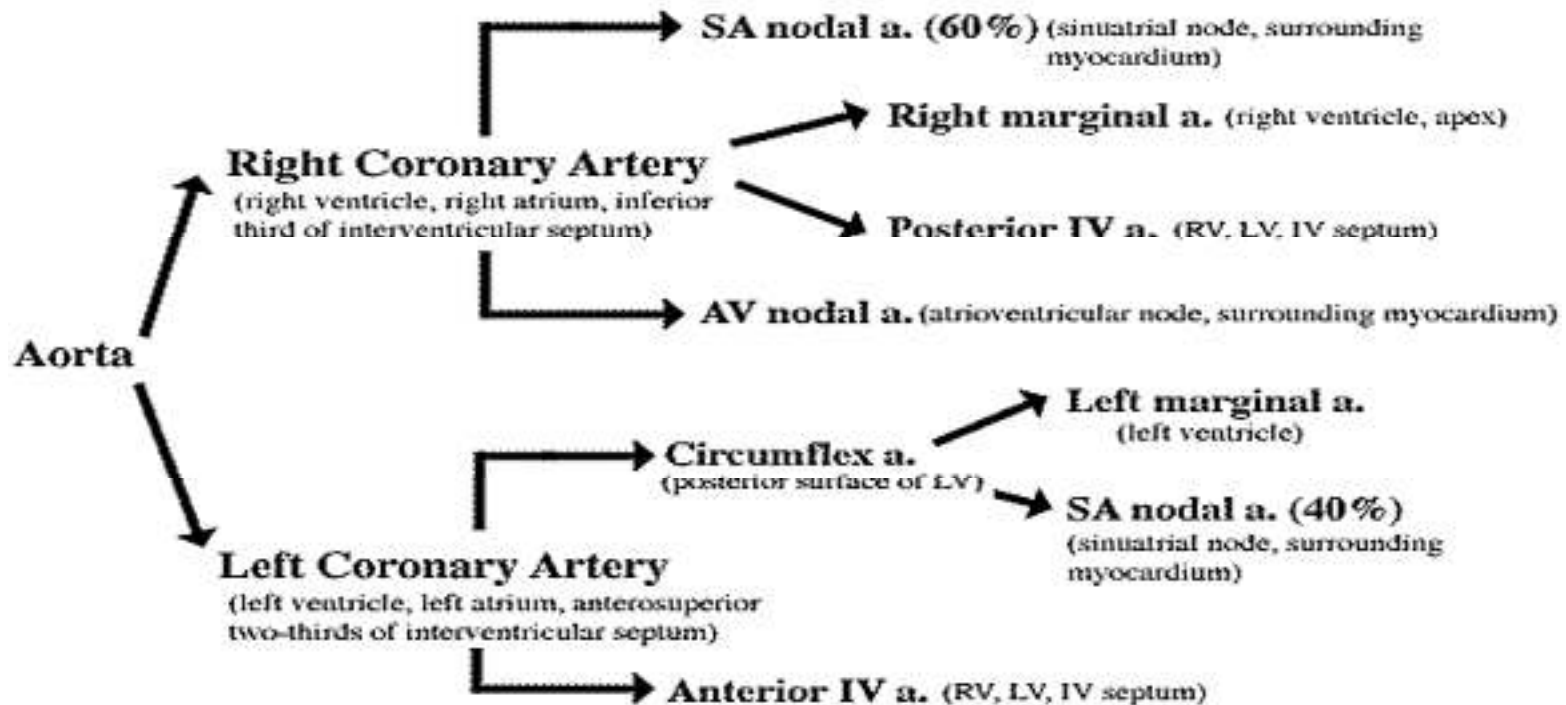




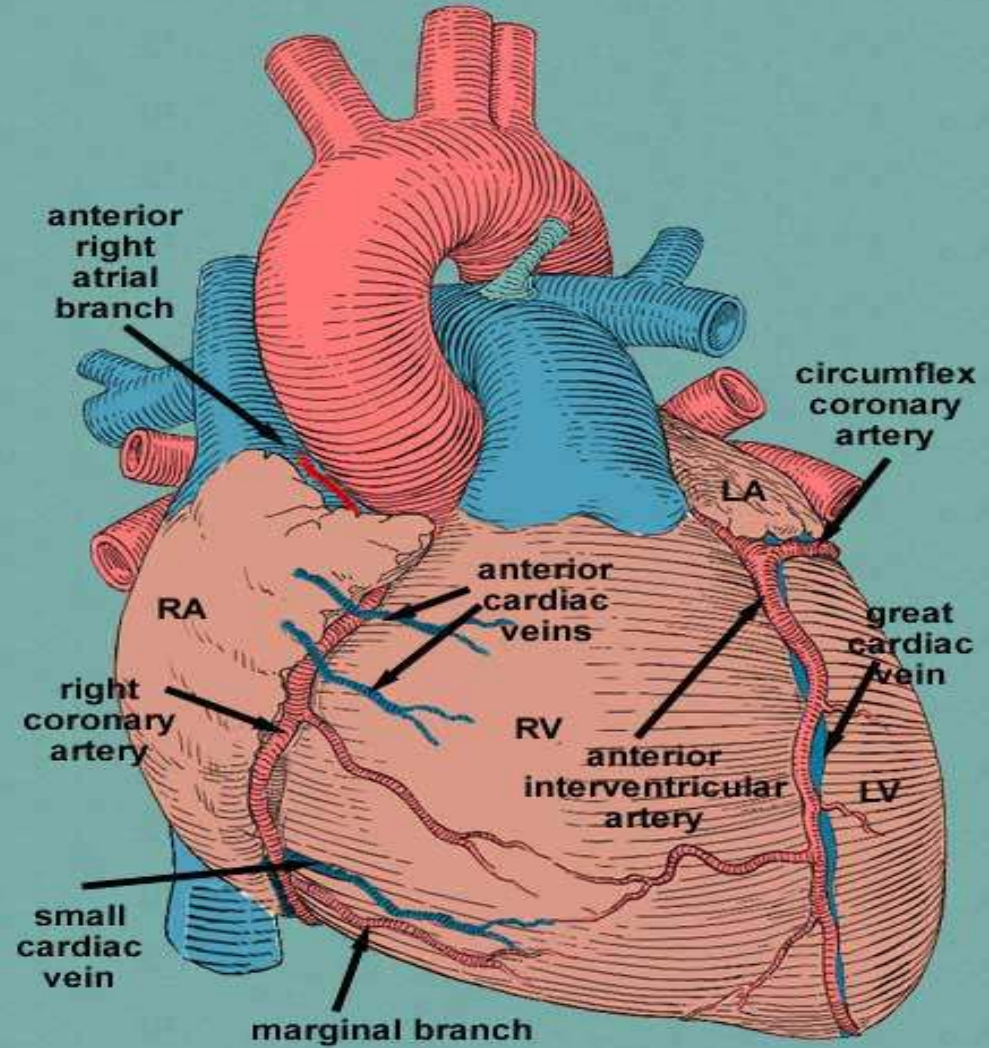
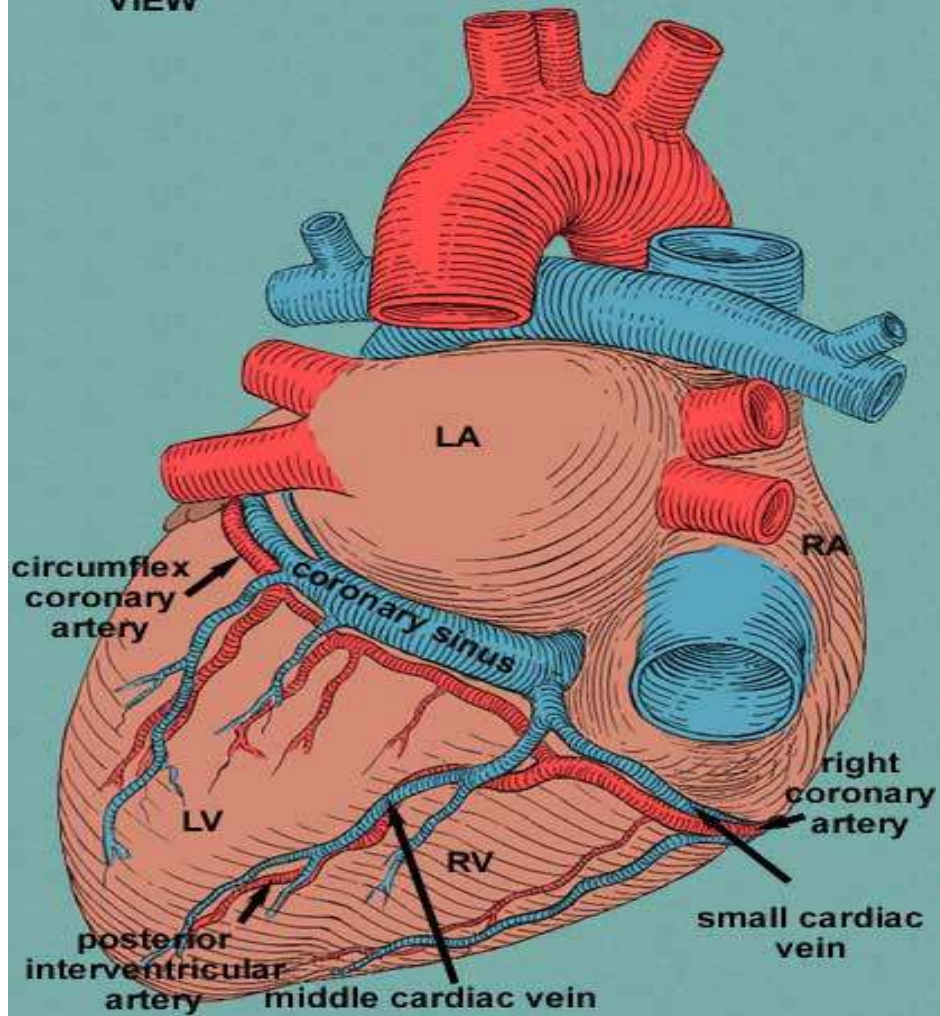


