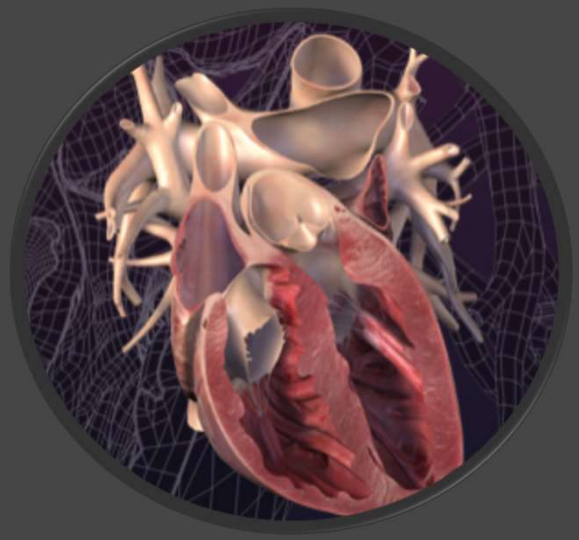
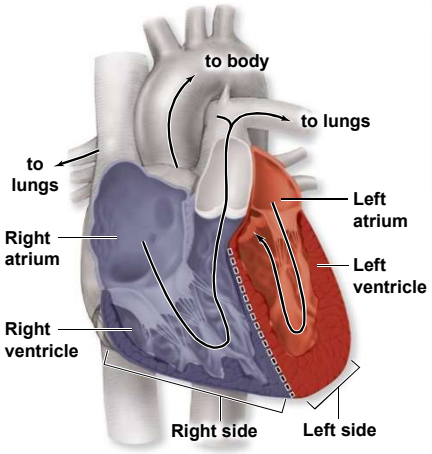


CARDIOVASCULAR SYSTEM

DANIL HAMMOUDI.MD

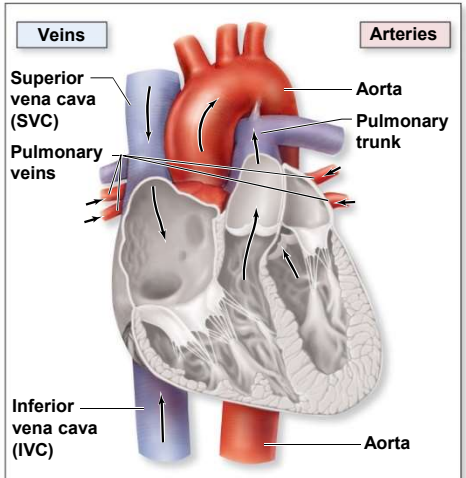


Two pumps

Each pump has a receiving chamber (atrium) and a pumping chamber (ventricle).

- Right side: pumps deoxygenated blood to the lungs
- Left side: pumps oxygenated blood to the body

(a)



Great vessels

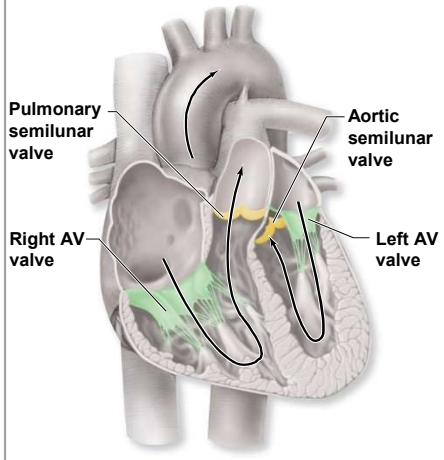
Arteries (arterial trunks) transport blood away from the heart.

- Pulmonary trunk transports from right side
- Aorta transports from left side

Veins transport blood toward the heart

- Vena cavae (SVC and IVC) drain into right side
- Pulmonary veins drain into left side

(b)

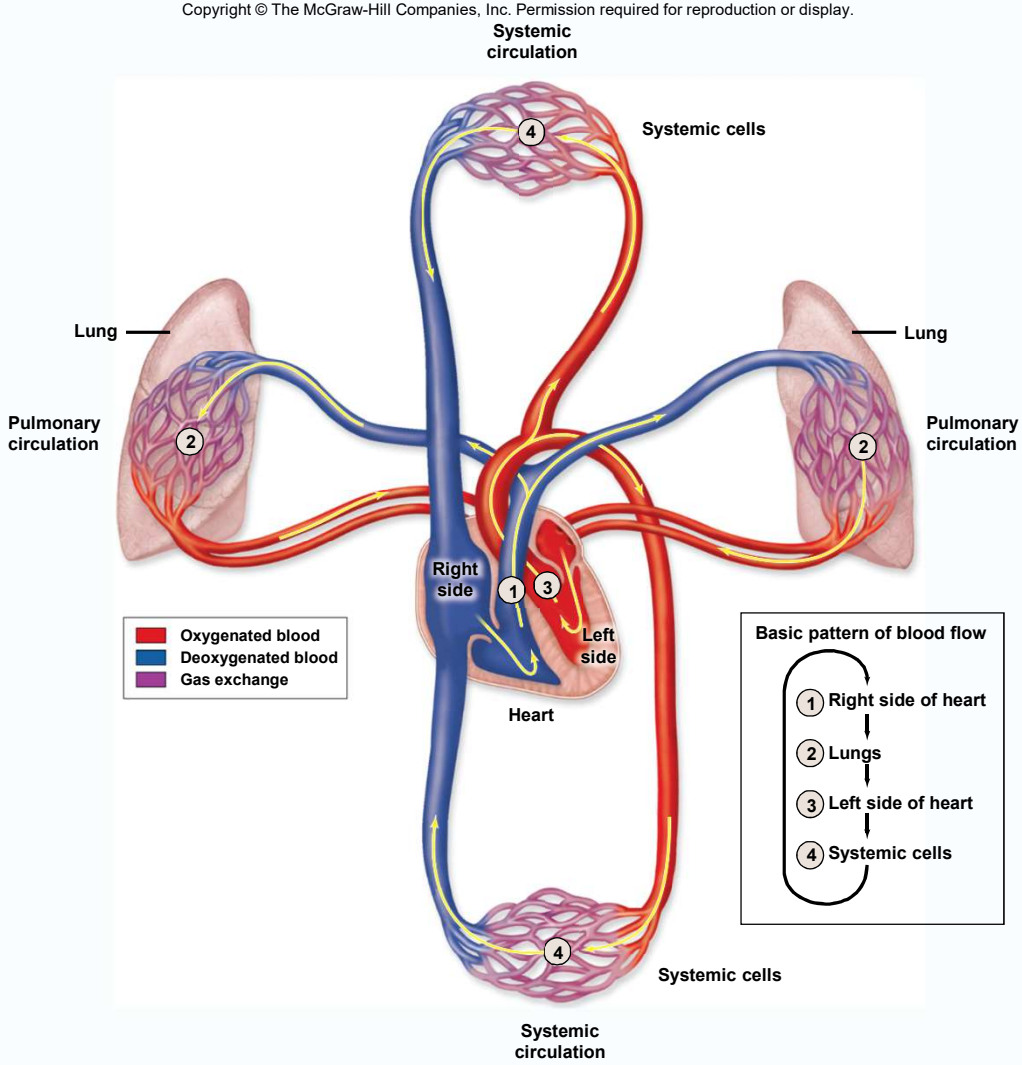


Valves

Heart valves prevent backflow to ensure one-way blood flow.

- Atrioventricular (AV) valves (i.e., right AV valve and left AV valve) are between atrium and ventricle
- Semilunar valves (i.e., pulmonary semilunar valve and aortic semilunar valve) are between ventricle and arterial trunk

(c)

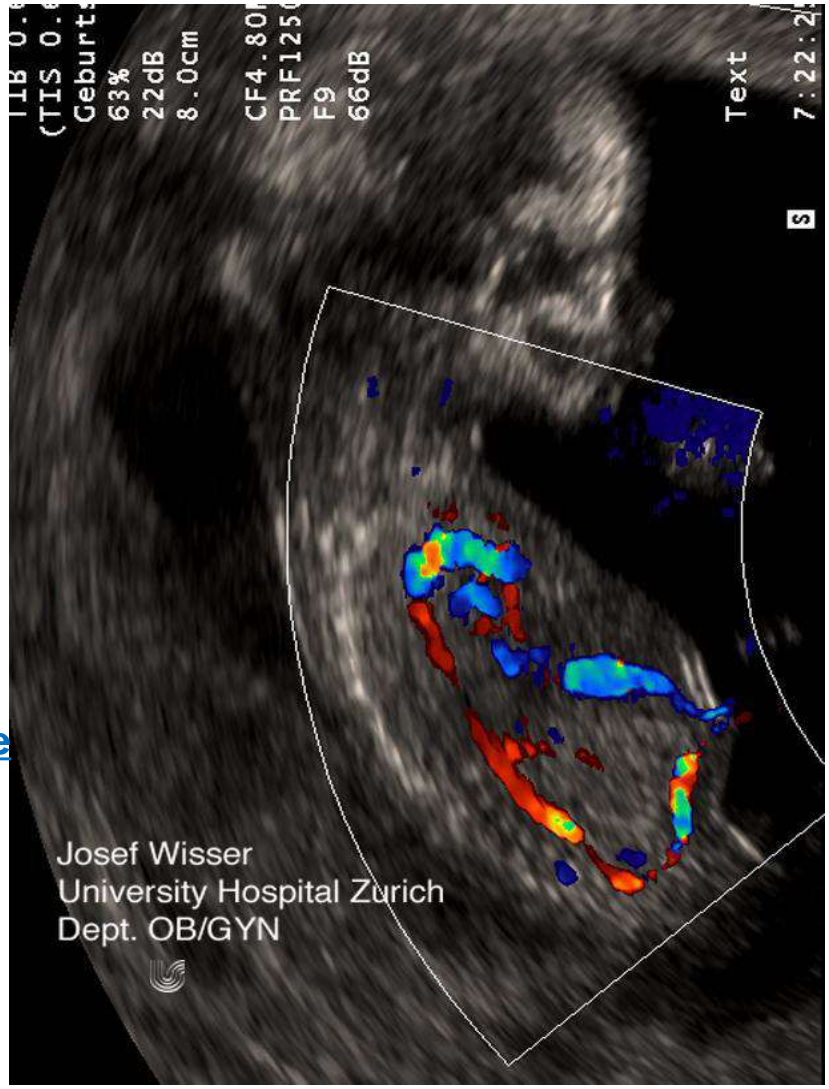


CARDIOVASCULAR EMBRYOLOGY

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

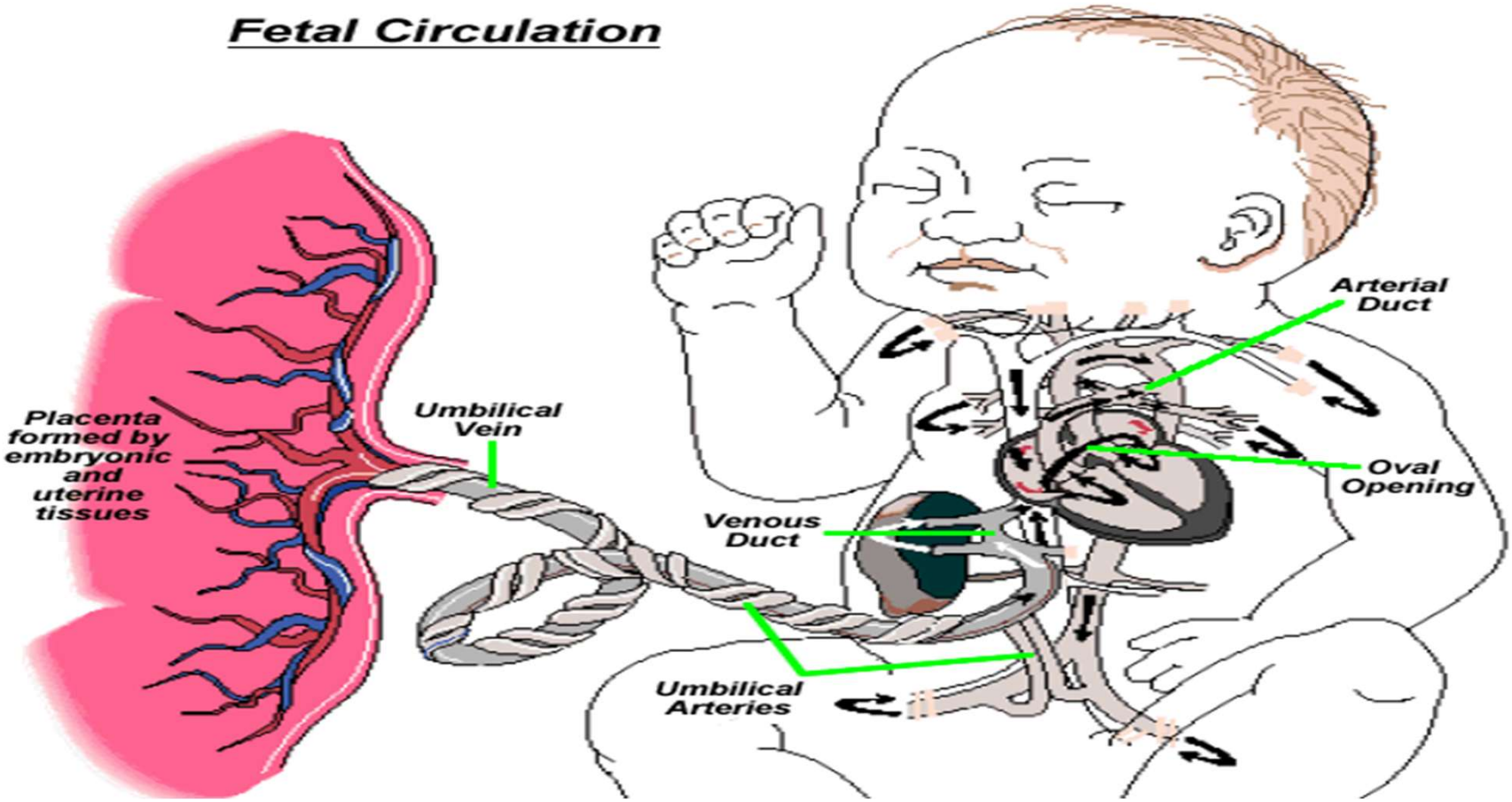
- 165-185 BPM during the early 7th week, (early 9th week after the LMP).

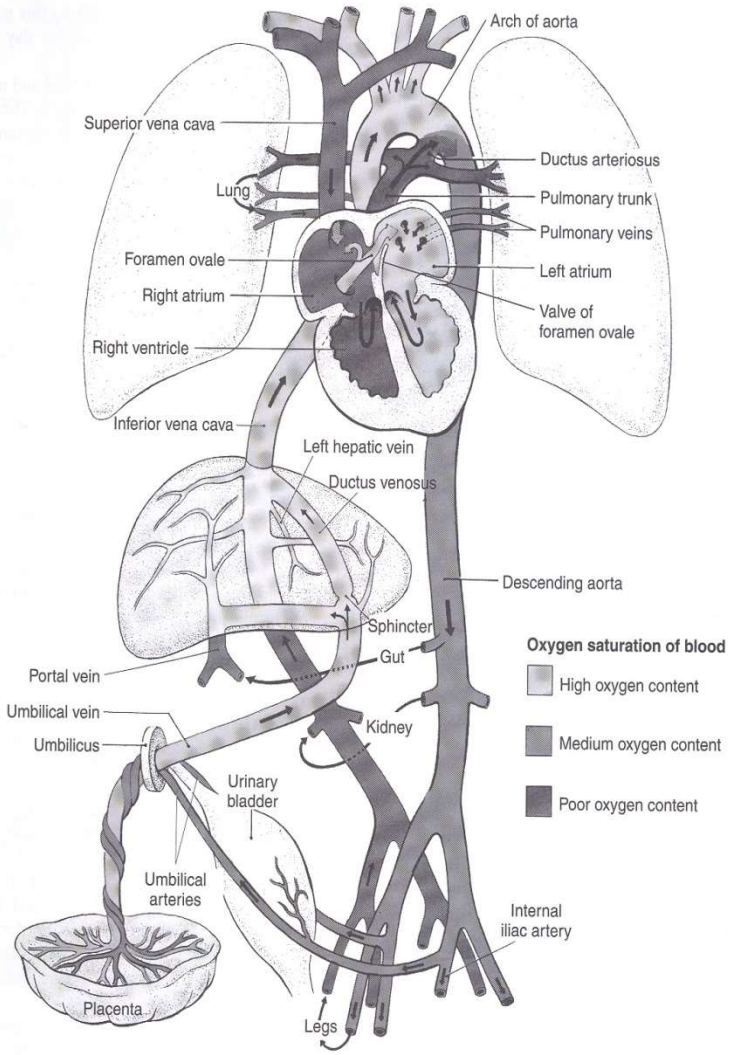
- This acceleration is approximately 3.3 BPM per day, or about 10 BPM every three days, an increase of 100 BPM in the first month

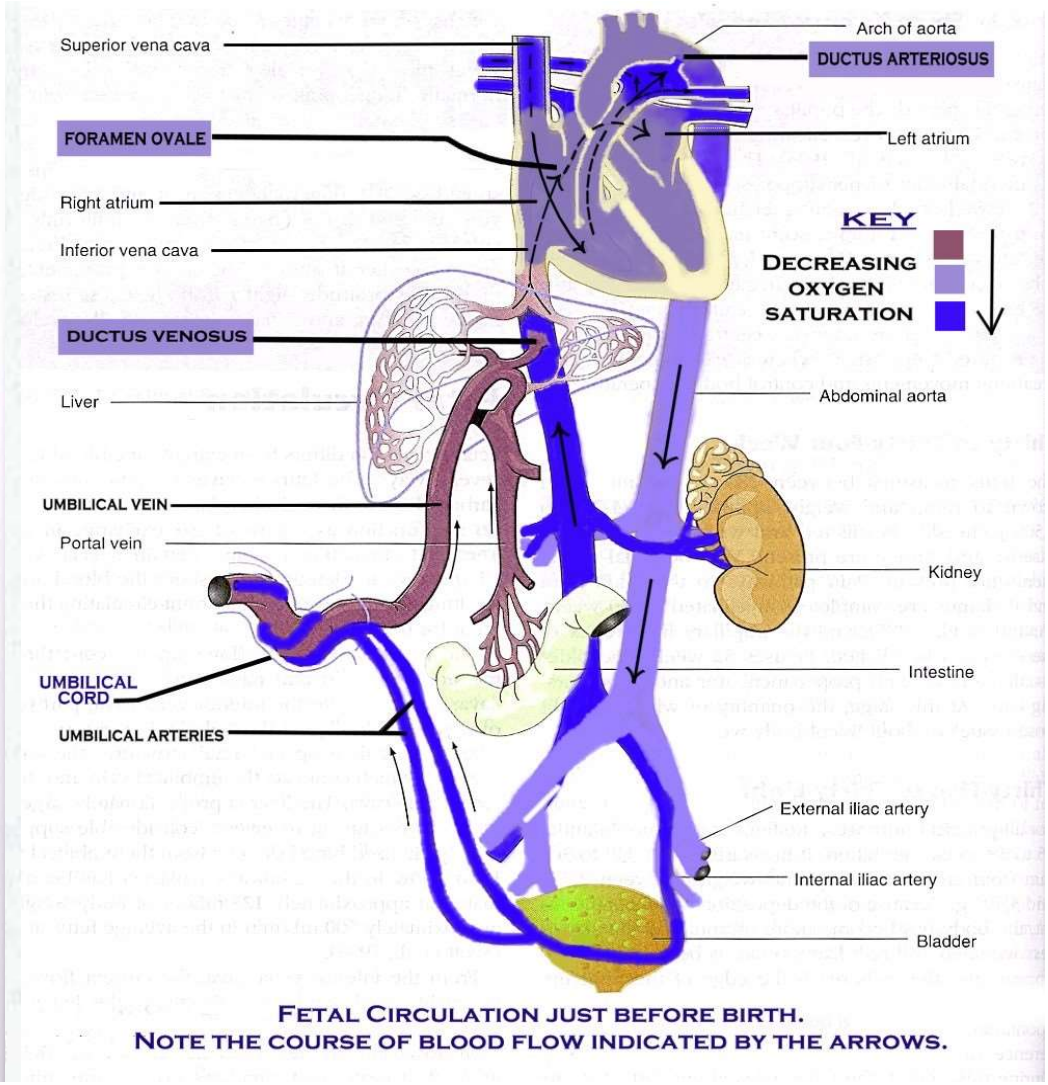
- After peaking at about 9.2 weeks after the LMP, it decelerates to about 150 BPM (+/-25 BPM) during the 15th week after the LMP. After the 15th week the deceleration slows reaching an average rate of about 145 (+/-25 BPM) BPM at term. The regression formula which describes this acceleration before the 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



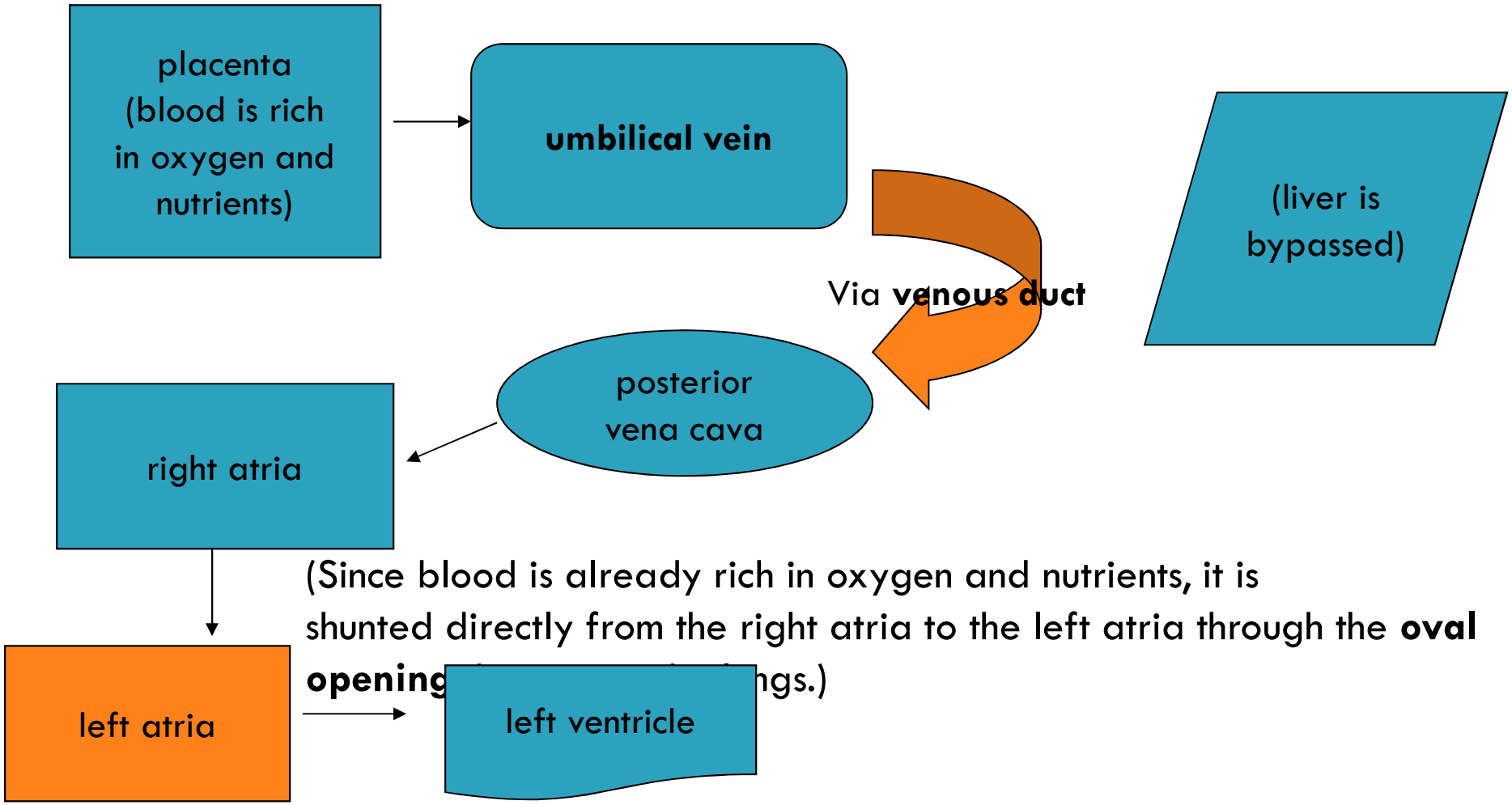




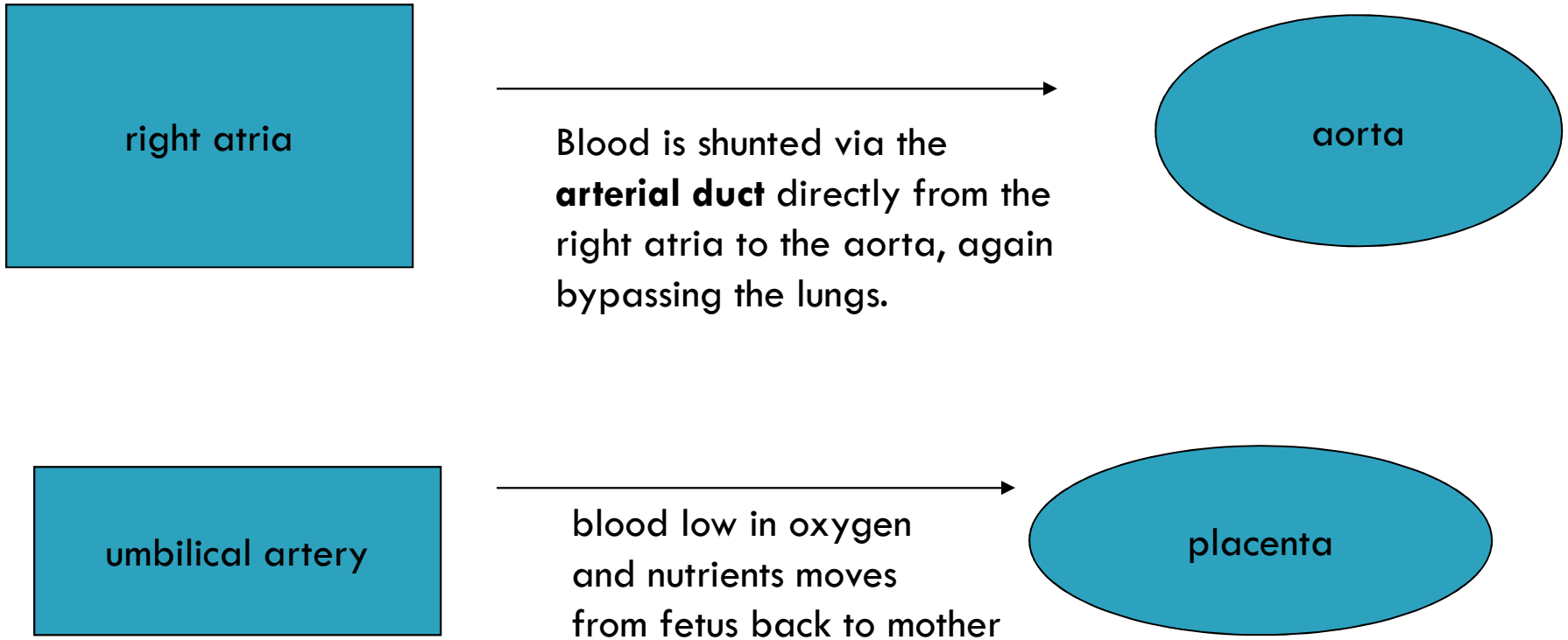
FETAL CIRCULATION JUST BEFORE BIRTH.
NOTE THE COURSE OF BLOOD FLOW INDICATED BY THE ARROWS.

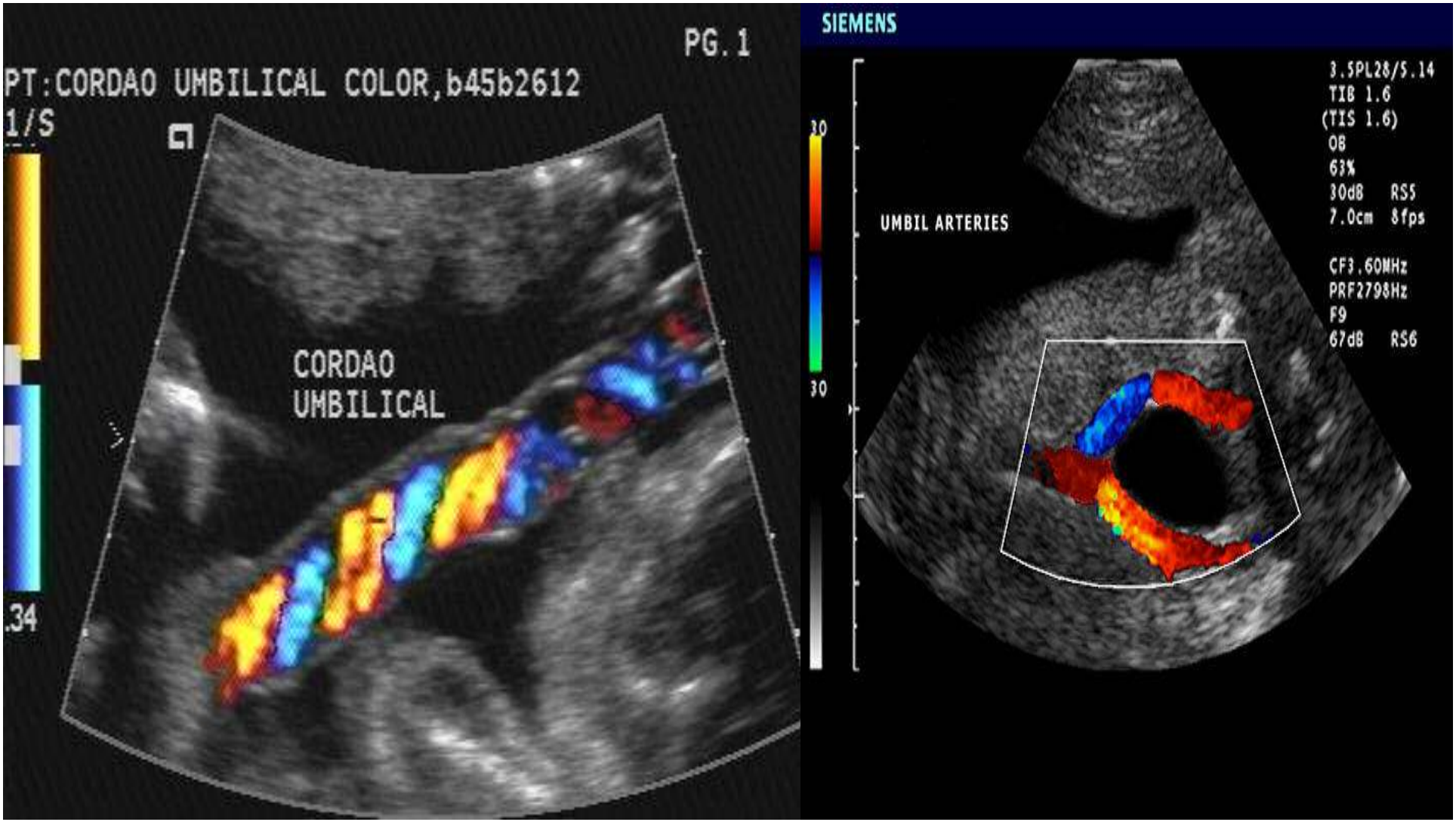
- In the developing fetus, the **ductus arteriosus** (**DA**), also called the **ductus Botalli**, is a shunt connecting the pulmonary artery to the aortic arch.
  - It allows most of the blood from the right ventricle to bypass the fetus fluid-filled lungs,
  - protecting the lungs from being overworked 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



(Since blood is already rich in oxygen and nutrients, it is shunted directly from the right atria to the left atria through the **oval opening**ngs.)


right atria
Blood is shunted via the **arterial duct** directly from the right atria to the aorta, again bypassing the lungs.
aorta
umbilical artery
blood low in oxygen and nutrients moves from fetus back to mother
placenta

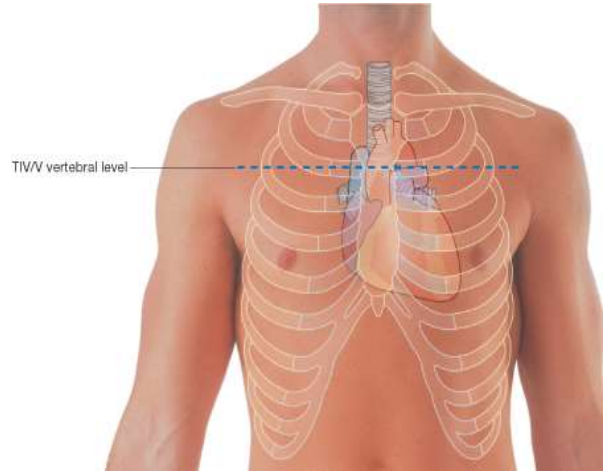

PG.1
PT:CORDAO UMBILICAL COLOR,b45b2612
1/S
CORDAO
UMBILICAL
.34
SIEMENS
UMBIL ARTERIES
3.5PL28/5.14
TIB 1.6
(TIS 1.6)
OB
63%
30dB RS5
7.0cm 8fps
CF3.60MHz
PRF2798Hz
F9
67dB RS6

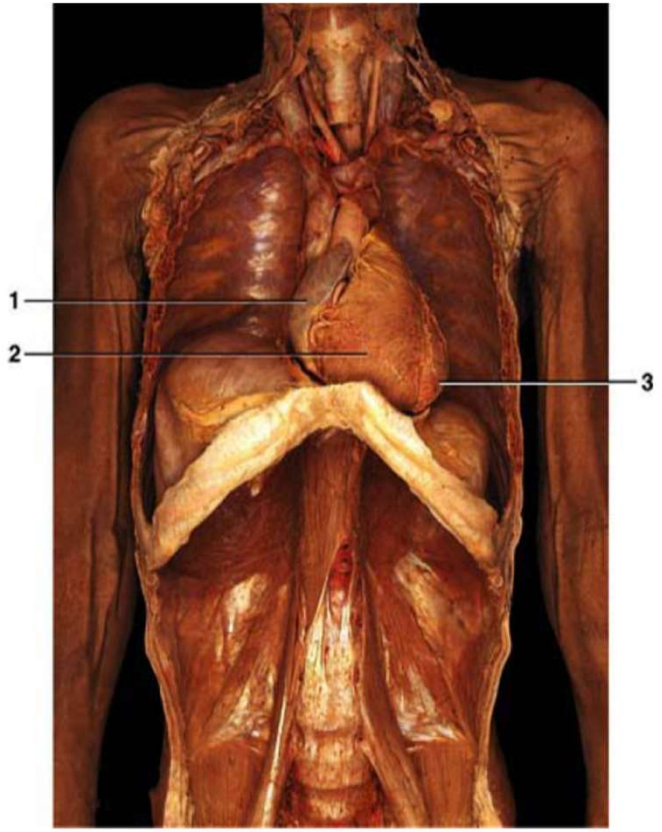
Adult remnants of fetal circulation

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

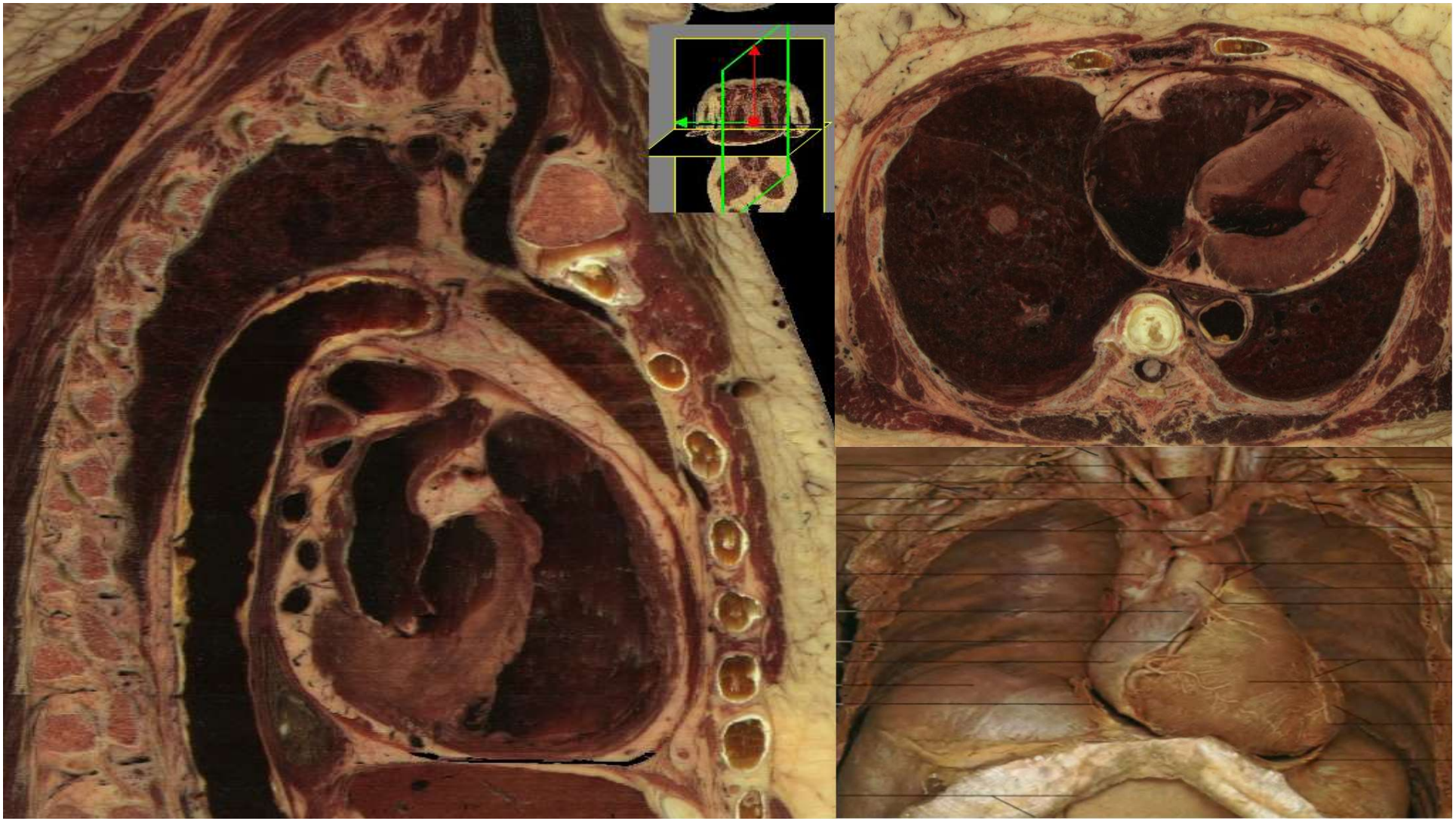
- Approximately the size of your fist
- Location
  - **Superior surface of diaphragm**
  - **Left of the midline**
  - **Anterior to the vertebral column, posterior to the sternum**
- The **heart** is positioned obliquely between the
- lungs in the mediastinum





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

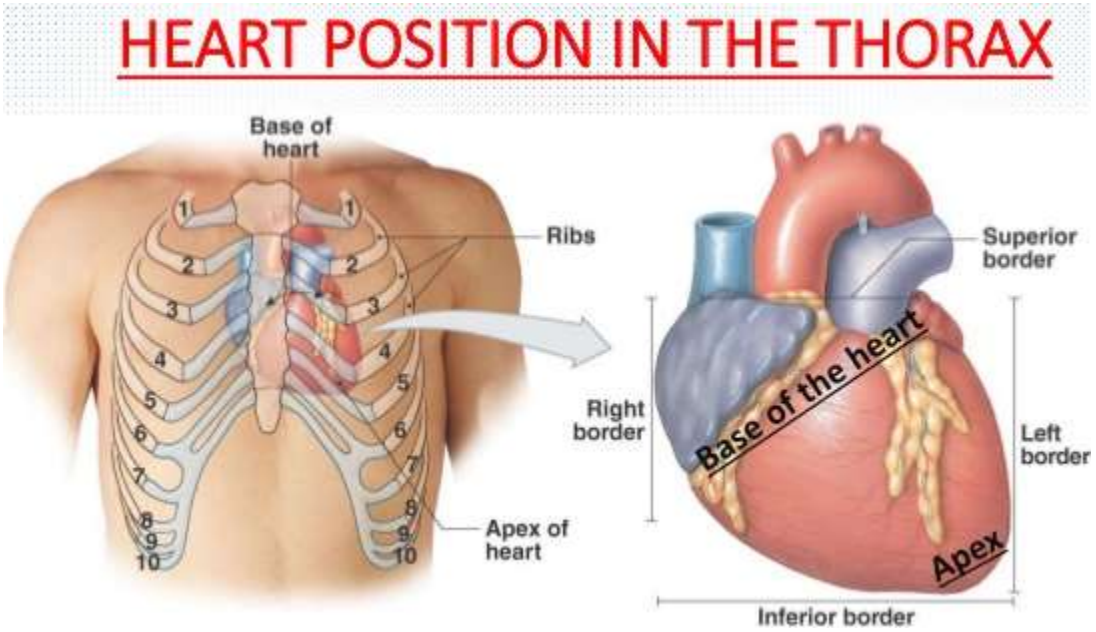


Orientation of the Heart

- 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**.

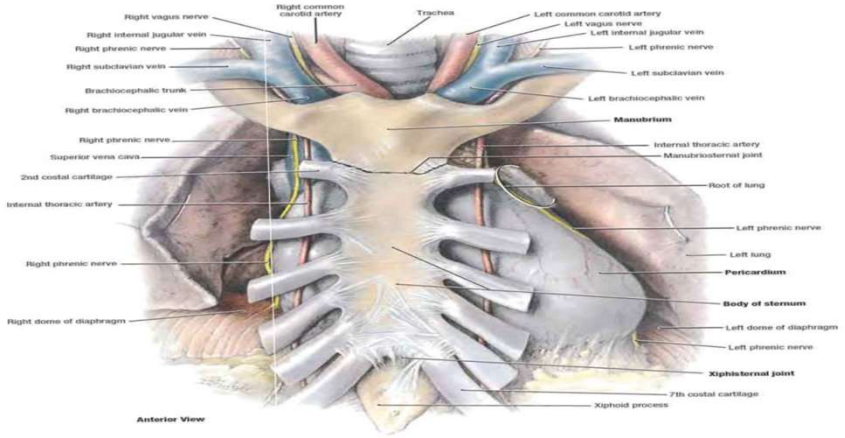
- The heart and pericardial sac are situated obliquely, about two thirds to the left and one third to the right of the median plane.

- The heart is shaped like a tipped over, three-sided pyramid with an **apex, base, and four surfaces**.



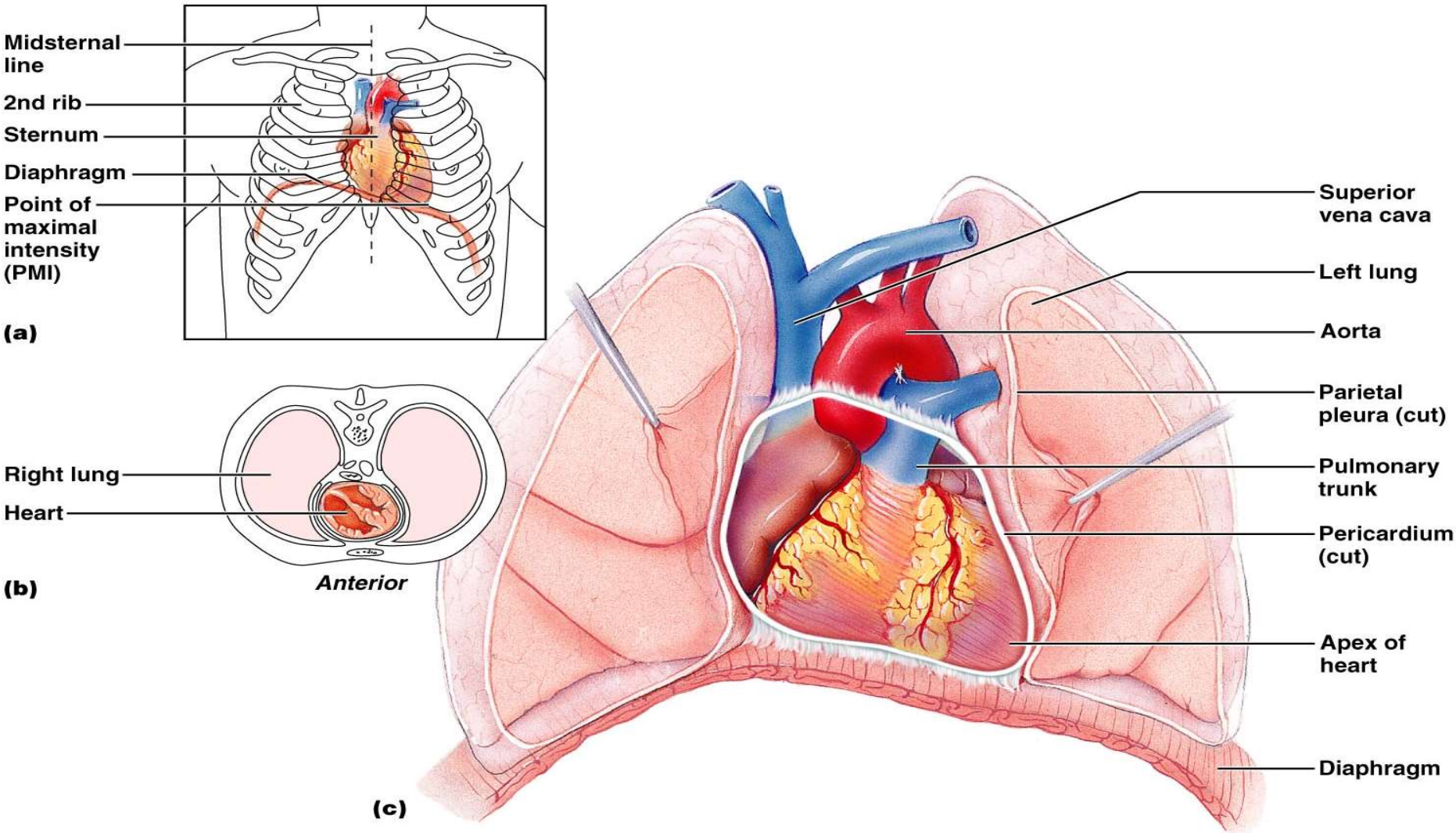
The apex of the heart

- 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.

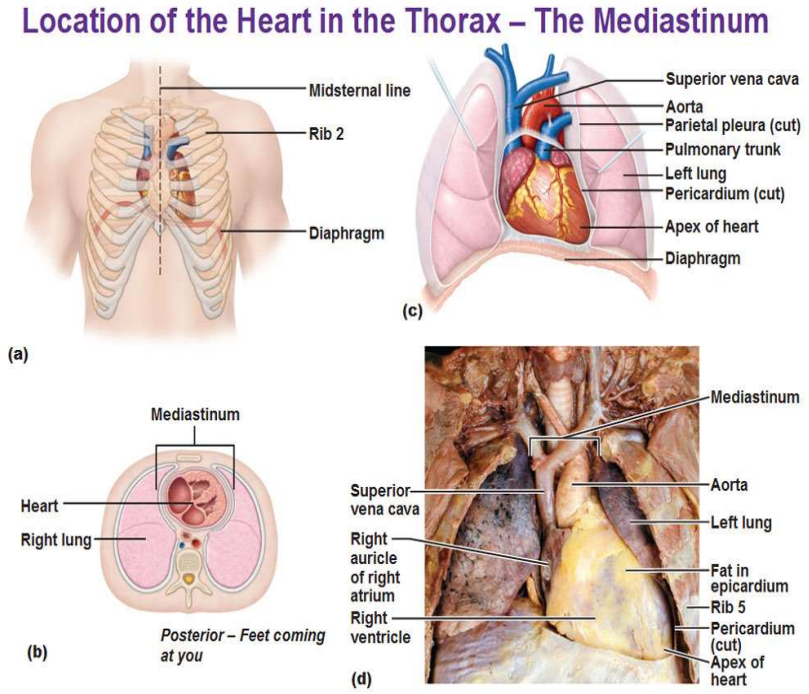

Midsternal line
2nd rib
Sternum
Diaphragm
Point of maximal intensity (PMI)
(a)
Right lung
Heart
(b)
Anterior
Superior vena cava
Left lung
Aorta
Parietal pleura (cut)
Pulmonary trunk
Pericardium (cut)
Apex of heart
Diaphragm
(c)

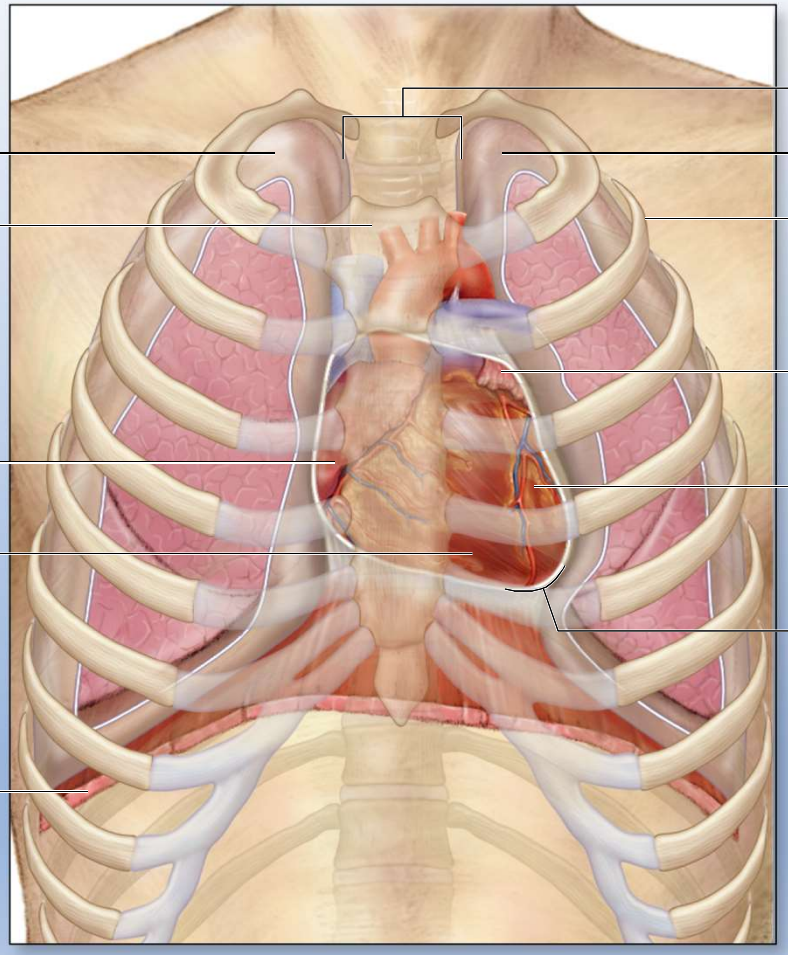
Orientation of the Heart

•**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.

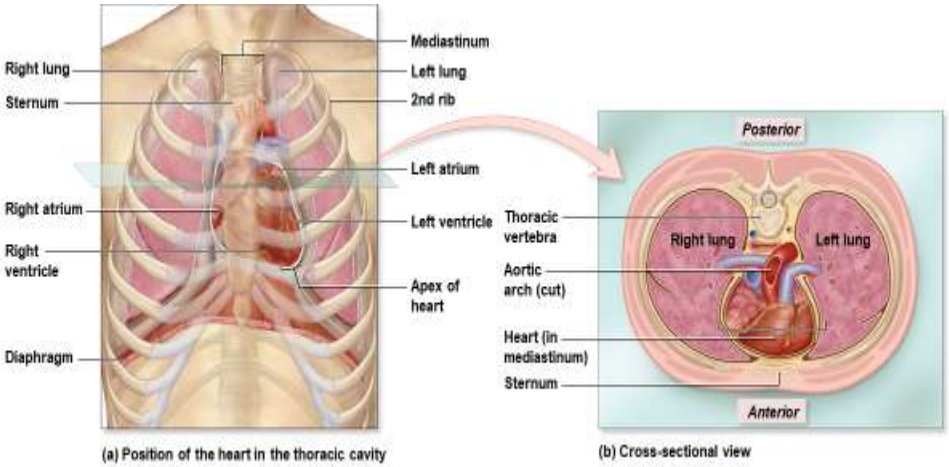
The four borders of the heart are the

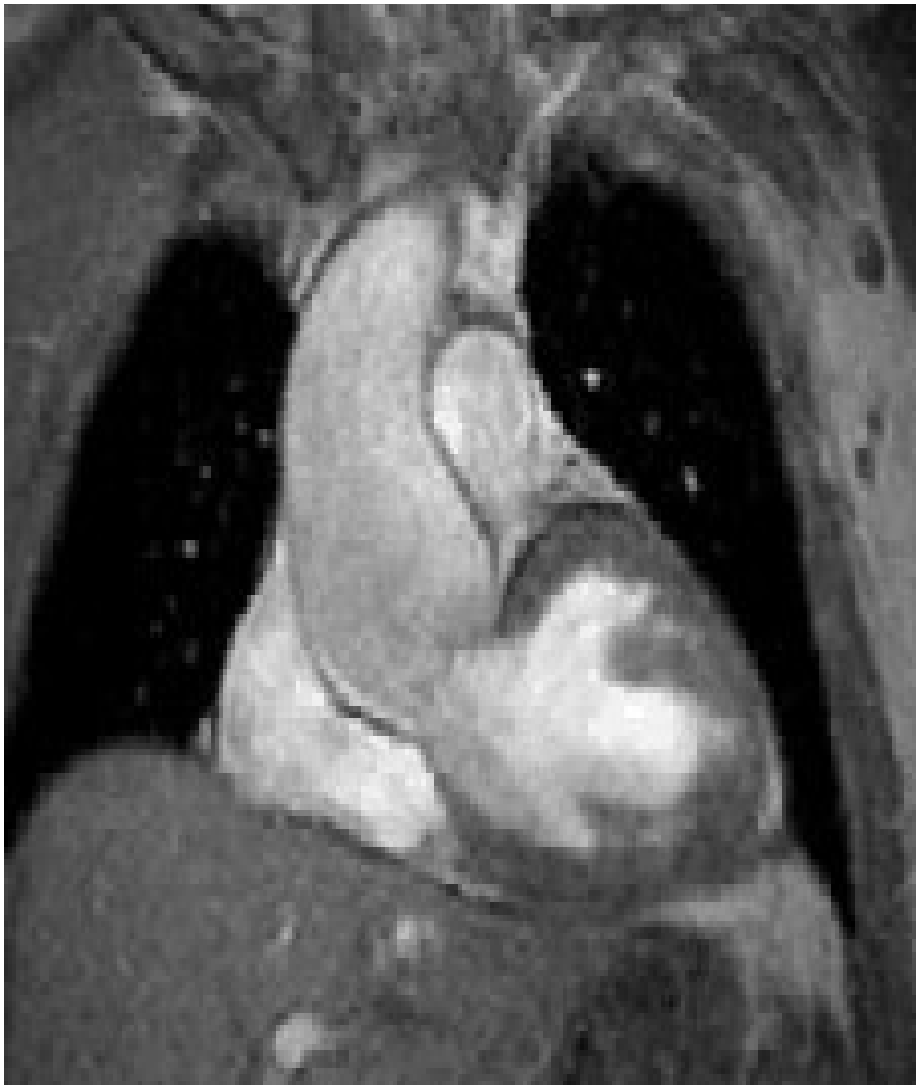
•**Right border** (slightly convex), formed by the right atrium and extending between the SVC and the IVC.
•**Inferior border** (nearly horizontal), formed mainly by the right ventricle and only slightly by the left ventricle.
•**Left border** (oblique), formed mainly by the left ventricle and slightly 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.

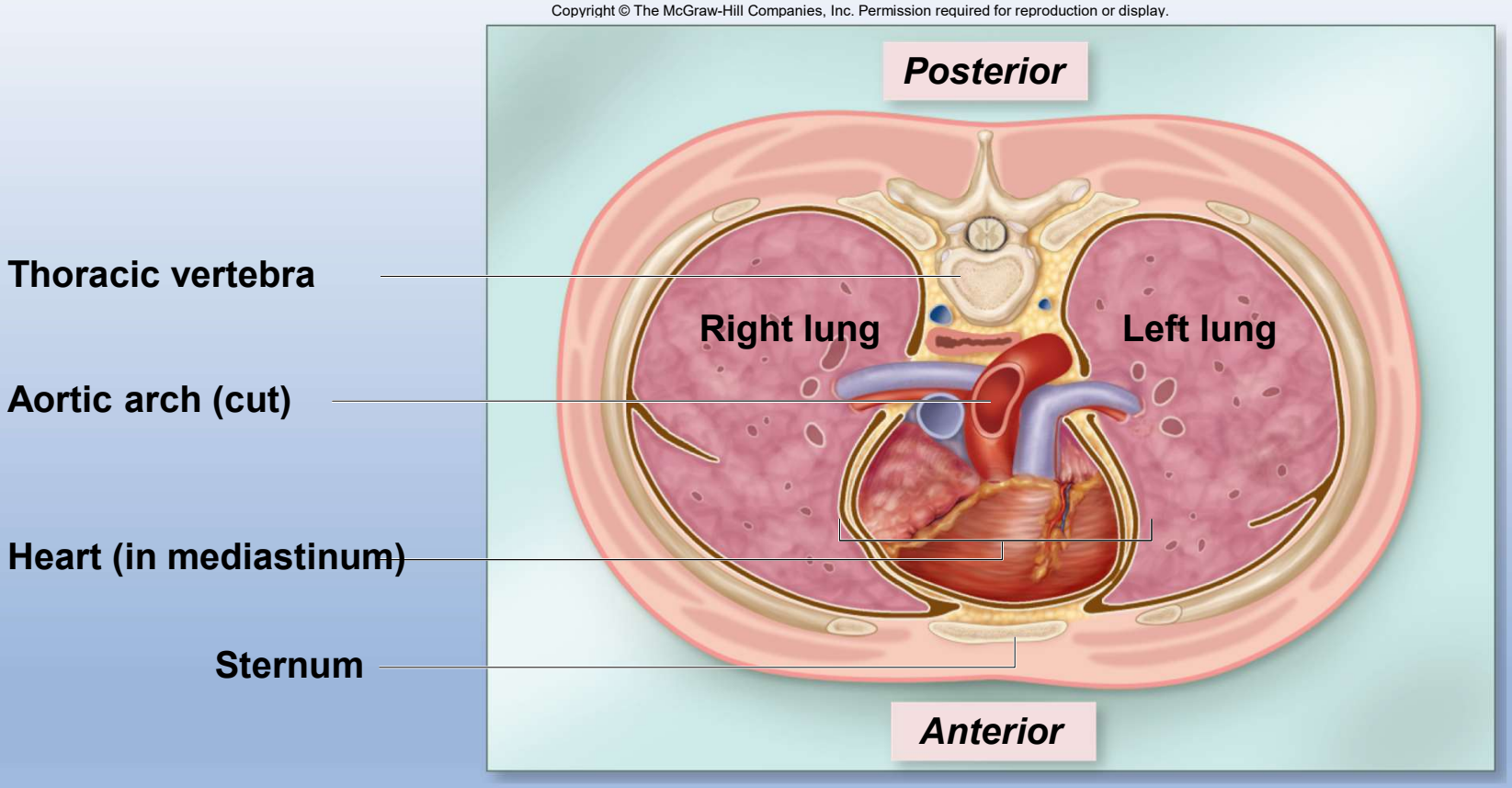




(a) Position of the heart in the thoracic cavity


Mediastinum
Right lung
Left lung
Sternum
2nd rib
Left atrium
Right atrium
Left ventricle
Right ventricle
Apex of heart
Diaphragm
Posterior
Thoracic vertebra
Right lung
Left lung
Aortic arch (cut)
Heart (in mediastinum)
Sternum
Anterior
(a) Position of the heart in the thoracic cavity
(b) Cross-sectional view

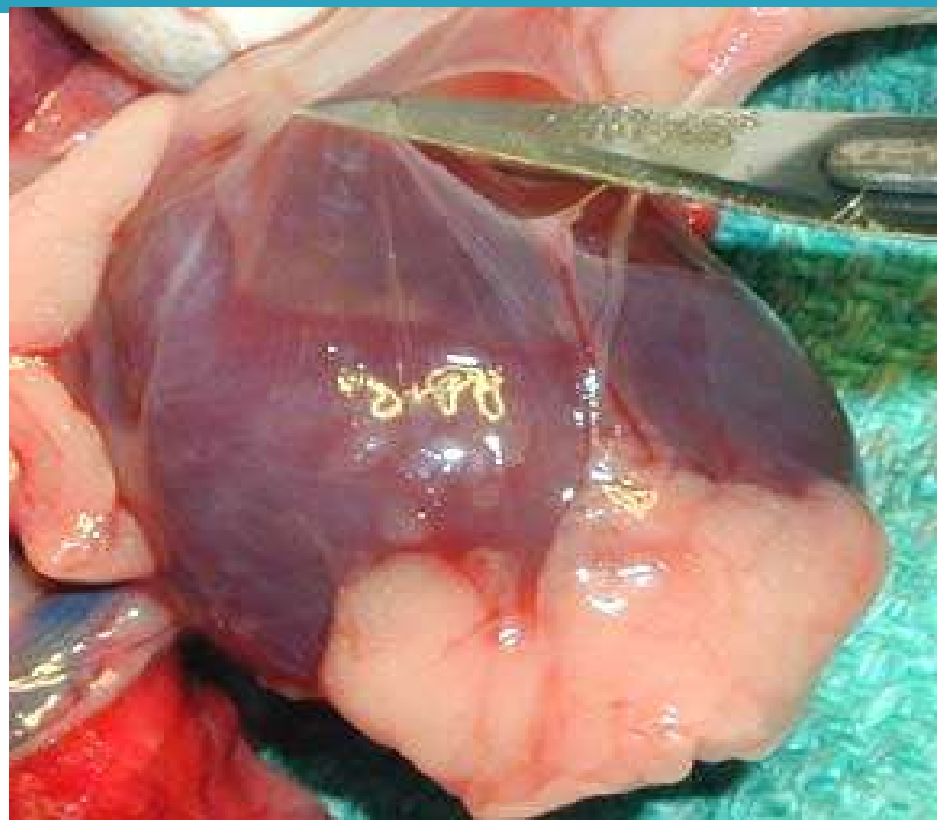




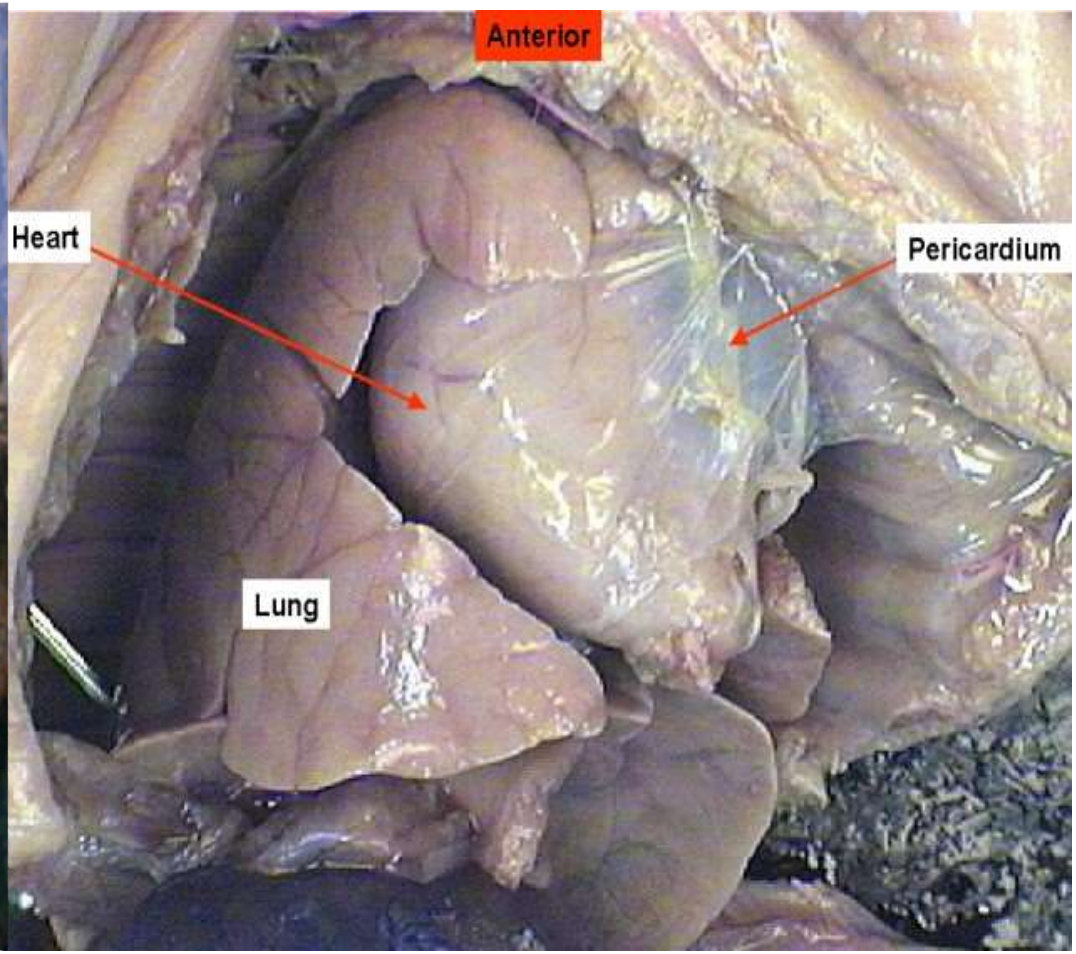
(b) Cross-sectional view

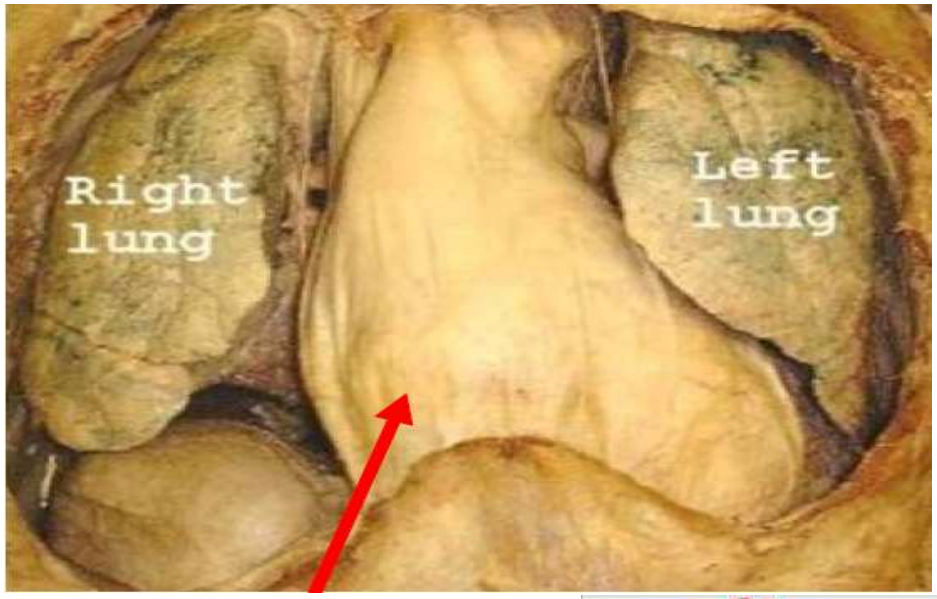
Coverings of the Heart: Anatomy

- **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



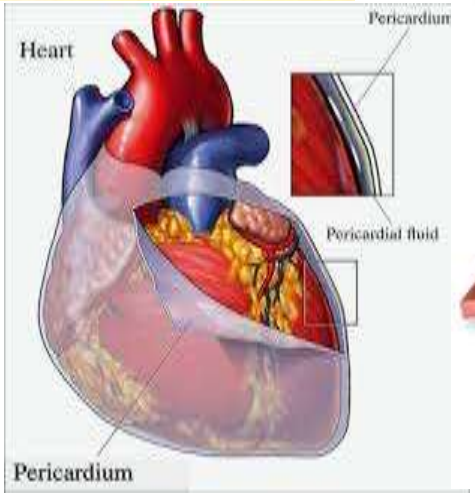
Pericardium

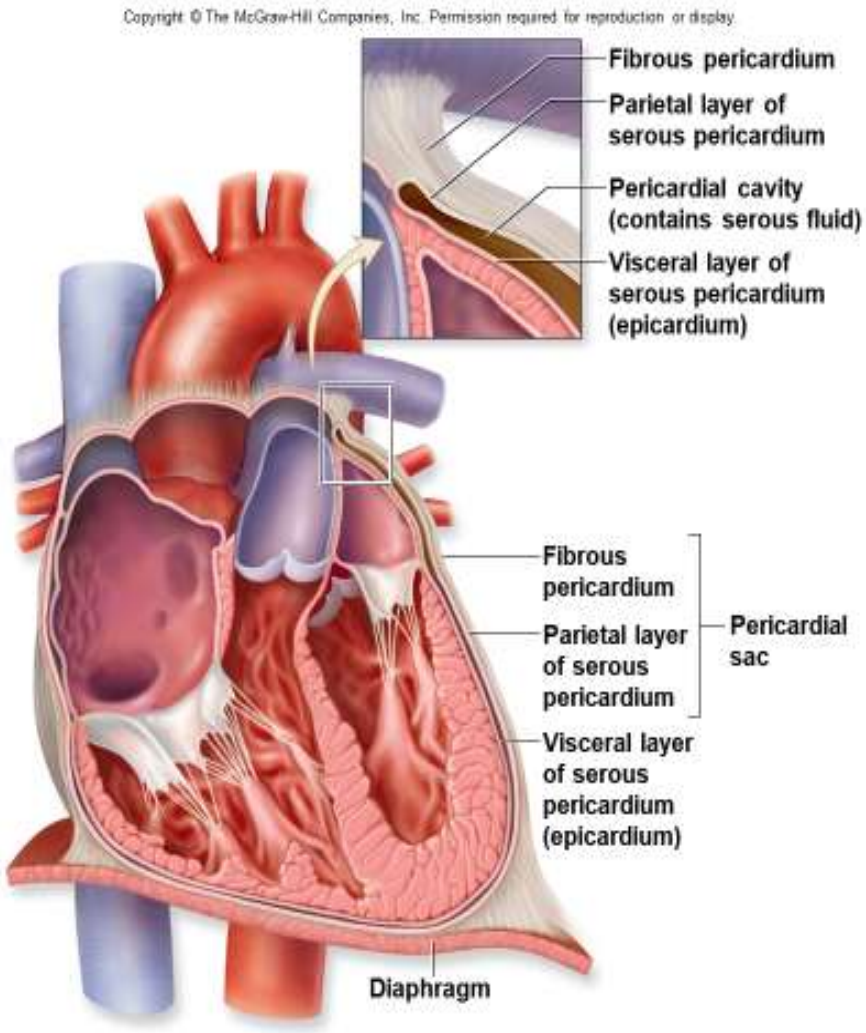




Fibrous Pericardium

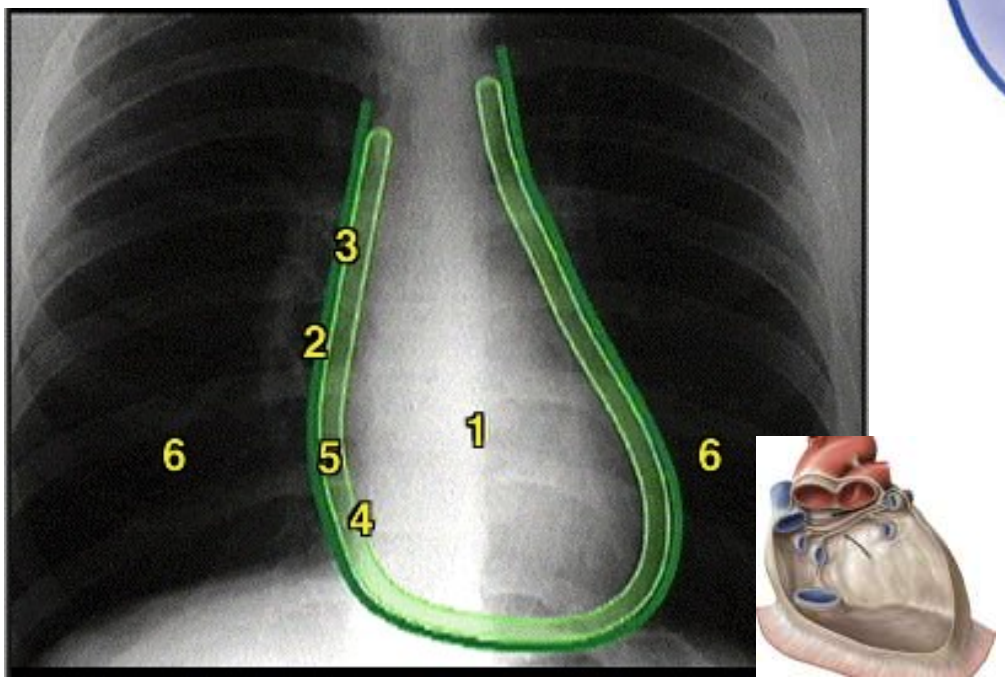
- Collagenous sac enclosing the heart.
- Stabilizes heart's position and prevents over distention.