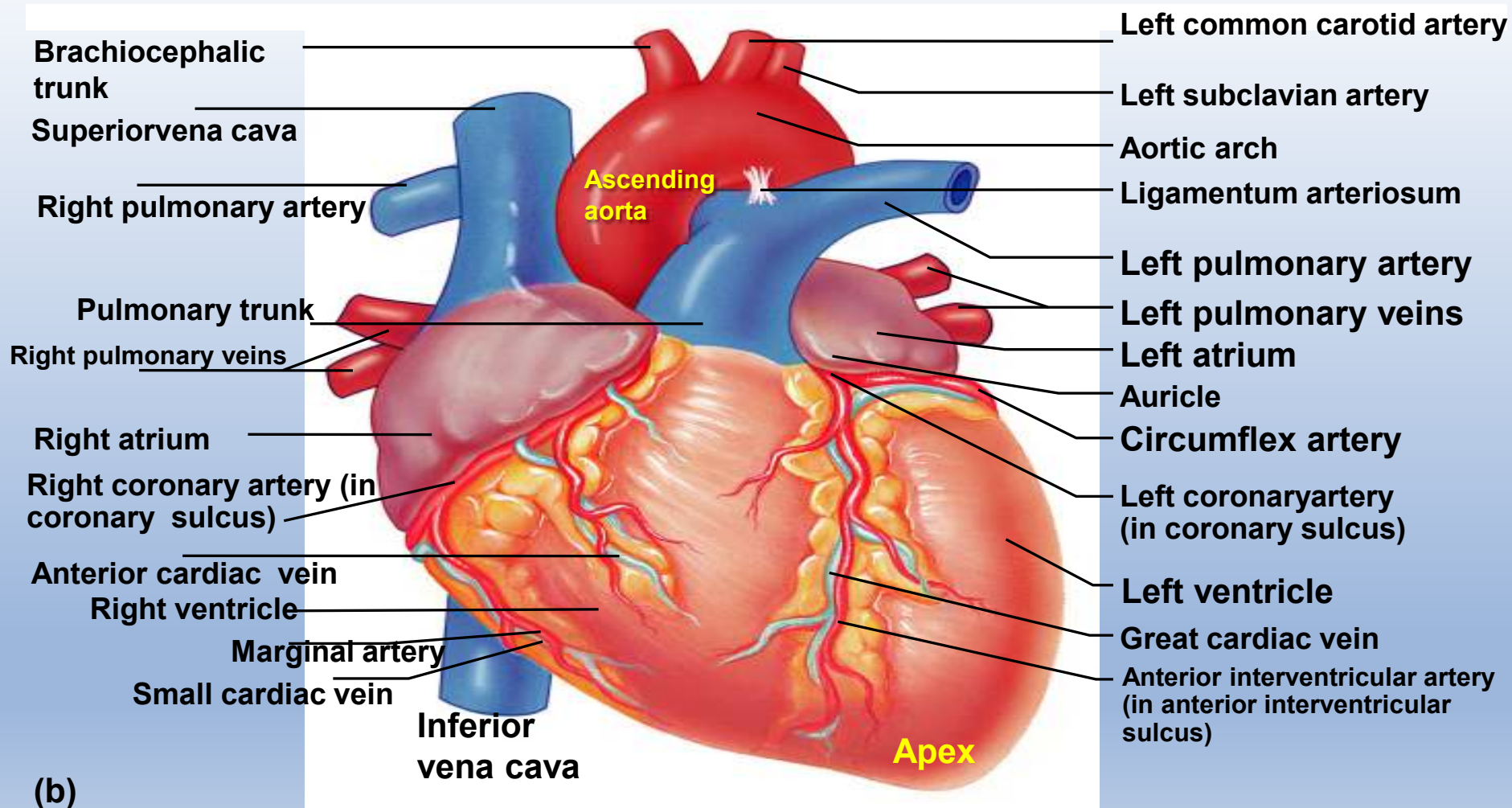
Coronary Circulation

- Coronary circulation is **the functional blood supply to the heart muscle itself**
- Collateral routes **ensure blood delivery to heart** even if major vessels are occluded



**POSTERIOR
VIEW**





Brachiocephalic trunk

Superior vena cava

Right pulmonary artery

Pulmonary trunk

Right pulmonary veins

Right atrium

Right coronary artery (in coronary sulcus)

Anterior cardiac vein

Right ventricle

Marginal artery

Small cardiac vein

Inferior vena cava

Left common carotid artery

Left subclavian artery

Aortic arch

Ligamentum arteriosum

Left pulmonary artery

Left pulmonary veins

Left atrium

Auricle

Circumflex artery

Left coronary artery (in coronary sulcus)

Left ventricle

Great cardiac vein

Anterior interventricular artery (in anterior interventricular sulcus)

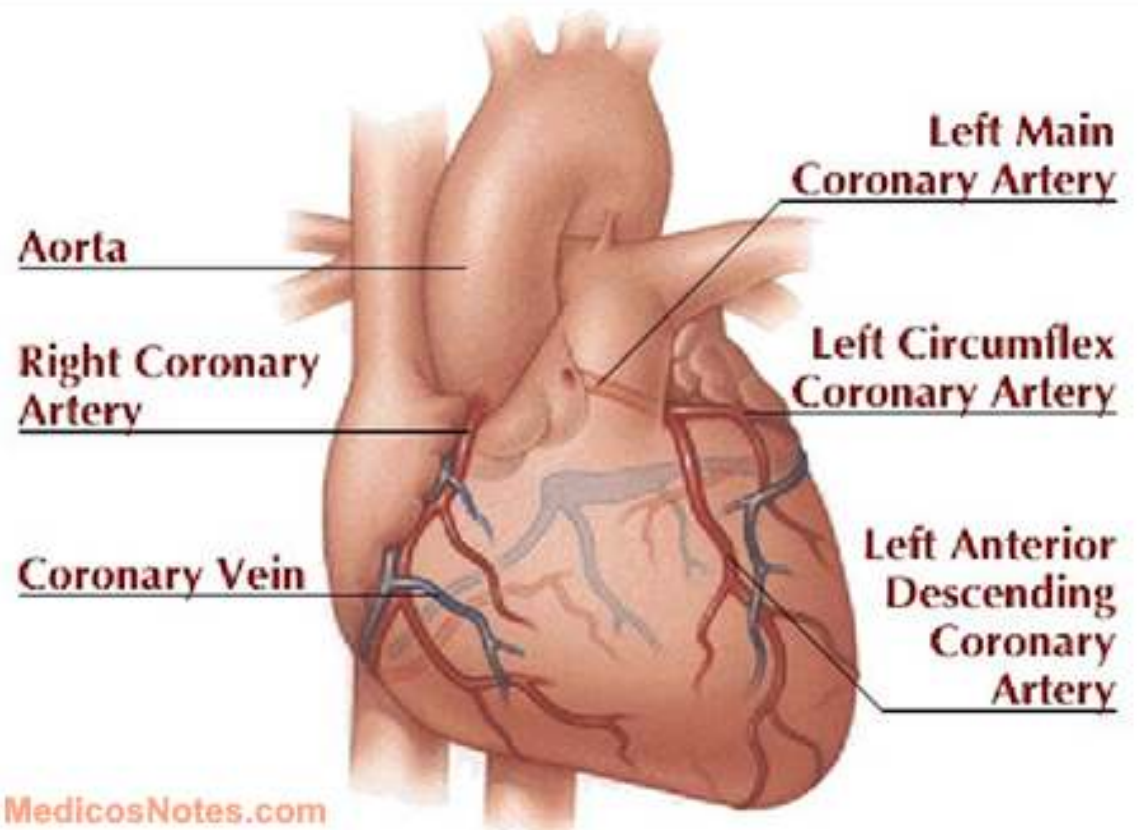
Ascending aorta

Apex

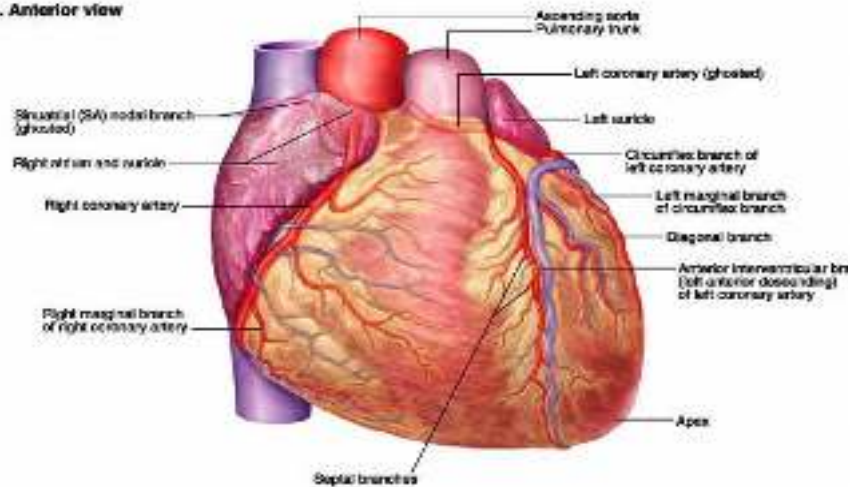
(b)

External Heart: Vessels that Supply/Drain the Heart (Anterior View)

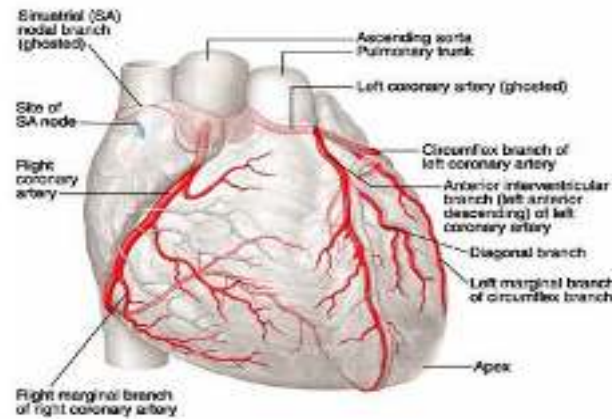
- **Arteries** –
 - right and left coronary (in atrioventricular groove),
 - marginal,
 - circumflex,
 - anterior interventricular arteries
- **Veins** –
 - small cardiac,
 - anterior cardiac
 - great cardiac veins



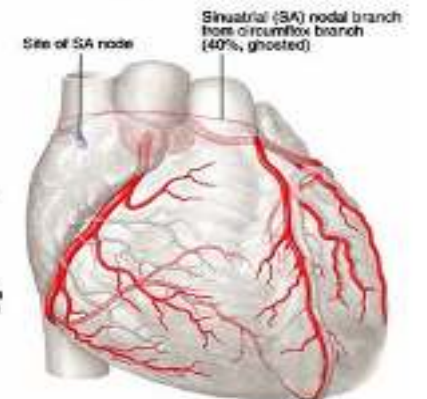
A. Anterior view



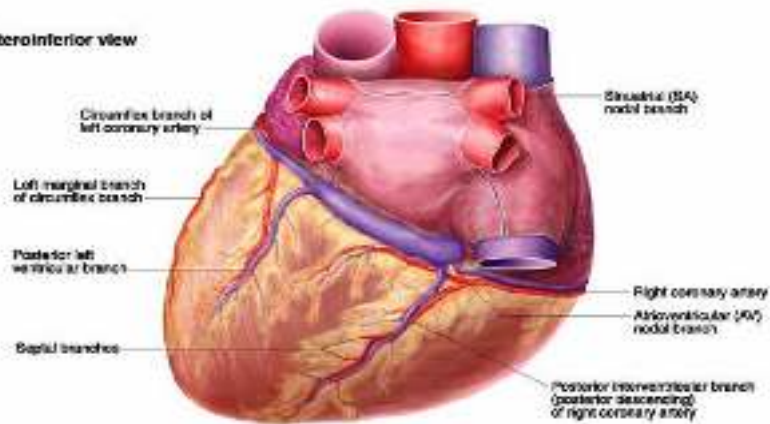
A. Normal arterial pattern, anterior view