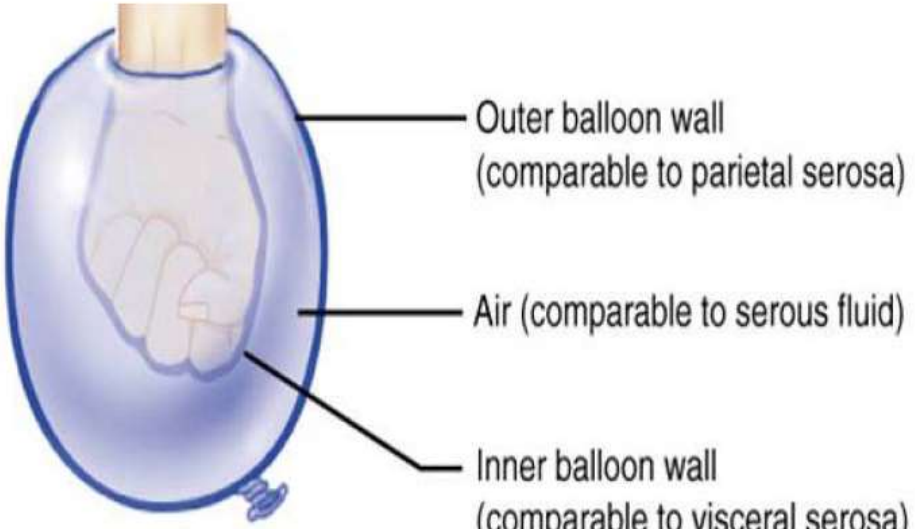


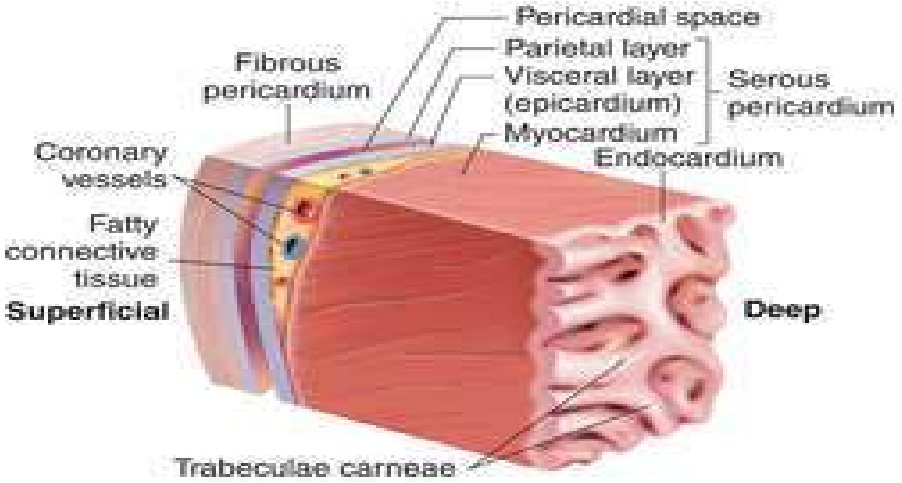


Serous Pericardium

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

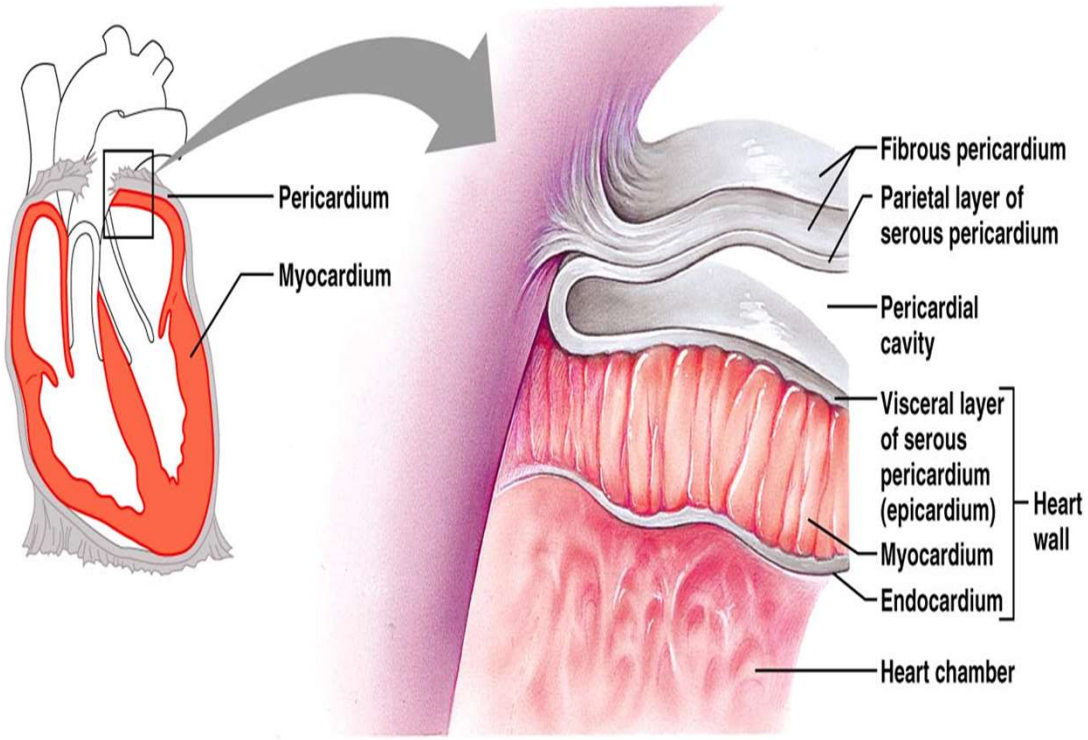






Coverings of the Heart: Physiology

- **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

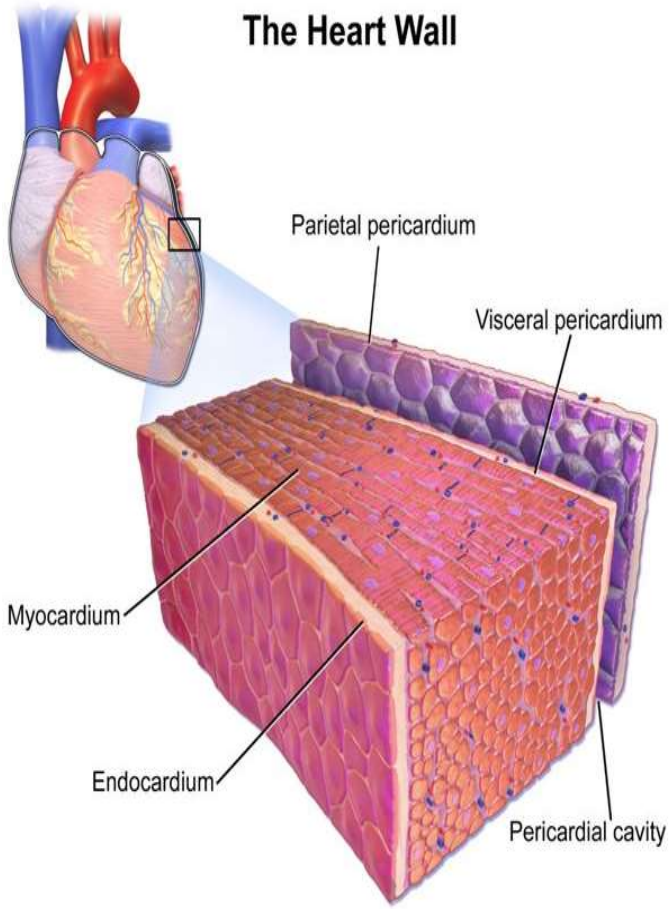
- Corresponds to the visceral pericardium.
- Functions as an outer protective layer.
- Serous membrane that consists of connective tissue covered by epithelium.
- **Includes blood capillaries, lymph capillaries, and nerve fibers**.

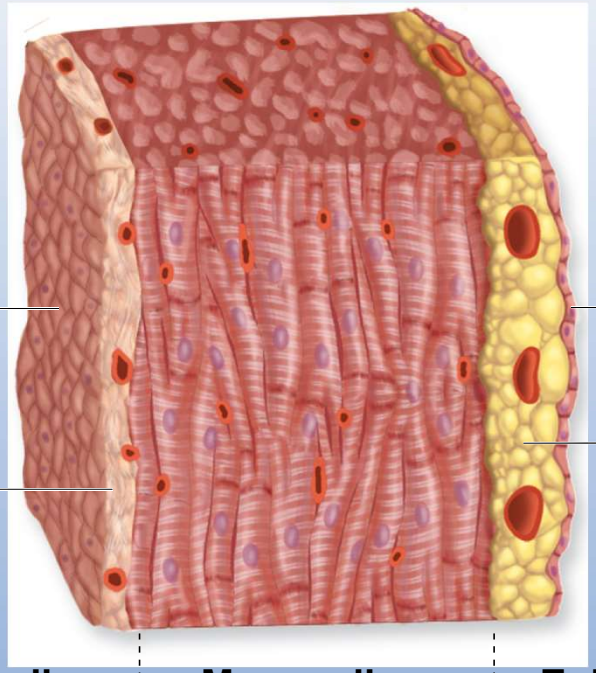
Myocardium

- 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.

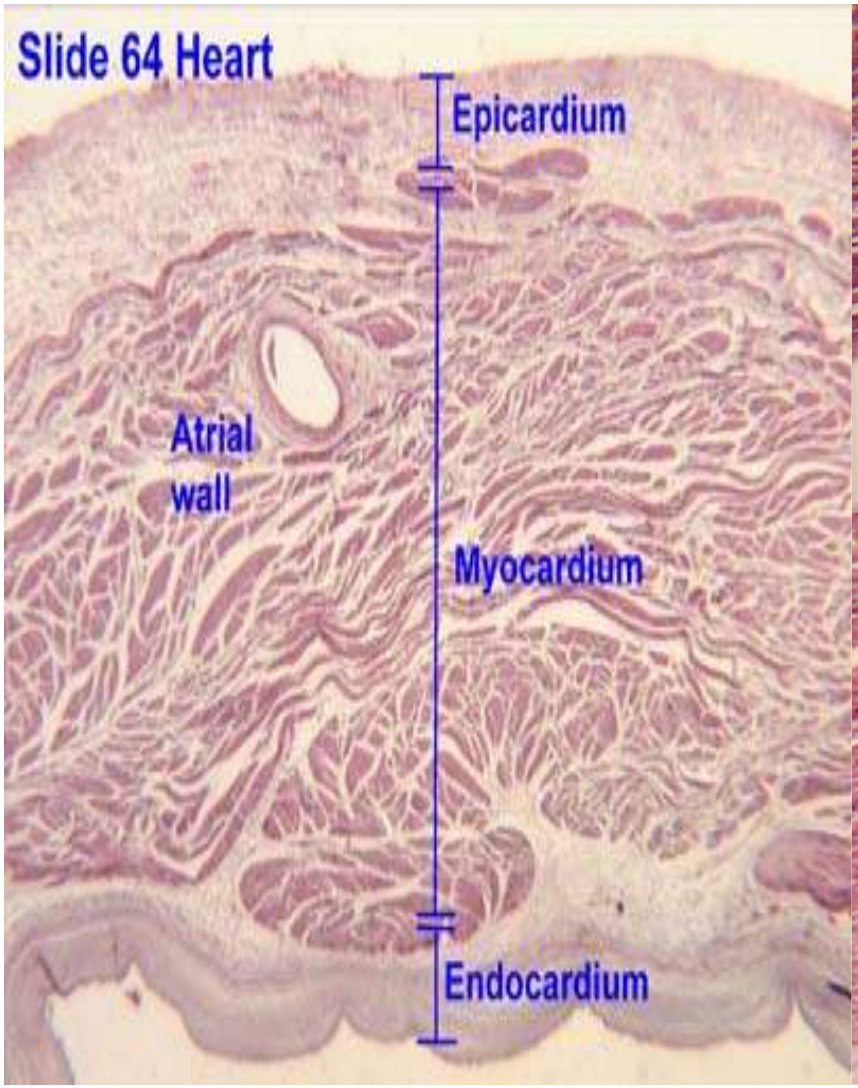
Endocardium

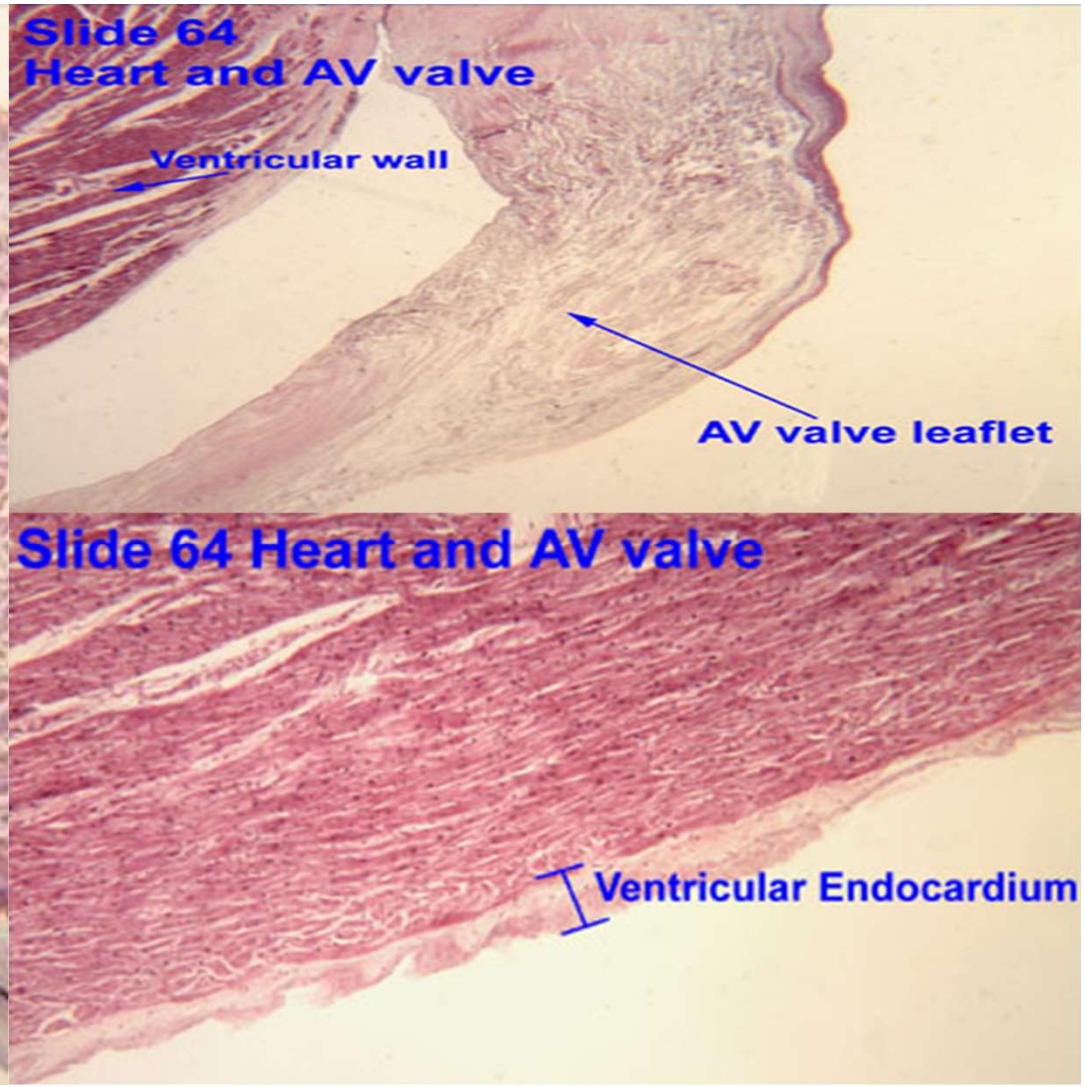
- Consists of epithelial and connective tissue that contains many elastic and collagenous fibers.
- Connective tissue also contains blood vessels and some specialized cardiacmuscle fibers called **Purkinje fibers**.
- Lines all of the heart chambers and covers heart valves.
- Is continuous with the inner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

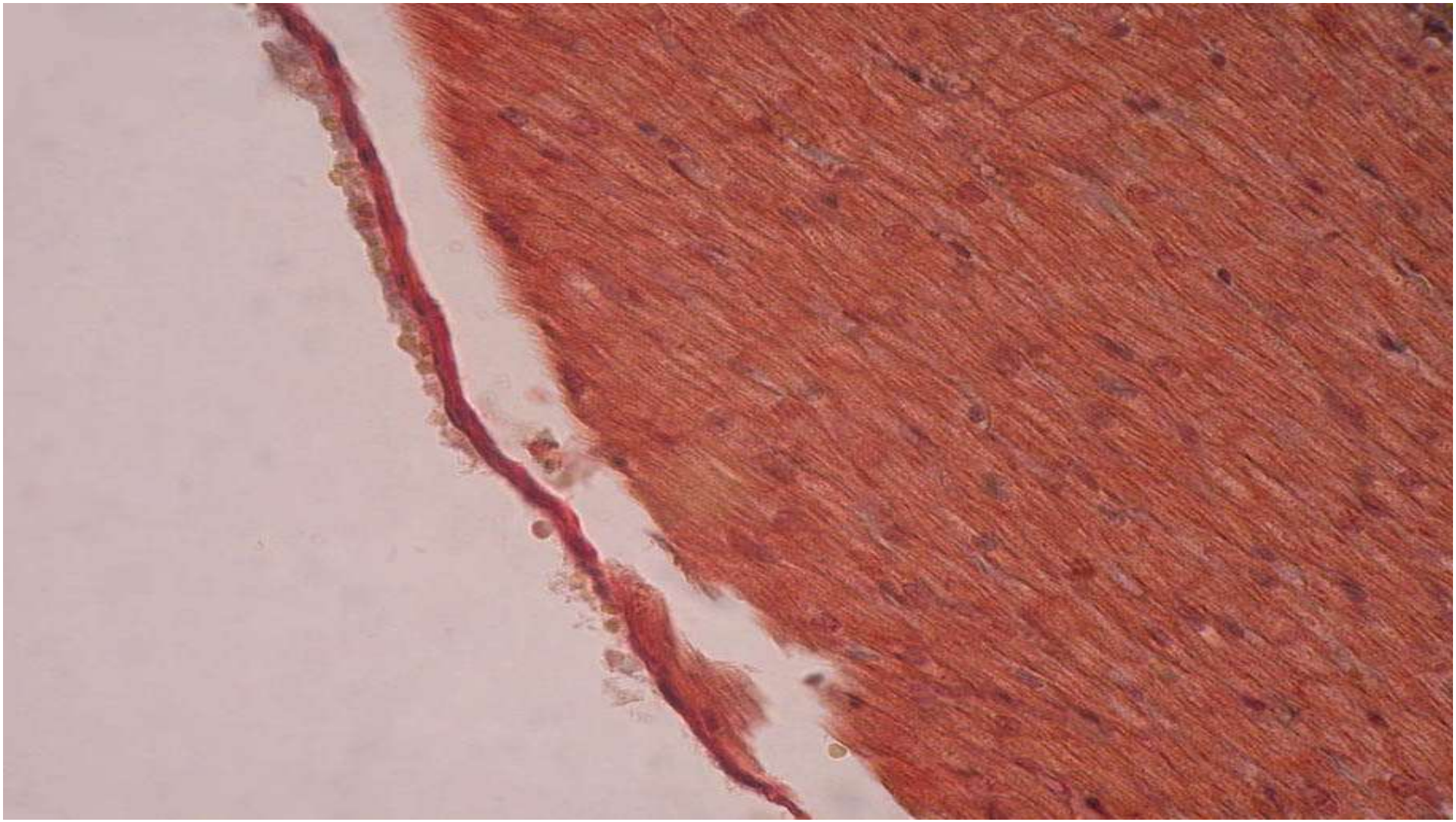




(b)

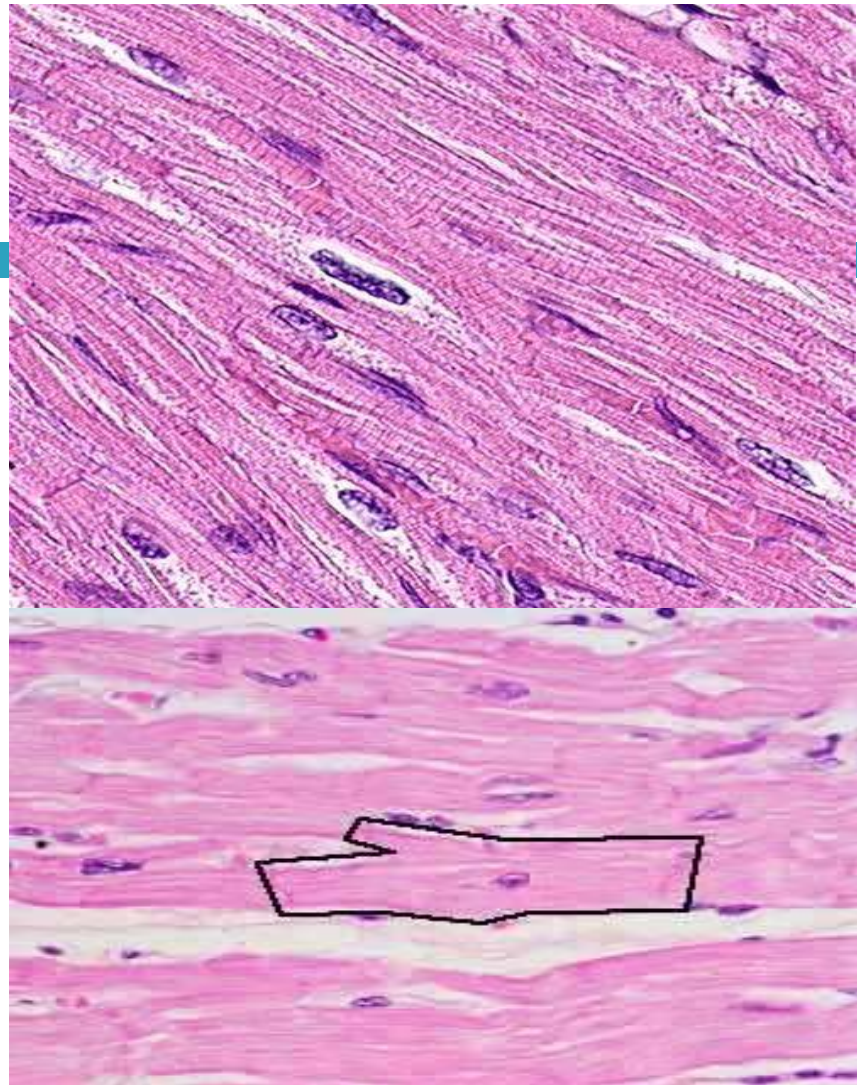

Slide 64 Heart
Epicardium
Atrial wall
Myocardium
Endocardium


Slide 64
Heart and AV valve
Ventricular wall
AV valve leaflet
Slide 64 Heart and AV valve
Ventricular Endocardium



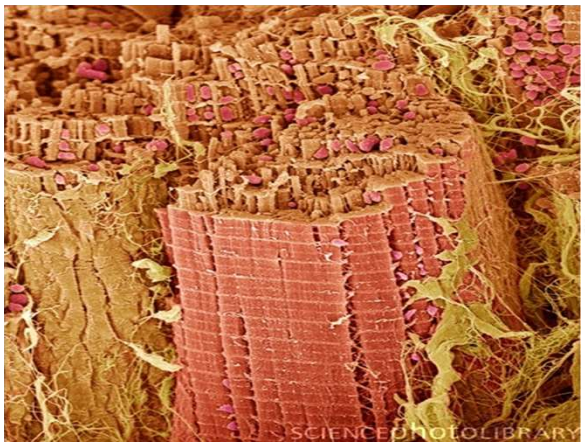
Microscopic Anatomy of Heart Muscle

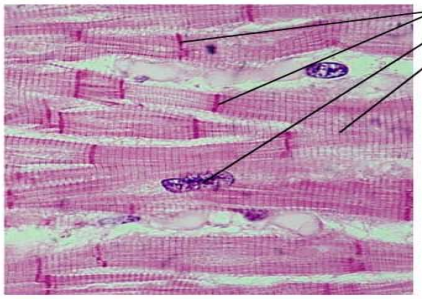
- **Cardiac muscle is striated, short, fat, branched, and interconnected**
- **The connective tissue endomysium acts as both tendon and insertion**
- **Intercalated discs anchor cardiac cells together and allow free passage of ions**
- **Heart muscle behaves as a functional syncytium**

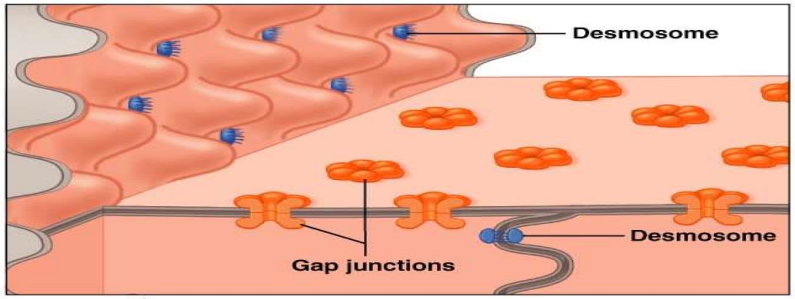


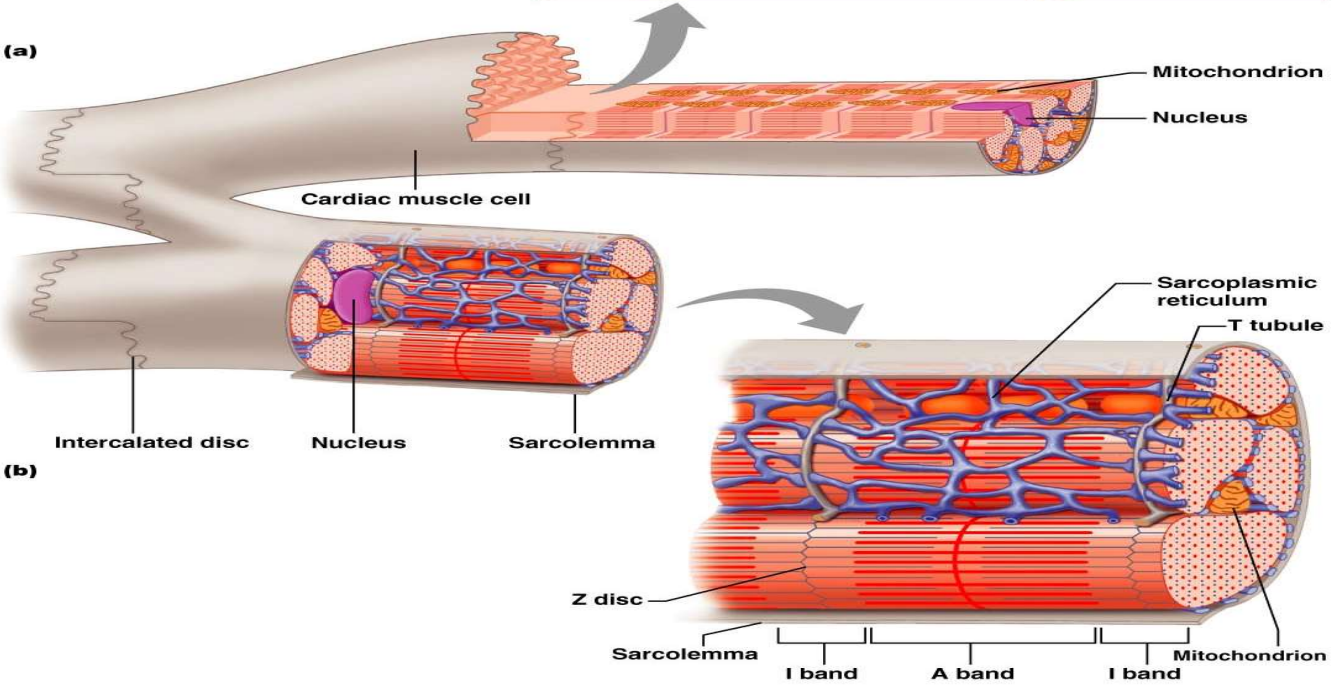
Microscopic Anatomy of Cardiac Muscle

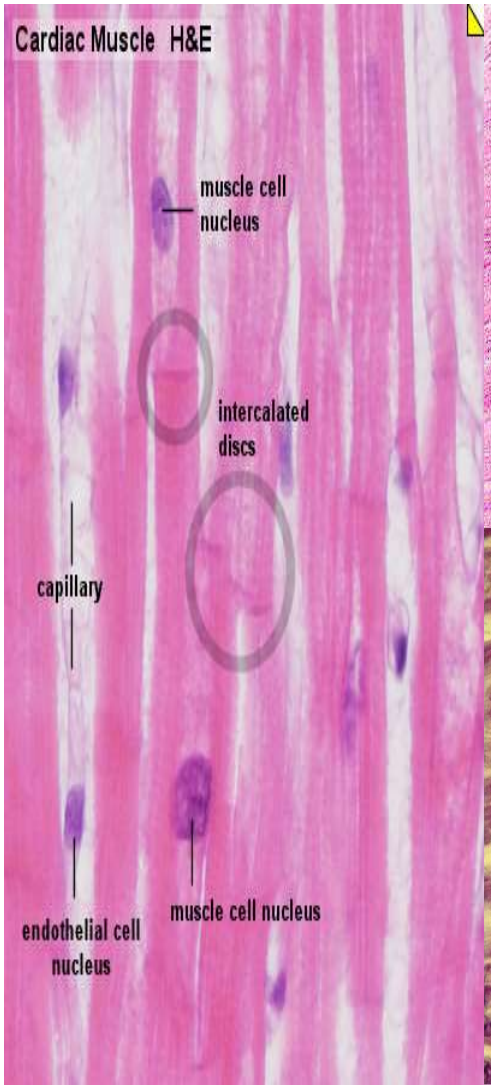
- Striated muscle but fibres divide and recombine.
- Though each cell is dictinct withits own nucleus, the cells are joined end to end by specialised cell junctions called intercalated disks.
- These junctions offer a veru weak resistance to electrical flow and thus the heart muscle acts as a syncetium.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

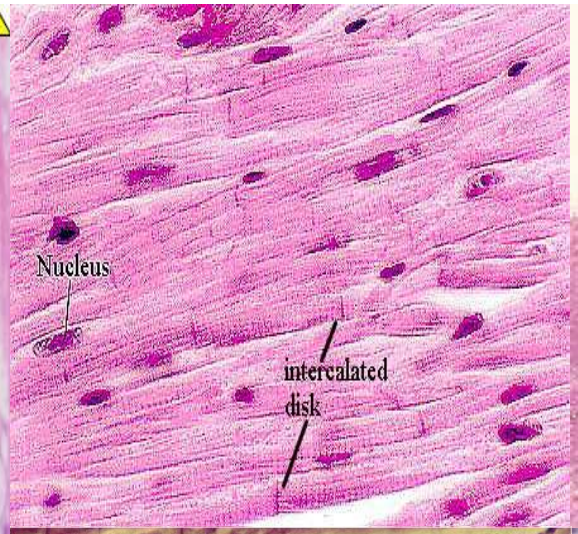




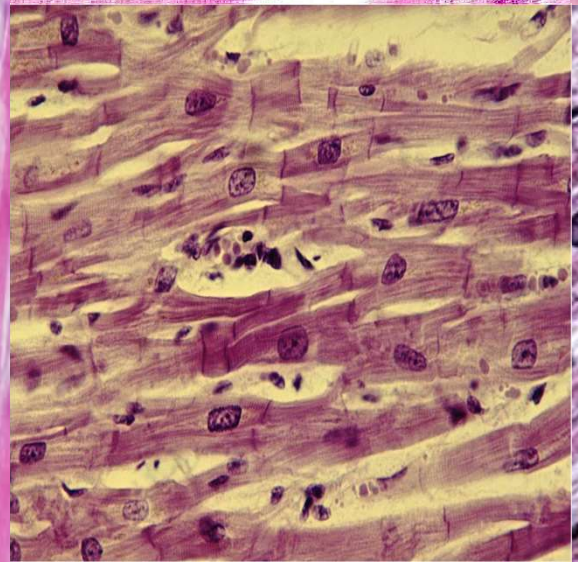


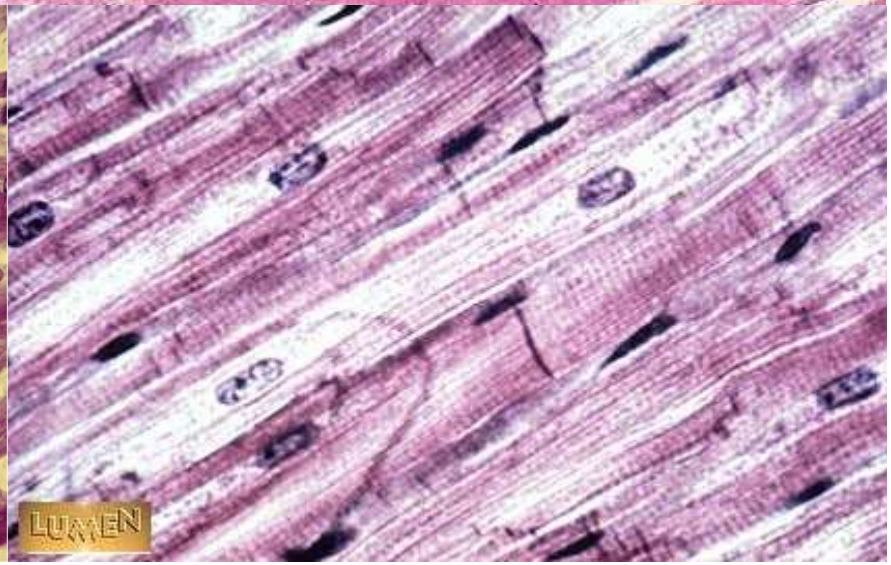


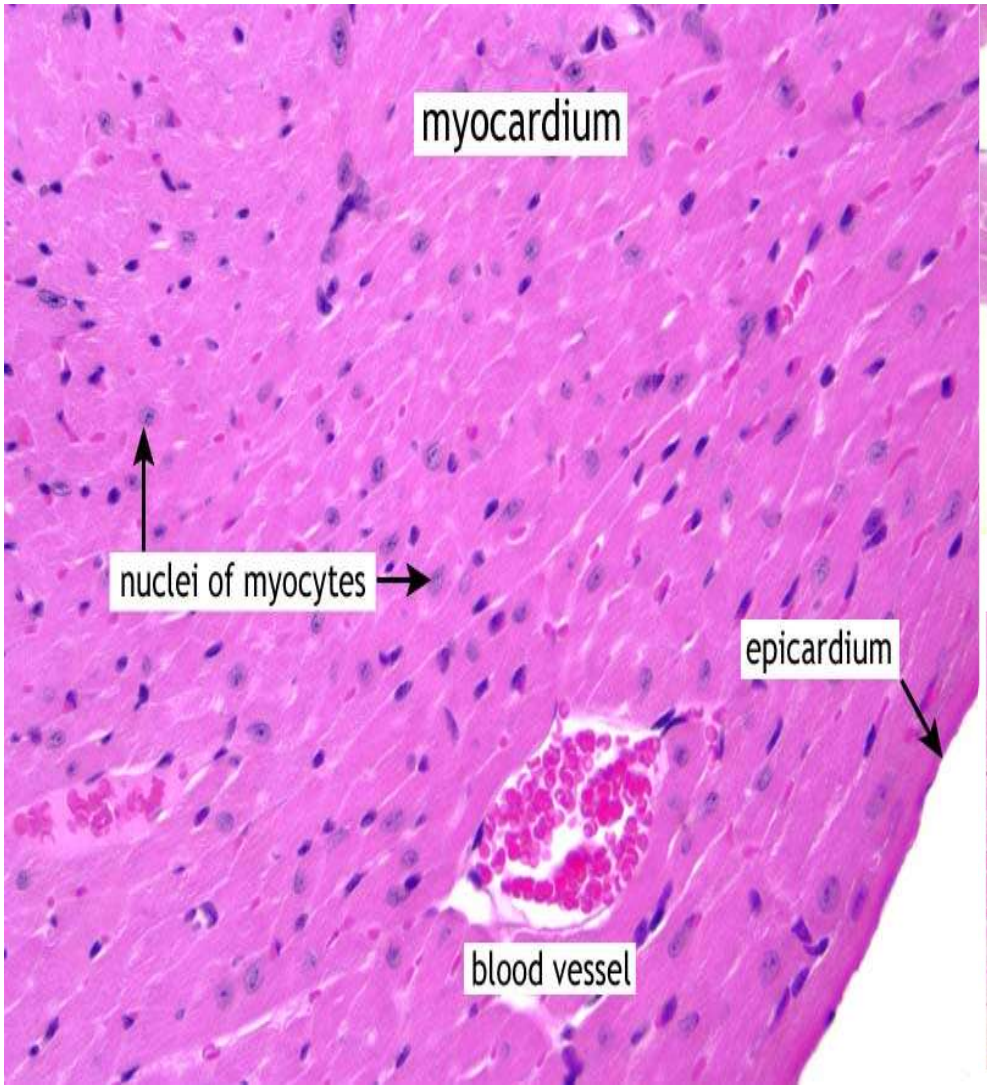

Cardiac Muscle H&E
muscle cell nucleus
intercalated discs
capillary
endothelial cell nucleus
muscle cell nucleus