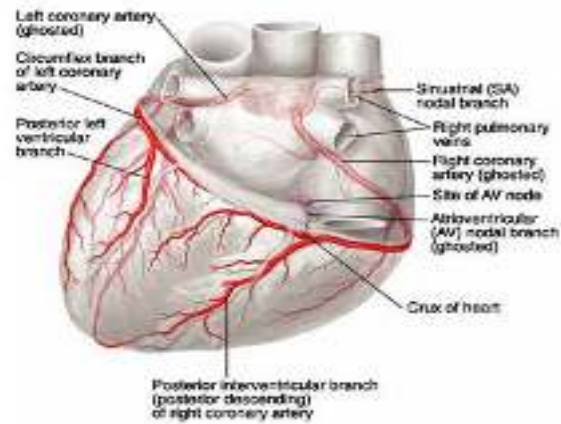
B. Variation, anterior view



B. Posteroinferior view



C. Normal arterial pattern, posteroinferior view



D. Variation, posteroinferior view

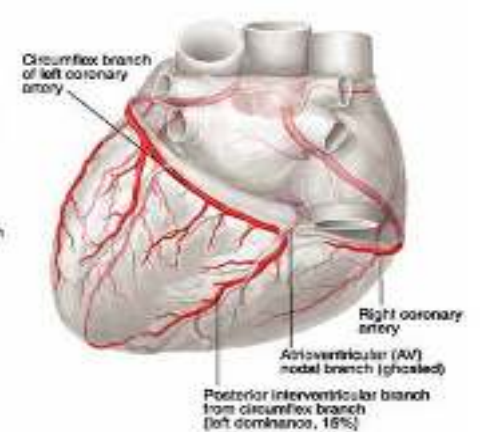
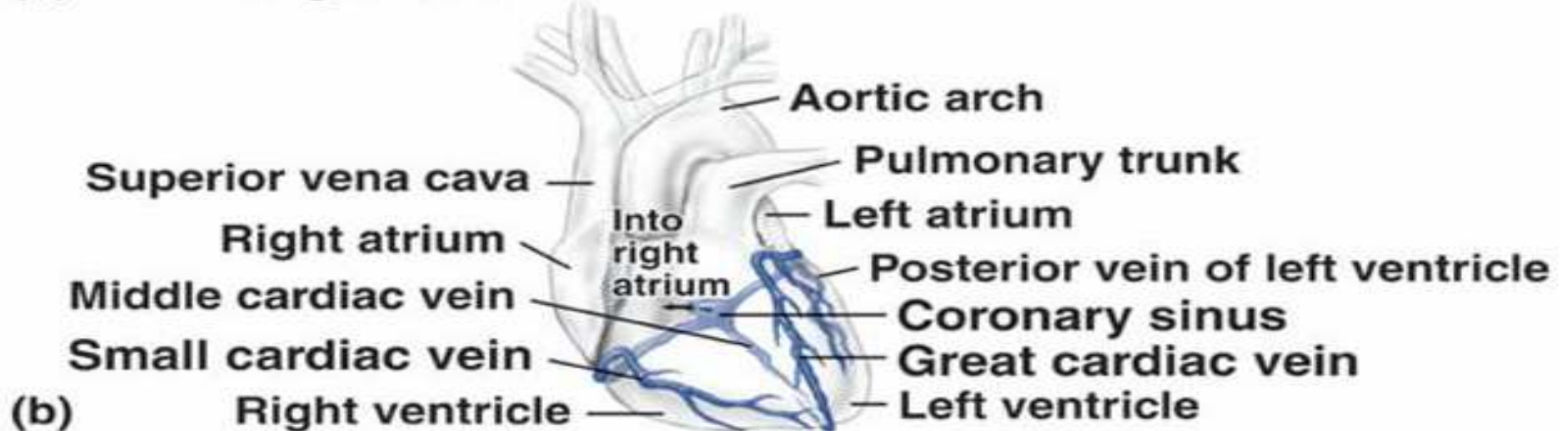
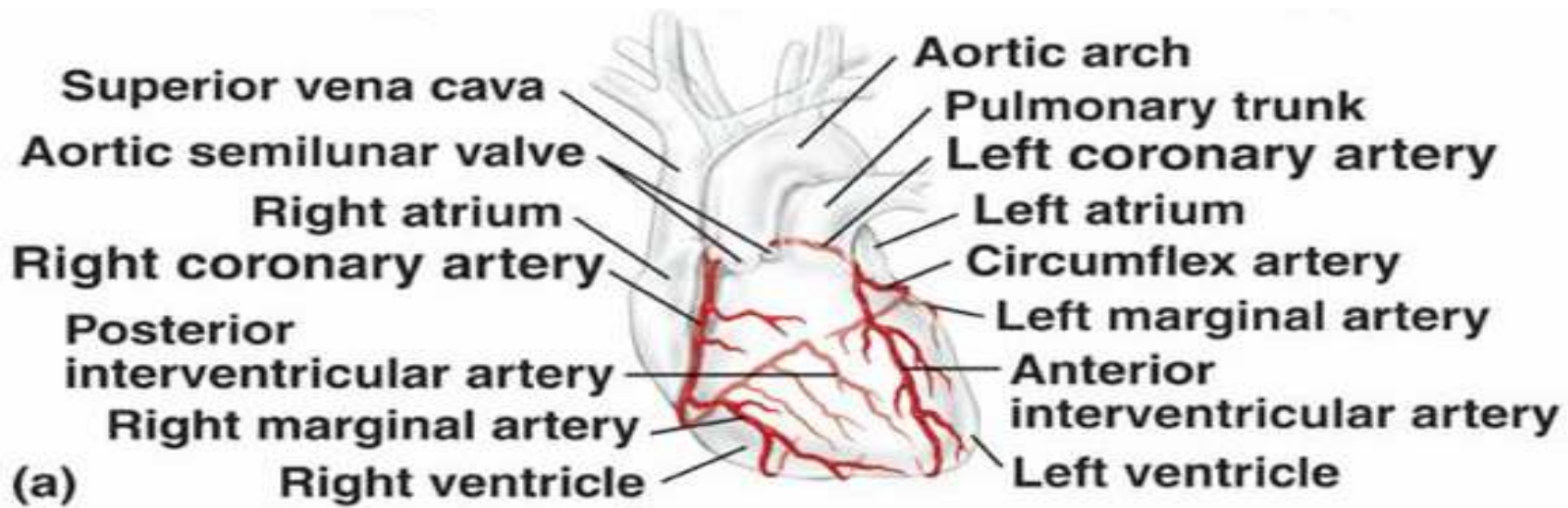
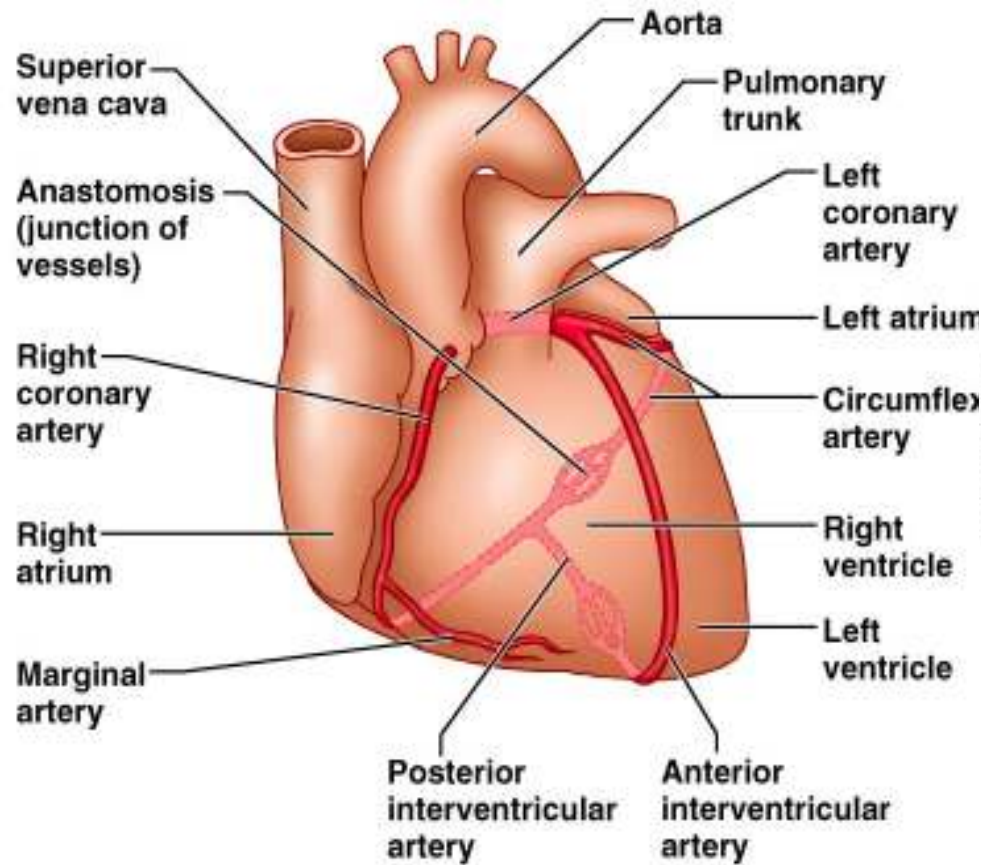


Plate 4-22 Coronary Arteries

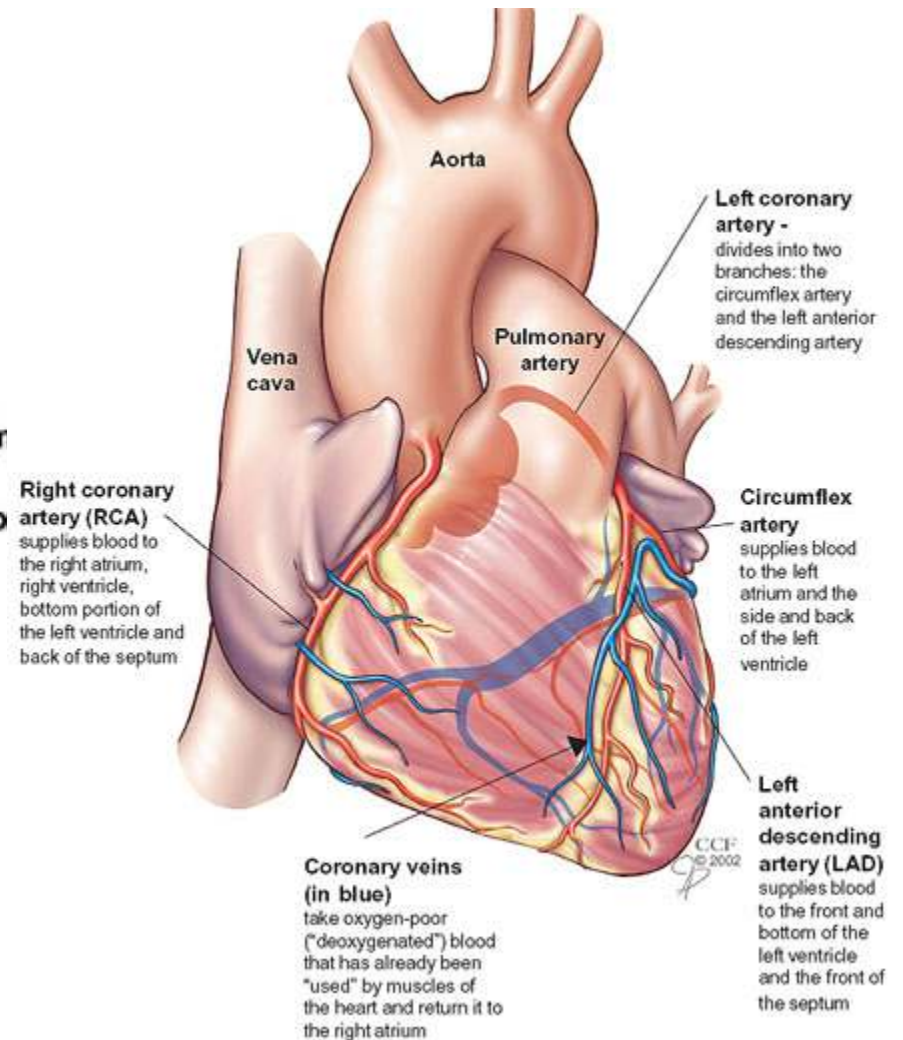
Plate 4-23 Coronary Arteries; Normal Patterns and Variations