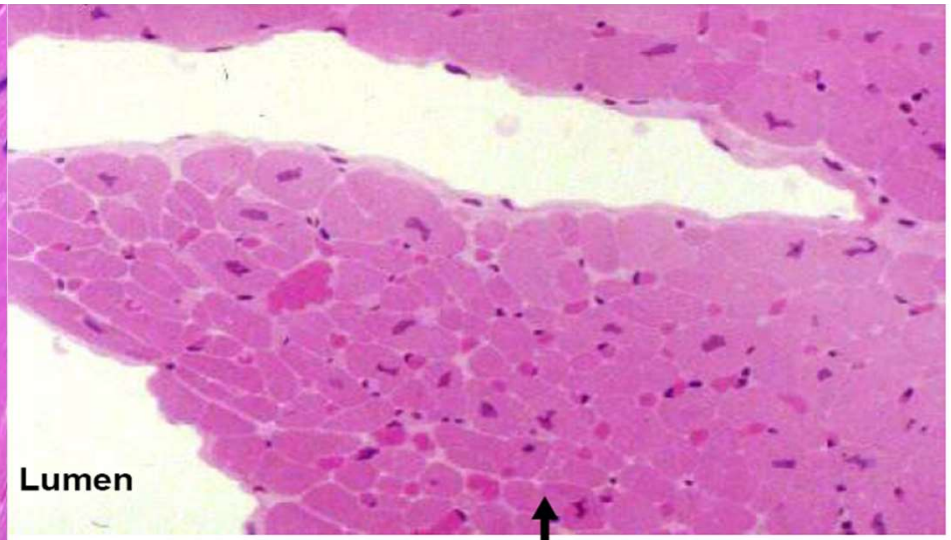

Nucleus
intercalated disk

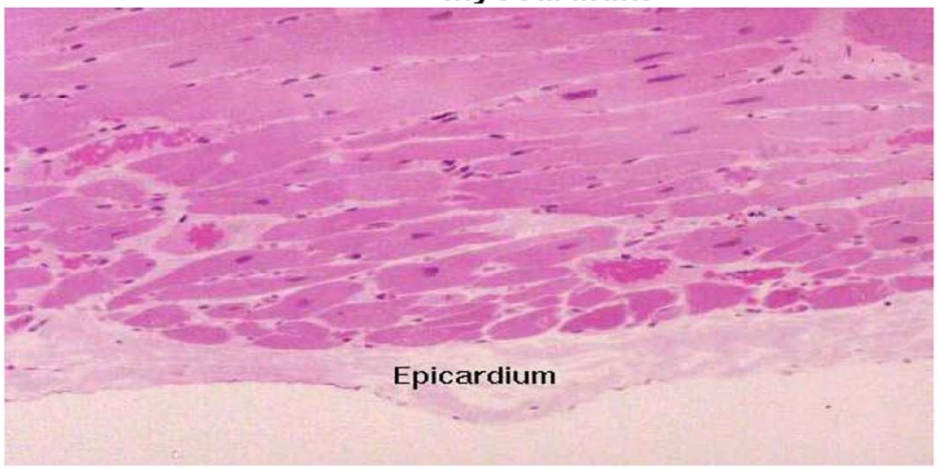

intercalated disk



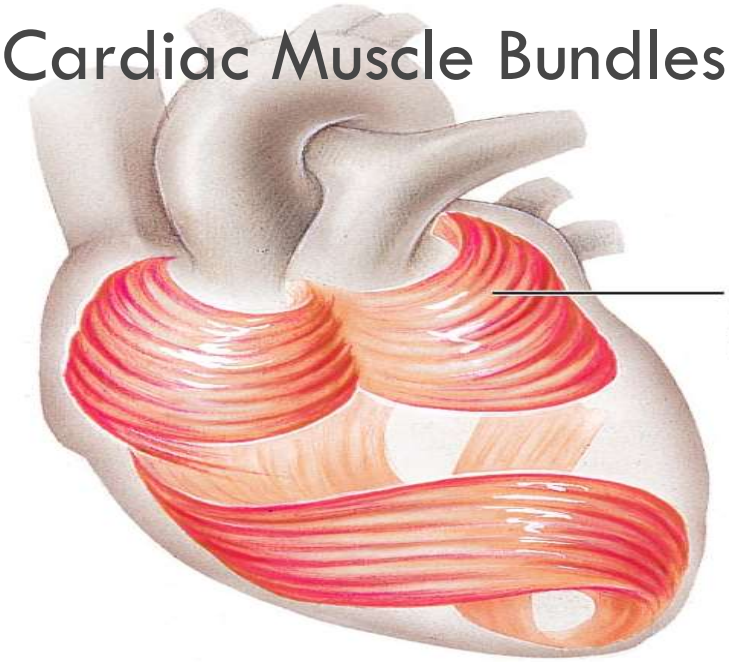

LUMEN

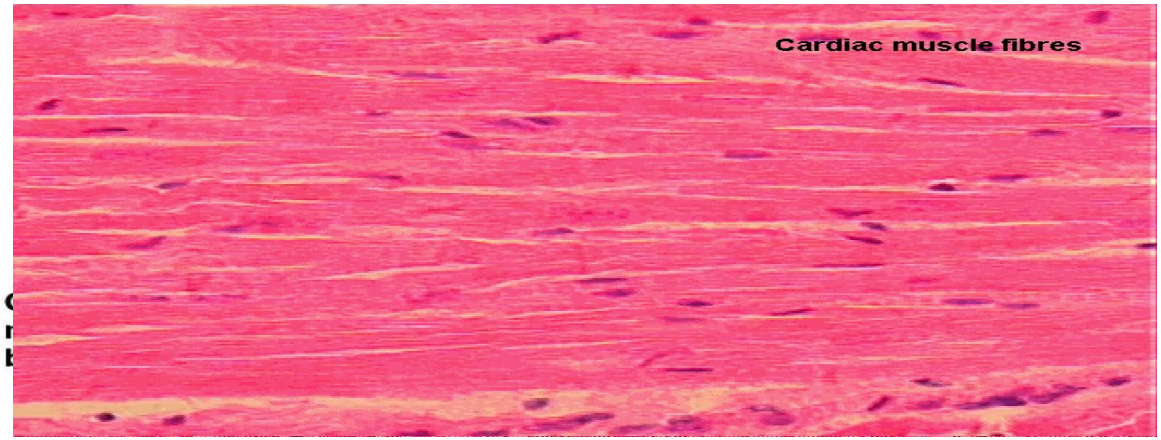

myocardium
nuclei of myocytes
epicardium
blood vessel

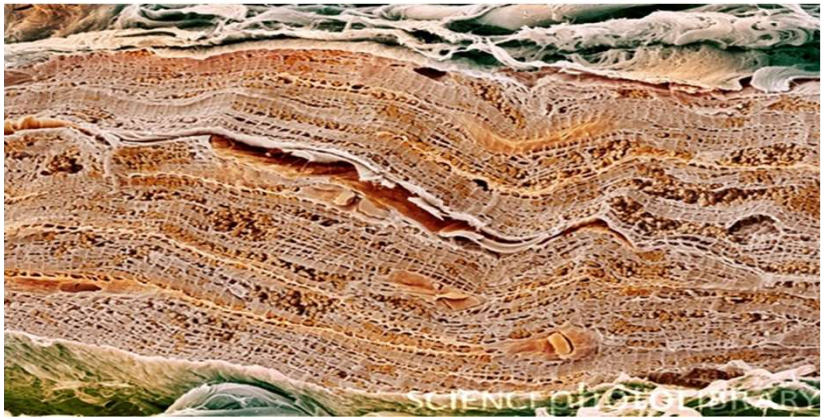

Lumen
Myocardium

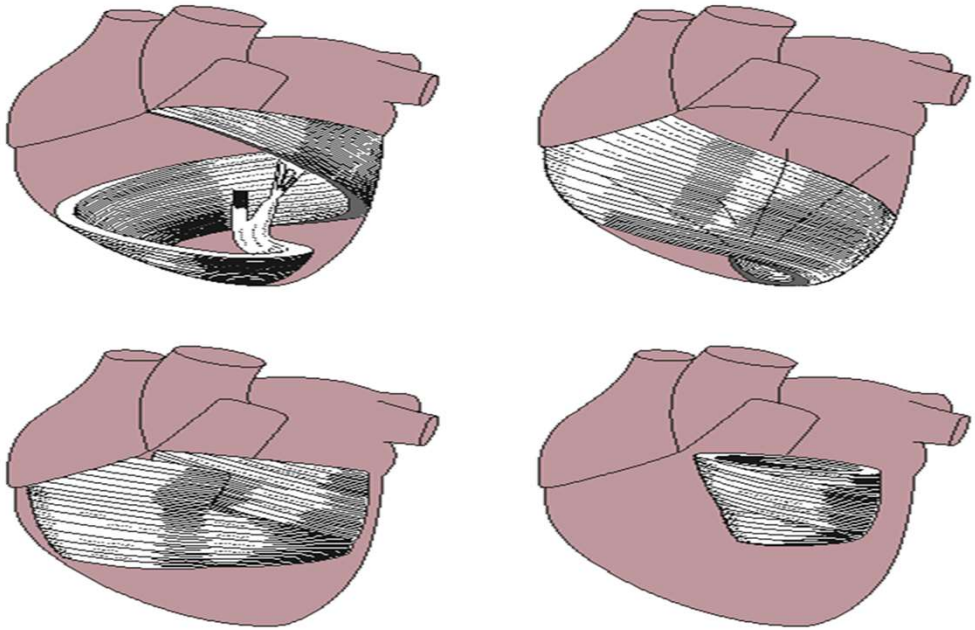

Epicardium

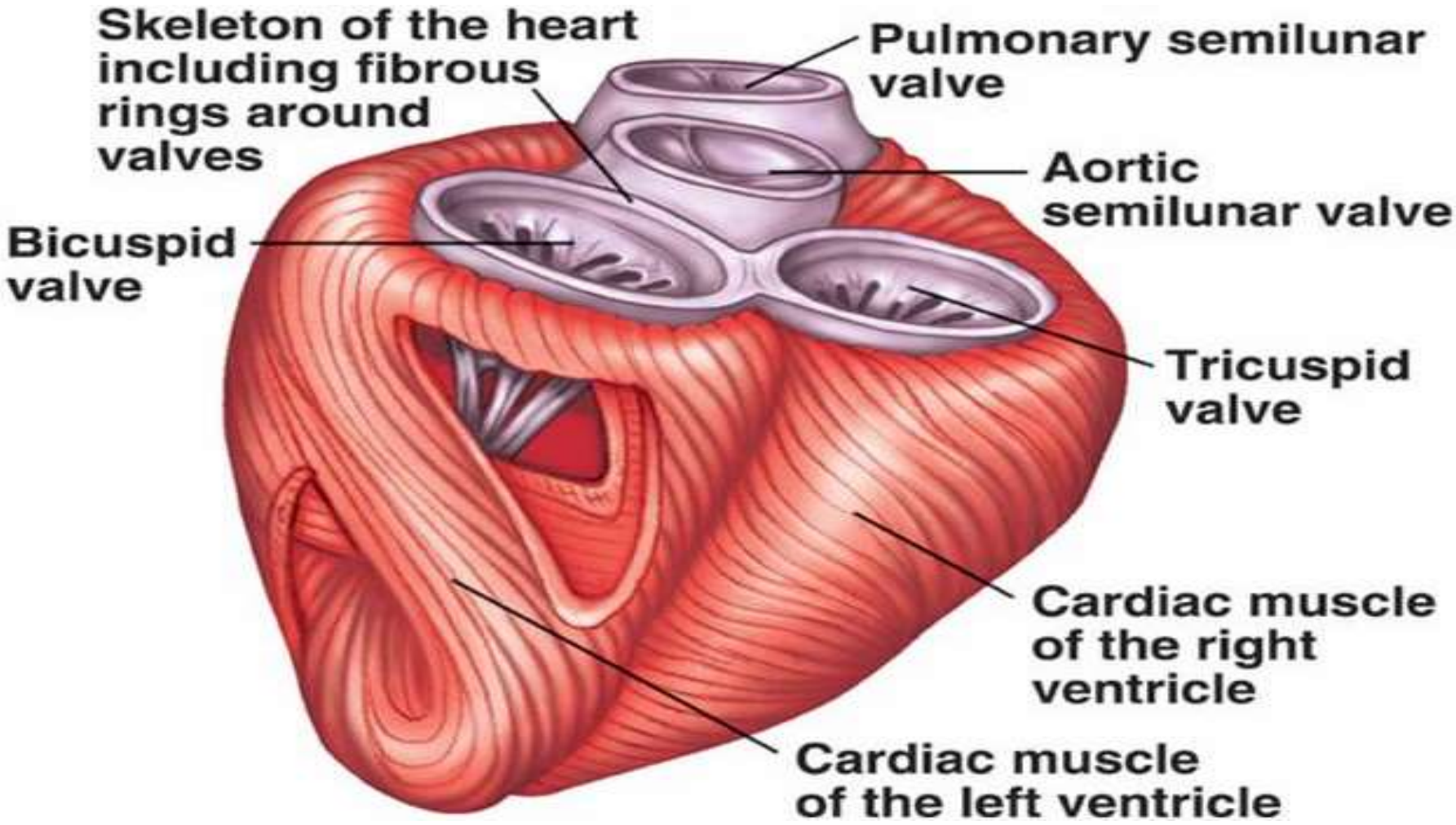
Cardiac Muscle Bundles

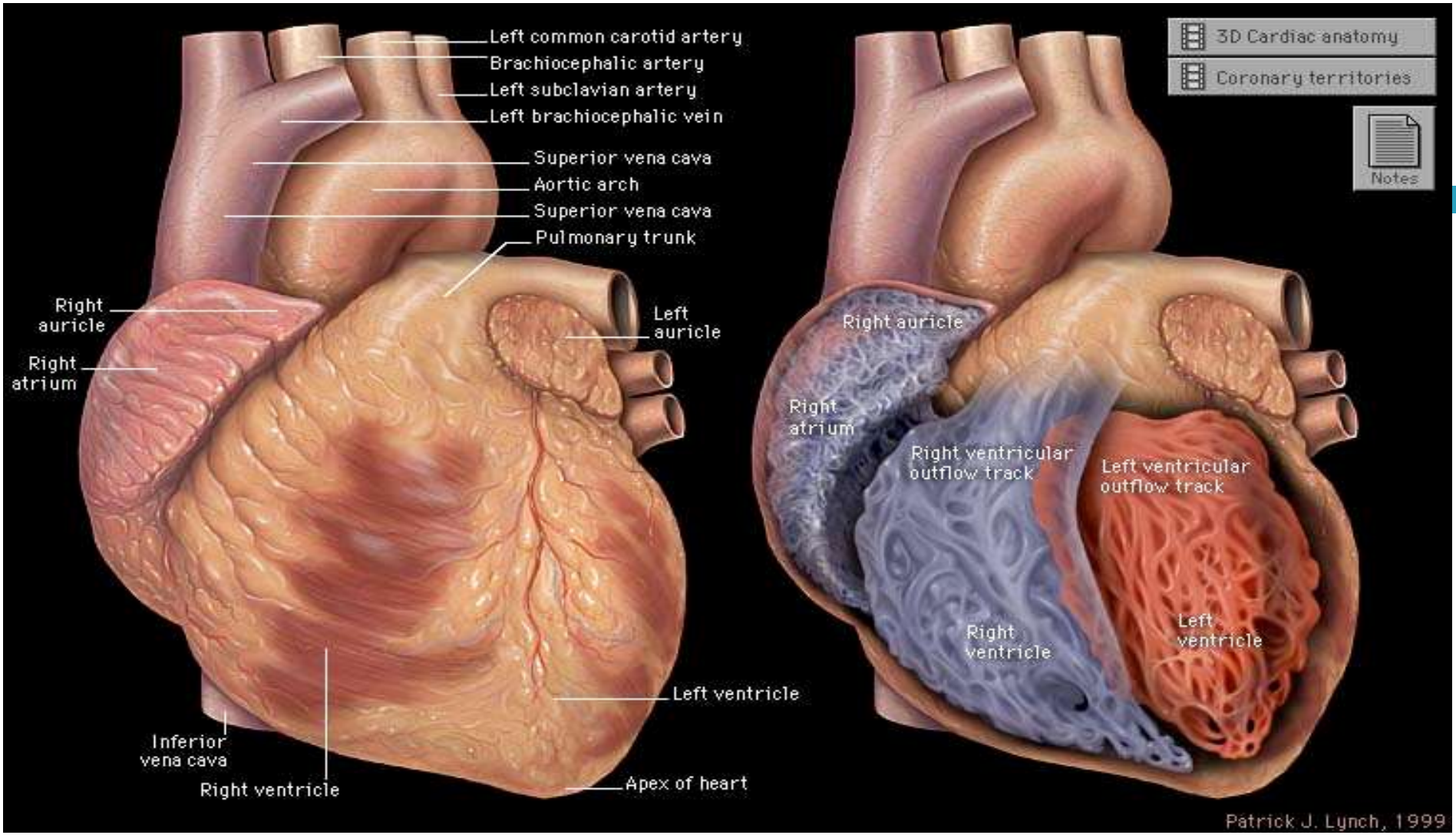









Skeleton of the heart including fibrous rings around valves
Pulmonary semilunar valve
Aortic semilunar valve
Bicuspid valve
Tricuspid valve
Cardiac muscle of the right ventricle
Cardiac muscle of the left ventricle


Left common carotid artery
Brachiocephalic artery
Left subclavian artery
Left brachiocephalic vein
Superior vena cava
Aortic arch
Superior vena cava
Pulmonary trunk
Right auricle
Right atrium
Left auricle
Left ventricle
Inferior vena cava
Right ventricle
Apex of heart
3D Cardiac anatomy
Coronary territories
Notes
Right auricle
Right atrium
Right ventricular outflow track
Left ventricular outflow track
Right ventricle
Left ventricle
Patrick J. Lynch, 1999

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 msecs.

•Cardiac muscle **resists wear and tear** better than skeletal muscle.

- This is important as cardiac muscle contracts som 100,000 times/day (in 70 years this totals to 2.5 billion times).

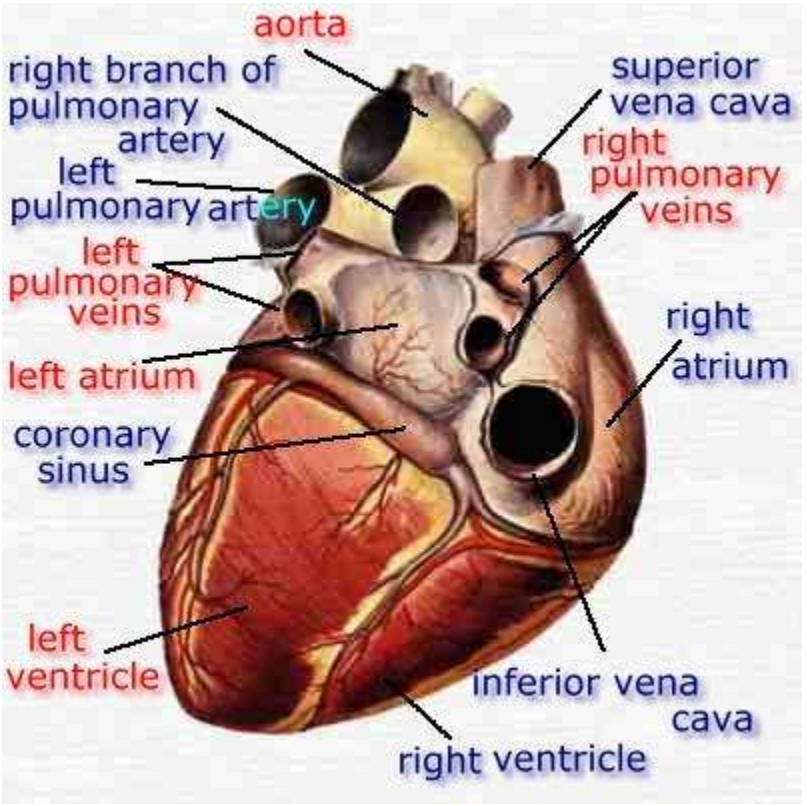
•Cardiac muscle is **very susceptible to oxygen lack -** can withstand not more than 30secs without oxygen before they stop working.

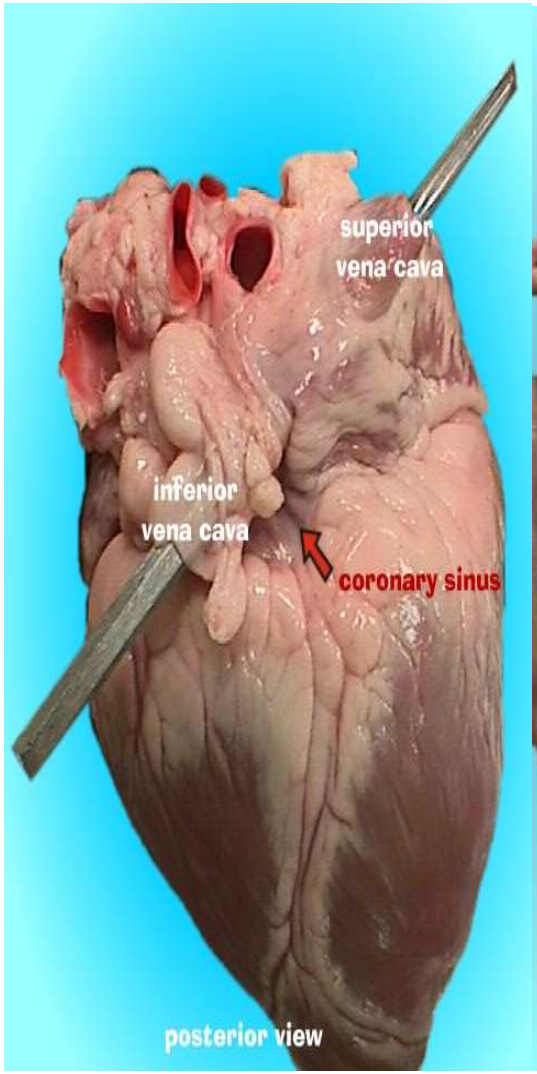
•The cardiac muscle as a whole, and not only the single muscle fibre, obeys the all or none rule i.e.

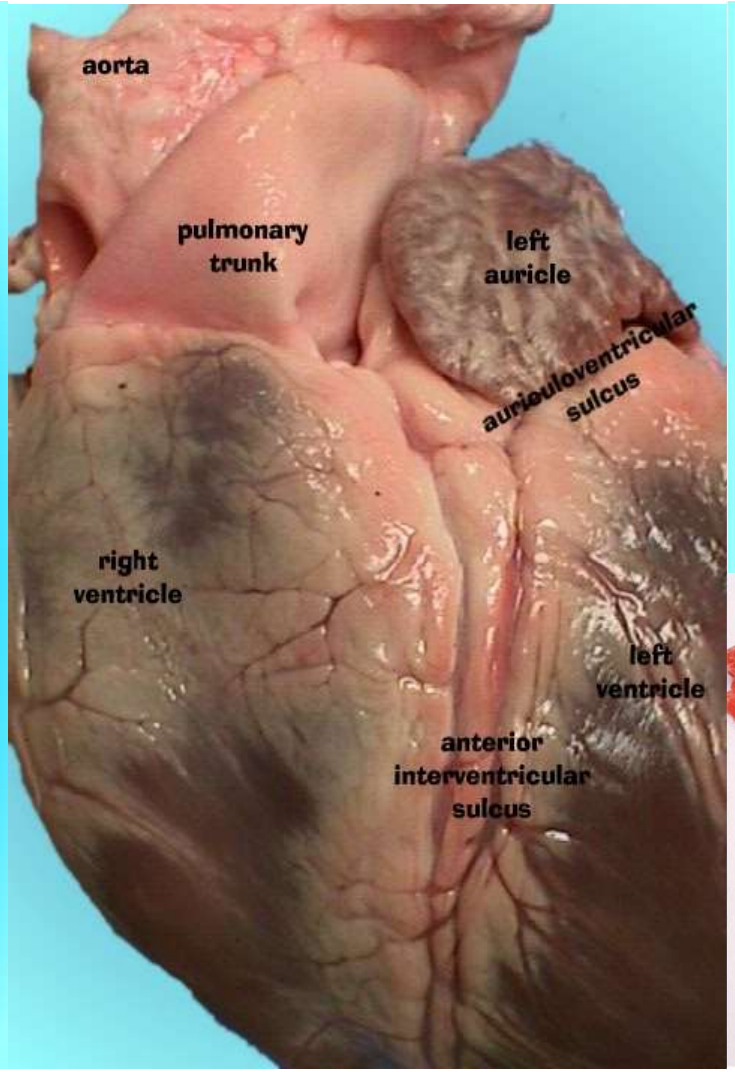
- if one muscle cell in the syncetium contracts, the rest contract at the same time.

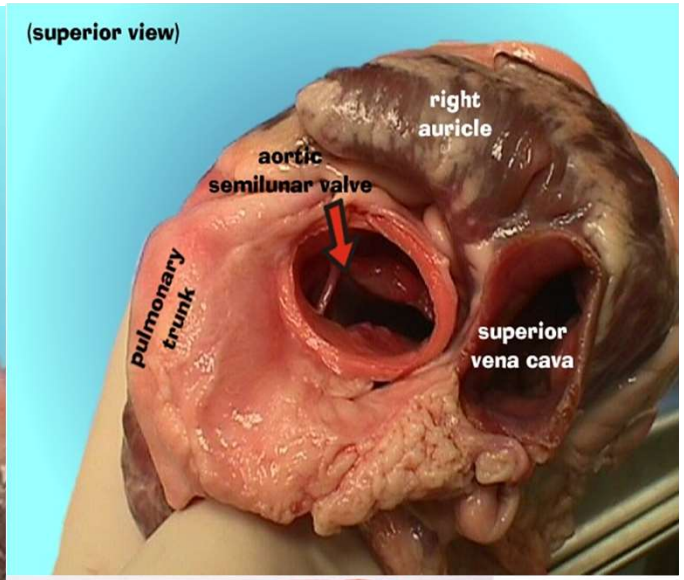
External Heart: Major Vessels of the Heart (Anterior View)

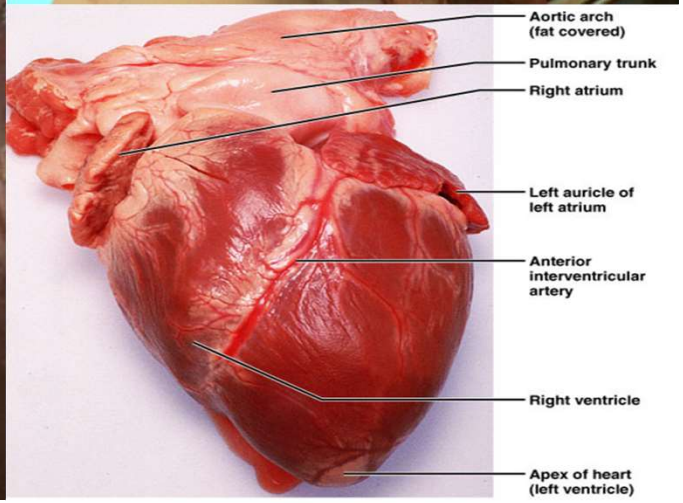
- **Vessels returning blood** to the heart include:
  - Superior and inferior venae cavae
  - Right and left pulmonary veins
- **Vessels conveying blood away from the heart**:
  - Pulmonary trunk, which splits into right and left pulmonary arteries
  - Ascending aorta (three branches) – brachiocephalic,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

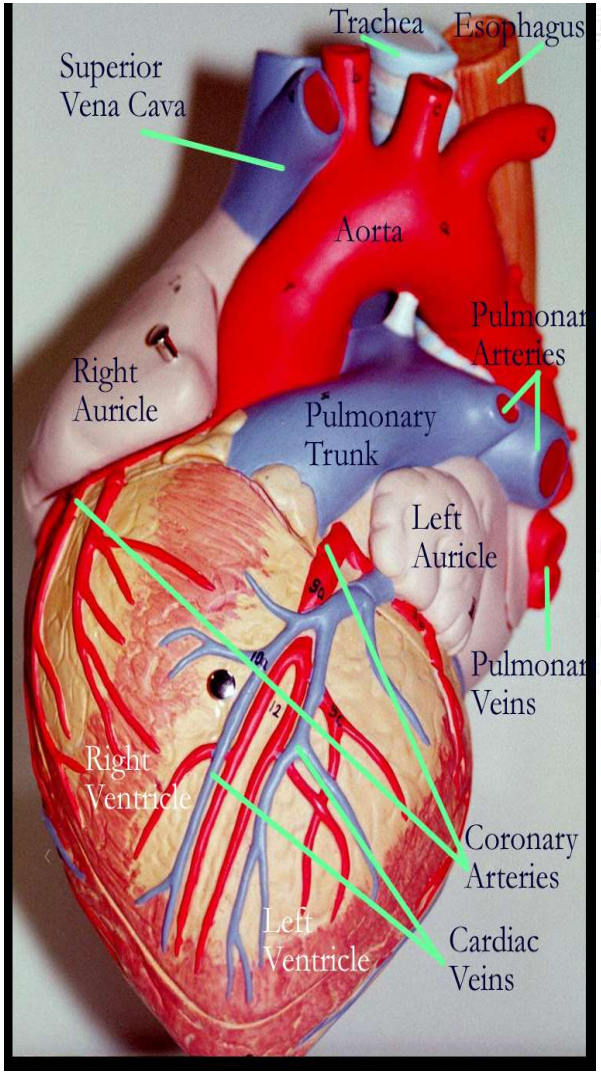


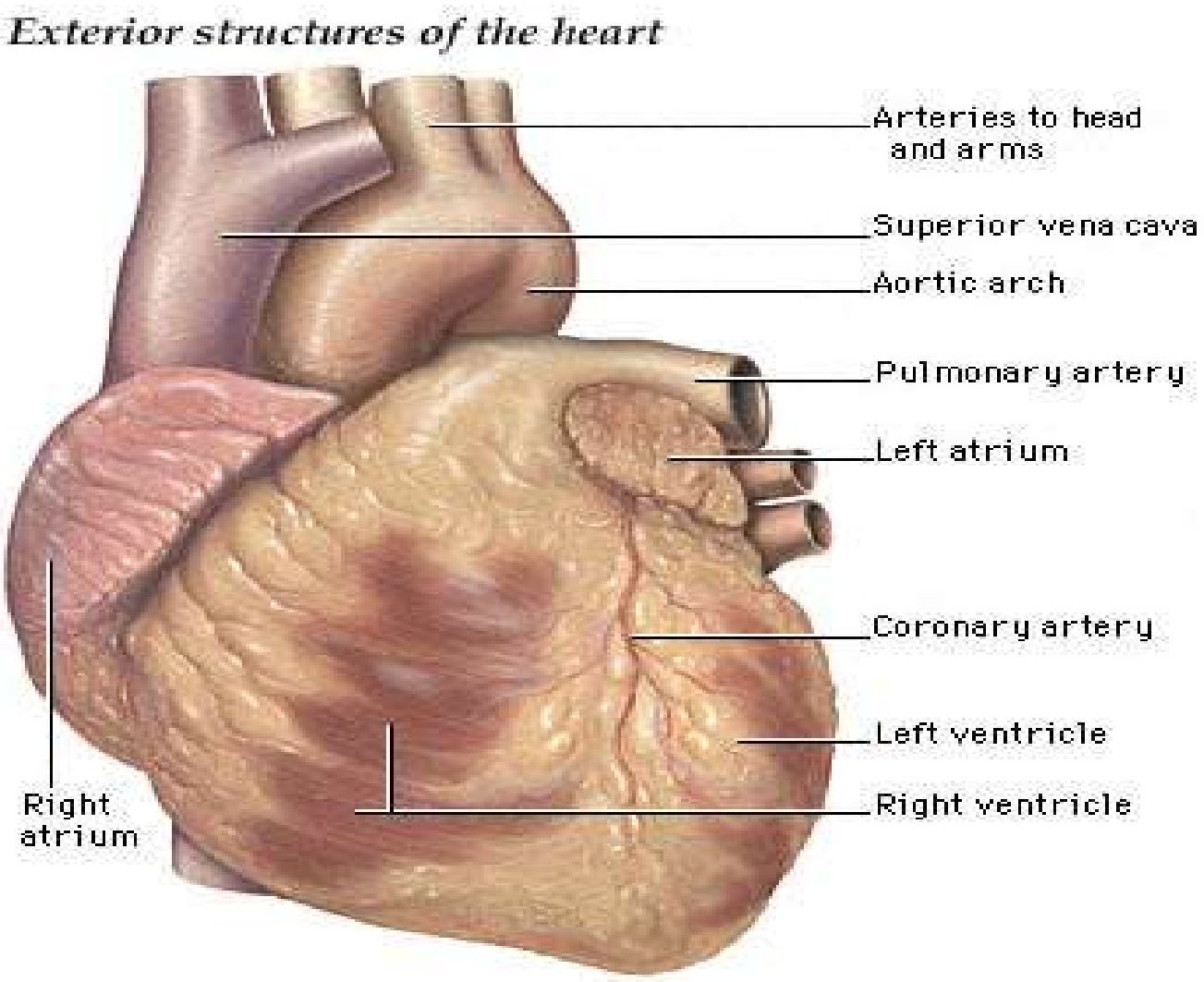

superior
vena cava
inferior
vena cava
coronary sinus
posterior view

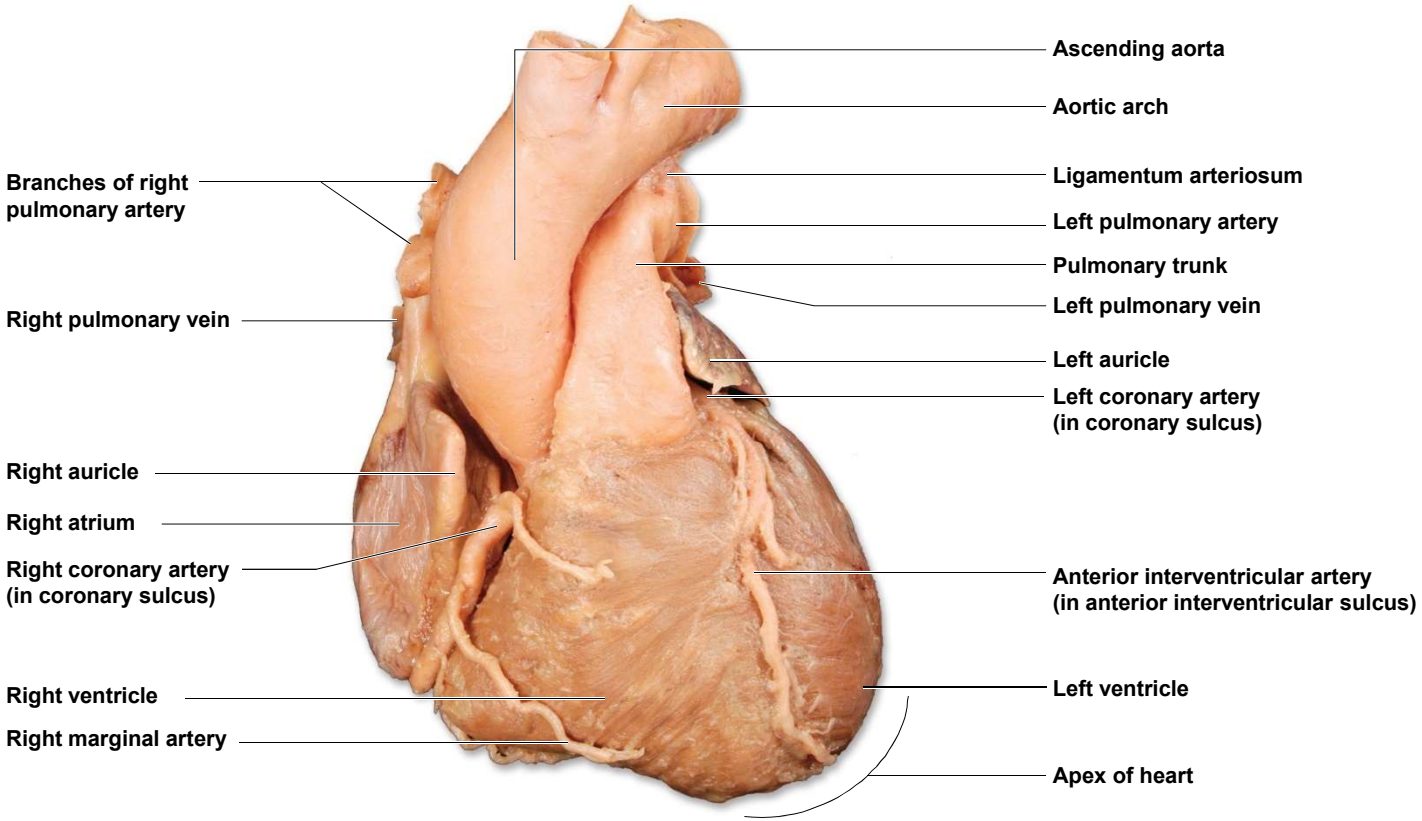

aorta
pulmonary
trunk
left
auricle
auriculoventricular
sulcus
right
ventricle
left
ventricle
anterior
interventricular
sulcus


(superior view)
right
auricle
aortic
semilunar valve
pulmonary
trunk
superior
vena cava

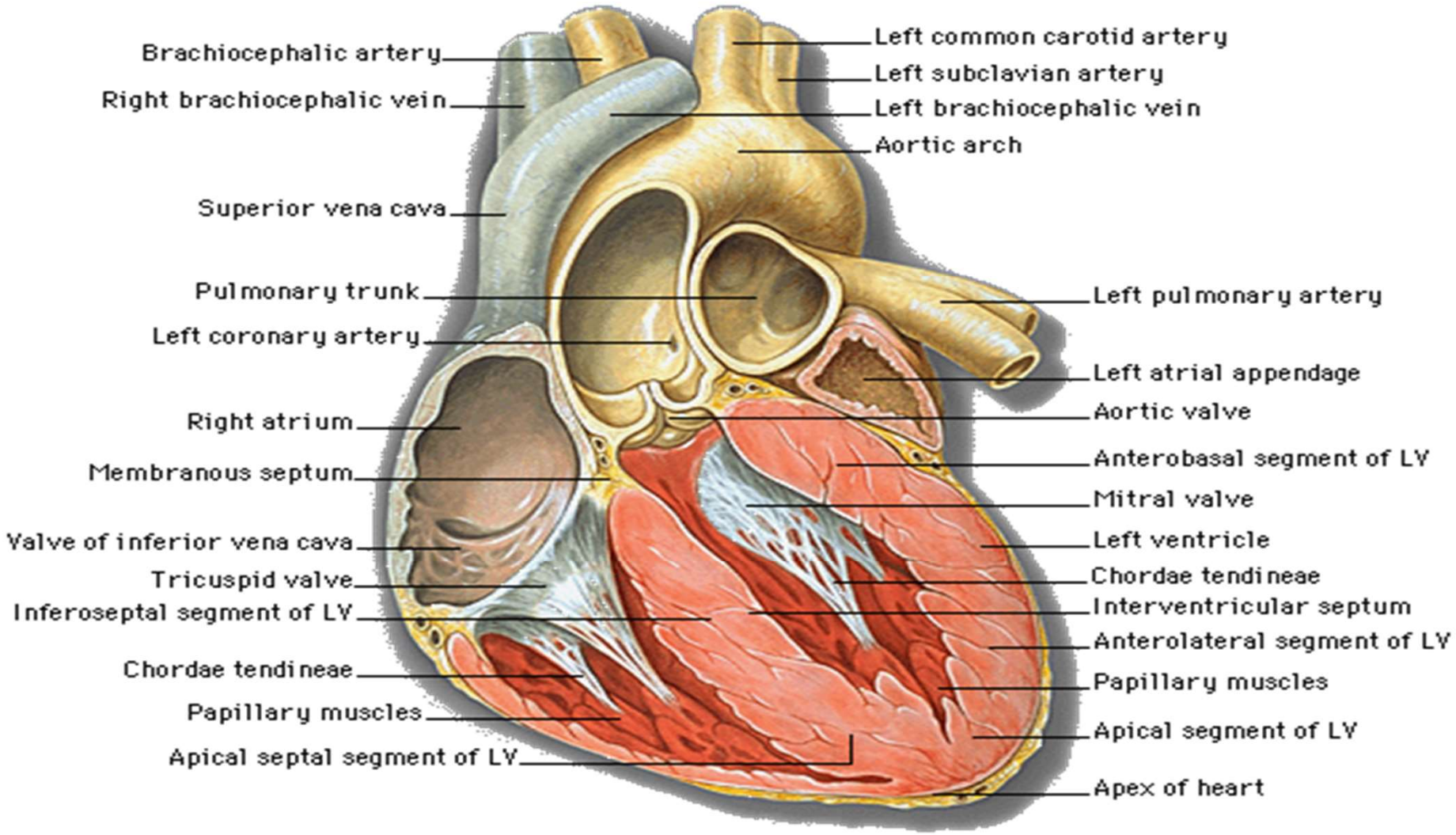

Aortic arch
(fat covered)
Pulmonary trunk
Right atrium
Left auricle of
left atrium
Anterior
interventricular
artery
Right ventricle
Apex of heart
(left ventricle)