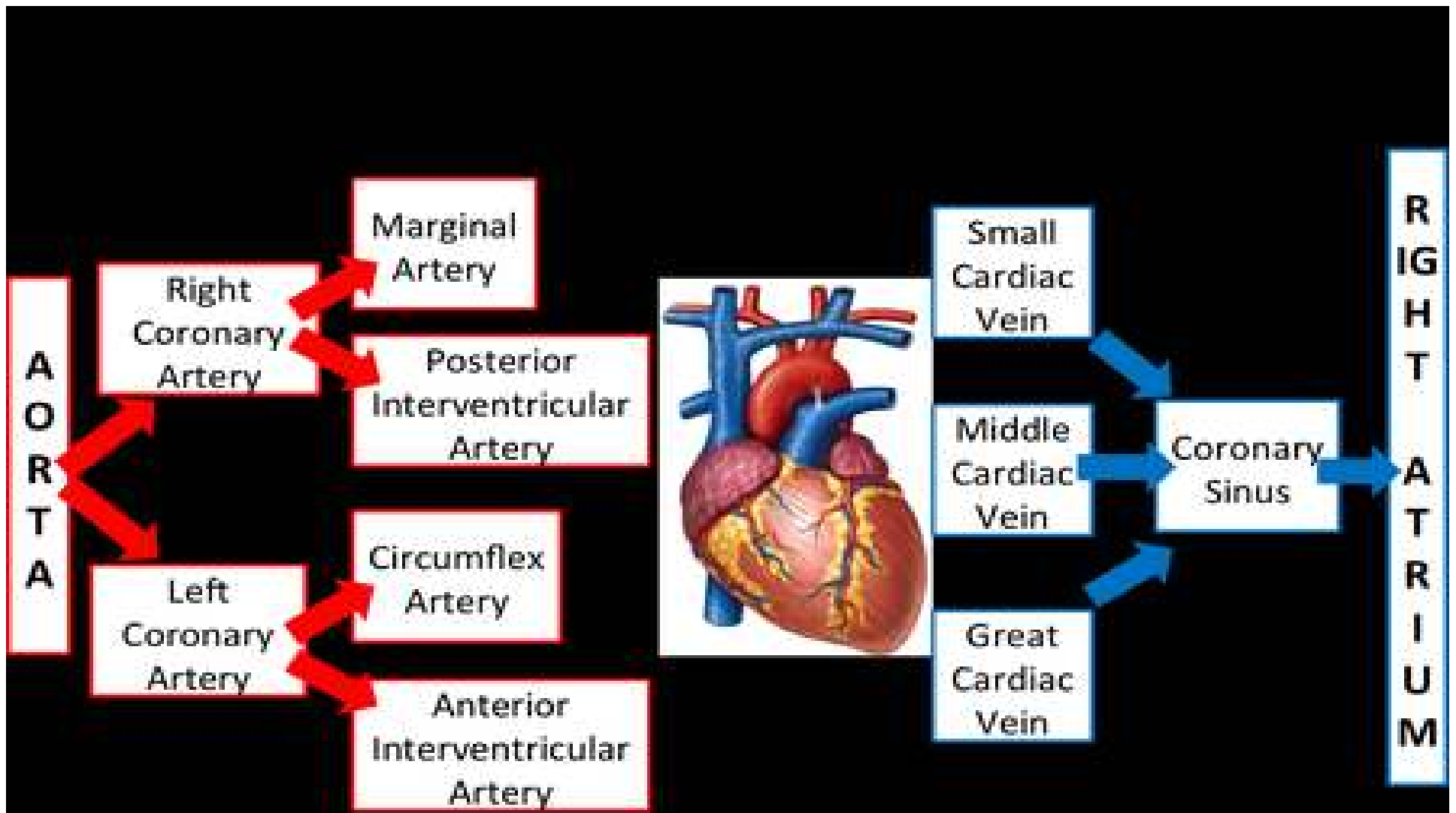


Coronary Circulation: Arterial Supply

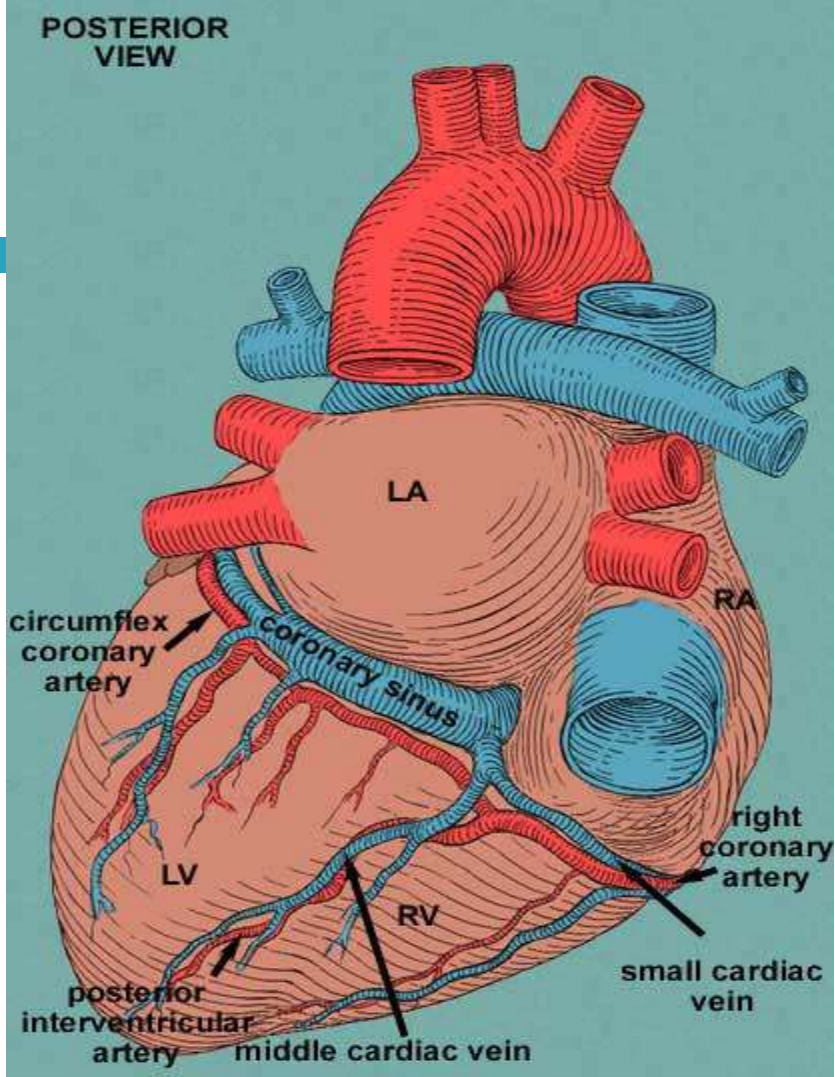
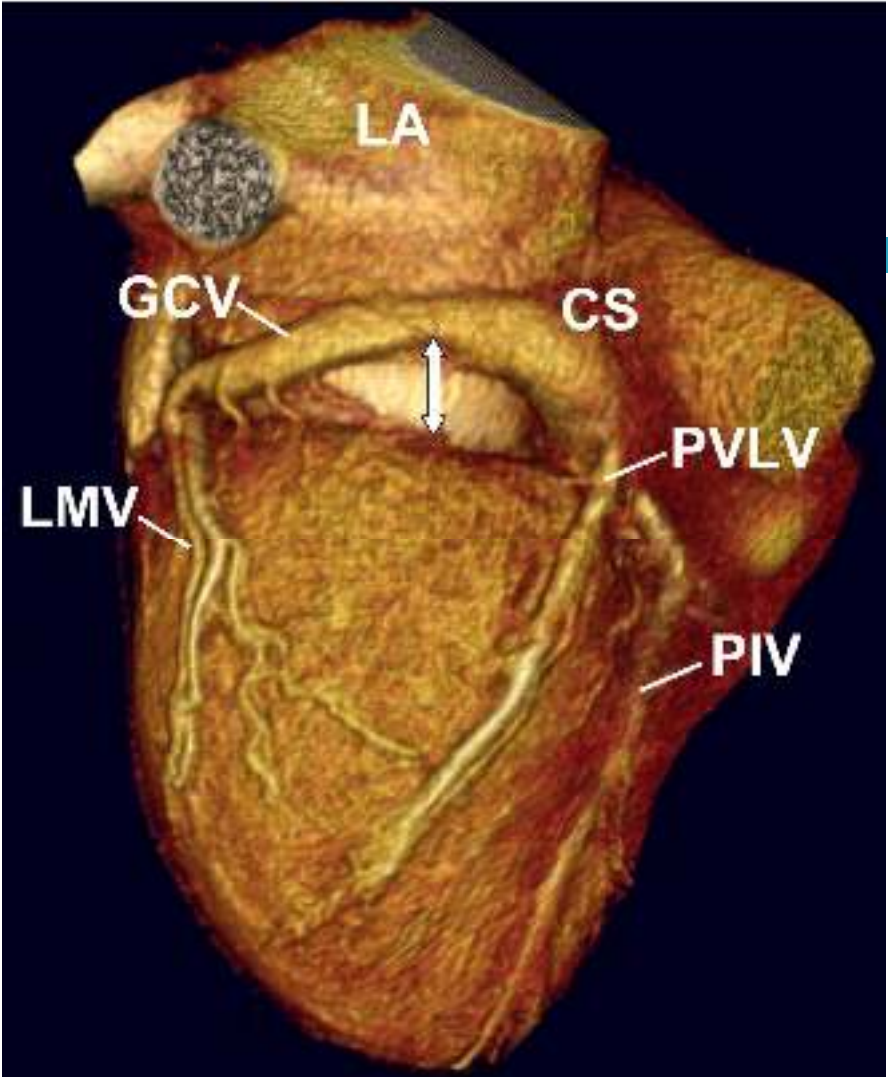


(a)

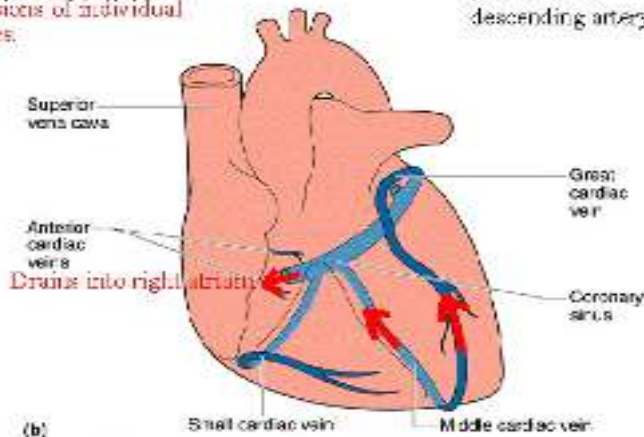
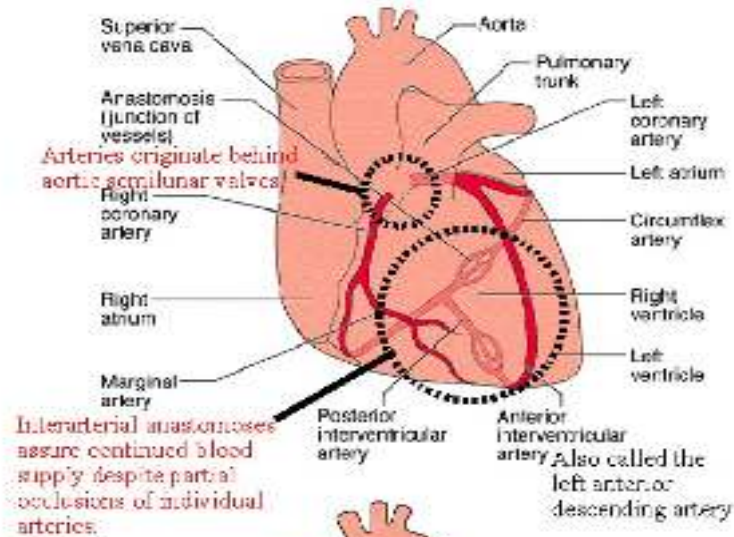




CORONARY SINUS

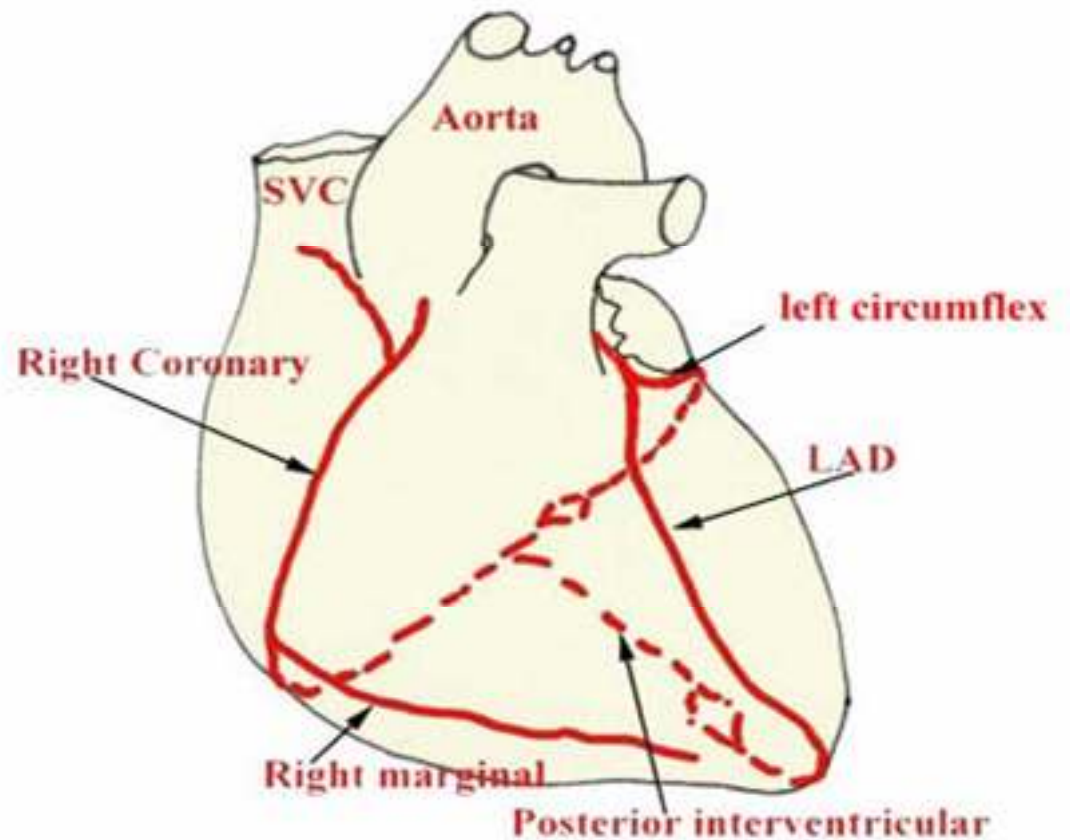


The Coronary Circulation

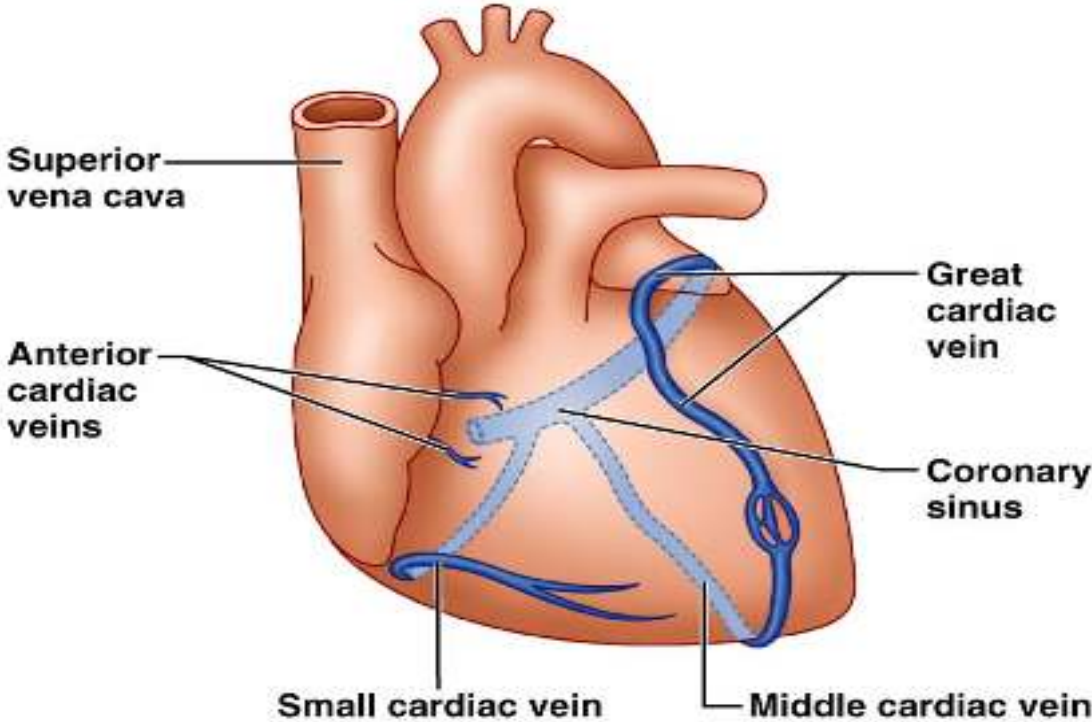


(b)