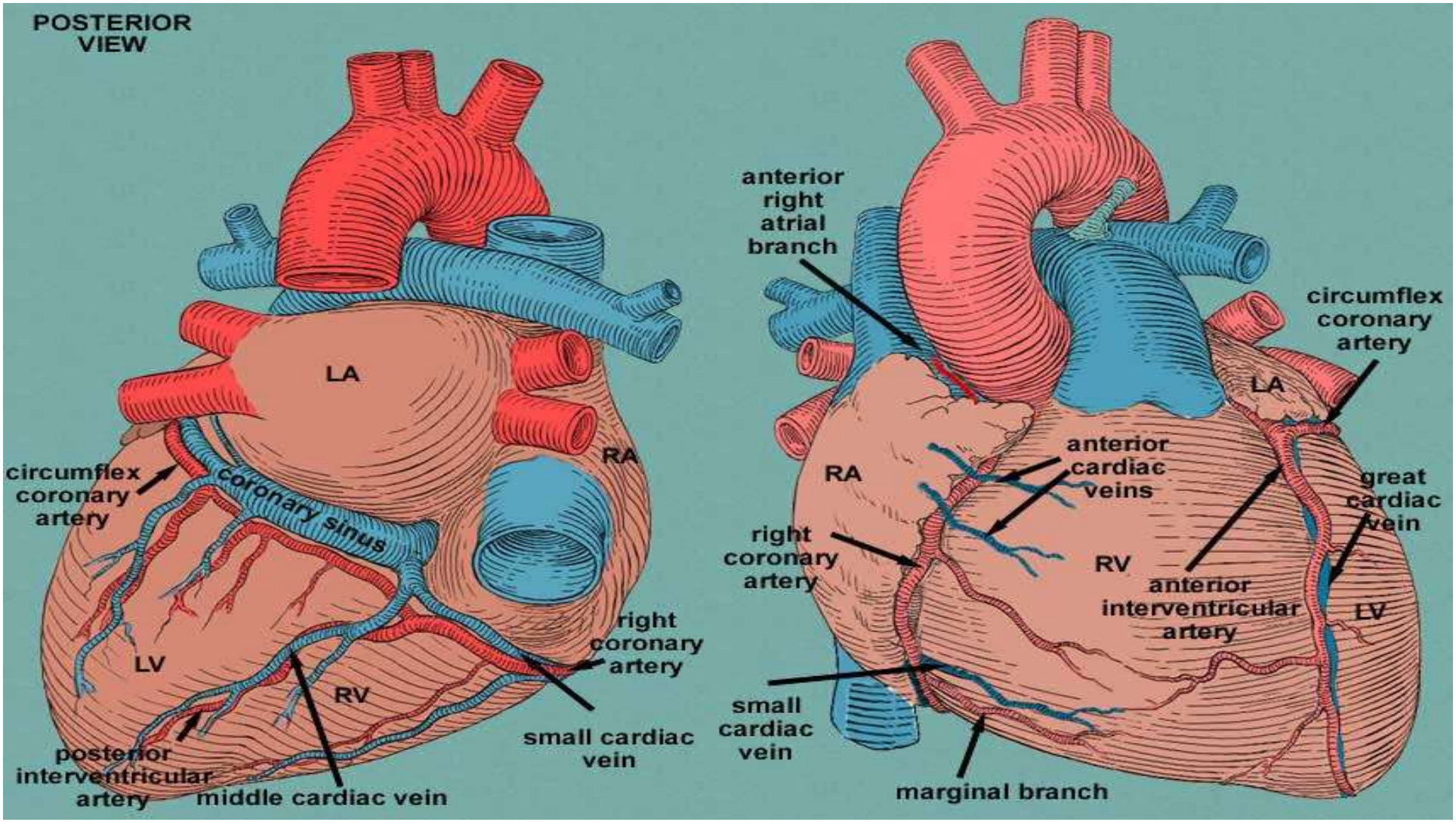

Trachea
Esophagus
Superior
Vena Cava
Aorta
Pulmonar
Arteries
Right
Auricle
Pulmonary
Trunk
Left
Auricle
Pulmonar
Veins
Right
Ventricle
Coronary
Arteries
Left
Ventricle
Cardiac
Veins

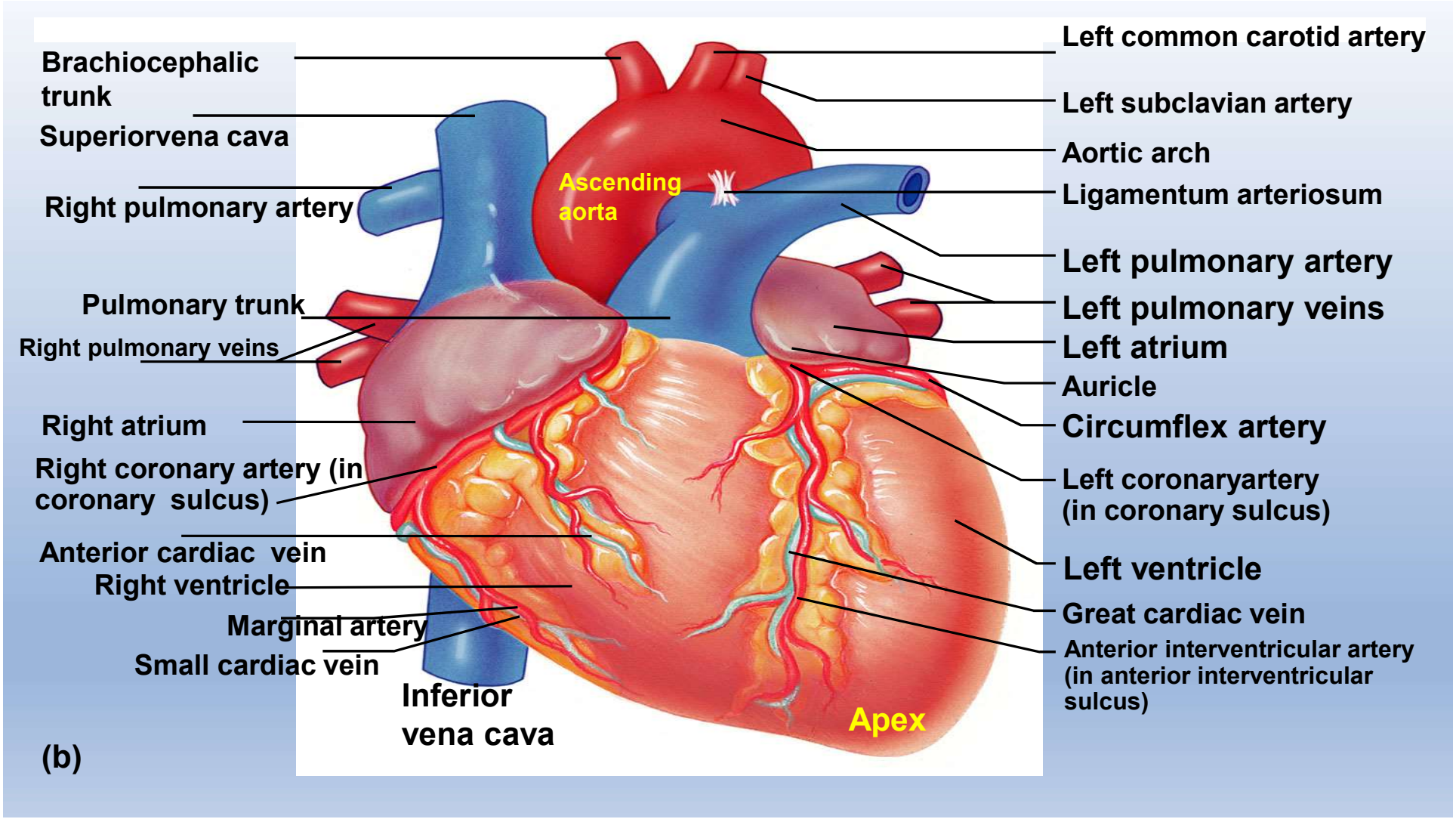

Exterior structures of the heart
Arteries to head
and arms
Superior vena cava
Aortic arch
Pulmonary artery
Left atrium
Coronary artery
Left ventricle
Right ventricle
Right
atrium



(a) Anterior view

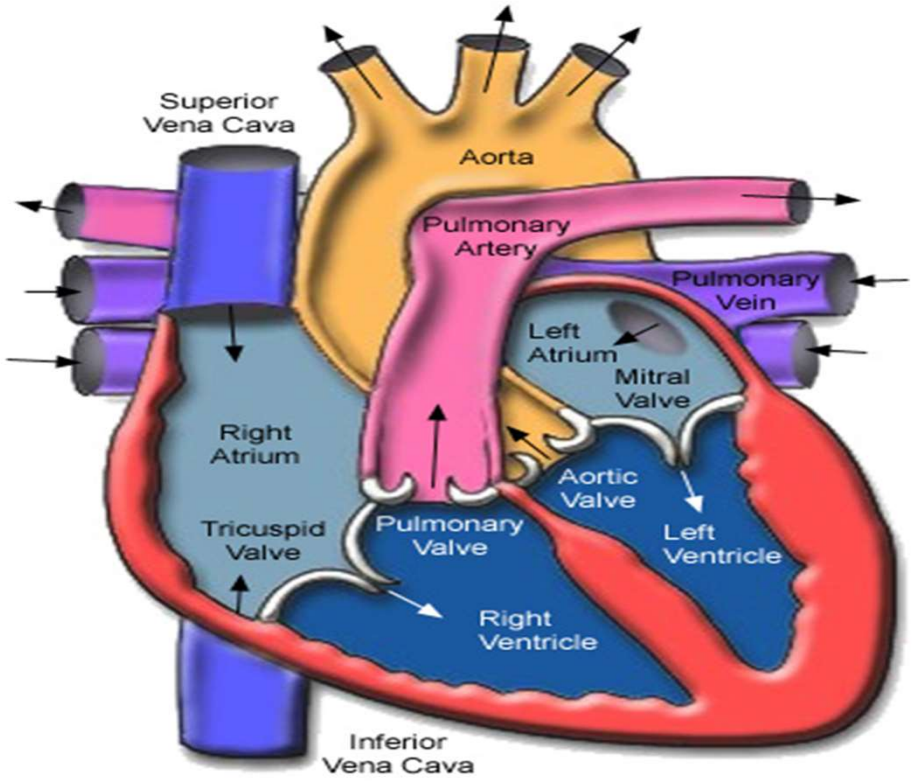

Brachiocephalic artery
Right brachiocephalic vein
Superior vena cava
Pulmonary trunk
Left coronary artery
Right atrium
Membranous septum
Valve of inferior vena cava
Tricuspid valve
Inferoseptal segment of LV
Chordae tendineae
Papillary muscles
Apical septal segment of LV
Left common carotid artery
Left subclavian artery
Left brachiocephalic vein
Aortic arch
Left pulmonary artery
Left atrial appendage
Aortic valve
Anterobasal segment of LV
Mitral valve
Left ventricle
Chordae tendineae
Interventricular septum
Anterolateral segment of LV
Papillary muscles
Apical segment of LV
Apex of heart


POSTERIOR VIEW
LA
RA
circumflex coronary artery
coronary sinus
LV
RV
posterior interventricular artery
middle cardiac vein
small cardiac vein
right coronary artery
anterior right atrial branch
circumflex coronary artery
LA
RA
anterior cardiac veins
great cardiac vein
right coronary artery
RV
anterior interventricular artery
LV
small cardiac vein
marginal branch


Brachiocephalic trunk
Superiorvena 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
Ascending aorta
Apex
Left common carotid artery
Left subclavian artery
Aortic arch
Ligamentum arteriosum
Left pulmonary artery
Left pulmonary veins
Left atrium
Auricle
Circumflex artery
Left coronaryartery (in coronary sulcus)
Left ventricle
Great cardiac vein
Anterior interventricular artery (in anterior interventricular sulcus)
(b)

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

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



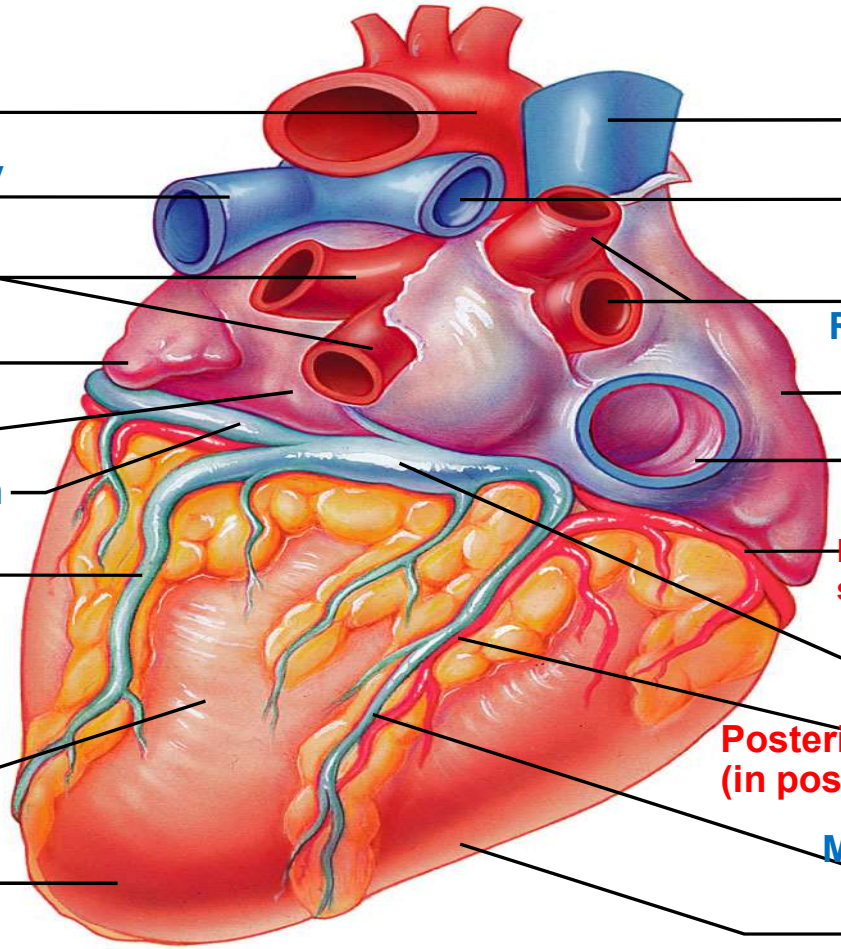
Blood Flow Through the Heart

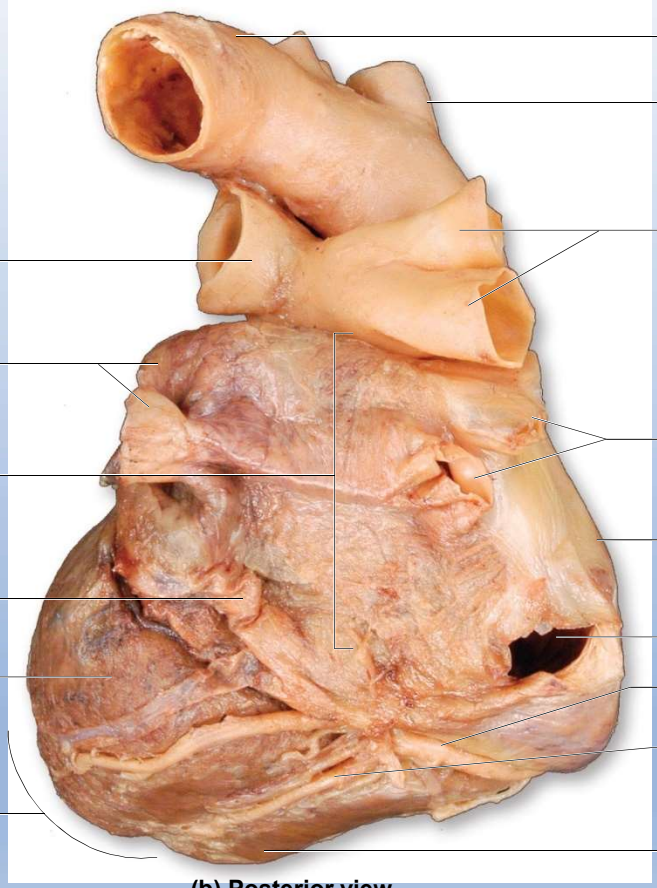
Heart Chamber	Receives Blood From	Sends Blood To	Valve Through Which Blood Flows
Right atrium	Superior vena cava Inferior vena cava Coronary sinus[1]	Right ventricle	Right atrioventricular (AV) valve
Right ventricle	Right atrium	Pulmonary trunk	Pulmonary semilunar valve
Left atrium	Pulmonary veins	Left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

1. Drains deoxygenated blood from the heart wall.

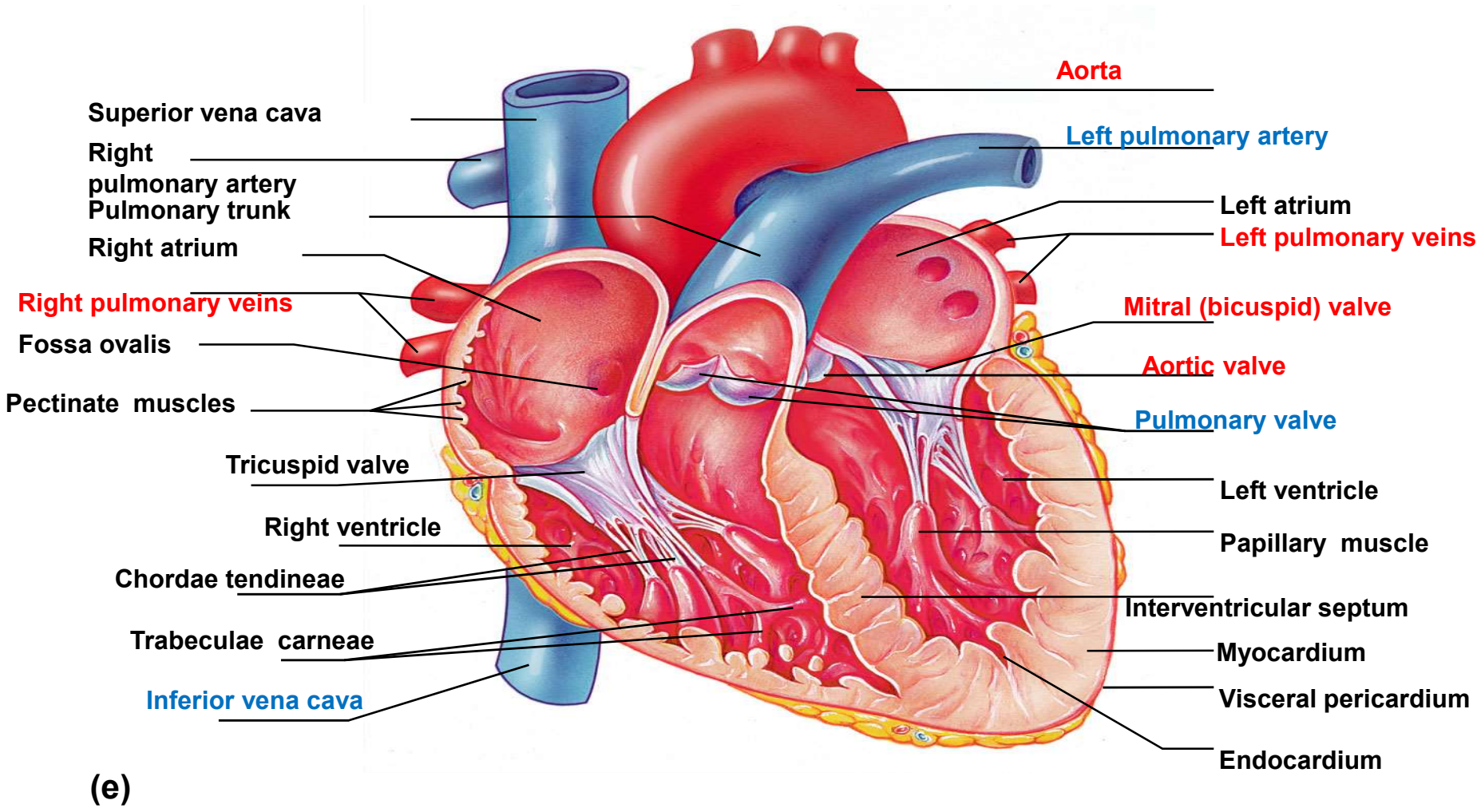
External Heart: Vessels that Supply/Drain the Heart (Posterior View)

- **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**


Aorta
Left pulmonary artery
Left pulmonary veins
Auricle of left atrium
Left atrium
Great cardiac vein
Posterior vein of left ventricle
Left ventricle
Apex
(d)
Superior vena cava
Right pulmonary artery
Right pulmonary veins
Right atrium
Inferior vena cava
Right coronary artery (in coronary sulcus)
Coronary sinus
Posterior interventricular artery (in posterior interventricular sulcus)
Middle cardiac vein
Right ventricle



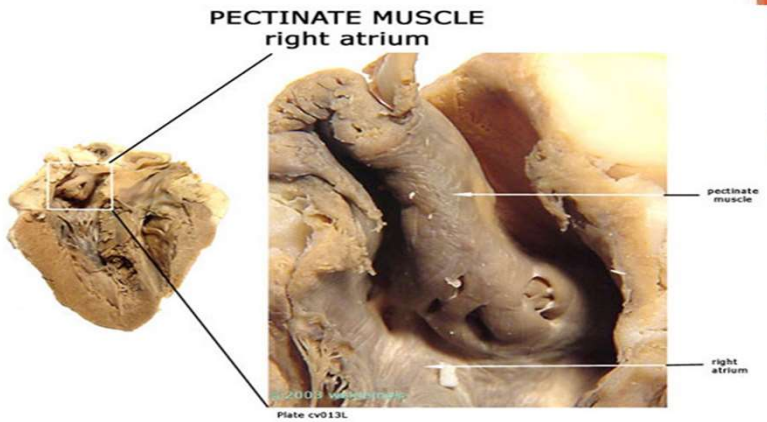
(b) Posterior view

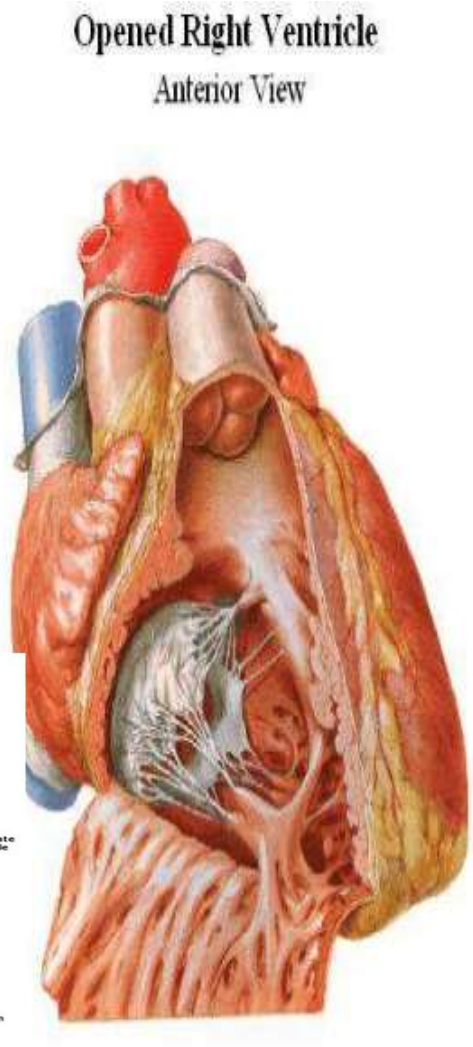

Aorta
Superior vena cava
Left pulmonary artery
Right pulmonary artery
Pulmonary trunk
Left atrium
Left pulmonary veins
Right atrium
Right pulmonary veins
Mitral (bicuspid) valve
Fossa ovalis
Aortic valve
Pectinate muscles
Pulmonary valve
Tricuspid valve
Left ventricle
Right ventricle
Papillary muscle
Chordae tendineae
Interventricular septum
Trabeculae carneae
Myocardium
Inferior vena cava
Visceral pericardium
Endocardium

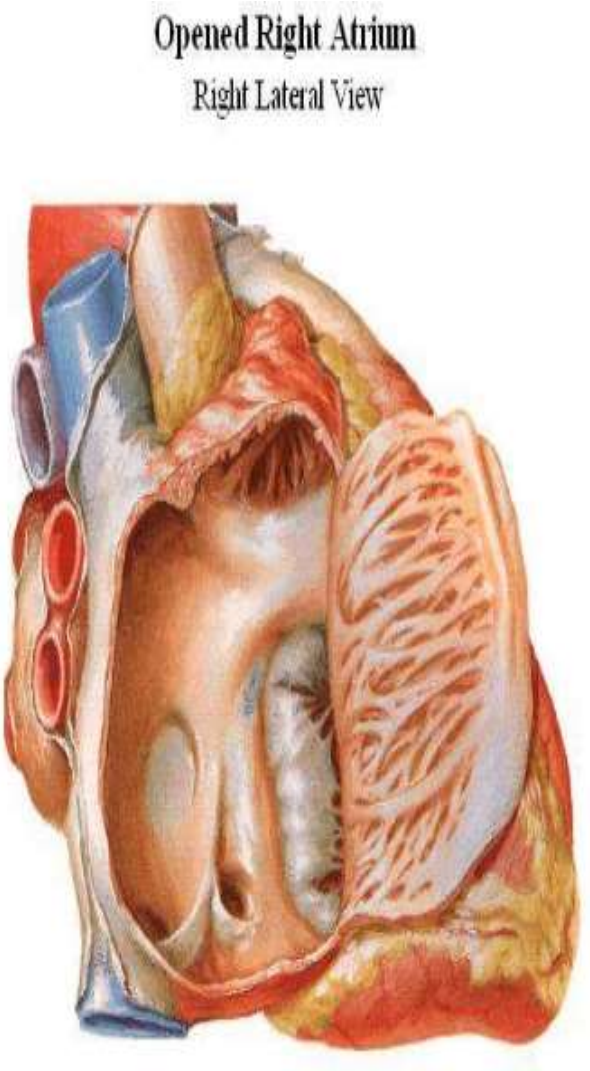
(e)

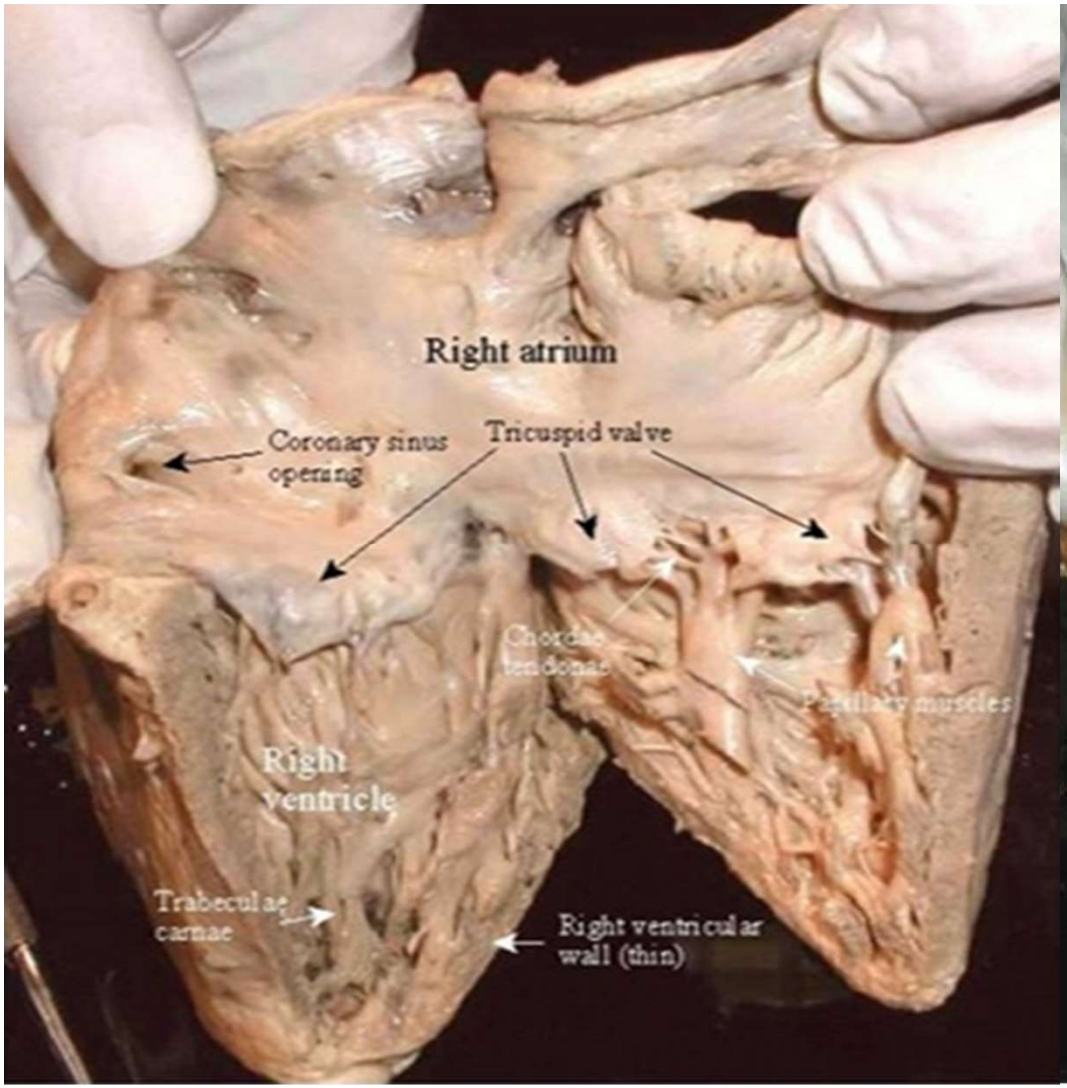
Atria of the Heart

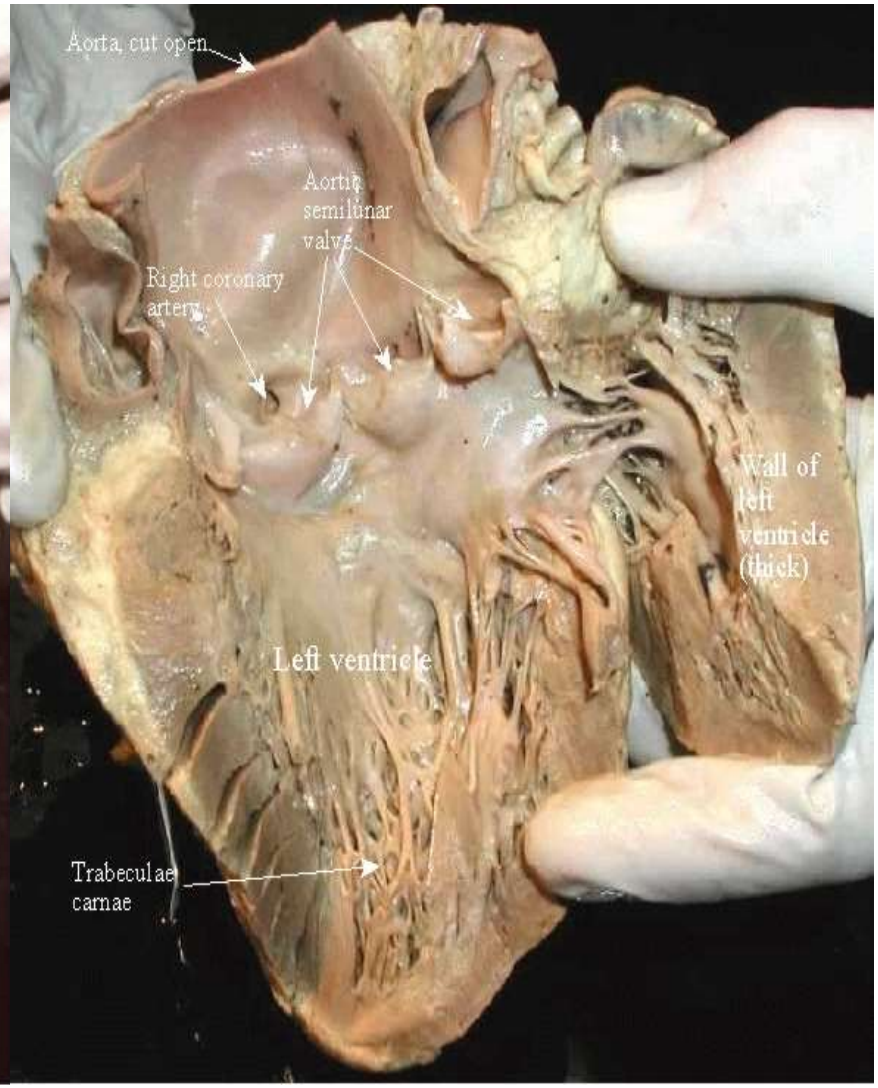
- Atria are the receiving chambers of the heart
- Each atrium has a protruding auricle
- Pectinate muscles mark atrial walls
- Blood enters right atria from superior and inferior venae cavae and coronary sinus
- Blood enters left atria from pulmonary veins





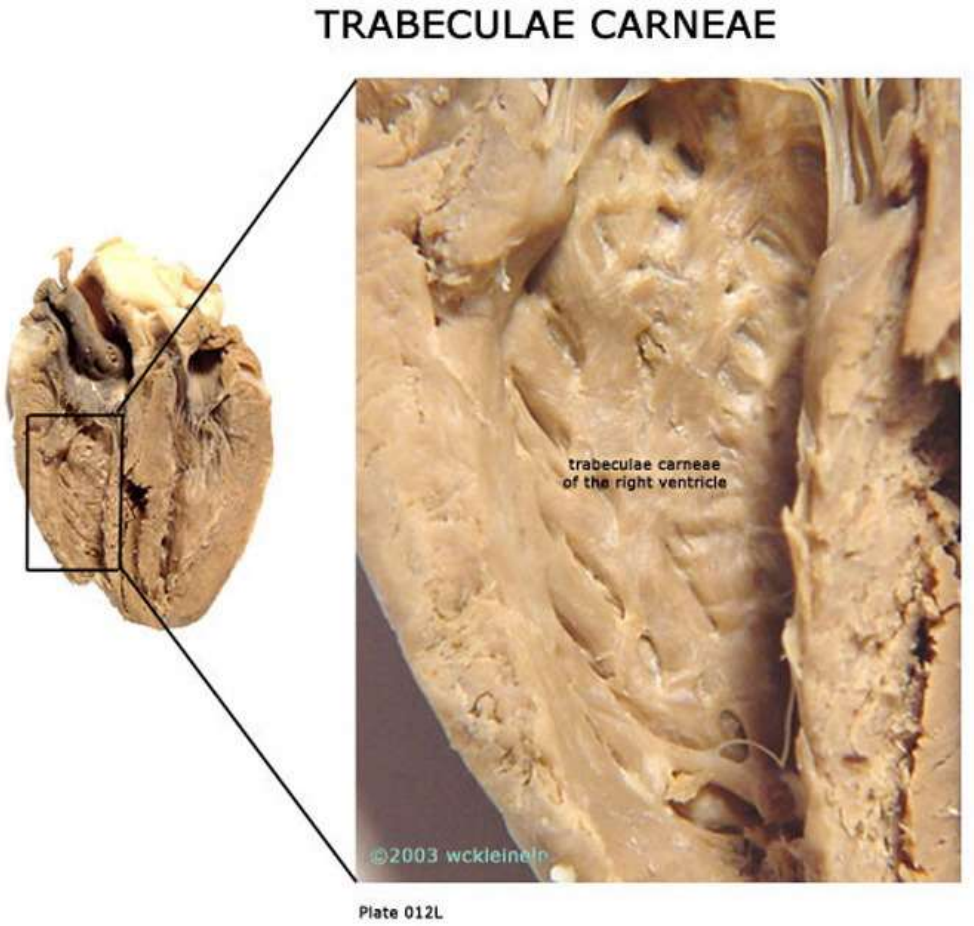



Right atrium
Coronary sinus opening
Tricuspid valve
Right ventricle
Trabeculae carnae
Right ventricular wall (thin)


Aorta, cut open
Aortic semilunar valve
Right coronary artery
Wall of left ventricle (thick)
Left ventricle
Trabeculae carnae

Ventricles of the Heart

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



LEFT ATRIUM & VENTRICLE DETAIL

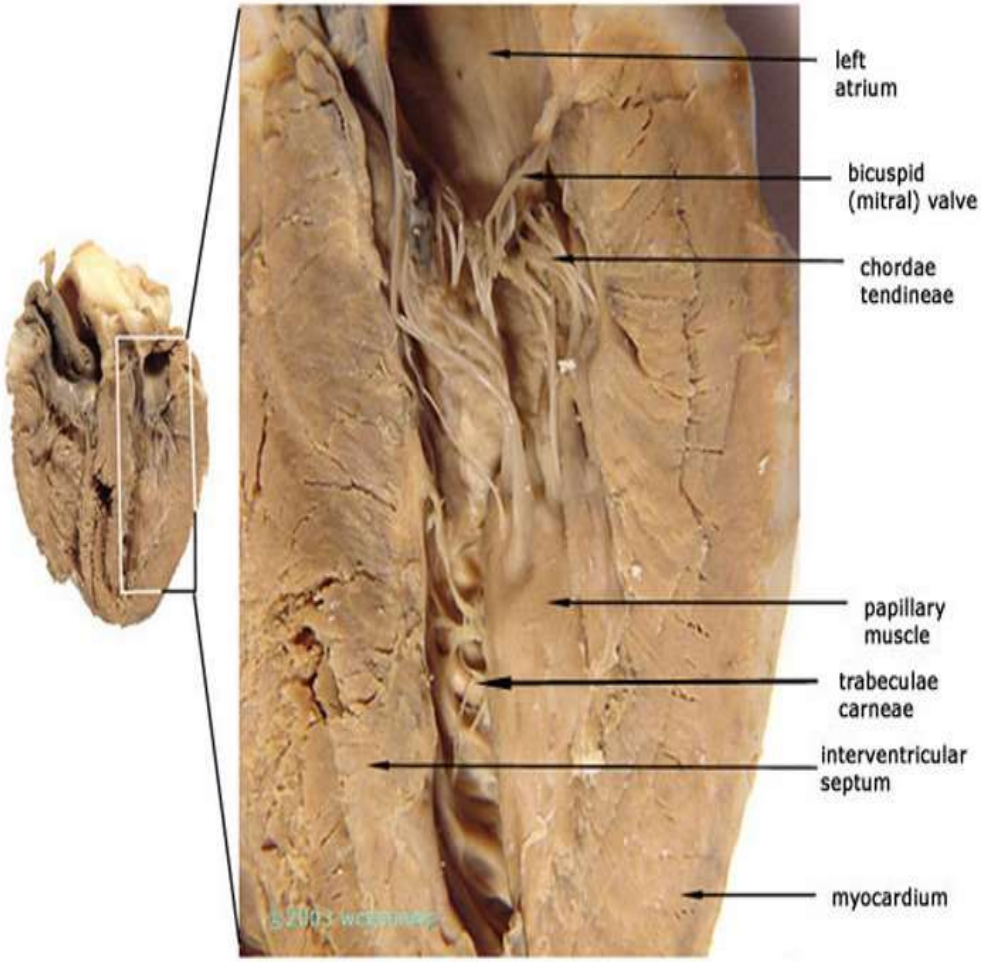


Plate cv013L

POSTERIOR SAGITTAL SECTION
sheep heart

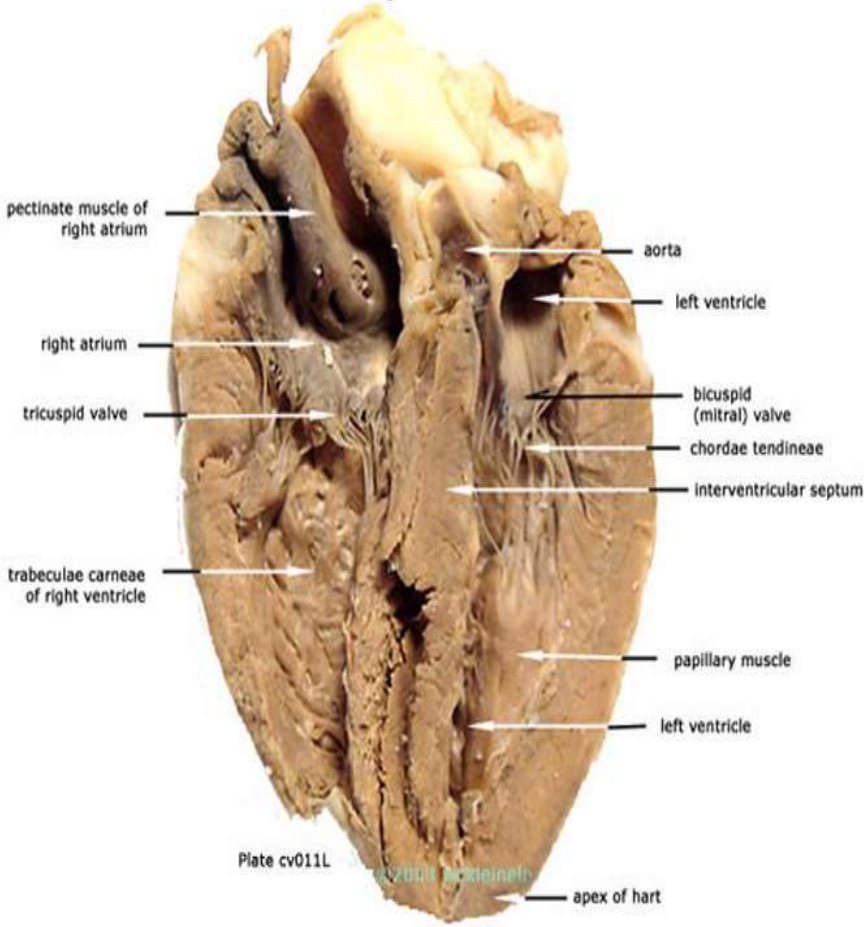
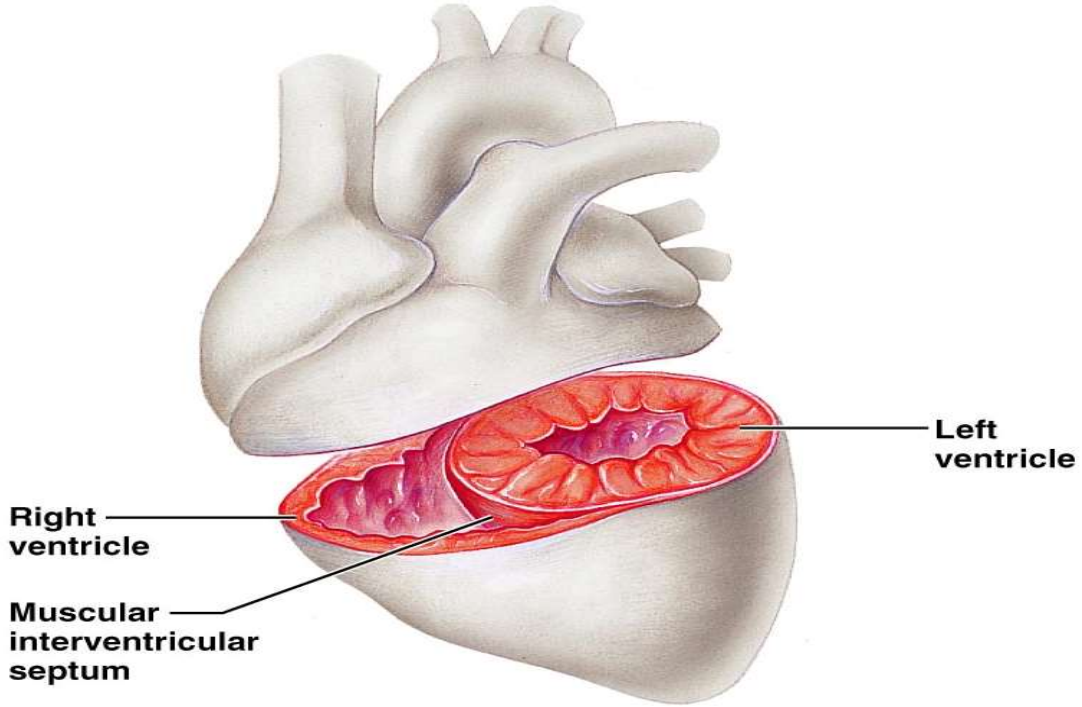


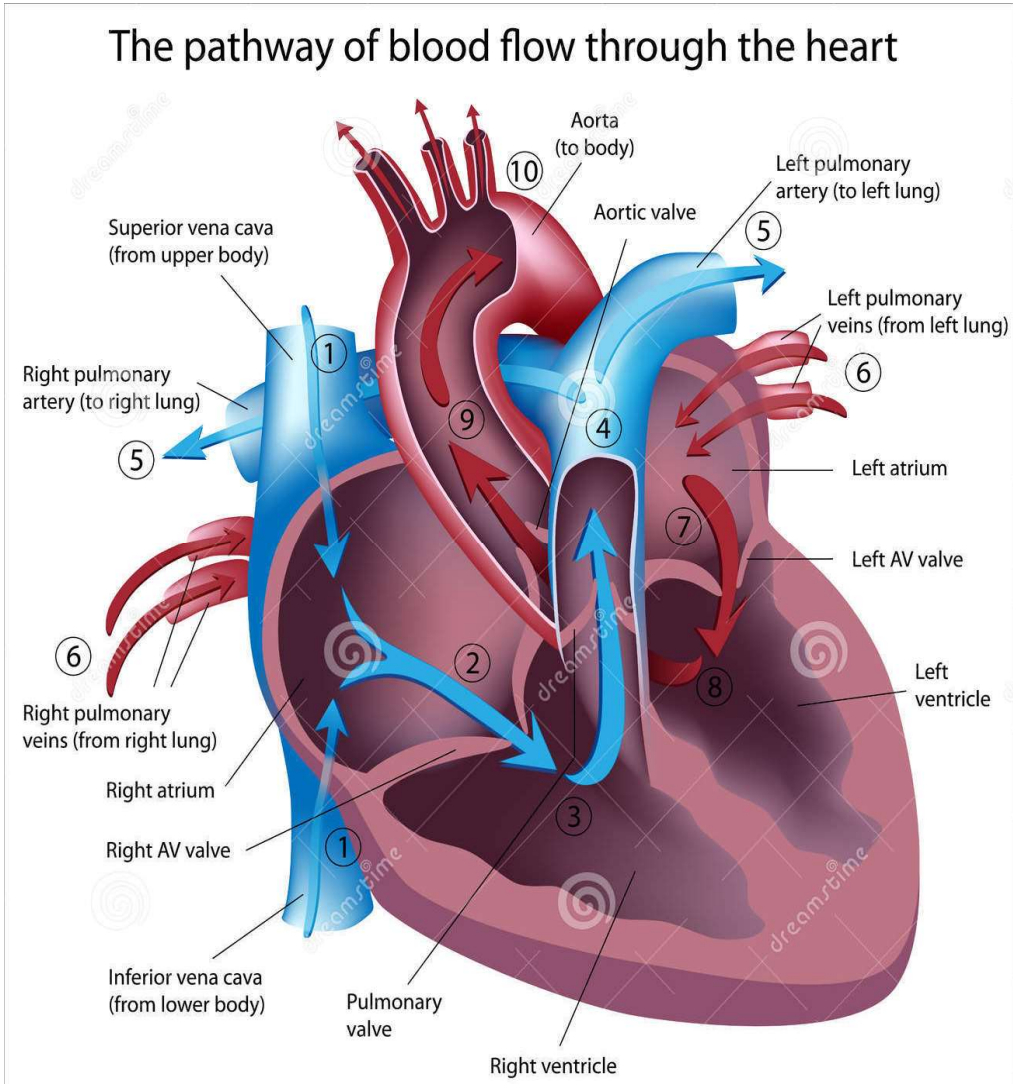
Plate cv011L

Right and Left Ventricles



Pathway of Blood Through the Heart and Lungs

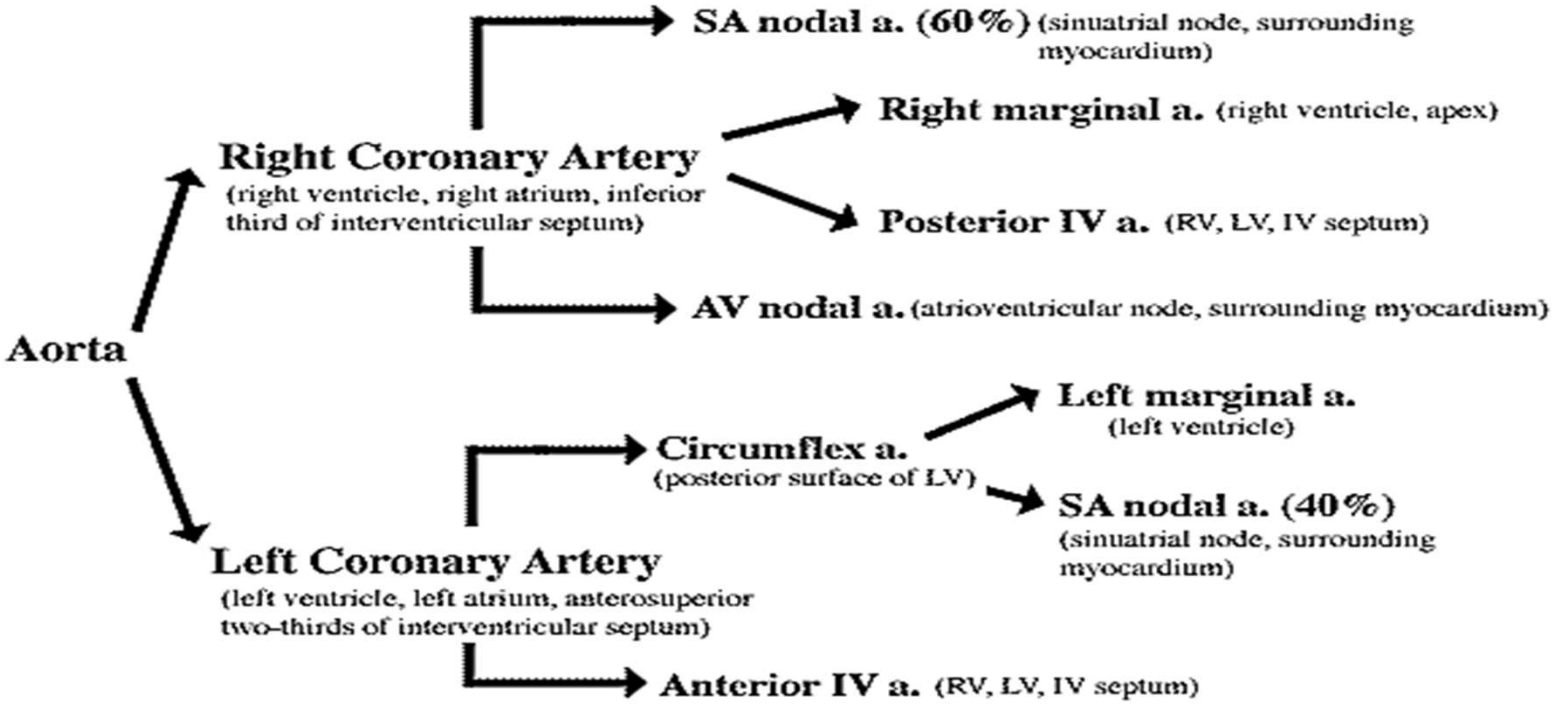
- **Right atrium → tricuspid valve → right ventricle**
- **Right ventricle → pulmonary semilunar valve → pulmonary arteries → lungs**
- **Lungs → pulmonary veins → left atrium**
- **Left atrium → bicuspid valve → left ventricle**
- **Left ventricle → aortic semilunar valve → aorta**
- **Aorta → systemic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



Coronary circulation

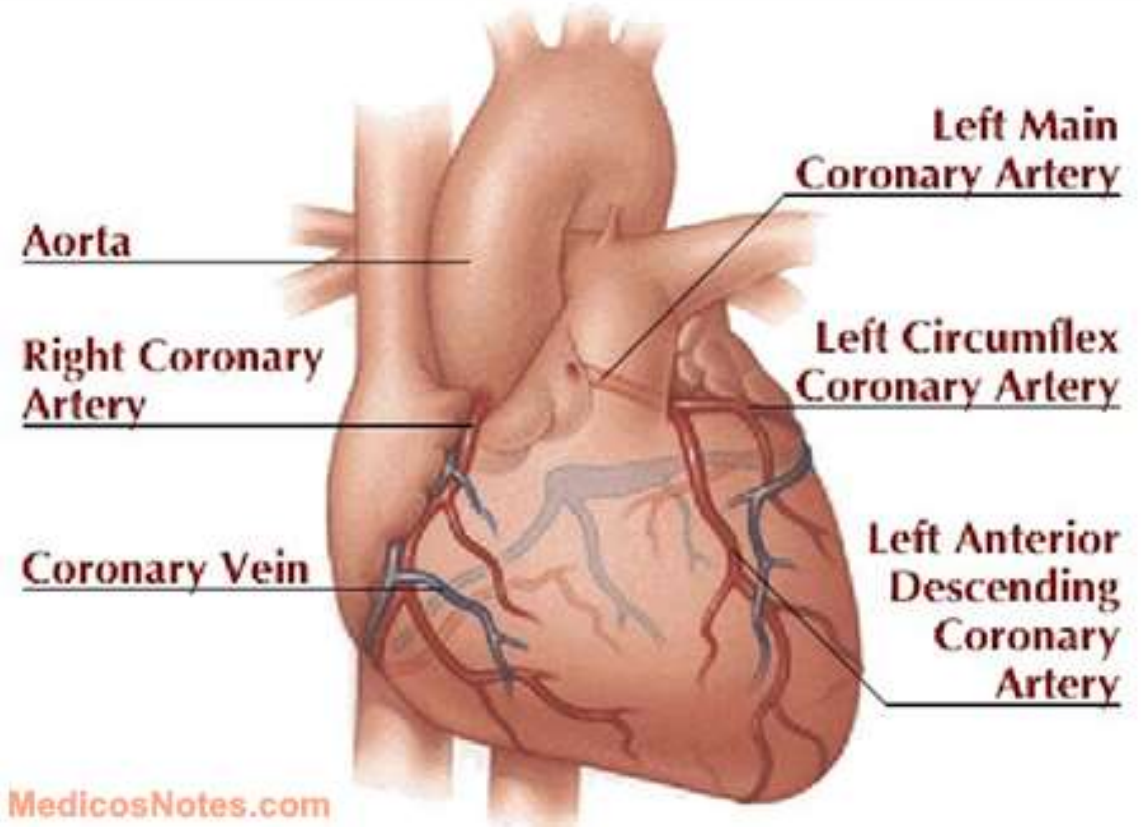
Coronary Circulation

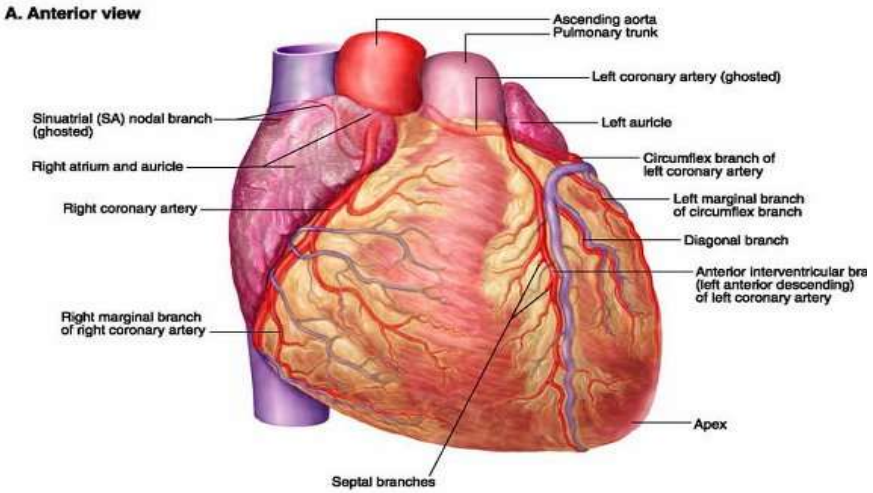
- **Coronary circulation is the functional blood supply to the heart muscle itself**
- **Collateral routes ensure blood delivery to heart even if major vessels are occluded**



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





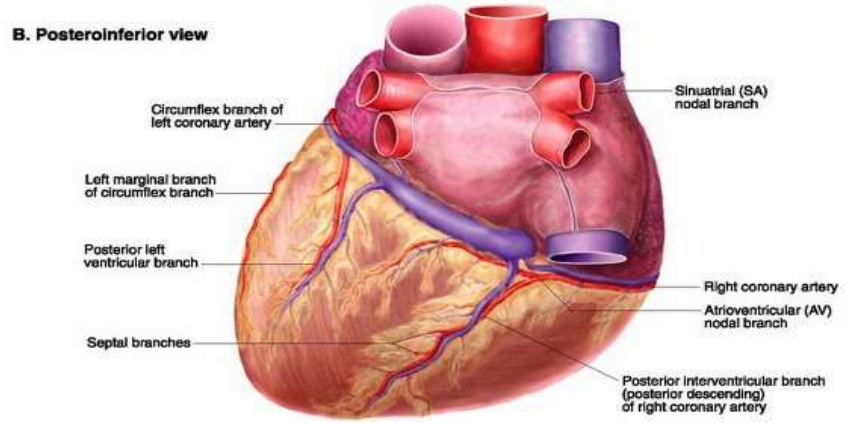
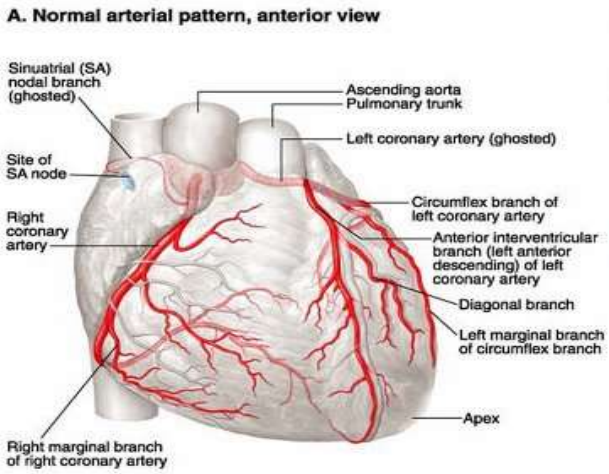
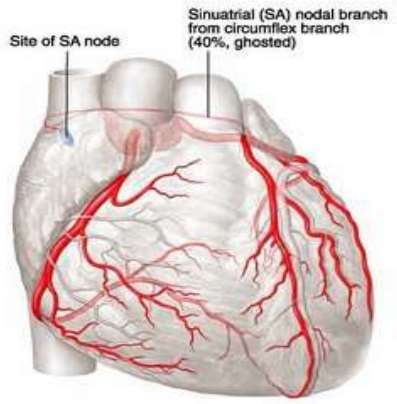
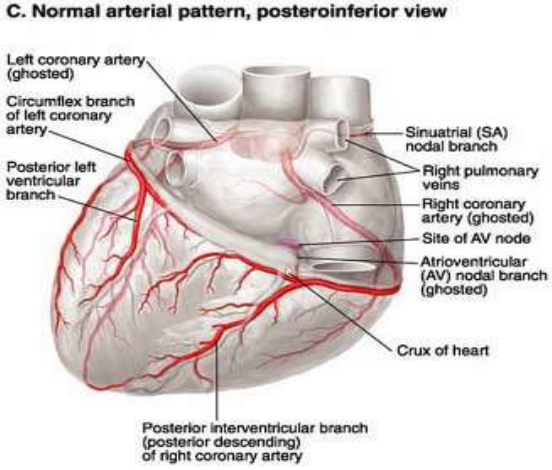


Plate 4-22 Coronary Arteries







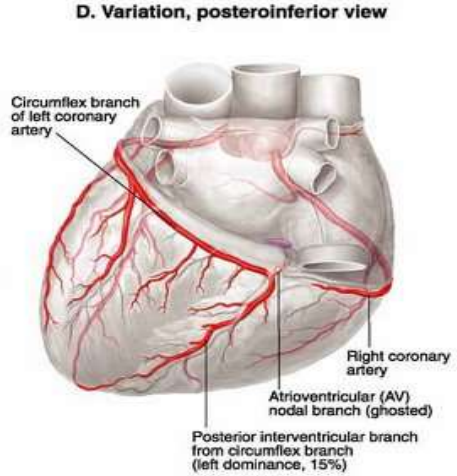
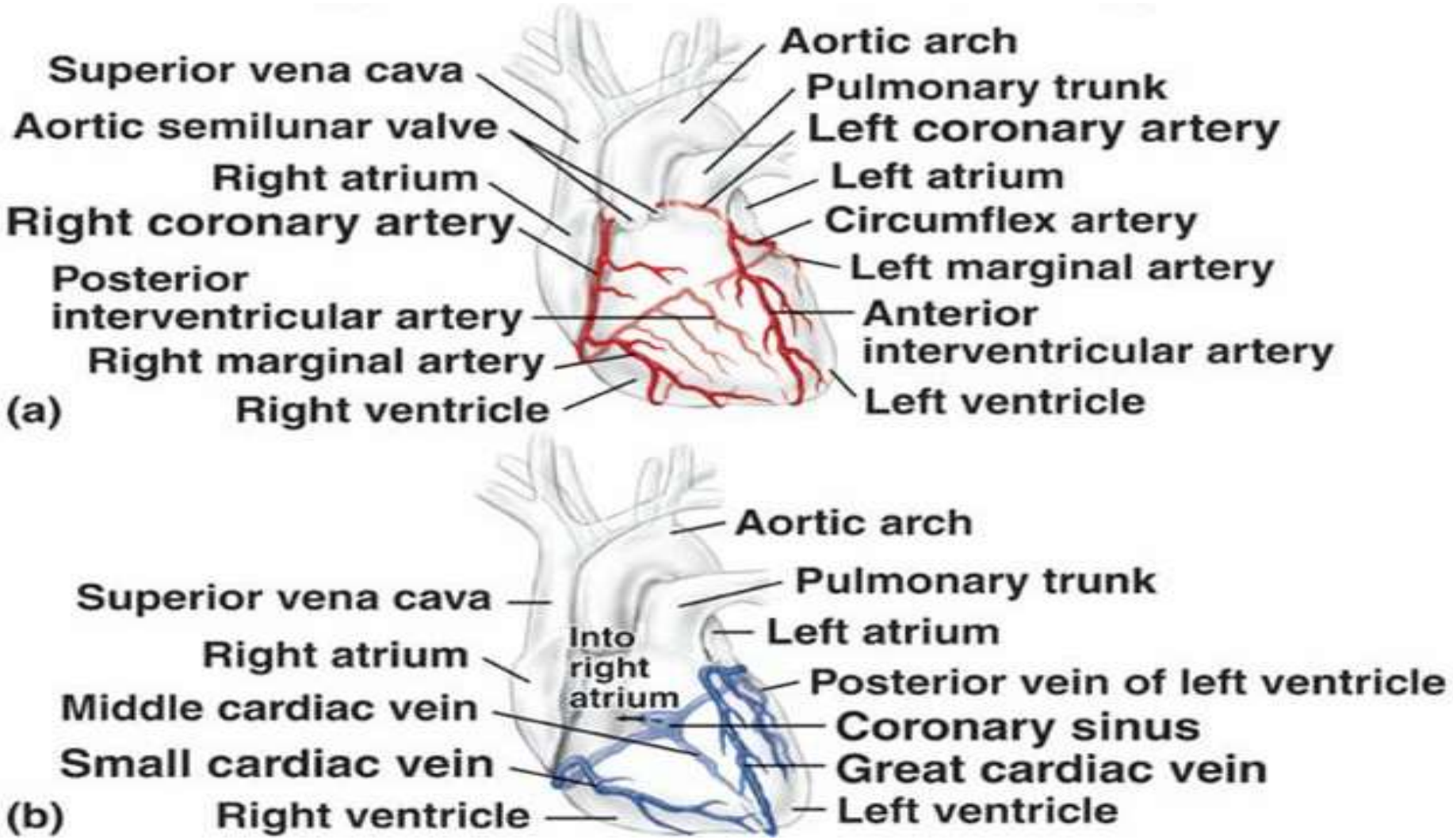
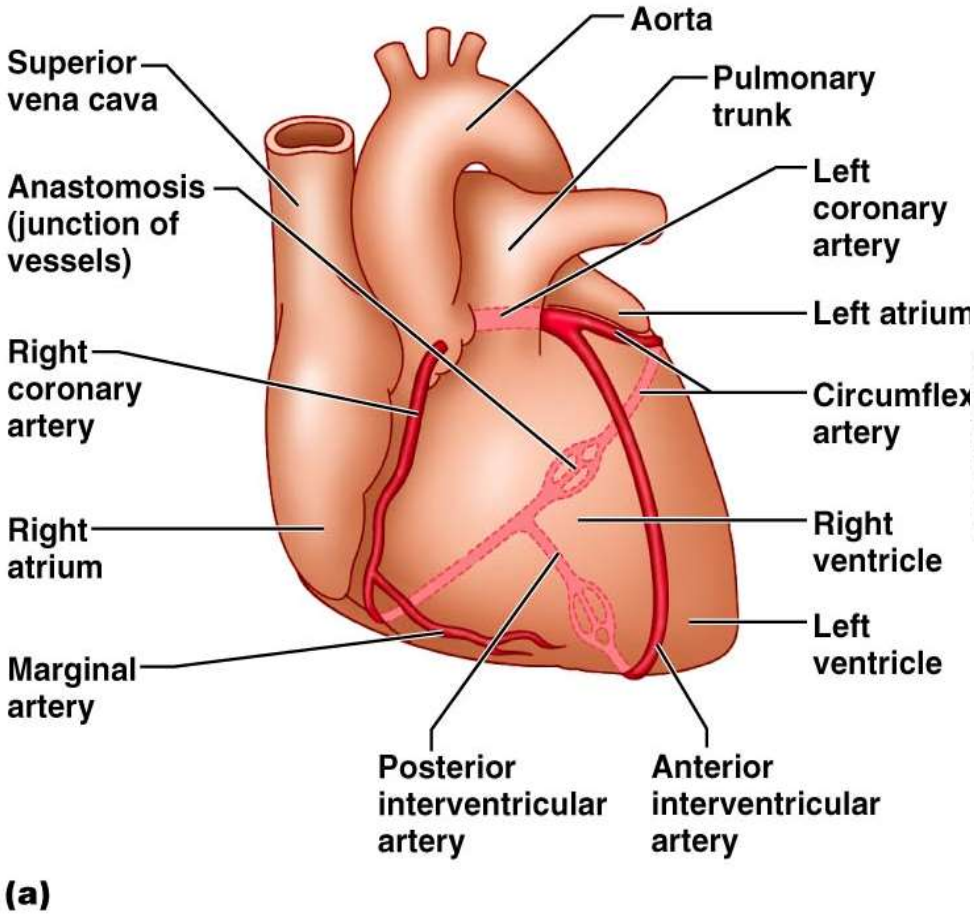
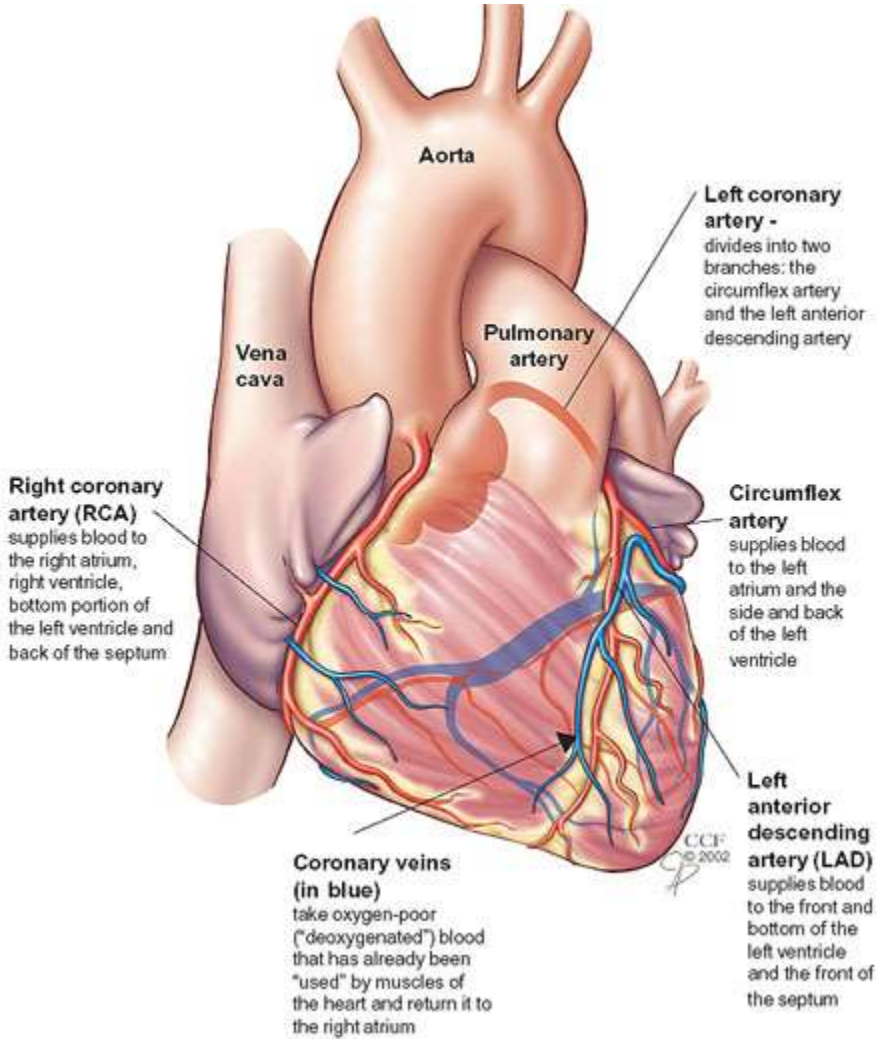


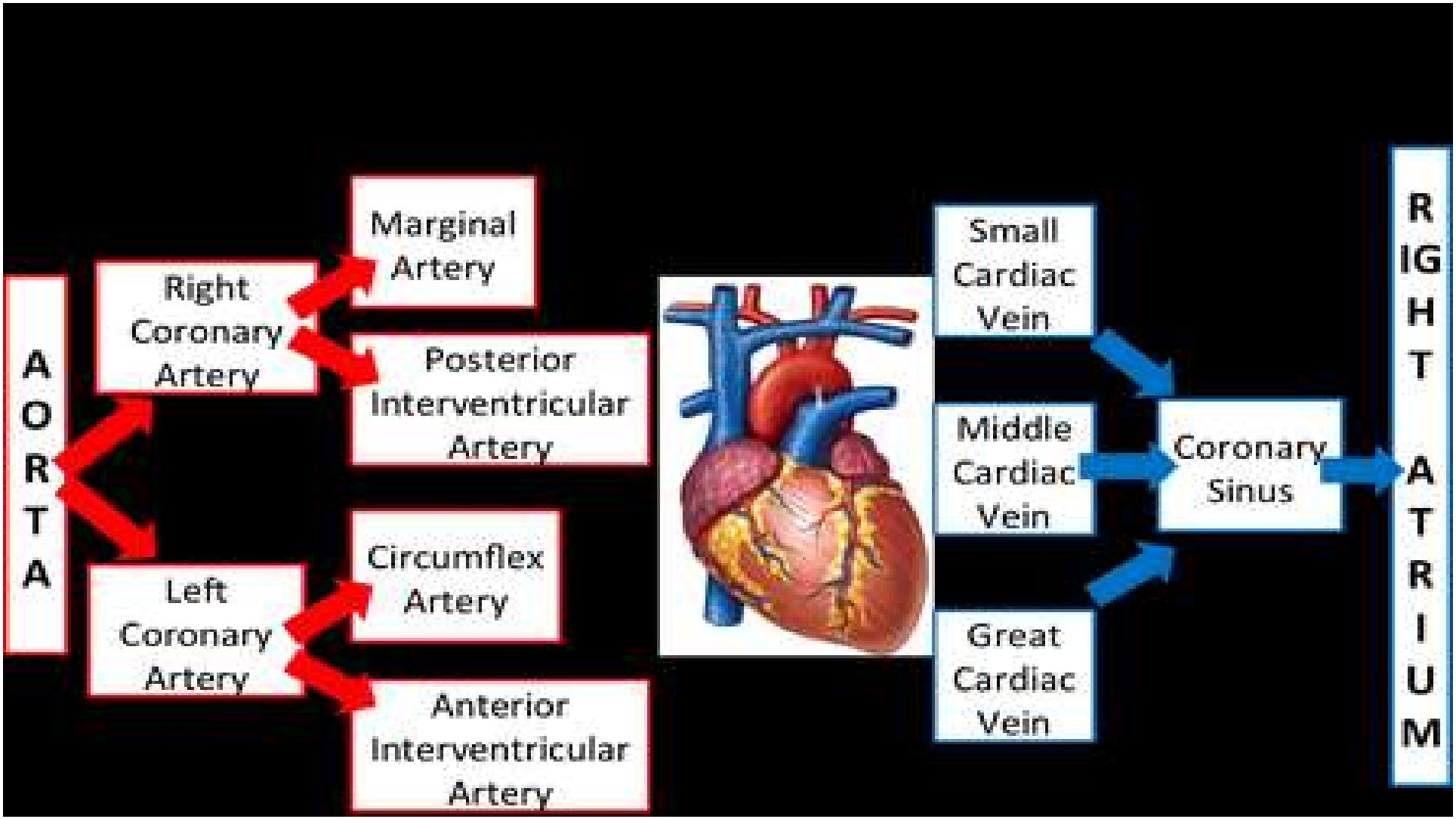
Plate 4-23 Coronary Arteries, Normal Patterns and Variations


Superior vena cava
Aortic semilunar valve
Right atrium
Right coronary artery
Posterior interventricular artery
Right marginal artery
(a)
Right ventricle
Aortic arch
Pulmonary trunk
Left coronary artery
Left atrium
Circumflex artery
Left marginal artery
Anterior interventricular artery
Left ventricle
Aortic arch
Superior vena cava
Right atrium
Middle cardiac vein
Small cardiac vein
(b)
Right ventricle
Into right atrium
Pulmonary trunk
Left atrium
Posterior vein of left ventricle
Coronary sinus
Great cardiac vein
Left ventricle