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Coronary Circulation: Venous Supply



(b)

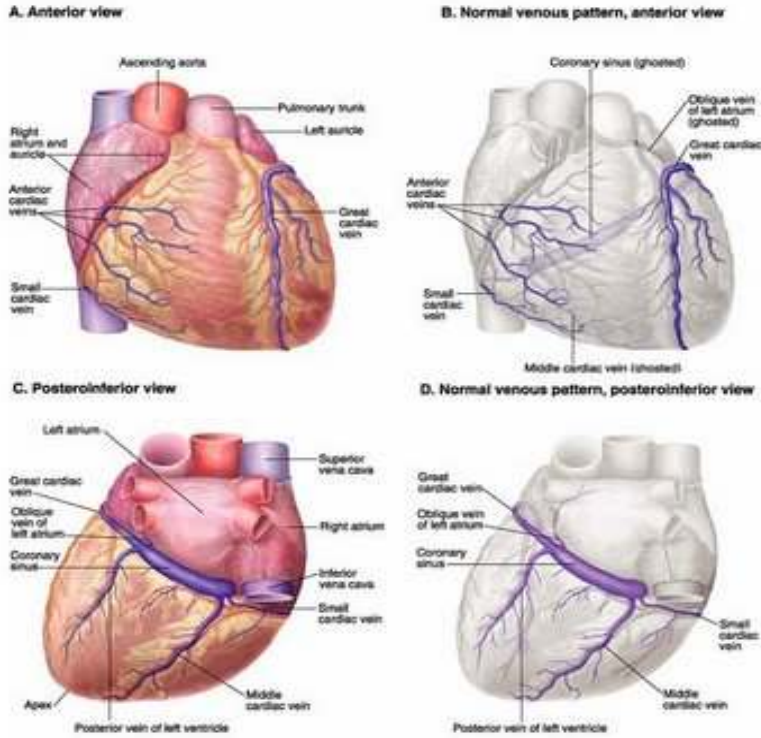
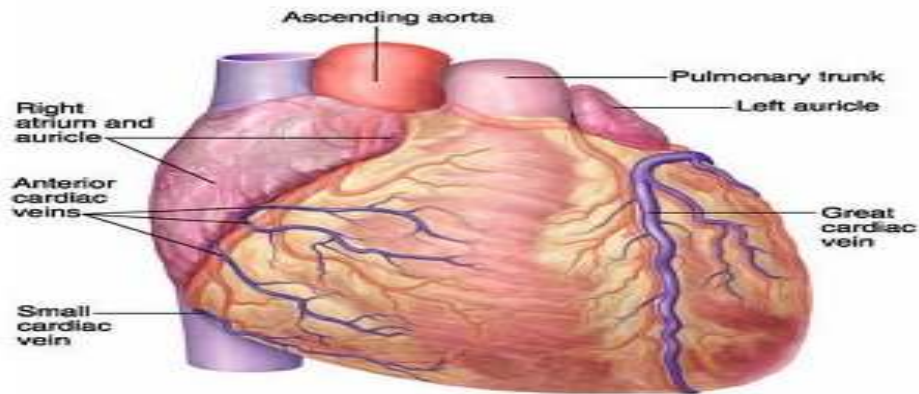
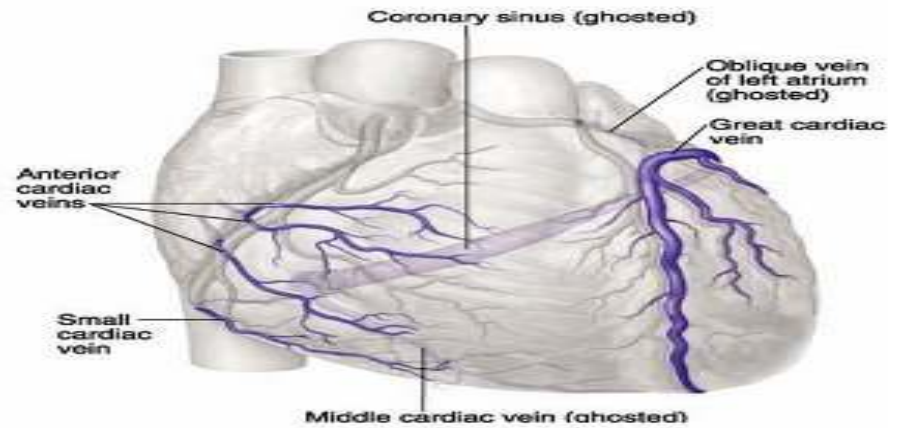


Plate 4-24 Cardiac Veins

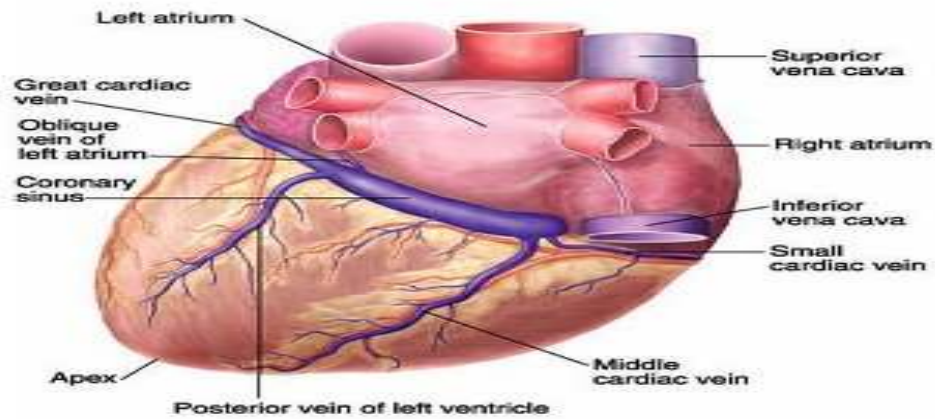
A. Anterior view



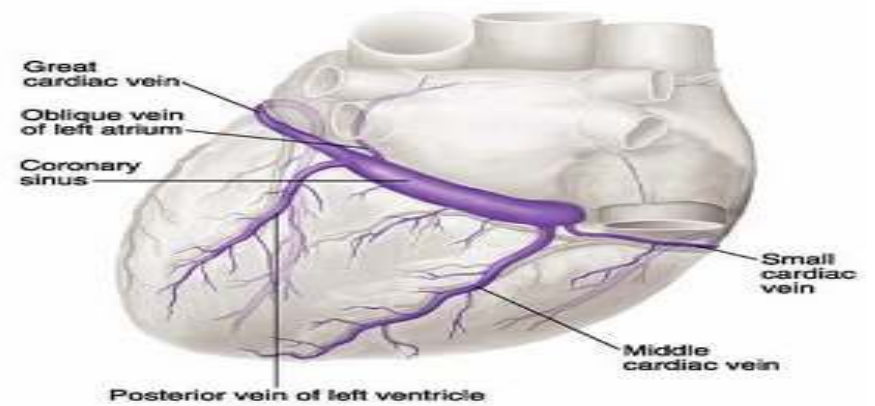
B. Normal venous pattern, anterior view



C. Posteroinferior view



D. Normal venous pattern, posteroinferior view



Myocardial Segment Anatomy