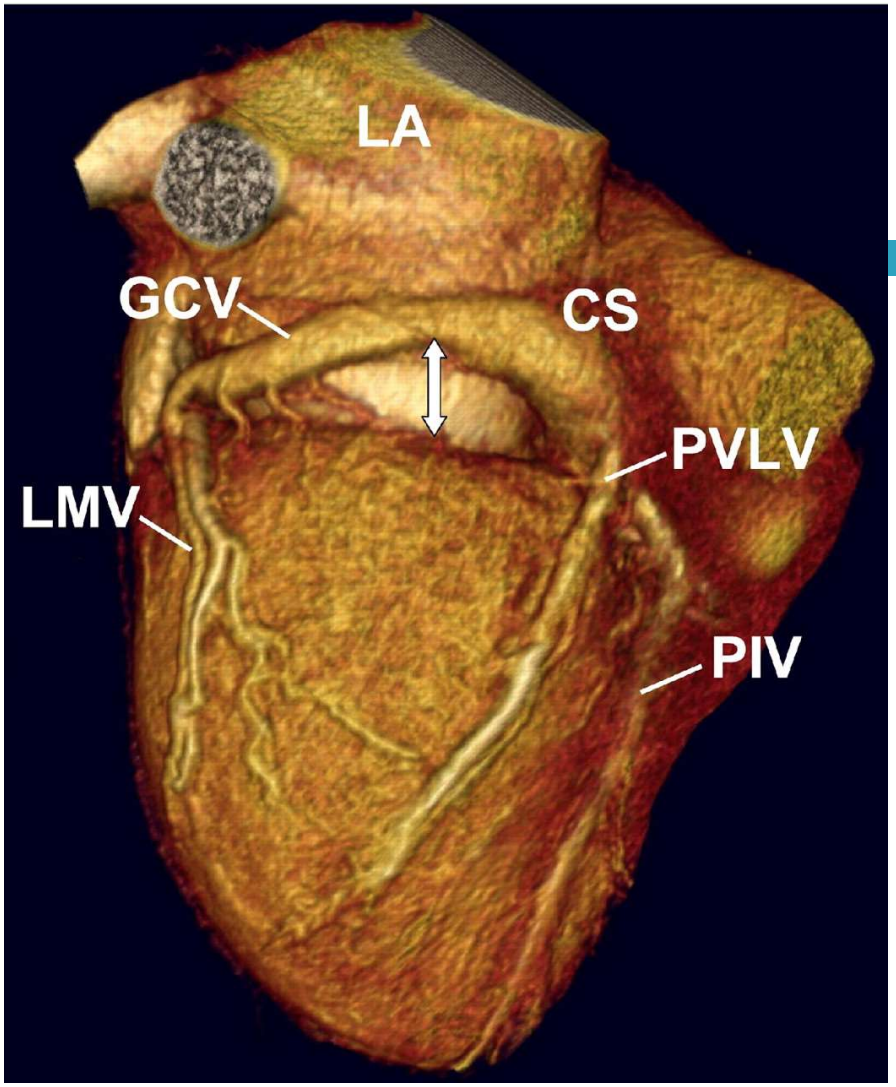
Coronary Circulation: Arterial Supply

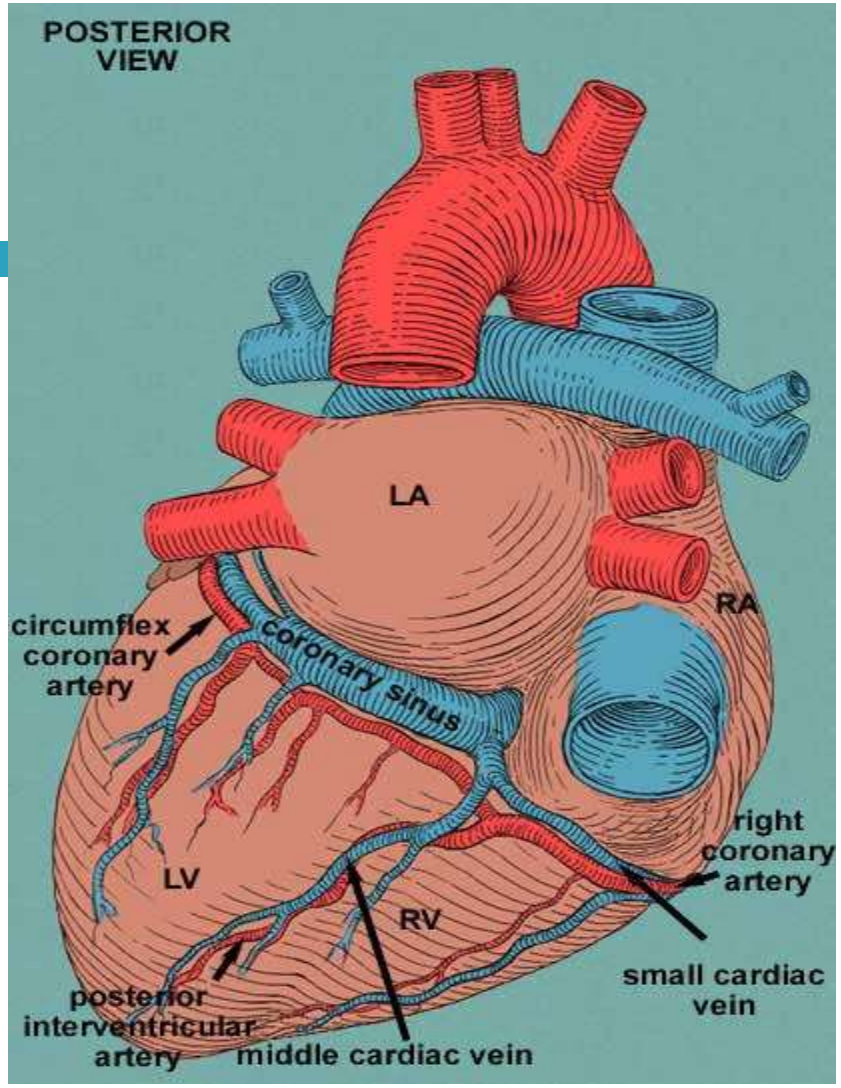




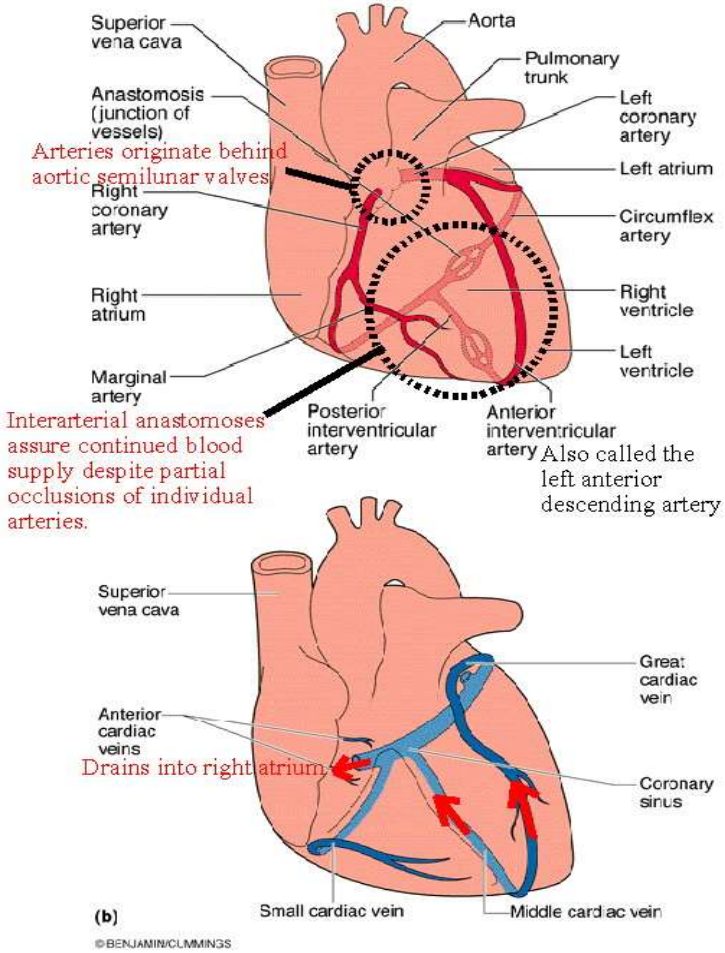

AORTA
Right Coronary Artery
Marginal Artery
Posterior Interventricular Artery
Left Coronary Artery
Circumflex Artery
Anterior Interventricular Artery
Small Cardiac Vein
Middle Cardiac Vein
Great Cardiac Vein
Coronary Sinus
RIGHT ATRIUM

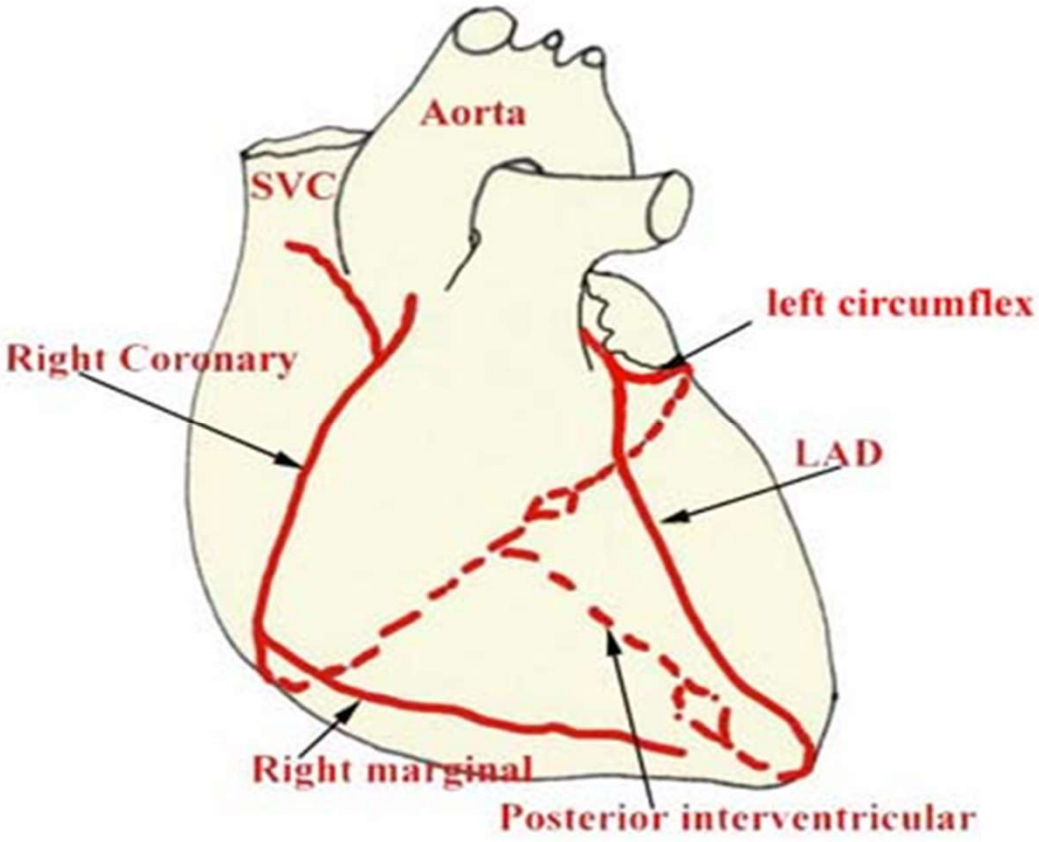
CORONARY SINUS



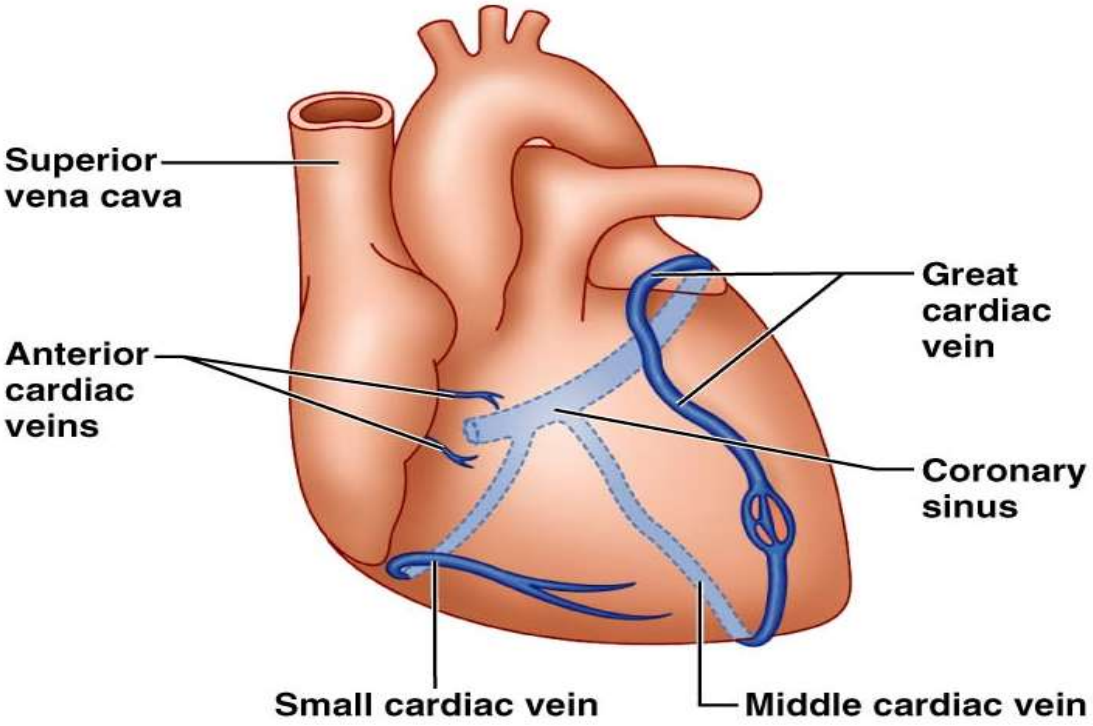


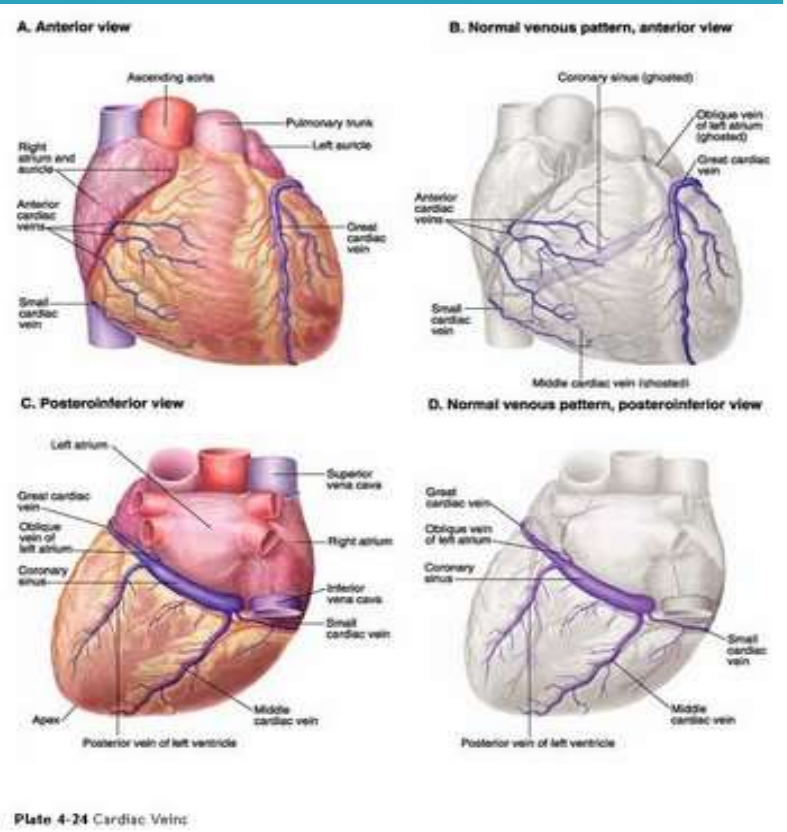
The Coronary Circulation





Coronary Circulation: Venous Supply





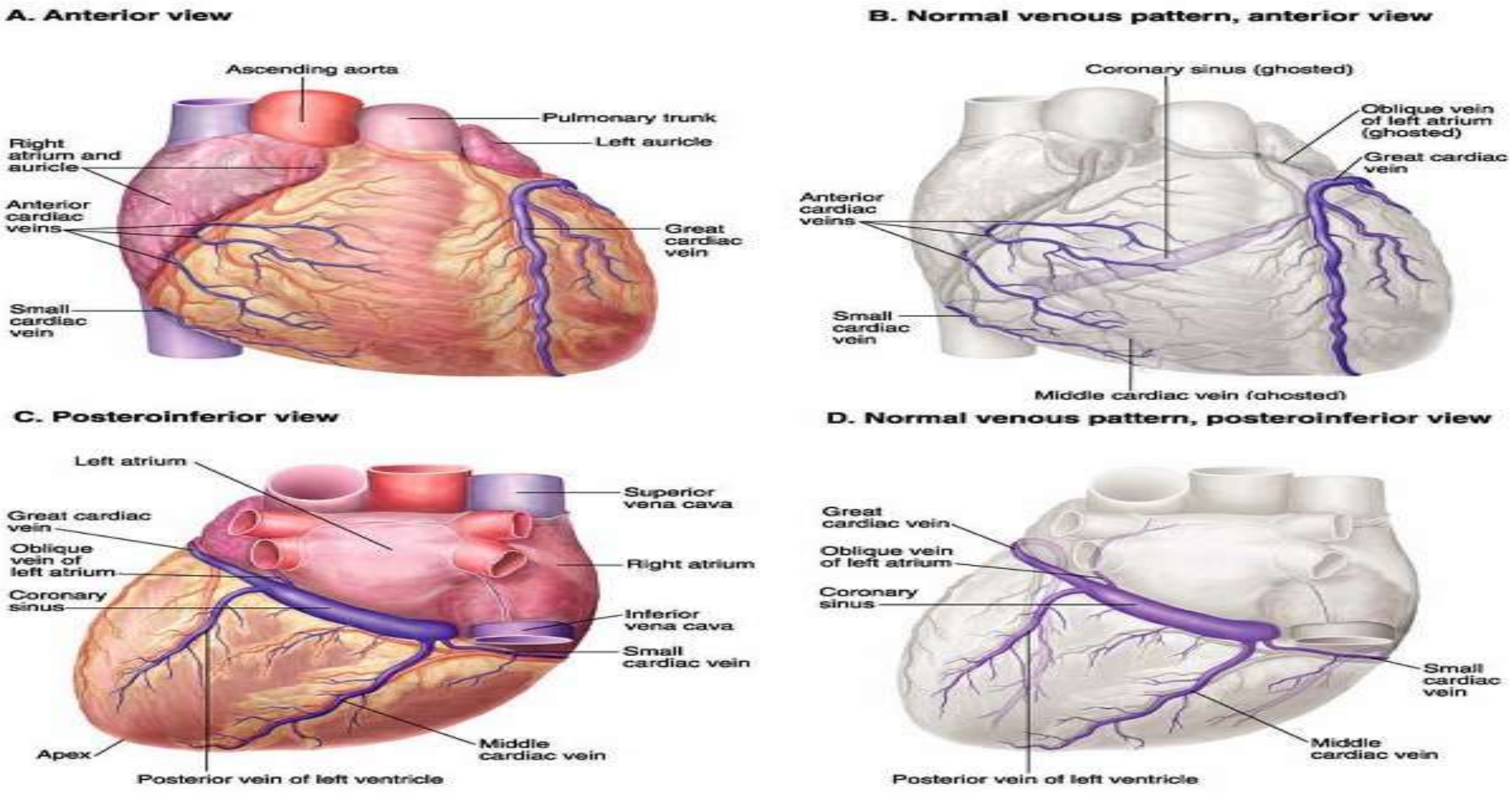
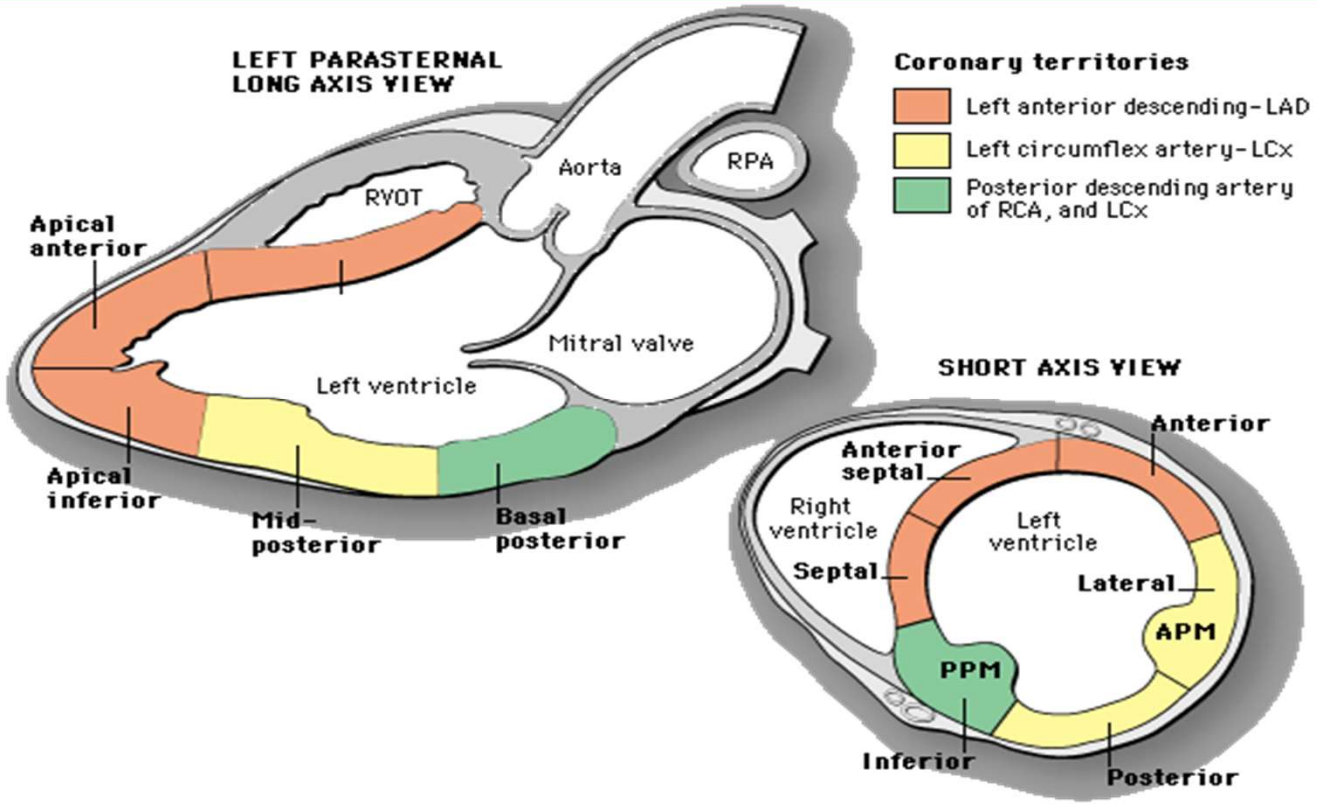
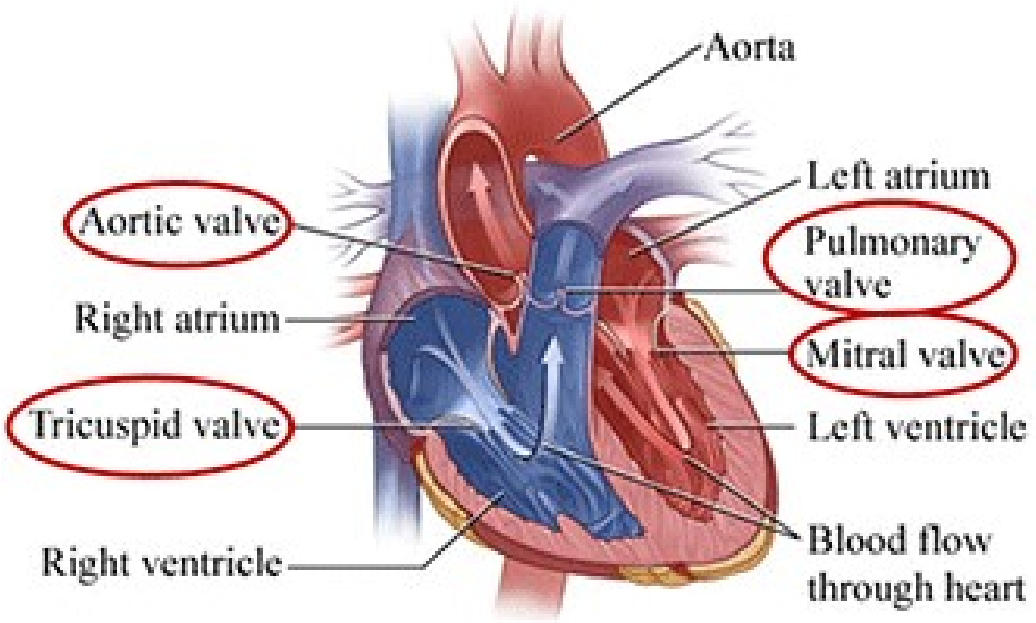


Plate 4-24 Cardiac Veins

Myocardial Segment Anatomy

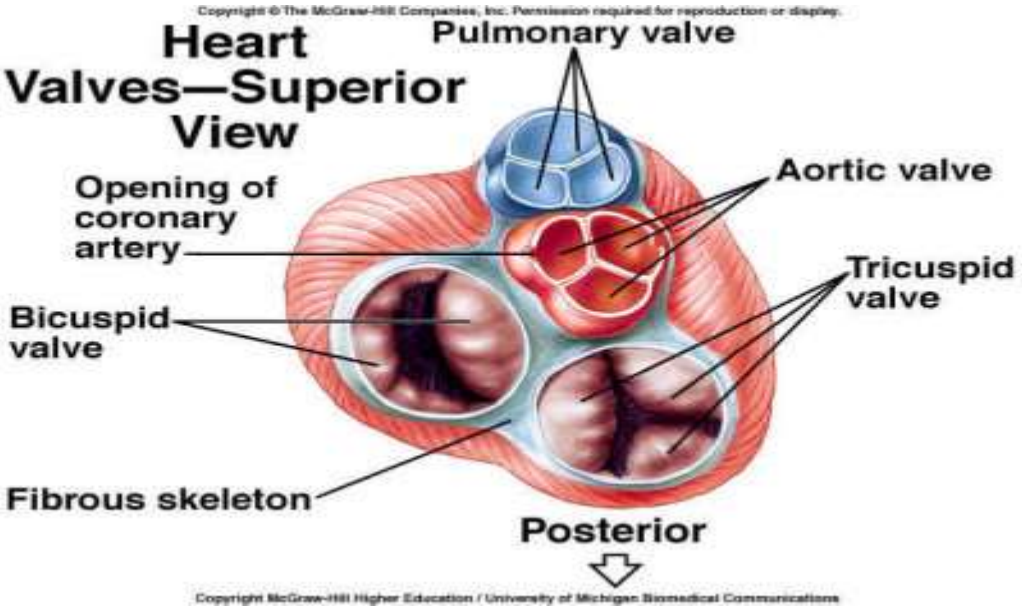


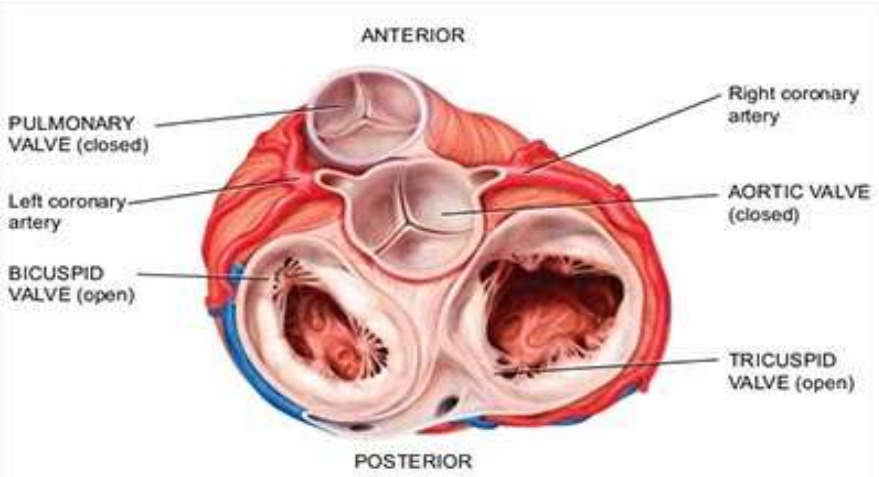
Cardiac valves



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





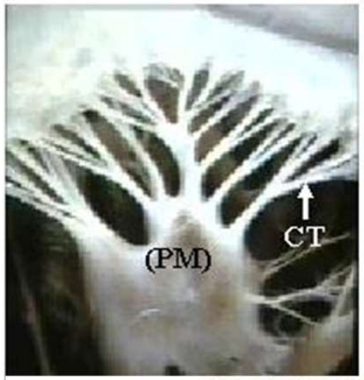
Superior view with atria removed: pulmonary and aortic valves closed, bicuspid and tricuspid valves open

Valves

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

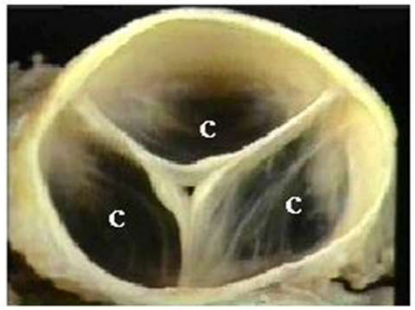
PAMT

CHORDAE TENDINEAE

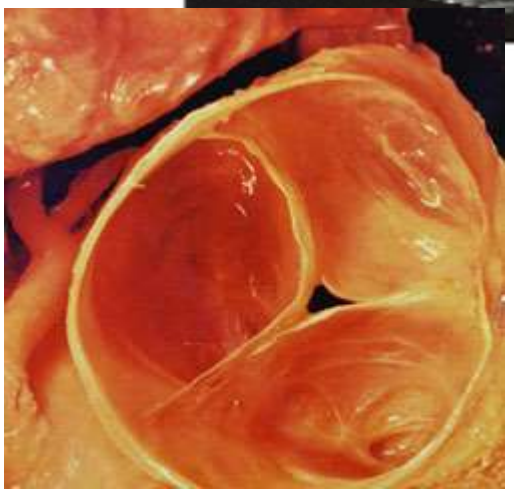


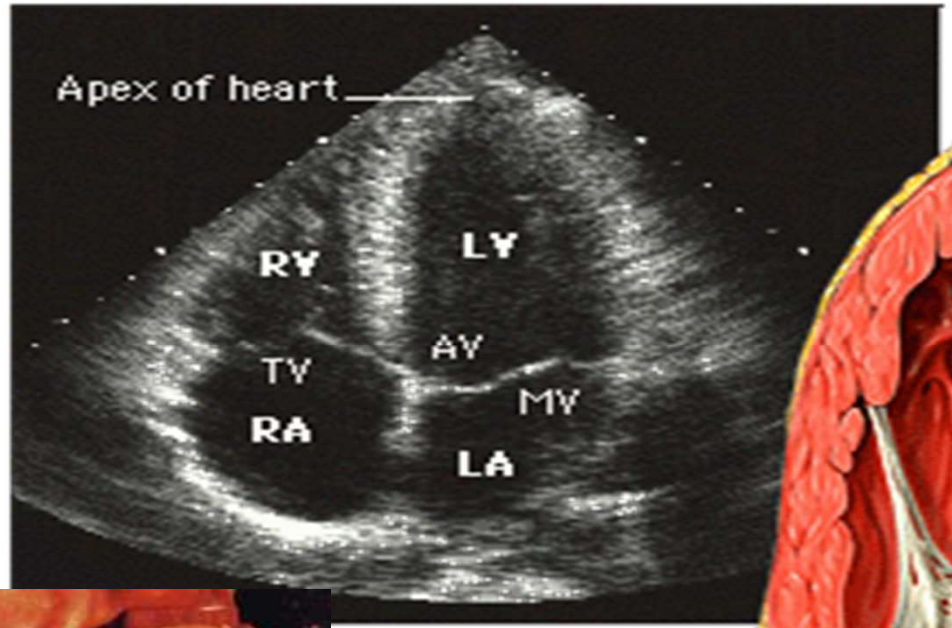
The papillary muscles (PM) anchoring the cords to the heart wall will contract to counter any stretch in the cordae tendineae (CT) during vigorous pumping of the heart.

SEMILUNAR VALVES

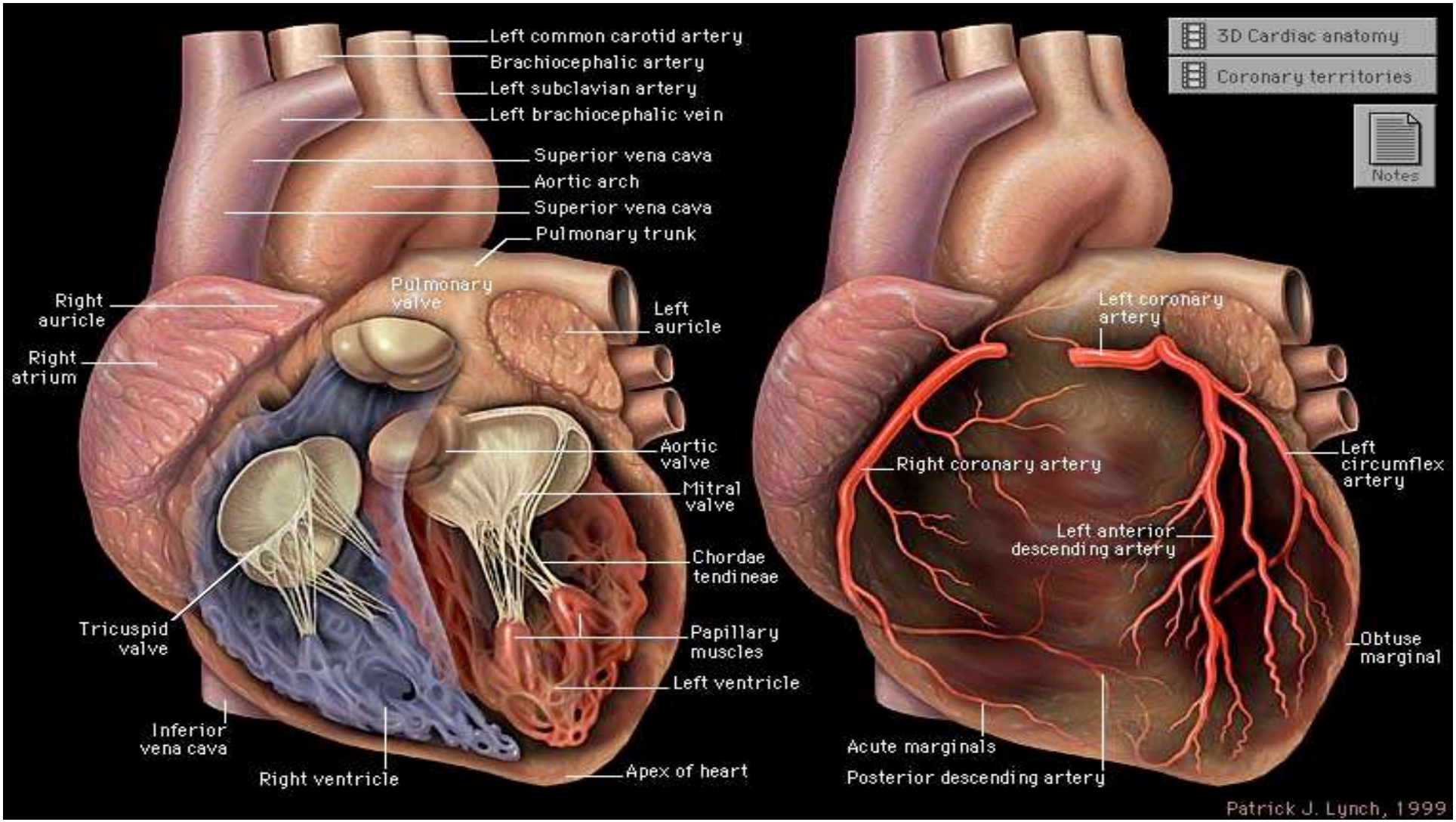


The semilunar valves are found lining the walls of the pulmonary trunk (pulmonary valve) and the aorta (aortic valve). Each valve consists of three pocket-like endocardial cusps (c). During contraction of the ventricles (ventricular systole), the pockets are flattened against the walls of the ejecting 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.



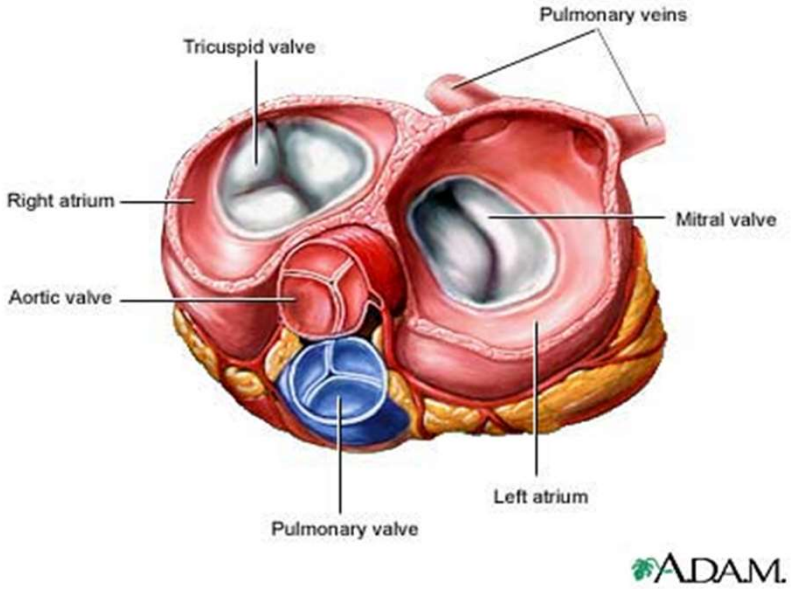

Apex of heart
RV
LV
TV
AV
MV
RA
LA

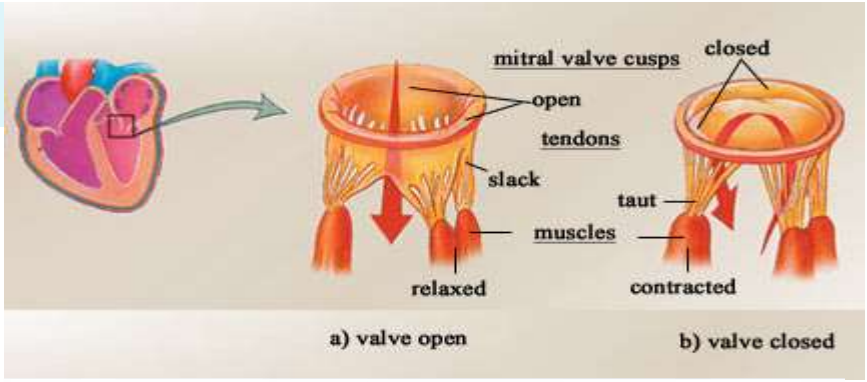
Septum
Apex of heart
Papillary muscles
Tricuspid valve
Aortic valve
Mitral valve
Right atrium
Interatrial septum
Left atrium

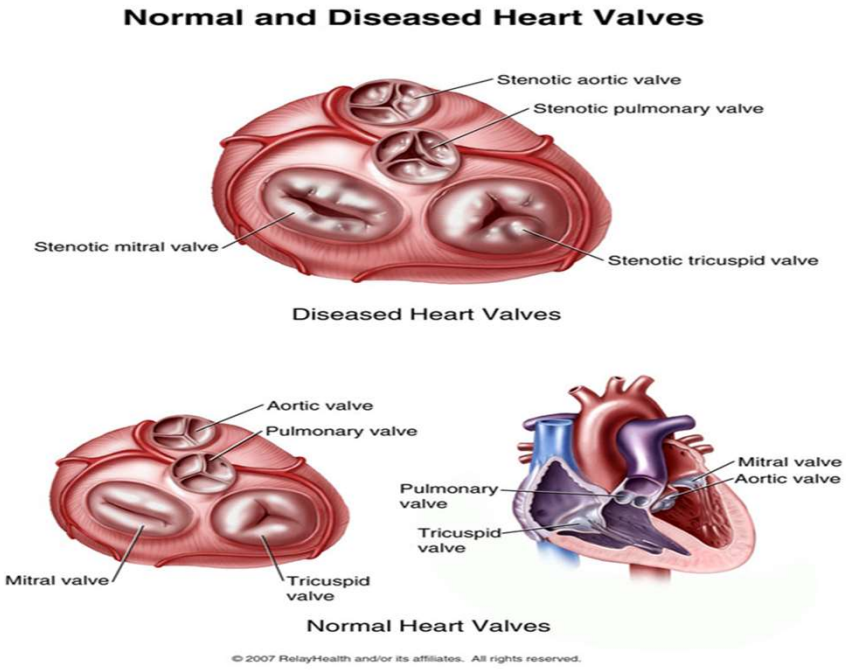

Left common carotid artery
Brachiocephalic artery
Left subclavian artery
Left brachiocephalic vein
Superior vena cava
Aortic arch
Superior vena cava
Pulmonary trunk
Pulmonary valve
Right auricle
Left auricle
Right atrium
Aortic valve
Mitral valve
Chordae tendineae
Tricuspid valve
Papillary muscles
Left ventricle
Inferior vena cava
Right ventricle
Apex of heart
3D Cardiac anatomy
Coronary territories
Notes
Left coronary artery
Right coronary artery
Left circumflex artery
Left anterior descending artery
Obtuse marginal
Acute marginals
Posterior descending artery
Patrick J. Lynch, 1999

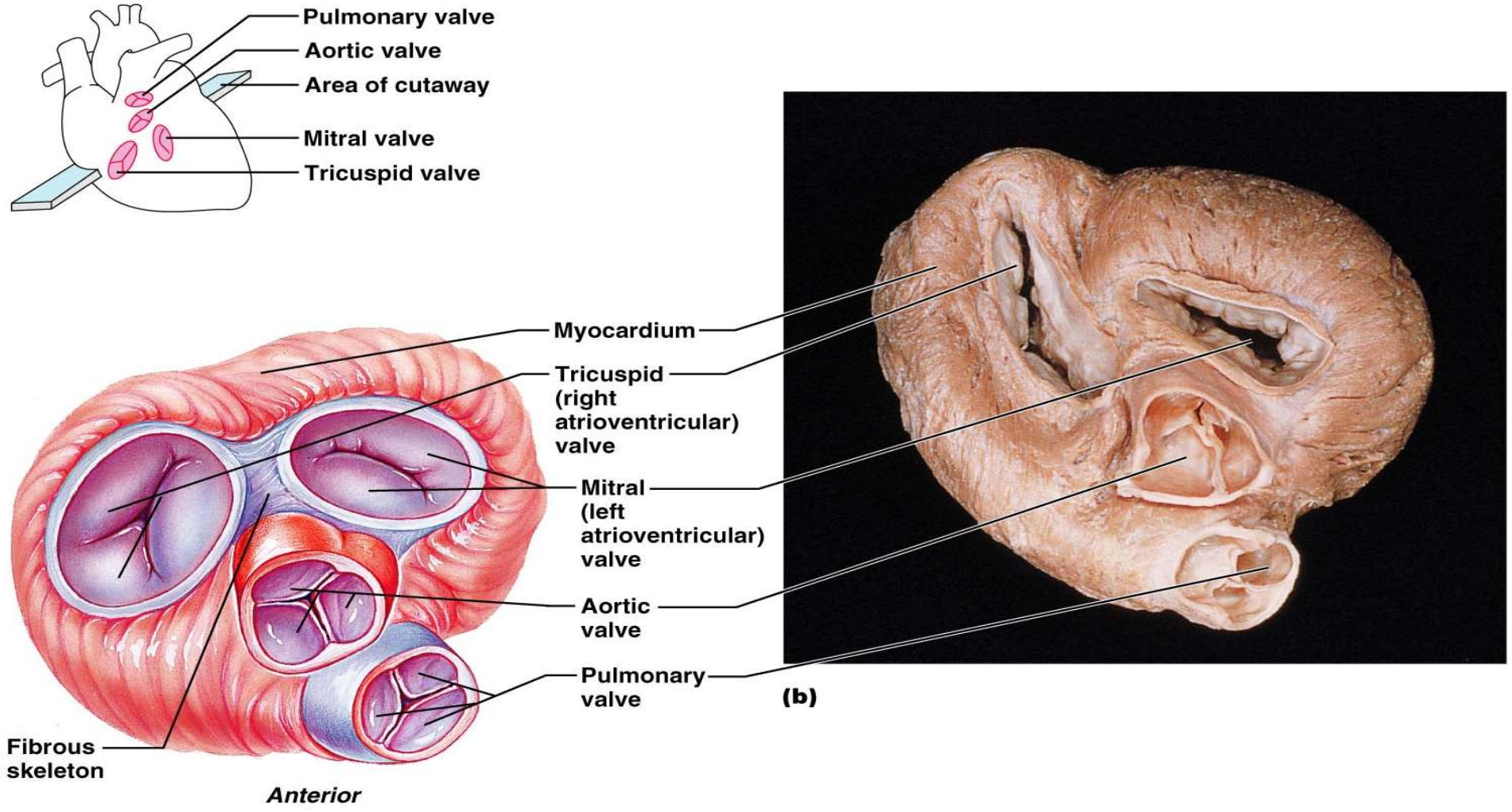
Heart Valves

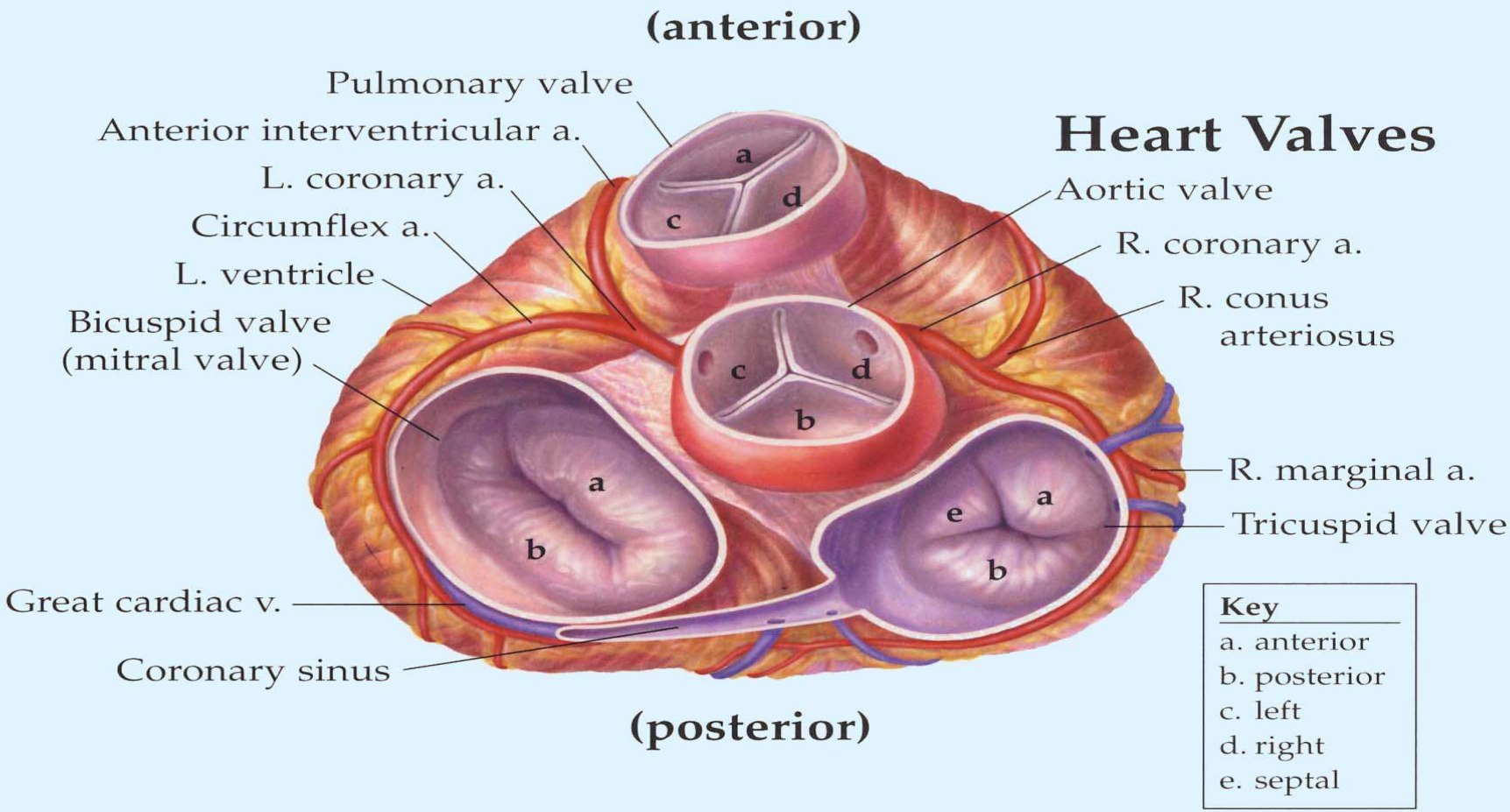
- Aortic semilunar valve lies between the left ventricle and the aorta
- Pulmonary semilunar valve lies between the right ventricle and pulmonary trunk
- **Semilunar valves prevent backflow of blood into the ventricles**

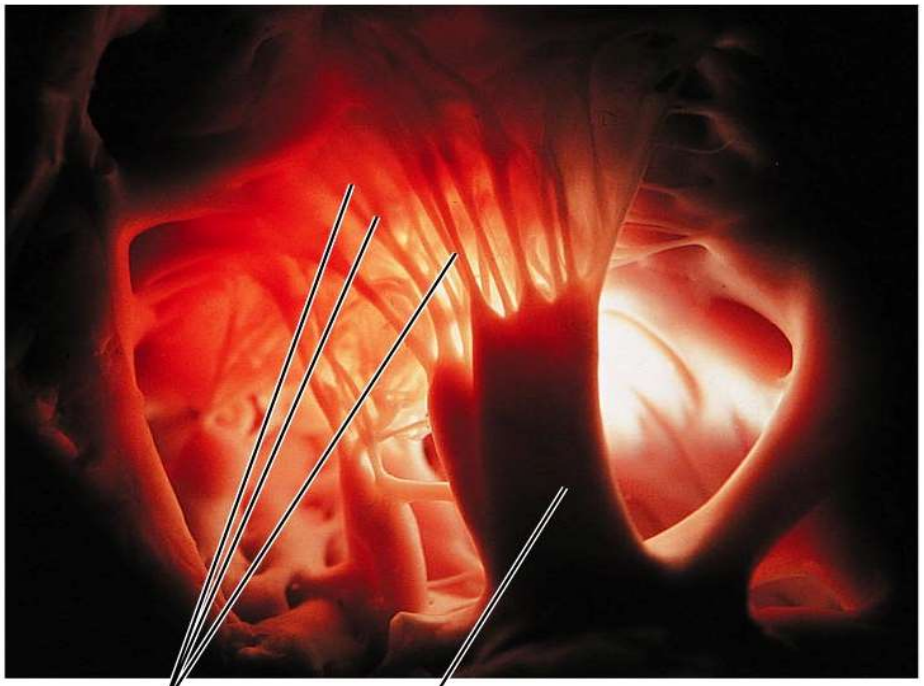




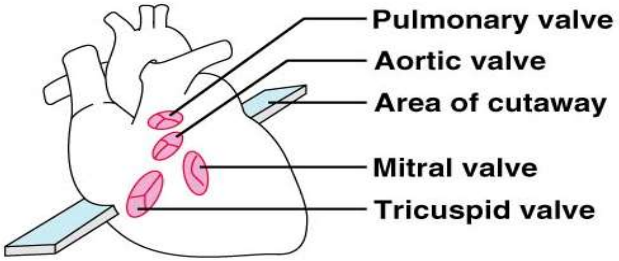


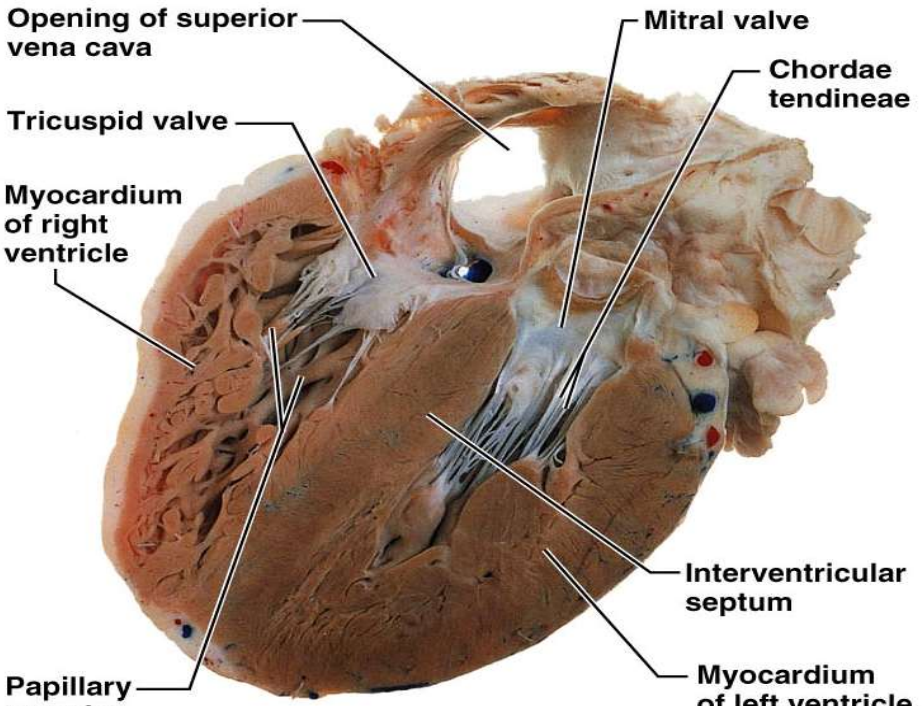

Pulmonary valve
Aortic valve
Area of cutaway
Mitral valve
Tricuspid valve
Myocardium
Tricuspid (right atrioventricular) valve
Mitral (left atrioventricular) valve
Aortic valve
Pulmonary valve
Fibrous skeleton
Anterior
(a)
(b)


(anterior)
Pulmonary valve
Anterior interventricular a.
L. coronary a.
Circumflex a.
L. ventricle
Bicuspid valve
(mitral valve)
Great cardiac v.
Coronary sinus
(posterior)
Heart Valves
Aortic valve
R. coronary a.
R. conus
arteriosus
R. marginal a.
Tricuspid valve
a
b
c
d
e
Key
a. anterior
b. posterior
c. left
d. right
e. septal

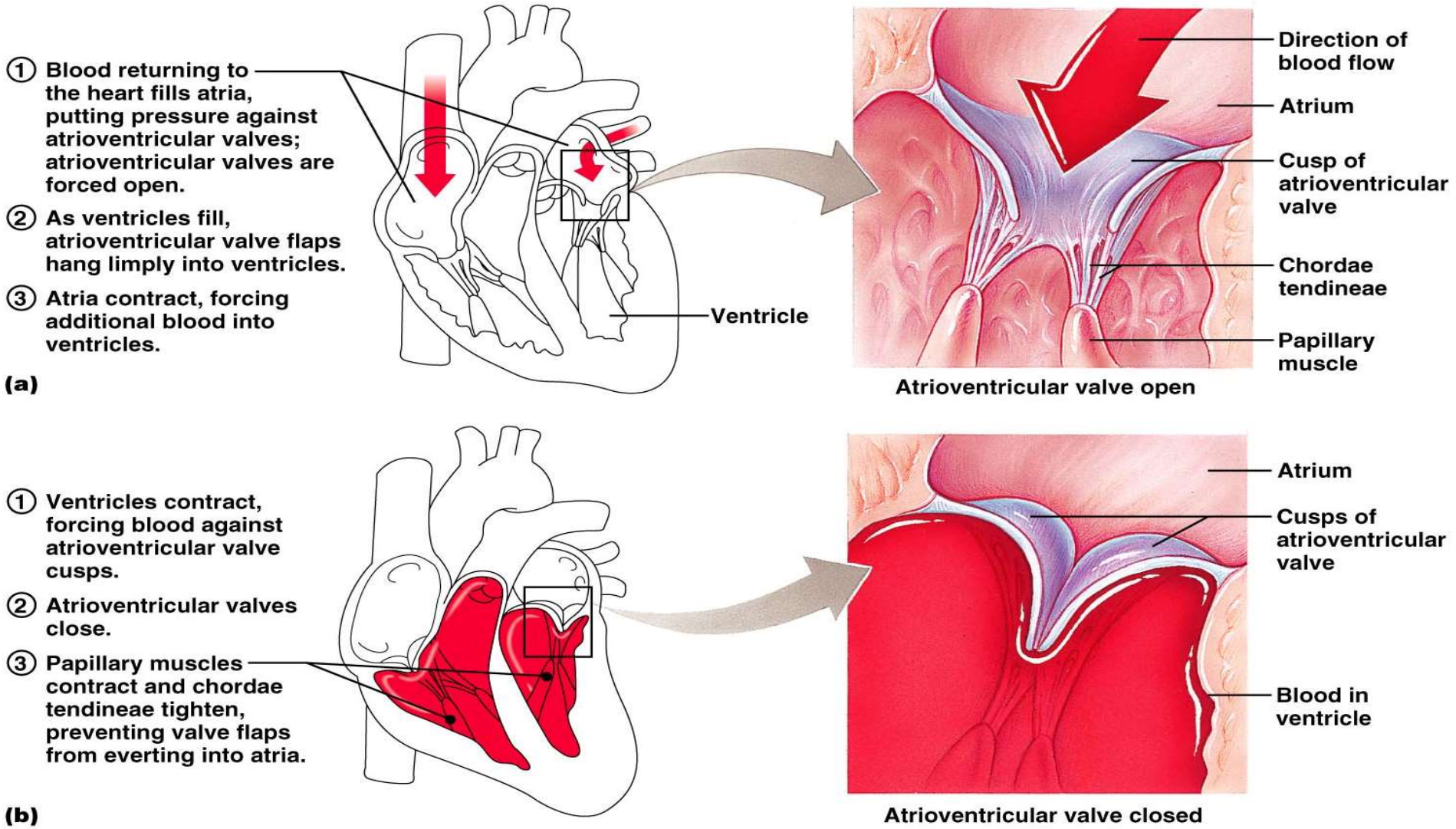

Chordae tendineae attached to tricuspid valve flap
Papillary muscle

(c)

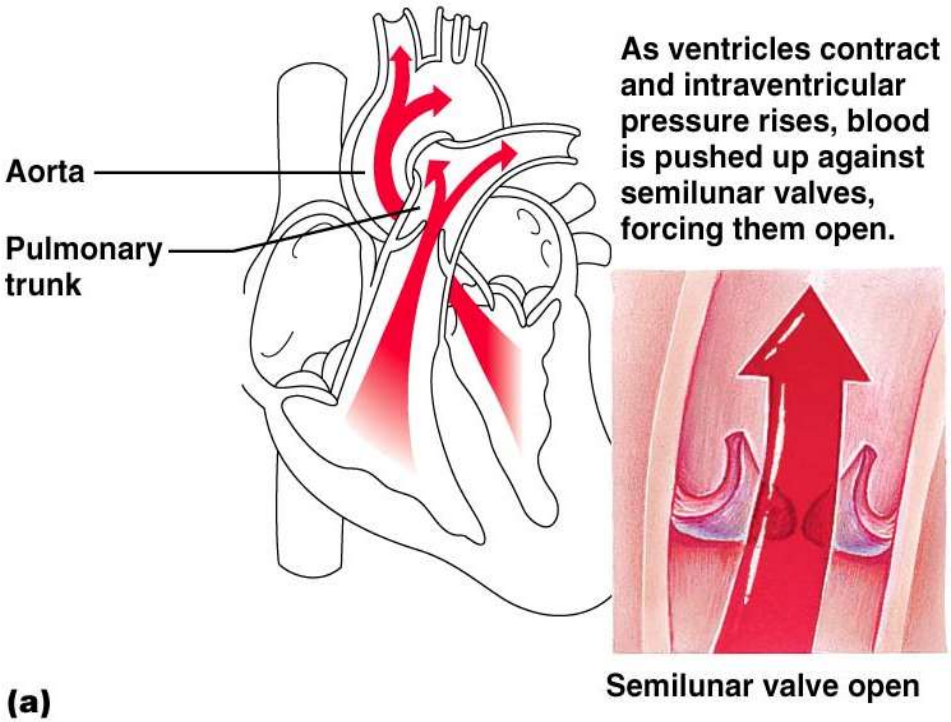

Pulmonary valve
Aortic valve
Area of cutaway
Mitral valve
Tricuspid valve

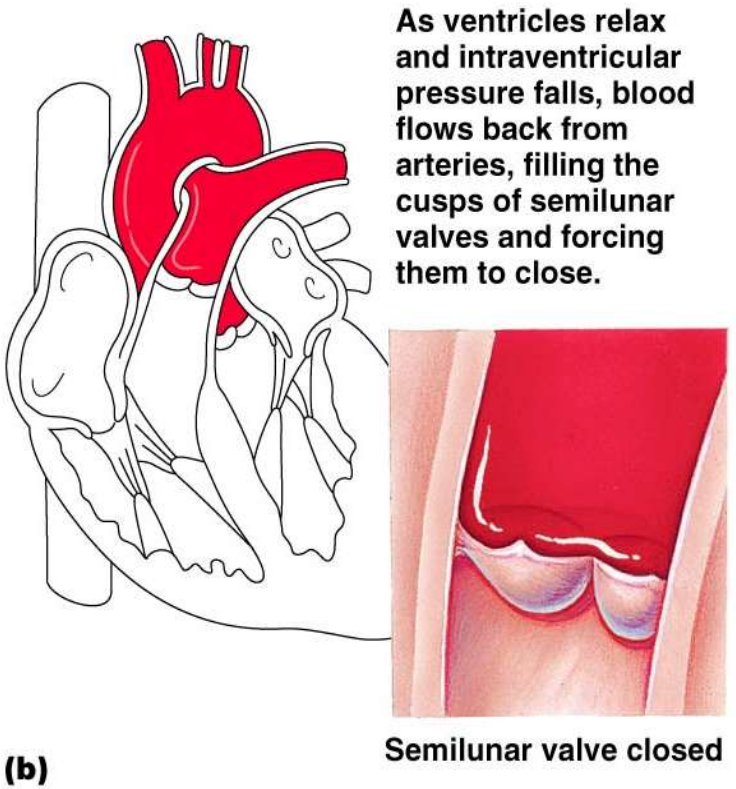

Opening of superior vena cava
Tricuspid valve
Myocardium of right ventricle
Papillary muscles
Mitral valve
Chordae tendineae
Interventricular septum
Myocardium of left ventricle

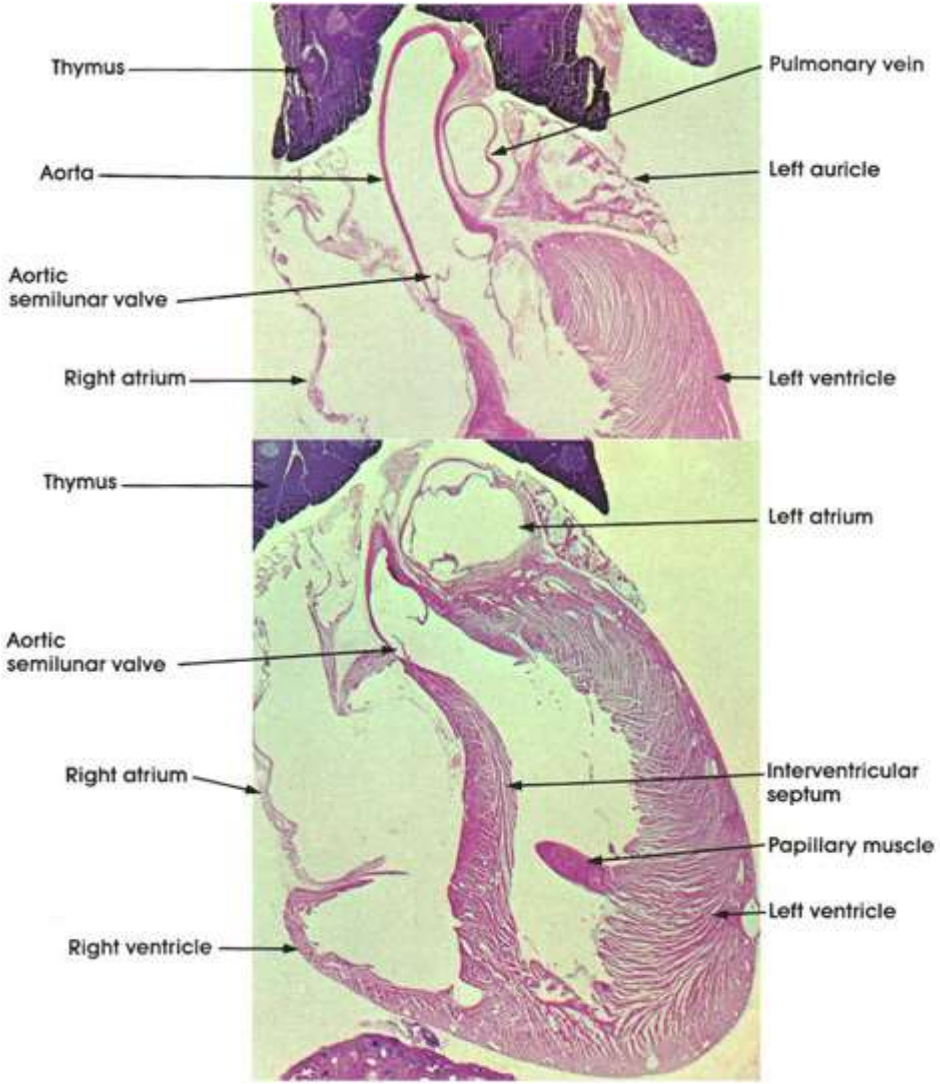
(d)

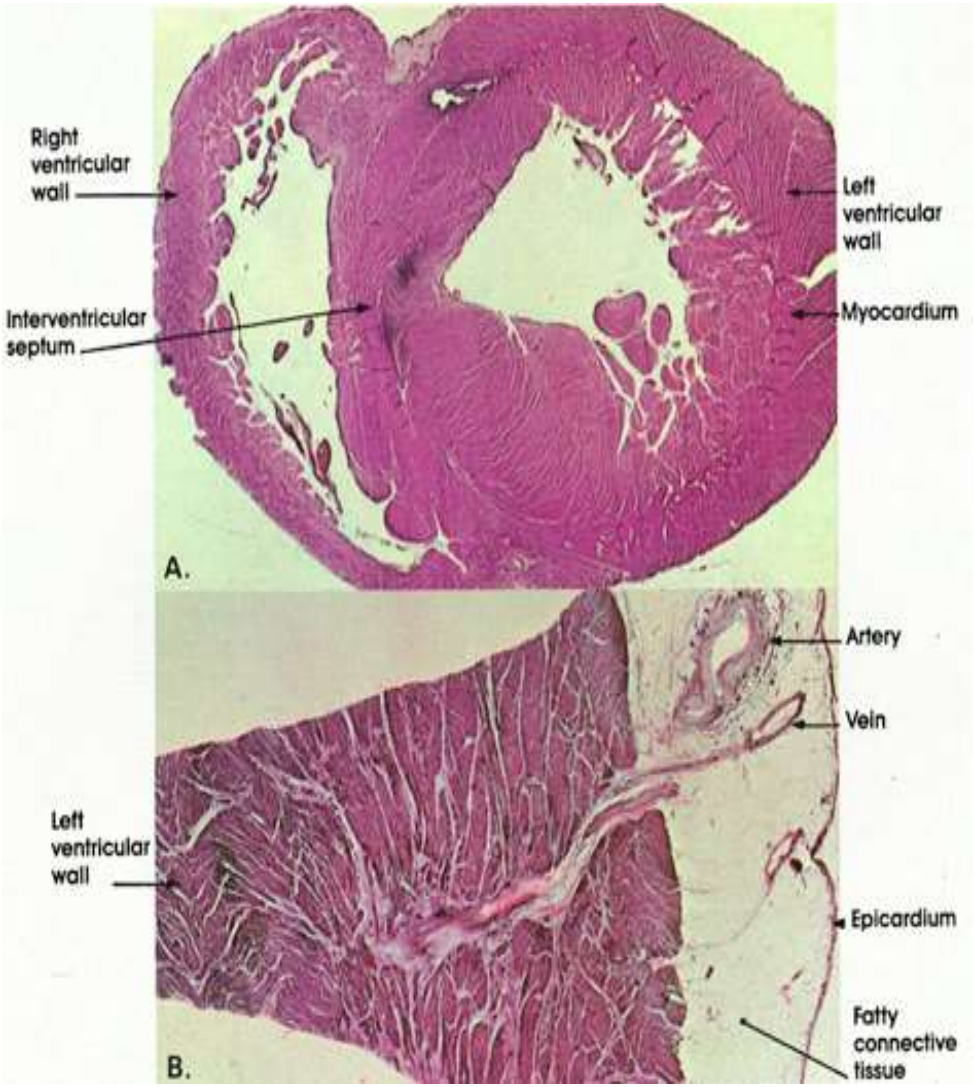

① Blood returning to the heart fills atria, putting pressure against atrioventricular valves; atrioventricular valves are forced open.
② As ventricles fill, atrioventricular valve flaps hang limply into ventricles.
③ Atria contract, forcing additional blood into ventricles.
(a)
Ventricle
Direction of blood flow
Atrium
Cusp of atrioventricular valve
Chordae tendineae
Papillary muscle
Atrioventricular valve open
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.
(b)
Atrium
Cusps of atrioventricular valve
Blood in ventricle
Atrioventricular valve closed

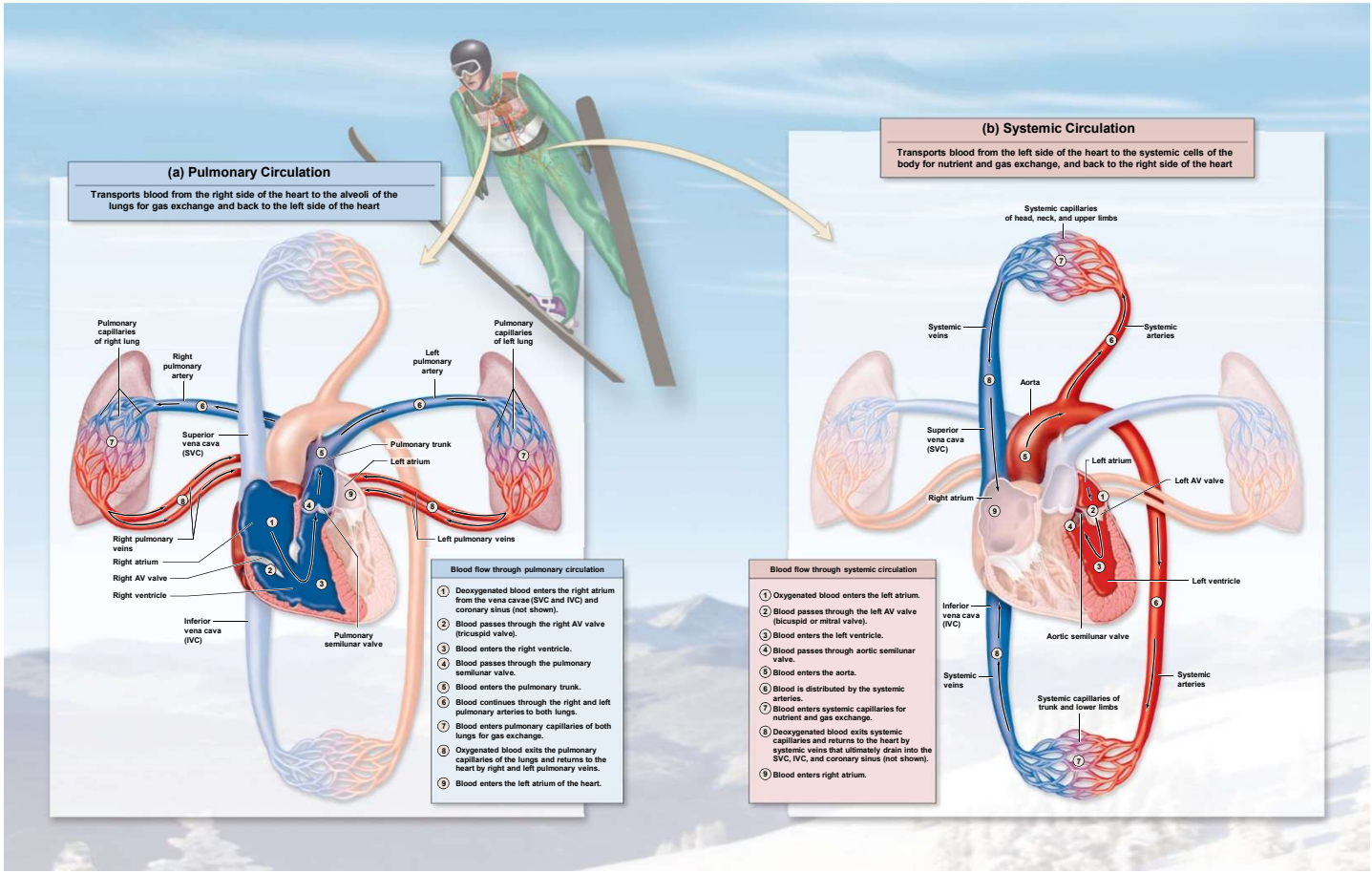
Semilunar Valve Function

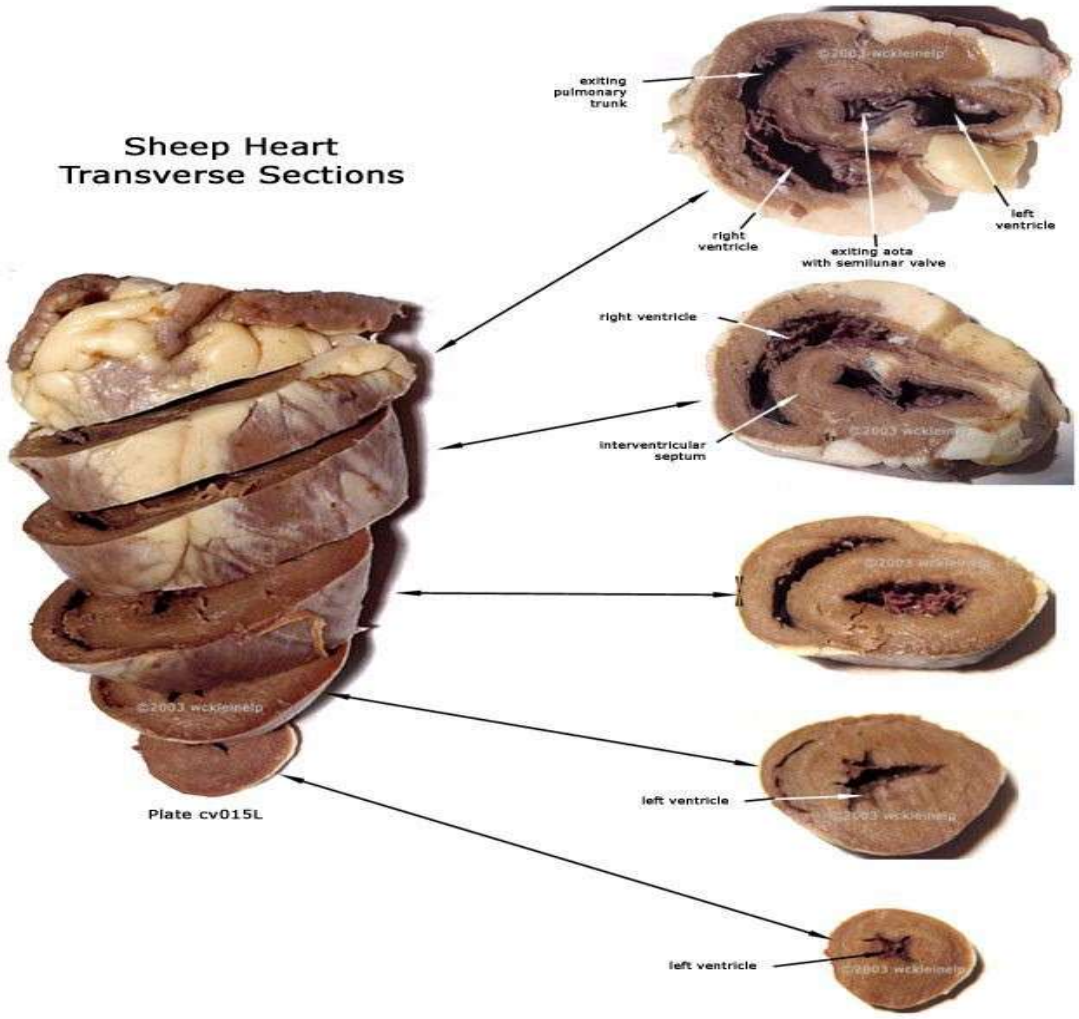





Thymus
Pulmonary vein
Aorta
Left auricle
Aortic semilunar valve
Right atrium
Left ventricle
Thymus
Left atrium
Aortic semilunar valve
Right atrium
Interventricular septum
Papillary muscle
Left ventricle
Right ventricle


Right ventricular wall
Left ventricular wall
Interventricular septum
Myocardium
A.
Artery
Vein
Left ventricular wall
Epicardium
Fatty connective tissue
B.




Sheep Heart
Transverse Sections
exiting
pulmonary
trunk
right
ventricle
exiting aota
with semilunar valve
left
ventricle
right ventricle
interventricular
septum
left ventricle
left ventricle
Plate cv015L